EXHIBIT NO. ___(RG-3)
DOCKET NO. UE-11___/UG-11___
2011 PSE GENERAL RATE CASE
WITNESS: ROGER GARRATT

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

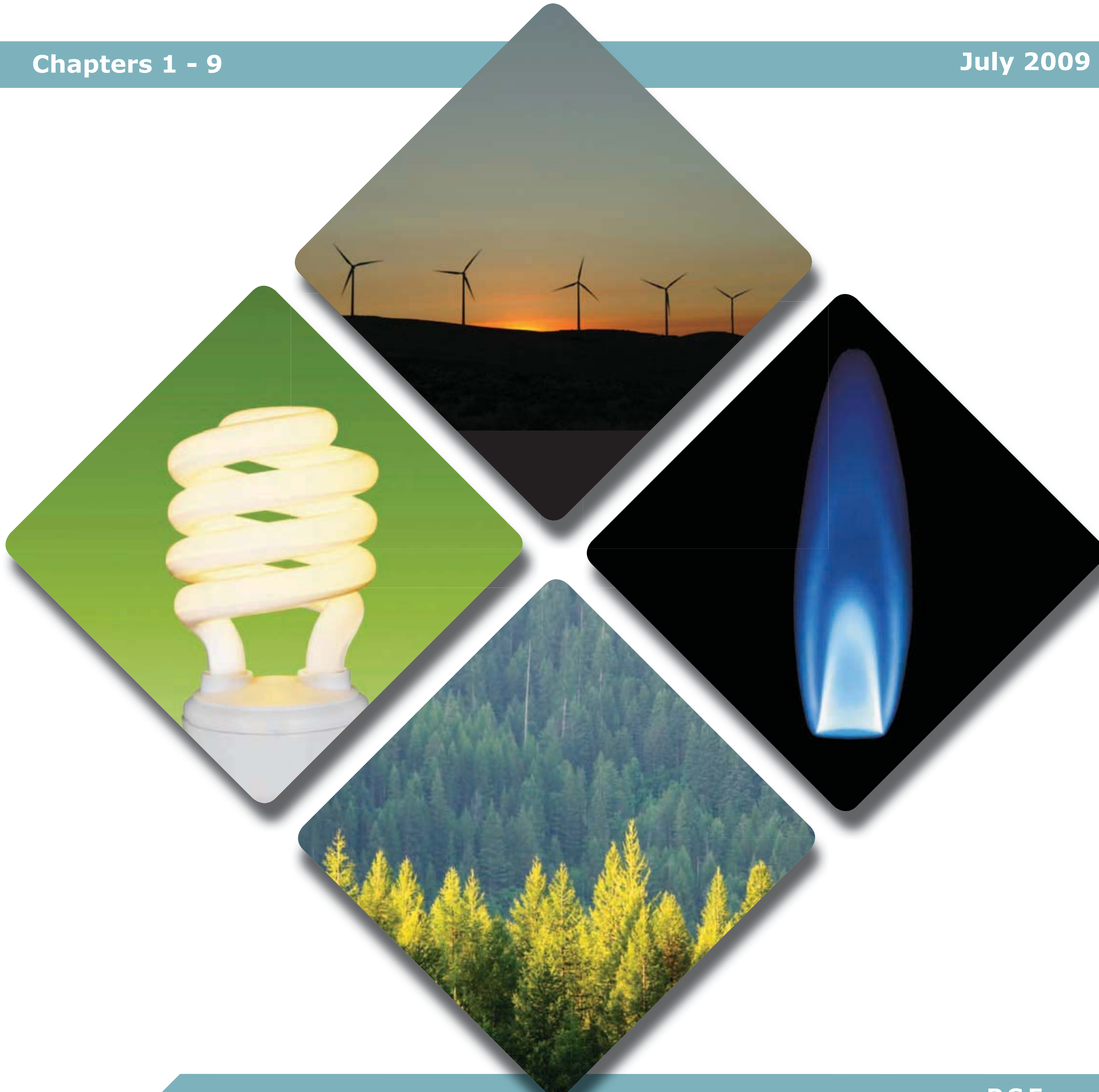
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.,** **Respondent.**	**Docket No. UE-11____** **Docket No. UG-11____**

SECOND EXHIBIT (NONCONFIDENTIAL) TO THE
PREFILED DIRECT TESTIMONY OF
ROGER GARRATT
ON BEHALF OF PUGET SOUND ENERGY, INC.

JUNE 13, 2011

Integrated Resource Plan

Chapters 1 - 9 **July 2009**



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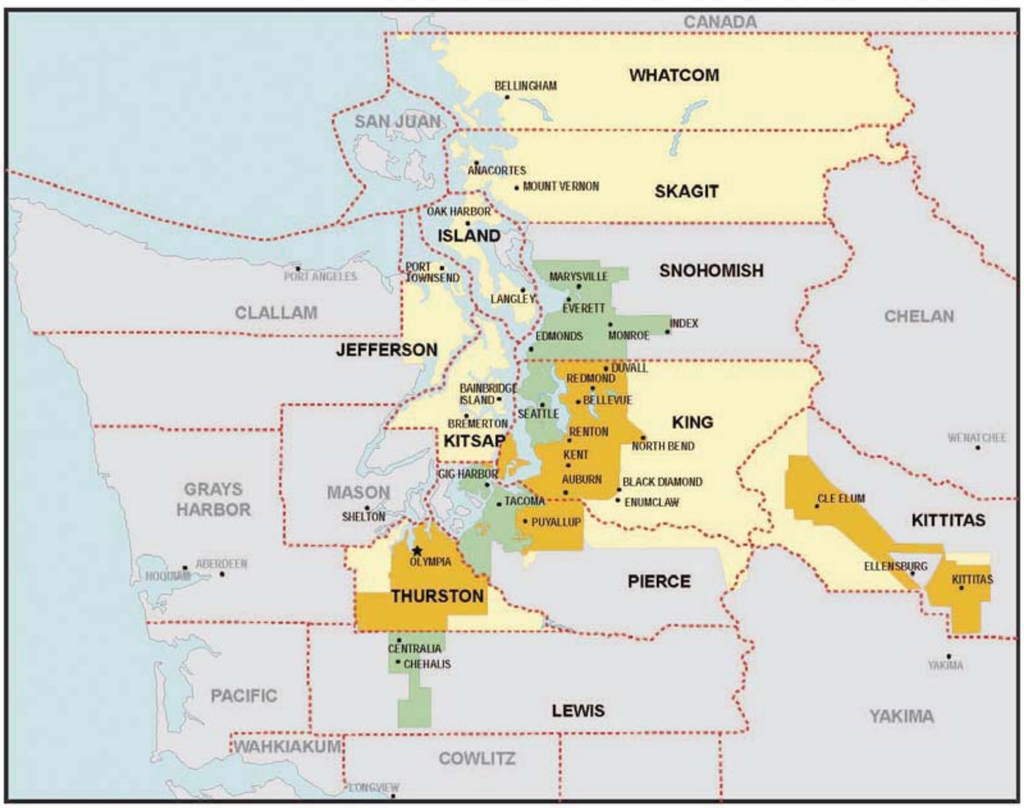
PSE PUGET SOUND ENERGY
The Energy To Do Great Things

About PSE

Puget Sound Energy is Washington state’s oldest and largest energy utility. With a 6,000-square-mile service area, stretching from south Puget Sound north to the Canadian border, and from Central Washington's Kittitas Valley west to the Olympic Peninsula, we serve more than 1 million electric customers and nearly 750,000 natural gas customers in 11 counties.



Combined electric and natural gas service
Electric service
Natural gas service

Contents

2009 Integrated Resource Plan

Executive Summary

This Integrated Resource Plan (IRP) presents a long-term forecast of the lowest reasonable cost combination of resources necessary to meet the needs of Puget Sound Energy's (PSE) customers over the next 20 years. The plan was developed during a two-year period in which U.S. and global economic conditions changed drastically. As a result, the scenarios developed for this analysis cover a wide range of circumstances. In the spring of 2009, PSE developed new demand forecasts and scenarios that allowed the company to incorporate post-downturn information about economic conditions into our assumptions.

The plan presented here will change as circumstances change, and actual resource acquisitions will take place in the real – rather than the hypothetical – marketplace. But examining the long-term implications of our customers' energy needs every two years makes it possible to identify many challenges as they appear on the horizon, study them as they approach, and better prepare to meet them. Among the key insights from this planning cycle are the following:

Expiring contracts and retiring assets are the biggest driver of electric resource need over the next 10 years. Even with NO growth in demand for power, PSE will need to acquire 490 megawatts (MW) of generation capacity by 2012 in order to fill the void created by expiring purchased power agreements. Aging units are assumed to begin retiring by 2016, so decisions will need to be made about whether it is more cost-effective to replace or refurbish and maintain aging assets. Either choice will mean substantial infrastructure investment.

Acquiring demand-side resources – as much as possible, as soon as possible -- is still the best strategy for avoiding both costs and risks. Natural gas prices and potential carbon emission costs affect portfolio costs more than any other factors tested in this analysis. Because energy efficiency consumes no fuel and produces no emissions, it continues to prove a cost-effective resource over the long term, even though it is becoming more expensive to acquire.

As PSE's reliance on natural gas for electric generation increases, supply diversity grows more important. At present, almost 70% of the combined gas portfolio (gas used for retail sales and gas used for electric generation fuel) is sourced from the Western Canadian Sedimentary Basin (WCSB). Under existing contracts, and absent implementation of a diversification strategy, 100% of the gas used for electric generation will come from that basin within a few years. This concentration leaves PSE exposed to physical supply disruptions and WCSB price volatility, with less ability to diversify that price risk across other supply basins. Investigating alternatives to increase supply diversity is an ongoing priority.

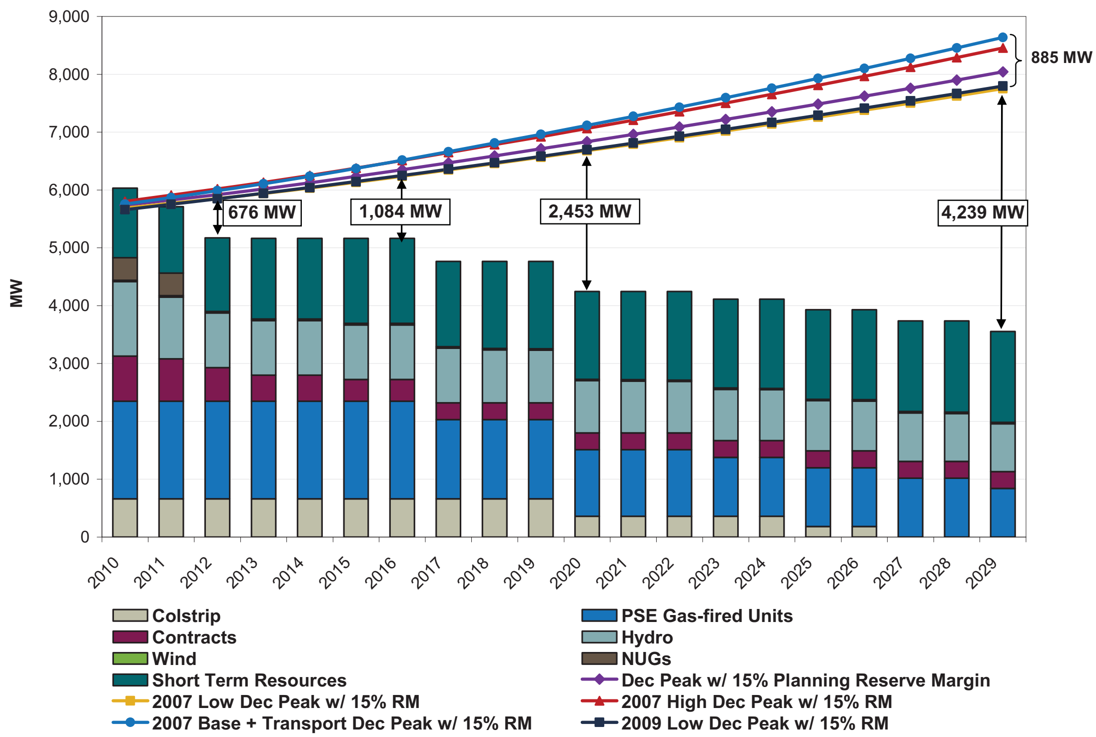
Consistent with prior resource plans, future energy costs are expected to increase and are highly uncertain. This IRP models a wide range of demand forecasts, gas prices, potential carbon dioxide (CO_2) costs, energy price volatility, and power plant costs. Overall, utility costs will continue to increase. In an environment in which both fixed and variable costs are rising, PSE will likely require regular rate increases as the utility system evolves to meet new legislative, compliance, and operational requirements, even if gas and purchased power prices remain low.

Additional renewable resources will be needed in the future. To meet renewable portfolio standards, this resource plan supports the same steady increase in renewable resources—assumed to be primarily wind—that PSE has shown in prior plans. Federal renewable portfolio standards and climate change legislation could change the amount of renewable resources required, and changing state and federal policies could also influence the types and locations of such resources. Notably, the same turbulent economic conditions that created the overall financial crisis may have also created opportunities to obtain development rights and renewable projects at substantial discounts compared to previous pricing, and some of these opportunities may offer long-term benefits to the utility and its customers.

Electric Resources

Electric Resource Need. (Figure 1-1) The company's electric resource outlook indicates the need for an additional 676 MW by 2012, 1,084 MW by 2016, and 2,453 MW by 2020 to meet customer demand.

Figure 1-1
Electric Peak Capacity Resource Need:
Comparison of Projected Loads with Existing Resources



Origins of Capacity Need. Expiring purchased-power contracts and the potential retirement of aging generation units contribute more to resource need than demand growth. For the first five years of the planning horizon, expiring contracts have the most effect; starting in 2016, resources decline as aging generating units begin to retire. Figure 1-2 shows how loads and resources, thus resource needs, change over time.

Figure 1-2
Drivers of Electric Capacity Need:
Expiring Resources Compared to Demand Growth

	2010	2012	Change from 2010	2020	Change from 2010	2029	Change from 2010
2009 Low Load Dec Peak w/ 15% RM	5660	5847	186	6697	1037	7,796	2135
Total Resources	6034	5171	(864)	4244	(1790)	3,556	(2478)
Total Need/(Surplus)	(374)	676		2453		4239	

Total Resources include 1200-1500 MW of Short-Term (<3 year) Market Purchases

Assumptions about the timing of resource retirements in this IRP are based on a depreciation study completed in 2006. The study established possible retirement dates based on typical operating lives as well as individual considerations for each unit. Analysis on whether to extend the useful life of existing assets is not incorporated in this IRP, but this information does highlight that the company will need to consider such decisions in the coming years.

Electric Resource Plan. Figure 1-3 illustrates the electric resource plan, displayed in terms of capacity. The line rising to the right represents peak customer demand. The bars below show the resources with the lowest reasonable portfolio cost used to meet that need. The table below shows the corresponding capacity builds. Because wind contributes only 5% of its capacity to meet peak, it is barely discernable on the chart in Figure 1-3. The table in Figure 1-4 lists the nameplate capacity additions by resource type included in the resource plan.

Options for resource additions remain limited. Wind is, generally speaking, still the only renewable resource capable of economically generating utility-scale power for PSE. New hydroelectric projects are not feasible at this time. Nuclear projects are unlikely to gain approval, and coal remains constrained by legislative restrictions and environmental concerns. Therefore, the plan recommends additional wind resources to fulfill renewables requirements, as much demand-side resources as possible (38 aMW per year for the first 11 years), and more natural gas-fired generating plants to fill the remainder of need.

Figure 1-3
Peak Capacity Electric Resource Plan, 2009 IRP
Cumulative Resource Additions (MW)

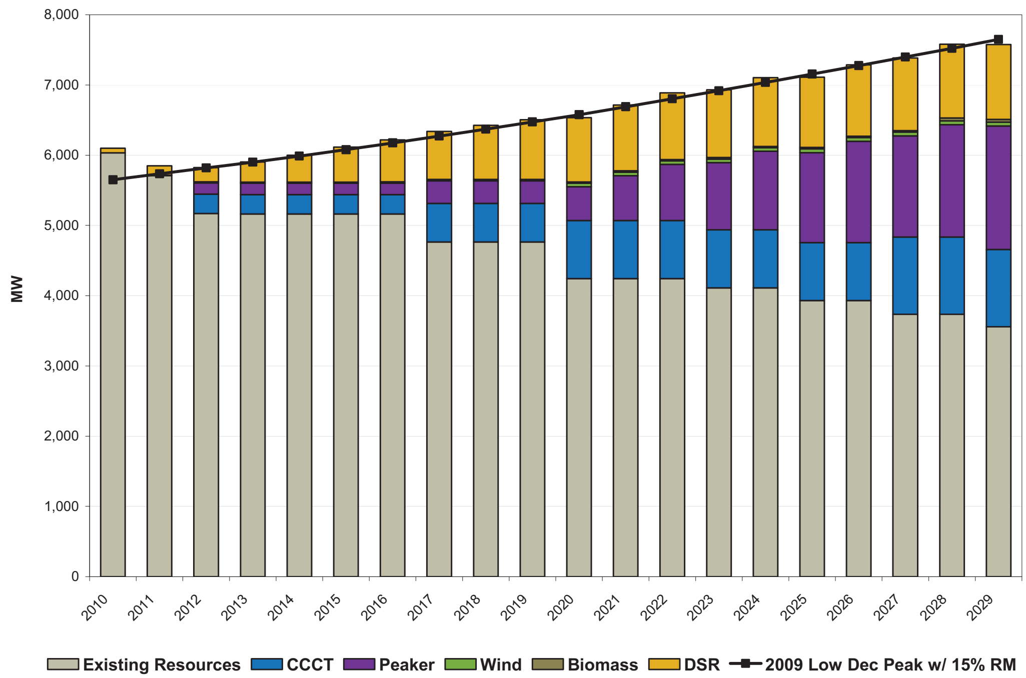
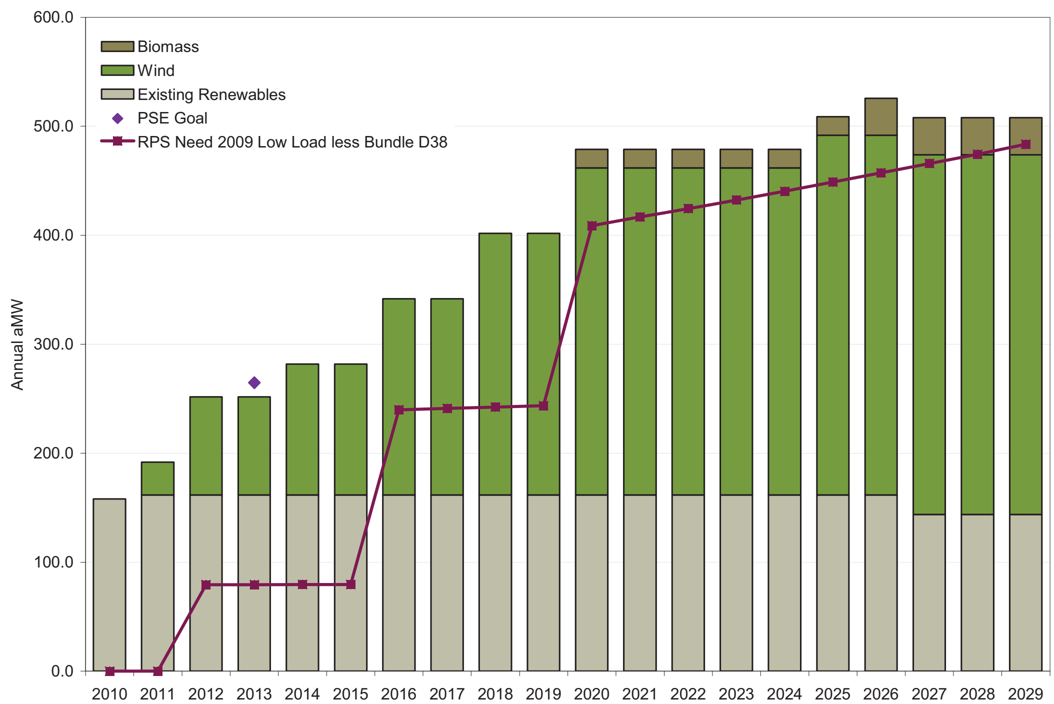


Figure 1-4
Cumulative Nameplate Resource Additions (MW)

	2012	2016	2020	2029
Demand-Side Resources	205	597	917	1064
Wind	300	600	1000	1100
Biomass	0	0	20	40
CCCT w/ Duct Firing	275	275	825	1100
Peakers	160	160	480	1760

Renewable resources reflected in this IRP are consistent with requirements of Washington's renewable portfolio standard (RPS) in RCW 19.285, the Energy Independence Act. PSE also has set a voluntary, internal goal to achieve a higher level of renewable resources in the portfolio, 10% of load by 2013, to the extent these renewable resources are reasonably commercially available, necessary to meet load, and cost effective.[1] Results of analysis in this IRP demonstrate that it is cost effective to accelerate acquisition of wind resources relative to minimums established by the RPS, but Figure 1-5 illustrates the resource plan does not quite achieve that 10% goal—the IRP cost effectively reaches 9% by 2013 under current assumptions.

Figure 1-5
Renewable Resources in the Resource Plan
(Annual Average MWh)



[1] Note: The cost effectiveness analysis reflects selling renewable energy credits into the wholesale market in excess of those needed to comply with RCW 19.285.

Looking Ahead

- Reliance on natural gas to fuel electric generation will continue to increase until other options become available.
- PSE will continue aggressive pursuit of geothermal, biomass, and solar technologies, but until those technologies develop the capability to produce economic, utility-scale power, wind will remain PSE's primary renewable resource.
- Acquiring the wind resources needed to meet renewables requirements has required changes in PSE's acquisition strategies that are likely to persist into the future. Until recently, independent developers were willing to sell PSE completed or ready-to-build wind facilities. In the last couple of years and prior to the current financial crisis, developers adopted a business model of developing projects to own, with the intent of selling their portfolio at an attractive profit. In furtherance of that model, developers became more focused on power purchase agreements, which are generally less attractive to utilities. With the financial crisis and the tightening of credit markets, the ability of developers to complete projects has been compromised. As a result, in order to meet renewable resource requirements, PSE has entered the development process earlier than we did in the past. We will probably do the same for natural gas generation resources as well, given the scarcity of independently owned resources remaining in the region. This means that PSE will be forced to take on more development risk than in the past to meet the needs of our customers.
- Finally, consideration of whether it is more cost effective to replace or refurbish and maintain older generation units needs to be addressed in PSE's resource acquisition and planning process.

Natural Gas Resources

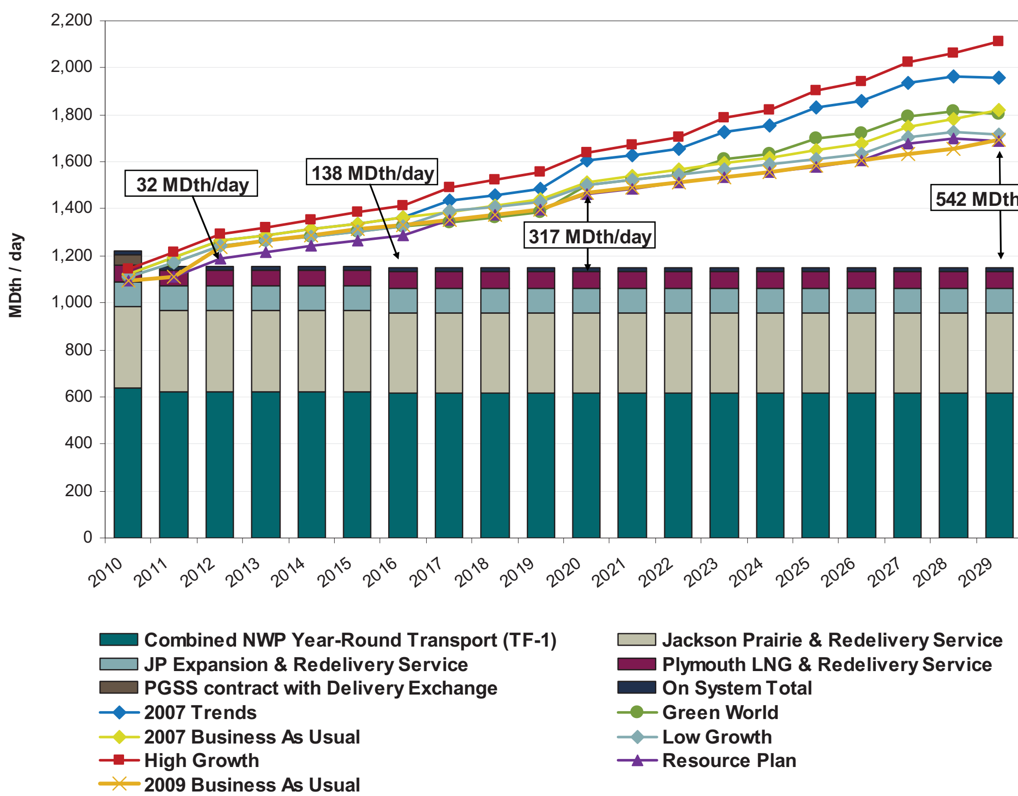
Reliance on natural gas continues to grow. In addition to the approximately 750,000 gas retail customers PSE serves, natural gas now fuels approximately 30% of electric generation. By 2029, it is projected to fuel 66% of electrical generation on an annual basis. Fuel for electric generation is now the primary driver of PSE's overall gas resource acquisitions, even though the total amounts required for generation remain lower than the total amounts needed for retail gas sales.

Because of this increasing dependence, we believe that looking at the total resource need for natural gas ("gas sales" and "gas for generation" combined) presents a more comprehensive picture of the challenges ahead and the decisions that must be made. Therefore, a plan for meeting the total gas needs of the utility is the focus here. (Separate gas sales and combined gas resource plans are presented in Chapter 8.)

Figure 1-6

Total Gas Resource Need (Gas Sales and Gas for Generation)

Projected Peak Demand Compared to Existing Resources



Origins of need. Different uses are driving natural gas need at different points on the timeline. Figure 1-7 identifies how each use (gas for retail sales and gas for electric generation), contributes to overall need. Gas for generation is the most immediate and pressing need for approximately the first five years of the planning horizon; additions for this purpose are required starting in 2010. Gas sales need begins after the 2015-2016 heating season.

Figure 1-7
Origins of Natural Gas Need: Electric Generation and Gas Sales

	2012	2016	2020	2029
Gas Sales Need/(Surplus)	(91)	15	102	318
Gas for Generation Need	123	123	215	224
Combined Need	32	138	317	542

Gas resource plan. Figures 1-8 and 1-9 show the lowest reasonable cost capacity expansion plan to meet PSE's total gas needs. PSE's plan to meet the total gas needs of our customers in 2012 calls for increased pipeline capacity for transportation of gas from northern British Columbia to our service area, the addition of Mist storage capacity, and aggressive levels of demand-side resources. By 2017, the plan calls for still more pipeline capacity, along with regional storage for liquefied natural gas (LNG), and additional demand-side resources. This plan does not include imported LNG. Eventually, imported LNG may become more cost effective than regional supplies, but in the near term, the better solution is to rely on regional storage and to expand access to areas with growing, competitively priced natural gas supplies. This can best be accomplished through investment in additional natural gas transportation infrastructure.

Figure 1-8

Combined Sales and Generation Fuel Resource Plan

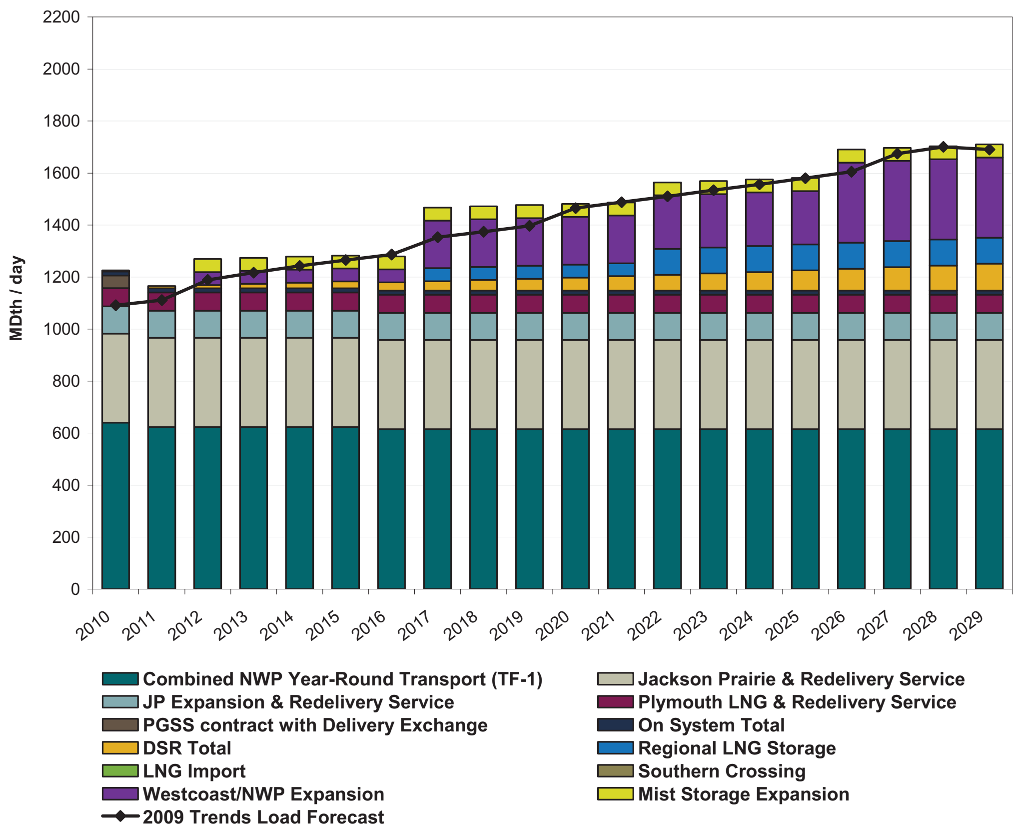


Figure 1-9

Combined Sales and Generation Fuel Resource Plan

	Additions in MDth/day				
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR	Total Annual Additions
2012		50	50	14	114
2017	50	129		26	205
2022	50	20		26	96
2026		111		20	131
2029				14	14
Total Additions	100	310	50	100	560

At this point, the plan prescribes pipeline capacity additions from northern British Columbia, which meets total gas resource need at the lowest reasonable cost identified during this analysis, but which does not address the risks of increasing the reliance on a single supply basin for a crucial resource. Reliability and price exposure are the two major risks.

Concern about supply diversity will increase as PSE's reliance on natural gas increases in coming years. Currently, both the gas sales and electric generation fuel portfolios rely heavily on gas sourced from the Western Canadian Sedimentary Basin (WCSB), especially British Columbia.

- 65% of the gas sales portfolio comes from the WCSB, mostly from British Columbia, and
- 86% of the fuel for the generation portfolio comes from the WCSB, all of which comes from British Columbia. Further, the generation portfolio will become 100% reliant on British Columbia supplies in June 2011, when existing contracts for Rocky Mountain basin supplies expire.

Such a high concentration of natural gas supply from one source leaves PSE vulnerable to supply shortfalls should WCSB supply development not expand as projected, should supplies be diverted to Alberta markets, or should interruptions occur due to well freeze-offs, forced outages at processing plants, or pipeline disruptions. It also exposes PSE to WCSB price volatility and limits the company's ability to take advantage of cost differentials across different supply basins.

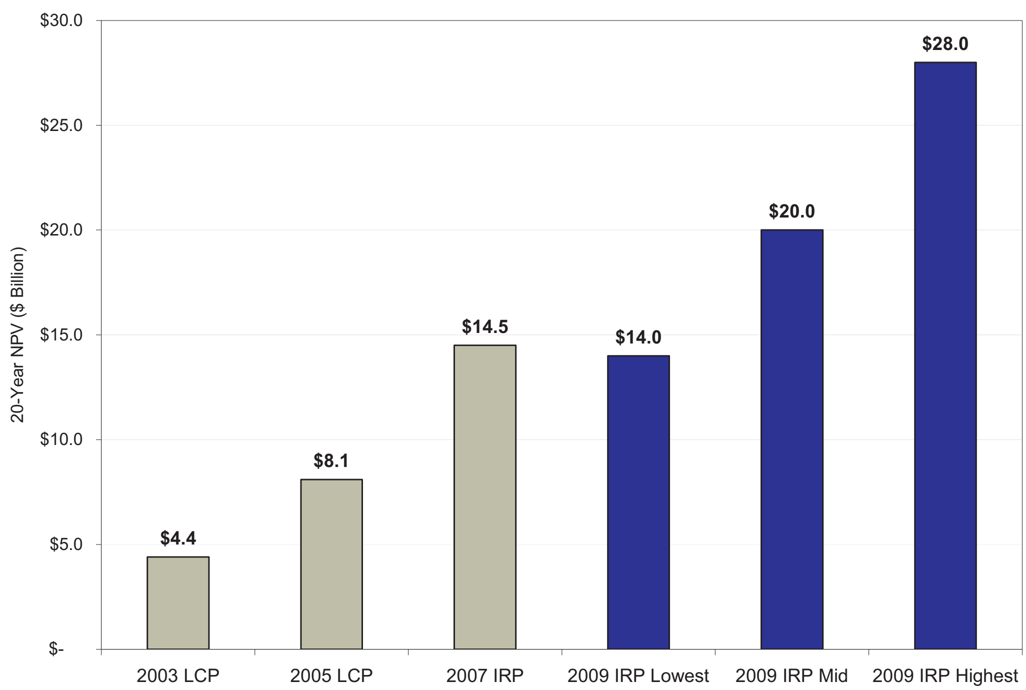
Increasing access to the Rocky Mountain basin may reduce these risks and increase the company's ability to take advantage of short-term price volatility, but the current analyses estimated that doing so at this time would increase costs. PSE will continue to investigate this issue. If the company is able to demonstrate that the benefits are greater than the costs, we will update resource strategies accordingly.

Energy Costs and Carbon Emissions

Electric Portfolio Costs—Higher and More Uncertain

Future estimates of incremental portfolio costs have increased in each resource plan since 2003. ("Incremental portfolio cost" refers to the variable cost of existing resources and the fixed and variable cost of new resources.) The range of portfolio costs projected in this IRP is extremely wide, as can be seen in Figure 1-10. Assumptions in the "highest cost" scenario produced portfolio costs that are fully twice those produced by the assumptions in the "lowest cost." Uncertainty about the future of natural gas prices accounts for approximately 60% of this difference. Uncertainty about the impact that cap and trade carbon regulation will have on energy costs and market prices accounts for most of the remainder. However, new regulation may also create carbon cost offsets; these potential offsets are not reflected in the costs shown below.

Figure 1-10
Rising and Uncertain Incremental Power Portfolio Costs

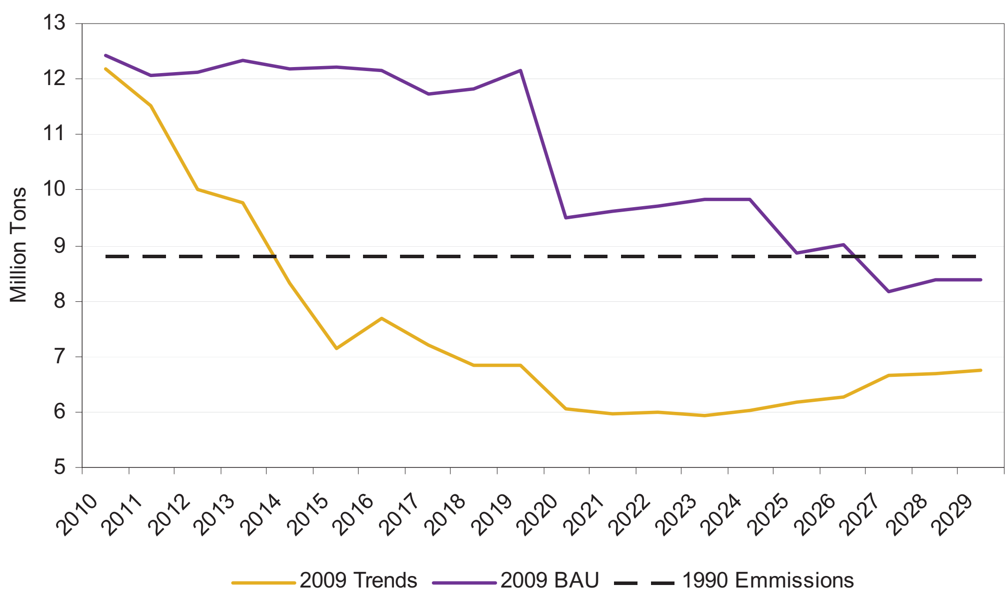


Electric Portfolio Projected Carbon Emissions

Carbon dioxide emissions are expected to fall in the future. Emissions from all portfolios fall below 1990 levels of 8.8 million tons per year by the end of the study period except for portfolios tested with no additional demand-side resources. While the imposition of carbon costs accelerates the reduction of carbon emissions, this is primarily a result of the assumed retirement of Colstrip units 1 and 2 in 2020. Figure 1-11 compares a portfolio that includes CO_2 costs of $37 per ton in 2012 rising to $130 per ton by 2029 (2009 Trends) with a portfolio that includes a negligible $0.32 per ton (2009 Business As Usual). In the 2009 Trends scenario, CO_2 emissions fall off much more quickly as carbon costs reduce the economic dispatch of PSE's Colstrip units significantly—with capacity factors in the range of 20%. Such carbon prices would reduce emissions, but how would it affect costs, as low cost generating resources are replaced by higher cost resources? How or whether carbon allowances are distributed will have a significant impact on carbon prices and the total costs to customers. Each iteration of proposed carbon regulation brings with it a different, complex allocation process. If regulation that imposes carbon costs is ultimately enacted, this allocation process will be very important to costs that utility customers will bear.

Figure 1-11

Falling Carbon Emissions



Summary of Action Plans

The following is a summary of the Action Plans that are summarized in Chapter 9, Action Plans.

Electric Resource Action Plan

- Assessment of Resource Need: Continue to refine analysis of resource need, including further refinements in the capacity planning standard with regard to operating reserves. Also, PSE will consider alternatives to address its long-term reliance on short-term markets for firm capacity needs.
- Demand-Side Resources: Issue RFPs and work with external stakeholders in the CRAG process to develop program goals, targets, and tariff filings that enable PSE to continue to increase energy efficiency and other demand-side resource programs.
- Renewable Resources: Continue to work toward meeting renewable energy obligations. This will include using the formal RFP process, looking for market opportunities, and continuing to evaluate the strategy of moving deeper into the development process for renewables to maximize the cost effectiveness of renewable resource acquisitions for our customers.
- Thermal Resources: As with renewable resources, PSE will use the formal RFP process, look for market opportunities, and consider self-build alternatives for base load and peaking resources to maximize cost effectiveness of thermal resource acquisitions for our customers, and to ensure reliable and stable operation of the electric system.

Natural Gas Resource Action Plan

- Diversity of Supply and Pipeline Capacity Expansions: Continue to refine the assessment of benefits and costs of maintaining access to both Canadian and Rocky Mountain supply basins.
- Demand-Side Resources: Issue RFPs and work with external stakeholders in the CRAG process to develop program goals, targets, and tariff filings that enable PSE to continue to increase gas energy efficiency programs.
- LNG and Underground Storage Resources: Consider regional market opportunities and self-build alternatives for both LNG storage and underground storage, to maximize cost effectiveness of such storage resource acquisitions for our customers.

Planning Environment

Long-term resource plans must fit within three sets of concerns: economic conditions, resource considerations, and policy requirements.

I. Economic Conditions

Economic conditions have changed considerably since work began on this IRP in the summer of 2007. At that time, uninterrupted growth was generally forecast for the U.S. economy, and the Pacific Northwest in particular. Worldwide appetite for energy was strong and increasing. Commodity prices – including oil, natural gas, and even coal – experienced a period of demand-induced speculation that drove prices to unprecedented highs. During 2008, economic conditions changed drastically. Major global banking institutions failed and others struggled to maintain solvency even with government help. The speculative bubble in commodity prices burst, driving prices to lows that are probably not realistic over the long term. By March 2009, the forecast for U.S. GDP growth had fallen to -3.7% for 2009 and 1.5% for 2010, with unemployment projected at more than 10% for 2010. Although many forecasts point to a recovery in 2011 or 2012, there is still little evidence to indicate when conditions might improve, or what that improvement might look like.

These conditions are having a variety of effects on long-term resource planning and acquisition.

Most immediately, uncertainty about future economic conditions affects PSE's ability to project energy demand. How much energy customers will require in coming years depends a great deal on economic activity; factors like employment and population growth are extremely important to calculating resource need. The wide range of demand forecasts modeled for this IRP analysis reflects how much conditions have changed since mid-2007. The challenge this presents is one of timing. Resources take time to develop, and should demand increase quicker than expected, the portfolios could be exposed to a greater reliance on spot markets at a time when demand and prices are high.

Compared to most utilities, PSE is in a relatively strong position. Financial markets have become constrained as a result of the economic downturn. Debt and equity capital are more difficult to find and more expensive for all marketplace participants. Declining stock prices have made equity financing more challenging. Overall, credit market turmoil has placed sizeable upward pressure on the cost of new capital. PSE has some insulation from these dynamics due to its committed credit facilities and its access to equity capital. (Committed credit facilities help fund short-term liquidity needs at pre-established rates, and access to equity capital helps to address resource needs.) Both result from the company's merger with a privately held consortium of long-term investors in February 2009.

Current economic conditions have changed the resource market in ways that may create opportunities for PSE. Prior to the financial crisis, low debt and equity requirements made it easy for independent developers to obtain financing. Also as demand increased – especially for renewable resources and lower-carbon alternatives like gas-fired generation – so did the number of developers in the market. Today, weaker players are departing, stressed by constraints on capital and the declining number of renewable tax credit investors. To raise cash, they are selling assets, and projects are becoming available earlier in the development cycle. This is creating opportunities to acquire resource development rights that could meet long-term customer needs at lower costs, relative to recent trends. Also, a shift away from the low debt and equity requirements that favored independent power producers over utilities may contribute to making utility ownership of renewable projects appear even more beneficial to customers than purchased-power agreements in the future. As a result, utilities that are strong enough to do so are reconsidering their reliance on purchased power agreements and reexamining ownership opportunities.

PSE is adapting our resource acquisition strategies accordingly. In the past few years, the company has secured gas-fired resources largely by acquiring distressed assets from independent generators. Wind development has been particularly affected by the rapid expansion in demand followed by diminishing access to capital, and PSE has found it advantageous to enter the development process earlier. With our relative financial strength and experience in developing wind resources, the company can be more effective at completing projects than many developers. Building the capability to do more development work also enables PSE to avoid large developer fees associated with mature or operating projects.

II. Resource Considerations

Limited resource alternatives increase reliance on natural gas for electric generation. Natural gas-fired generating resources appear to be the only viable option for filling the resource need that remains after adding demand-side and wind resources. Large-scale expansion of hydroelectric generation is not viable due to licensing challenges; nuclear generation is not financially feasible; and coal generation is constrained due to legislative and environmental issues. Although limited development of biomass has occurred, utility-scale renewable options have not yet expanded much beyond wind and solar, and wind is the only practical renewable for PSE's territory at this time. For PSE and others in the region, dependence on natural gas will increase until more choices become available, and this makes diversity of gas supply a growing concern. At this time, almost 70% of PSE's "combined" gas portfolio capacity is sourced from the Western Canadian Sedimentary Basin, and 86% of the generation portfolio's fuel capacity comes from this source.

Gas supplies and pricing. Portfolio costs tested for this IRP were extremely sensitive to two factors: natural gas prices, and CO_2 costs. Gas prices have been extremely volatile in the recent past. Between July 2008 and April 2009, Sumas prices fell from a high of $14.64 per MMBtu to a low of $3 per MMBtu. Although this drop has allowed PSE to obtain additional energy commodity supplies at more favorable prices, most experts do not expect such very low prices to continue over the long term.

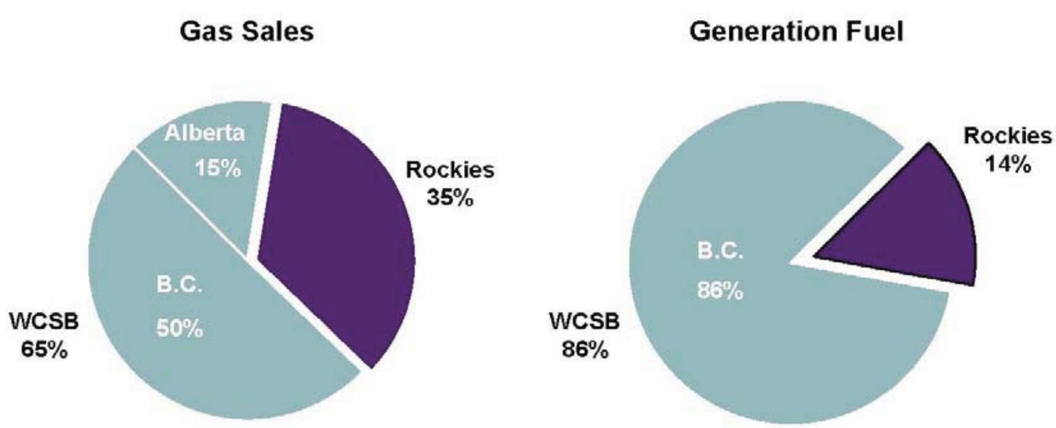
Availability of supply does not appear to be a significant concern. In October 2008 PSE asked Global Insight to assess the security of future supplies of gas to the Pacific Northwest. This study concluded that expanded supplies – primarily of unconventional gas sources in the United States and Western Canada, such as shale gas, coal bed methane, and tight formation gas – appear sufficient to meet the future gas needs of the region. (This study is included as Appendix K.) More recently, in June 2009, the Potential Gas Committee at the Colorado School of Mines reported an unprecedented increase in magnitude of the U.S. natural gas resource base.[1] The majority of the increase came "from reevaluation of shale-gas plays in the Appalachian basin and in the Mid-Continent, Gulf Coast and Rocky Mountain areas." Finally, large amounts of natural gas have reportedly been discovered in shale deposits located in northeastern British Columbia, a claim supported by the record drilling rights leasing activity reported for the region by the

[1] http://www.mines.edu/Potential-Gas-Committee-reports-unprecedented-increase-in-magnitude-of-U.S.-natural-gas-resource-base

B.C. Ministry of Energy and Mines. Fiscal year 2008-09 mineral license sales of CDN$2.4 billion were more than double the previous record.[2]

Diversifying natural gas supply is a challenging proposition. Maintaining geographic diversity in the company's gas supply portfolio is important. Such diversity helps protect against the risk of physical disruptions in either of the two basins that supply PSE: British Columbia and Alberta (which are different parts of the Western Canadian Sedimentary Basin, or "WCSB"), and the Rockies basin. Diversity of supply also helps mitigate cost risk, as prices between those basins fluctuate with long- and short-term market conditions. Figure 2-1 illustrates that the gas sales portfolio is more reliant on the WCSB—mainly British Columbia—than the Rocky Mountain basin. Gas for the generation fuel portfolio is heavily weighted toward British Columbia supplies. The challenge to maintaining diversity in the supply portfolio is that the least-cost route for pipeline expansion is to British Columbia, the basin from which PSE already draw most of its supplies. The analysis presented in Chapter 6 indicates that, given the assumptions used as inputs, gas prices in the Rockies basin would not be low enough to fully offset the cost of expanding pipeline capacity to the region. The simple "least-cost" solution would be to have all incremental supply sourced from British Columbia, but it does not address other concerns.

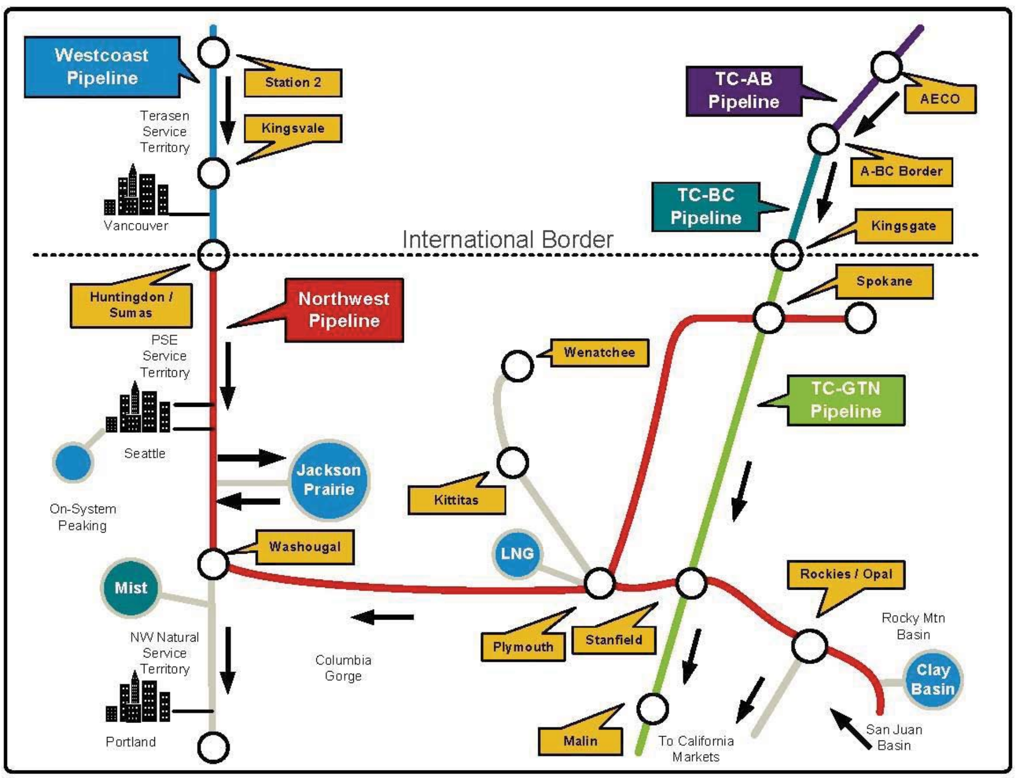
Figure 2-1
Summary of Gas Supply Sources
By Supply Basin—2009



[2] http://www2.news.gov.bc.ca/news_releases_2005-2009/2009EMPR0020-000532.pdf

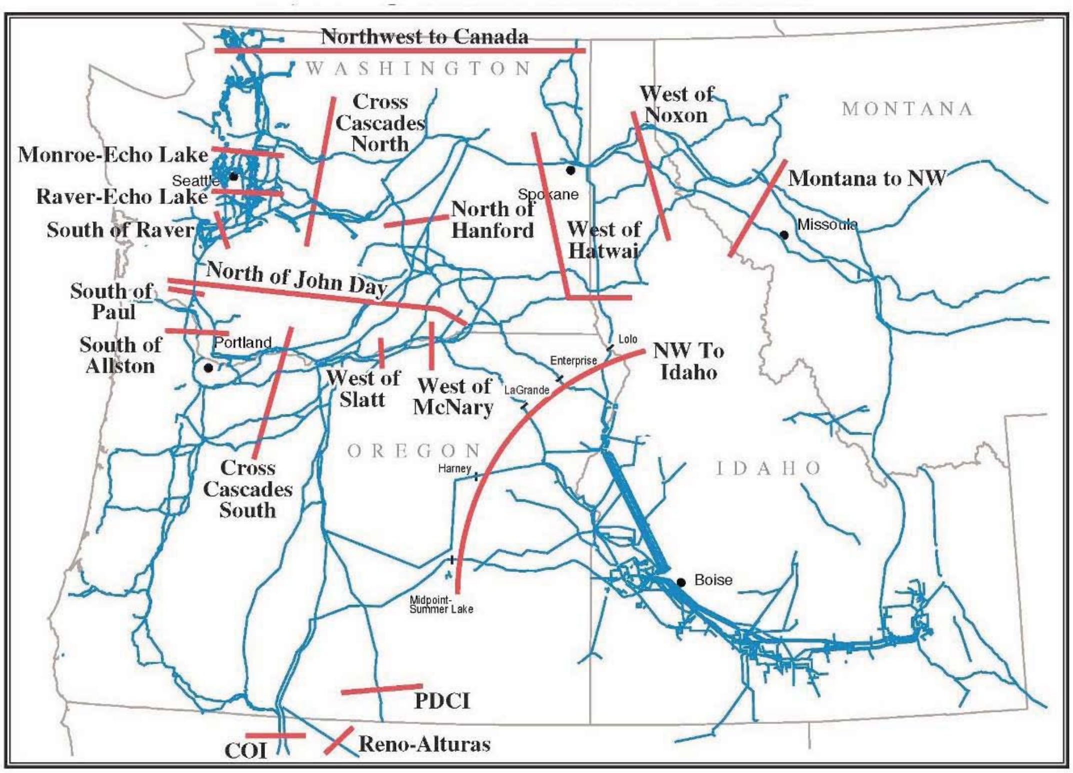
This diversity study focused on additional pipeline capacity to southwestern Wyoming or "the Rockies." A cross-Cascades pipeline would pick up gas from Stanfield, at the intersection of Northwest Pipeline and GTN, and take it west and then north to PSE's service territory. Figure 2-2 illustrates the geographic layout. The analysis assumed that this gas would carry Rockies prices, plus the full transportation cost of moving the gas from the Rockies via Ruby Pipeline to Malin, then north on GTN to Stanfield.

Figure 2-2
Northwest Regional Gas Pipeline Map



Electric transmission can be a hurdle to the acquisition of new resources. The Pacific Northwest's regional transmission situation is marked by an increasing frequency and duration of transmission constraints. This figure shows the constraints that limit flow of energy from generation to load. The prevailing constraint direction is from east to west and from north to south.

Figure 2-3
Northwest Constrained Transmission Paths



In order to overcome these constraints, transmission needs to be built. The ability to build new transmission has been hindered by:

- Limited coordination between generation and transmission development,
- The absence of a single regional transmission planning body,
- Limited access to significant amounts of capital, and
- No central permitting and siting authority.

There are some signs that some of these problems are being addressed:

- Bonneville Power Administration (BPA) has implemented a Network Open Season process to facilitate its ability to plan and construct new transmission lines.
- Other regional utilities are planning large transmission projects to interconnect generation, particularly wind, from outside the Pacific Northwest.
- Federal Energy Regulatory Commission (FERC) Order 890 requires transmission companies to establish a coordinated, open and transparent planning process. The Pacific Northwest region is responding to this requirement by having ColumbiaGrid perform the regional transmission planning function.

Demand-side resources may also be affected by deteriorating economic conditions. Lower customer growth and lower energy use per customer could result in less demand-side potential than projected. Lower incomes may reduce customers' willingness to invest in energy efficiency and this may mean that PSE will need to pay significantly higher incentives to achieve cost-effective levels of energy efficiency. Typically, on aggregate, PSE has paid approximately 50% of measure costs. While PSE does not anticipate having to pay 100% of total resource costs to achieve higher efficiency targets, there is considerable potential for increased levels of incentives.

III. Policy Requirements

Public policy requirements and recent economic impacts have increasing influence on utility decisions about resource additions. Two of the most important ones are summarized in this section.

Renewable Portfolio Standards (RPS). Renewable portfolio standards require utilities to meet a specified portion of their total resource need with renewable resources, even if the resources used to meet the portfolio standard are not the lowest cost. PSE has been a leader in building and acquiring wind resources. When the company acquired the Hopkins Ridge and Wild Horse wind projects in 2005, with the help of production tax credits, these were least cost resources. Since then, the picture has become more complicated. First, adoption of RPS requirements by other states—currently, 29 states and the District of Columbia have RPS mandates—increased demand for renewable resources, driving project costs up. In an environment of RPS requirements and rising fossil fuel prices, independent wind developers entered the market seeking to build and own projects, with the help of tax-equity investors to monetize the tax credits. As a result of the recent economic crisis, fossil fuel prices have declined dramatically, the number of tax-equity investors has fallen sharply, and the weaker players are looking for exit strategies. For utilities with the financial strength to take advantage of this phenomenon, there may be opportunities to meet long-term renewable requirements at a discount from previous prices.

CO_2 Emissions Costs. CO_2 costs and gas prices have the largest effect on portfolio prices in this IRP analysis. Future greenhouse gas emission policy decisions will have profound and far-reaching impacts on utility resource plans, whether they originate at the federal or state level. Emissions charges will increase the cost of fossil fuel-burning power plants, change market power prices, and potentially change the mix of resources chosen to meet need. This IRP models a range of CO_2 costs that vary from $0.32 to $150 per ton. Increasing the use of renewable resources is part of the answer, but it is not the same thing as reducing emissions. Intermittent resources, such as wind and solar, must be backed up and integrated with other power supplies, which will generally be fueled by fossil fuels.

Key Analysis Components

For this IRP, PSE developed seven scenarios and seven sensitivities to capture a wide spectrum of possible future outcomes.

I. Overview

Planning scenarios and sensitivities are key components of PSE's resource planning process. Using them allows the company to evaluate the costs and risks associated with a multitude of possible futures, resource combinations, and the timing of resource additions. Key inputs to the analysis include demand forecasts (described in Chapter 4), resource alternatives (described in Chapters 5 and 6) and the price forecasts, emissions assumptions, and resource cost forecasts described in Section IV of this chapter.

For the 2009 IRP planning cycle, developing scenarios and sensitivities for long-term planning was particularly challenging. The economic fundamentals that existed when PSE began this planning cycle became outdated, and new patterns have yet to be established. Policy issues with great importance to utility operations remain undecided, such as CO_2 costs and the potential for a federal renewable portfolio standard (RPS). Technology has not yet significantly increased the types of commercially viable renewable resources that are capable of generating utility scale power, and infrastructure limitations still restrict the company's options. Meanwhile, utilities continue to be responsible for reliably and cost-effectively meeting the energy needs of their customers.

Underlying economic conditions shifted dramatically during the two-year planning cycle, so much so that in early 2009 PSE determined it was necessary to develop two additional low-demand scenarios to reflect deteriorating economic conditions and their effect on PSE's load. Altogether, seven scenarios were developed to test the performance of a variety of portfolios in different potential futures.

- 2007 Trends
- Green World
- 2007 Business as Usual (2007 BAU)
- High Growth
- Low Growth
- 2009 Trends
- 2009 Business as Usual (2009 BAU)

In order to test how a single important unknown might affect resource decisions, PSE also tested the following sensitivities.

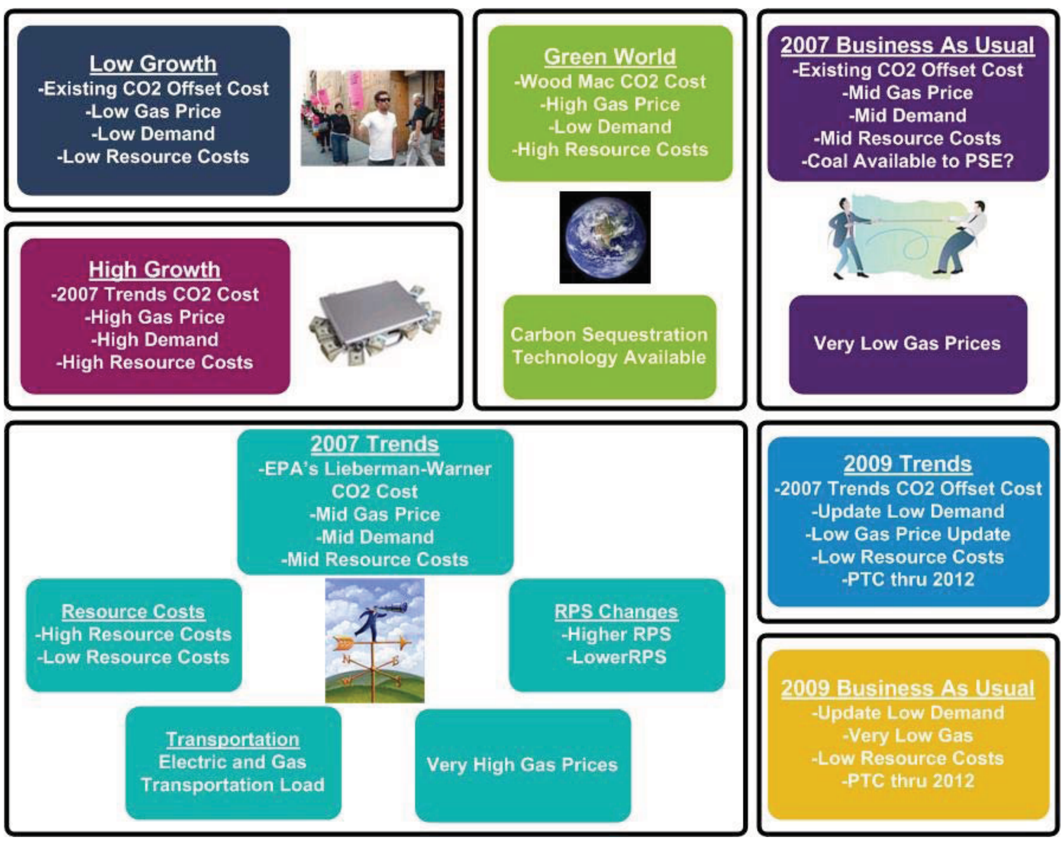
- Very High Gas Prices

- Very Low Gas Prices
- High Resource Costs
- Low Resource Costs
- High Renewable Portfolio Standards (RPS)
- Low Renewable Portfolio Standards (RPS)
- Transportation Load effects

With one exception, all of the sensitivities were tested in the 2007 Trends reference scenario. The exception — the Very Low Gas Price sensitivity – was tested in the 2007 Business as Usual scenario to investigate the sensitivity of portfolio builds to gas prices absent a CO_2 cost.

Figure 3-1 illustrates the seven planning scenarios and relevant sensitivities.

Figure 3-1
Planning Scenarios



II. Scenarios

Scenarios help us understand how changes in fundamental market conditions affect the cost and risk of various resource plans. Scenarios provide different “pictures” of the future that allow us to incorporate significant changes to important issues that are observed today, but whose outcome is unknown. Scenarios reflect a set of integrated assumptions that could occur together, such as high economic growth that leads to high demand for resources, and ultimately, high resource costs. Lastly, scenarios reflect uncertainty about the performance of the economy, environmental regulation, natural gas prices, and energy policy.

Reference case scenarios provide a starting set of assumptions so that other scenarios can be described by how they differ from that benchmark. People often assume that the reference case created for planning purposes is a reflection of current trends, and in less volatile times this is sometimes true – but not in this instance. The reference case depicted here was developed in late 2007 under very different economic conditions; despite how conditions have changed, its value as a reference case remains. The reference case still makes it possible for PSE to compare meaningful differences between scenarios.

Below, we describe the seven scenarios created for PSE’s 2009 IRP electric and gas planning analysis. Five of these were developed at the beginning of the 2-year process in late 2007 and early 2008. Two additional scenarios were created in the spring of 2009 to reflect increasingly pessimistic economic conditions. Subjective probabilities are not assigned to the likelihood of any particular scenario occurring; in other words, it is important to remember that no scenario is judged to be more likely to occur than any other.

When reading the descriptions of scenarios, sensitivities, and key assumptions it is important to note that unless otherwise stated, all dollar amounts are in nominal dollars.

A. 2007 Trends Scenario

The 2007 Trends scenario establishes a starting-point baseline for comparison to the scenarios, so it is described in the greatest detail. Modifications made in the other scenarios and sensitivities are deviations from these reference points.

Resource costs. The estimated cost of generic resources is based on offers received in response to PSE's formal 2008 Requests for Proposals (RFPs), along with information obtained during 2008 as part of PSE's ongoing market activity. Offer prices received were not firm and were occasionally revised upward. The cost of each resource is escalated at varying rates over the 20-year time horizon.

- For gas combined-cycle plants and wind plants, PSE developed cost escalation rates using studies produced by ION Consulting as a starting point.
- For solar capital costs, the company used escalation rates from the "Annual Energy Outlook 2008" published by the Energy Information Administration (EIA).
- For conventional coal and IGCC escalation costs, we relied on the historical relationship between the Producer's Price Index and the cost of resources.
- Biomass and geothermal cost escalation rates were kept constant in real terms; in other words, the nominal cost rises at the same rate as inflation.
- A 2.5% annual inflation rate was assumed in this analysis.

In general, cost assumptions used in this reference case are higher than those used in the 2007 IRP. For the most part, they represent the "all-in" cost to deliver a resource to customers, which includes plant, citing, and financing costs. PSE's activity in the resource acquisition market during the past five years informs the company's cost assumptions, and our extensive discussions with developers, vendors of key project components, and firms that provide engineering, procurement, and construction services lead us to believe the estimates used here are appropriate and reasonable.

Heat rates. PSE applies the improvements in new plant heat rates as estimated by EIA in the 2007 Trends scenario. New equipment heat rates are expected to improve slightly over time, as they have in the past.

Regional demand growth. Demand growth varies by area in the Western Electric Coordinating Council (WECC). These regional demands affect PSE costs because the company competes for resources with other WECC sub-regions.

- For the Northwest states, demand growth is based on the 2006 Northwest Regional Forecast, published by the Pacific Northwest Utilities Coordinating Council (PNUCC).
- For the non-northwest regions, PSE uses estimates provided by the AURORA model developer EPIS.

According to these sources, the annual demand growth in the WECC ranges from 2.5% in the Southwest to 1.4% in the Northwest.

PSE demand growth. PSE-specific demand growth incorporates assumptions about regional demand growth, but also includes many factors specific to its service territory. Development of PSE demand forecasts is discussed in detail in Chapter 4. For this reference scenario, we assume the 2007 Base Case demand forecast.

Natural Gas prices. Gas price forecasts are a combination of forward marks in the near term and Global Insight forecasts for the longer term.

- From 2010 through 2013, PSE used the three month average of forward marks for the period ending July 1, 2008. Forward marks reflect the price of gas being purchased at a given point in time for future delivery.
- Beyond 2013, PSE uses long-run, fundamentals-based gas price forecasts acquired from Global Insight. Global Insight's modeling assumptions and resulting forecasts are first compared with other forecasts for reasonableness.

CO_2 costs. This scenario assumes a CO_2 charge of $37 per ton starting in 2012, increasing to $130 per ton by 2029.

Production tax credits. The Production Tax Credit (PTC) is a federal subsidy identified in the American Recovery and Reinvestment Act of 2009 (ARRA) for production of renewable energy. Currently, the PTC amounts to approximately $21 (in 2010 dollars) per MWh for 10 years of production after a project is placed into service. The PTC is indexed for inflation and is currently scheduled to expire at the end of 2012 for wind resources and 2013 for other qualifying resources. This scenario assumes PTCs are extended at the current rate through 2013, and that no further PTCs are available for new resource development as of 2014.

Investment tax credits. The Investment Tax Credit (ITC) is another federal subsidy related to production of renewable energy. Currently, the ITC amounts to approximately 30% of the capital cost for solar resources and 10% of the capital cost for biomass and geothermal resources; it is scheduled to expire at the end of 2016. Through 2016, this scenario assumes ITCs remain at current levels; beginning in 2017 and for the remainder of the time horizon, they drop to 10% for solar and remain unchanged for biomass and geothermal.

Renewable portfolio standards. Renewable portfolio standards (RPS) currently exist in 29 states and the District of Columbia, including most of the states in the WECC[1] and British Columbia. They affect PSE because they increase competition for development of such resources. Each state and territory defines renewable energy sources differently, sets different timetables for implementation, and establishes different requirements for the percentage of load that must be supplied by renewable resources.

To model these varying laws, PSE first identifies the applicable load for each state in the model and the renewable benchmarks of each state's RPS (e.g. 3% in 2015, then 15% in 2020, etc.). For each state the company then applies those requirements to loads. No retirement of existing WECC renewable resources is assumed, which perhaps underestimates the number of new resources that need to be constructed. After existing and "proposed" renewable energy resources are accounted for, "new" renewable energy resources are matched to the load to meet the applicable RPS. Following an internal and external review for reasonableness, these resources are created in the AURORA database. Technologies included wind, solar, biomass and geothermal. Creation of RPS resources was guided by estimates of potential production by states that appear in the "Renewable Energy Atlas of the West," which can be found at www.EnergyAtlas.org. These vary considerably depending on local conditions; Arizona, for example, has little wind potential but great solar potential. Appendix I, Electric Analysis, includes a table that identifies renewable portfolio standards by jurisdiction.

Build constraints. PSE added constraints on coal technologies to the AURORA model in order to reflect current political and regulatory trends. Specifically, we limited conventional coal to the central states to meet load growth. For certain other states, coal resources were reduced even further due to regulatory constraints or uncertainties. For instance, Washington state law RCW 80.80 (Greenhouse Gases Emissions-Baseload Electric Generation Performance Standard) clearly prohibits construction of new coal-fired generation within the state without carbon capture and sequestration. Absent constraints, the AURORA model would have identified coal as a least cost resource and built a large number of coal units in the WECC – more than seems reasonable given present-day trends and attitudes.

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[1] At http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart, the U.S. Department of Energy website includes a summary of state RPS requirements with links to more detailed information.

B. Green World Scenario

The Green World scenario investigates the consequences of a future in which, relative to the 2007 Trends reference case,

- CO_2 emission costs are much higher,
- gas prices are much higher,
- demand for electricity is lower because of price and social preference,
- and resource costs are higher.

Demand growth. A low growth rate has been applied for the WECC region, and the 2007 Low Growth demand forecast has been applied for PSE.

Gas prices. Gas prices are expected to move higher as developers of new generating resources move from coal to natural gas to satisfy legal and environmental requirements, thereby increasing natural gas demand. The region's use of gas-fired generation increases as more intermittent renewable energy generation comes online (wind and solar). For Green World, PSE applies Global Insight's long-run high forecast.

CO_2 costs. CO_2 emission costs rise from $55 per ton in 2012 to $150 per ton in 2029 – much higher relative to the reference scenario. Quantitative values were estimated based on the Wood Mackenzie report cited in the Emissions Cost Assumptions section of this chapter.

Production tax credits. PTCs are extended through 2015.

Resource costs. High resource costs exist as more stringent environmental regulations are assumed to drive up the cost of raw inputs, including industrial manufacturing, siting, and construction.

C. 2007 Business as Usual (2007 BAU) Scenario

The 2007 Business as Usual scenario is characterized by

- continued political discussion about important energy policies, but no actions actually being taken;
- emissions costs that are less stringent;
- and fewer constraints on conventional coal plants.

While this scenario may seem unlikely at a time when the state of Washington is moving to enact carbon regulations, consideration of this future is important to understanding risks associated with pursuing resource strategies based on significant carbon costs.

Natural Gas prices. This scenario uses the same natural gas price forecast as the 2007 Trends scenario.

CO_2 costs. $1.60 per ton for 20% of the CO_2 emitted by plants producing greater than 250 MW. This equates to $0.32 per ton, i.e., nearly zero. This cost is based on Washington state law RCW 80.70 – Carbon Dioxide Mitigation.

Production tax credits. PTCs are not extended beyond 2009. (This scenario was developed before ARRA extended PTCs through 2012.)

Build constraints. Conventional coal plants are assumed to be more widely available. Coal remains significantly constrained, primarily to meeting load growth in certain coal producing states. Out-of-state coal plants and the transmission resources they require are considered commercially viable resources for PSE's portfolio analysis in this scenario. This assumption was developed before new revisions to RCW 80.80 were finalized; these appear to foreclose on the option of importing coal-fired generation from out of state.

D. High Growth Scenario

This scenario models more robust long-term economic growth than assumed in the reference case, and is characterized by

- higher demand for energy in the region and in PSE's service territory,
- higher natural gas prices,
- and higher resource costs.

Demand growth. High growth rate for demand in the WECC region and, more specifically, the 2007 High demand forecast for PSE.

Natural gas prices. Global Insight's long-run high forecast is applied.

Resource costs. Robust economic growth drives higher demand for generation resources (relative to the reference case), which in turn is assumed to result in high resource costs.

E. Low Growth Scenario

This Low Growth scenario was created before the current economic downturn. This scenario models the impact of weaker long-term economic growth than is assumed in the reference case. This creates

- lower demand for energy in the region and PSE's service territory,
- lower natural gas prices due to lower energy demand,
- and lower cost of energy resources because demand for power plants is depressed by lower economic growth.

Demand growth. A low growth rate has been applied for the WECC region, and the 2007 Low Growth demand forecast has been applied for PSE.

Natural gas prices. Global Insight's long-run low forecast is applied.

Resource costs. Lower resource costs are expected to result from lower demand for energy in this scenario.

F. 2009 Trends Scenario

This scenario was created in early 2009 to reflect altered economic conditions and reflects the following conditions:

- low demand growth,
- low gas prices,
- CO_2 consistent with 2007 Trends,
- and low resource costs.

Demand growth. A low growth rate has been applied for the WECC region, and the 2009 Low Growth Update demand forecast has been applied to PSE's service territory. As explained in Chapter 4, this forecast was updated with the latest macroeconomic data available in February 2009.

Production tax credits. PTC assumptions are based on ARRA, so all PTCs extend through 2012 and only biomass PTCs extend through 2013.

Natural gas prices. To better reflect the gas market as of early 2009, forward marks based on the three-month average for the period ending March 2, 2009 is used for gas prices from 2010 through 2013; thereafter, Global Insight's long-run low forecast applies.

CO_2 costs. The same emissions costs as the reference scenario are used: $37 per ton starting in 2012, increasing to $130 per ton by 2029.

Resource costs. Low resource costs are expected to result from lower demand for energy.

G. 2009 Business As Usual (2009 BAU) Scenario

This scenario is the most pessimistic of the seven. Here, low economic activity leads to

- low demand,
- very low gas prices,
- and no CO_2 legislation is enacted.

Demand growth. This scenario uses the same demand growth as the 2009 Trends scenario.

Natural gas prices. The Very Low Gas Price sensitivity described later in this chapter is used.

CO_2 costs. Negligible CO_2 costs of $0.32 per ton are assumed, the same emissions cost modeled in the 2007 BAU scenario.

Resource costs. Low resource costs are expected to result from lower demand for energy.

Build constraints. Out-of-state coal plants and the transmission resources they require are considered commercially viable resources for PSE's portfolio analysis in this scenario. This assumption was developed before new revisions to RCW 80.80 were finalized; these appear to foreclose on the option of importing coal-fired generation from out of state.

III. Sensitivities

During this planning cycle, a number of discrete variables have grown increasingly difficult to forecast. For this reason, PSE decided to apply sensitivity analysis to examine how changes in a single factor would affect the resource plan. Isolating impacts of specific variables makes it possible to perform an "all else equal" (ceteris paribus) risk analysis. PSE performed sensitivity analyses along with integrated scenario analysis for both the electric and gas portions of this IRP.

A. High and Low Renewable Portfolio Standards Sensitivity

All of the scenarios described above assume meeting current Washington state RPS requirements. PSE wanted to know how changes to that standard might impact resource builds. To test for this sensitivity, the company created high and low variations from RCW 19.285.

- Current targets are 3% of load by 2012, 9% of load by 2016, and 15% by 2020.
- The high RPS sensitivity assumes targets of 4% by 2012, 10% by 2016, 16% by 2020 and 20% by 2025.
- The low RPS sensitivity assumes that the law is changed and only the first level, 3%, is required.

B. High and Low Resource Costs Sensitivity

Resource costs have grown increasingly volatile in the recent past. While PSE's market experience gives us confidence in the resource cost estimates and escalation rates developed for the scenarios described above, PSE wanted to examine this question: Holding all other variables constant, how will changes in resource costs affect plan decisions? Cost escalation rates were developed for all resource alternatives, and then high and low resource cost assumptions were created to test in the 2007 Trends reference scenario.

C. High and Low Natural Gas Prices Sensitivity

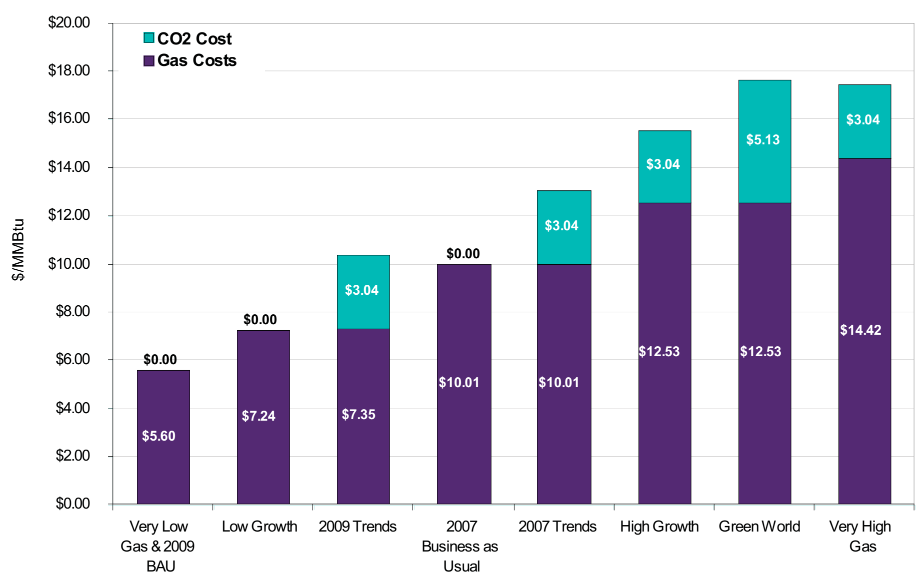
Market prices for natural gas have been extremely volatile; between July and November 2008, Sumas prices fell from a high of $14.64 per MMBtu to a $6.66 per MMBtu. By April 2009, prices were down to $3 per MMBtu. This price level is outside the ranges depicted in the Global Insight long-run forecasts used in the scenarios. To encompass a broader range of future price possibilities, the company developed very high and very low gas price sensitivities by increasing the Global Insight high prices beyond 2013 and assuming a symmetrical low price. (Unlike the Global Insight forecasts, these are not based on future supply and demand scenarios.)

- The very high gas price sensitivity models a 20-year levelized[2] price of $14.42 per MMBtu, $4.41 higher than the Global Insight price used for the 2007 Trends reference scenario.
- The very low gas price sensitivity models a 20-year levelized price of $5.60 per MMBtu, $4.41 per MMBtu lower than the Global Insight price used in the 2007 Trends reference scenario.

Figure 3-2 shows the full range of levelized gas prices modeled in this IRP, including CO_2 cost (per MMbtu) if applicable to the scenario.

Figure 3-2

Range of Levelized Natural Gas Prices and CO_2 Costs Modeled in the 2009 IRP



2 Levelized prices are average prices over the 20-year planning period.

D. Transportation Loads Sensitivity

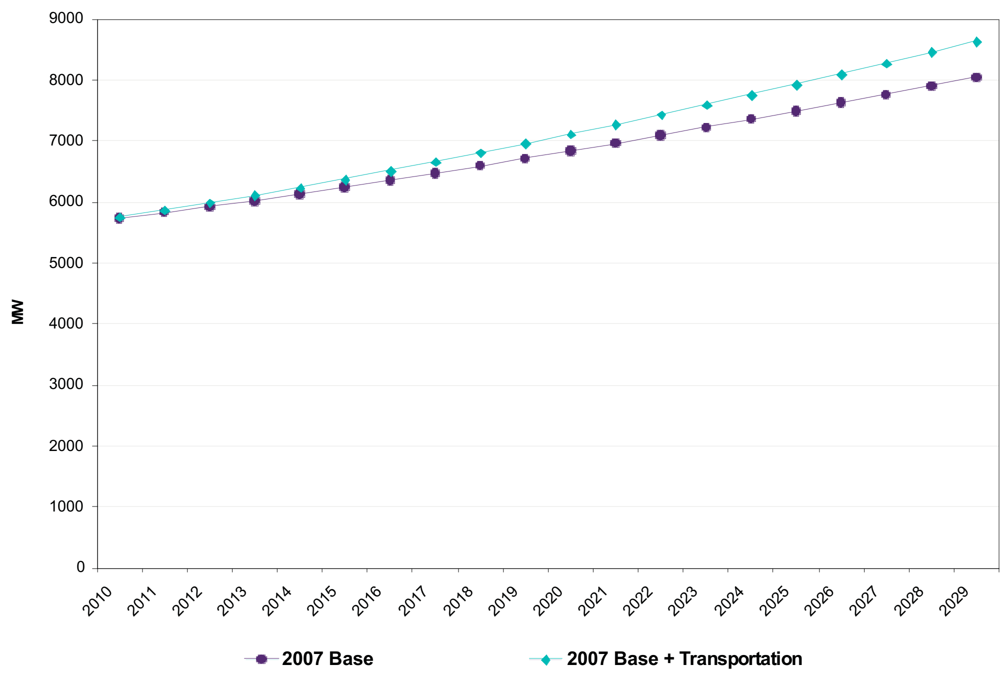
Support at the federal and regional levels for plug-in hybrid electric vehicles (PHEVs) and vehicles powered by compressed natural gas may increase the number of alternative-fuel vehicles operated in PSE's service territory. We wanted to examine the impact that new transportation loads could have on PSE demand forecasts.

To calculate these loads, PSE relied on census data and assumptions in a Northwest Power and Conservation Council study titled "Impact of Plug-in Hybrid Vehicles on Northwest Power System: A Preliminary Assessment." While the study focuses on PHEVs, PSE believes that its assumptions are broad enough to reasonably be used to gauge the discrete additions to both electric and gas loads caused by switching transportation fuels.

Electric transportation load. Figure 3-3 compares the demand curve with and without the transportation load, based on the following assumptions:

- PHEVs will begin to enter the marketplace by 2010 and increase to 20% of the vehicles in the service territory by 2029, or about 500,000 PHEVs.
- The vehicles have a 40-mile, all-electric range.
- The vehicles will charge in the evenings and take eight hours to charge at a rate of 1.25 KW per hour.
- Total demand is discounted to reflect the possibility that not all vehicles may need a full charge or be charging at the same time.

Figure 3-3
Transportation Adds 595 MW to Electric Peak Capacity Resource Need



Gas transportation load. To test how gas demand would be affected, PSE used the same assumptions described above for PHEVs, except that the vehicles' fuel was compressed natural gas rather than electricity. Figure 3-4 shows the incremental increase in gas load needed to meet these requirements.

Figure 3-4
Transportation Adds 56 MDth/Day to Gas Peak Capacity Resource Need

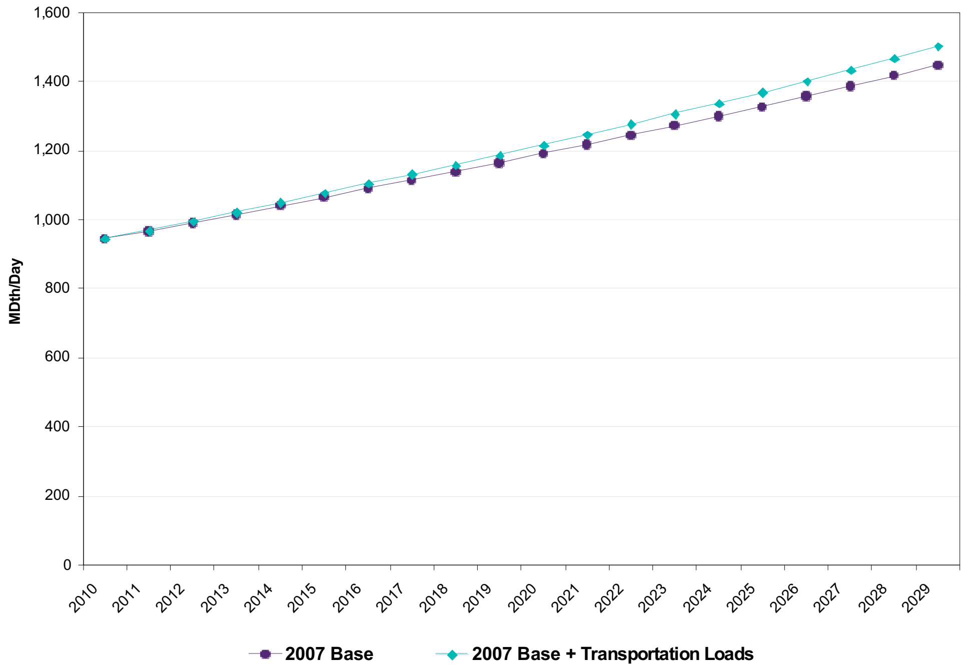


Figure 3-5 summarizes all scenarios and sensitivities used in the analysis.

Figure 3-5
Scenarios and Sensitivities

		Reference Assumptions	Planning Scenarios: 2007 Trends	Planning Scenarios: Green World	Planning Scenarios: Low Growth	Planning Scenarios: High Growth	Planning Scenarios: 2007 Business As Usual	Planning Scenarios: 2009 Trends	Planning Scenarios: 2009 Business As Usual	Sensitivites: Very High Gas	Sensitivites: Very Low Gas	Sensitivites: Resource Costs	Sensitivites: High RPS	Sensitivites: Low RPS	Sensitivites: Transport
Theme			Best estimate of current resource costs and characteristics, fuel prices, state laws and moderate federal environmental policies	Support for stronger environmental legislation at the federal level, with continuation of state level RPS	Lower regional and PSE demand load growth based on lower long-term economic growth.	Higher regional and PSE demand load growth based on related long-term economic growth.	Best estimate of current costs with current environmental policies	Lower regional and PSE demand load growth based on lower long-term economic growth.	Lower regional and PSE demand load growth based on lower long-term economic growth.	Impact of very high gas prices	Impact of Very Low Gas Prices	Impact of resource costs greater or lower than reference	Higher RPS than I-937	Lower RPS than I-937	Impact of plug-in electric hybrid vehicles (PHEV) loads
WECC Demand (AURORA)		EPIS Averages: CA: 1.97% SW: 2.5% PNW: 1.43% RM: 1.86%	Reference	Low Growth	Low Growth	High Growth	Reference	Low Growth	Low Growth	Reference	Reference	Reference	Reference	Reference	Reference
PSE Demand		Base: 2%	Base	Low	Low	High	Base	Updated Low	Updated Low	Base	Base	Base	Base	Base	Base + Transport load
Gas Price		Forward marks for 2010-2013, and Global Insights long-run fundamental forecast	Reference	Global Insights long-run high forecast	Global Insights long-run low forecast	Global Insights long-run high forecast	Reference	Global Insights long-run low forecast, with updated forward marks	Very Low Gas price forecast $5.60/MMBtu	Very High Gas price forecasts $14.42/MMBtu	Very low Gas price forecast $5.60/MMBtu	Reference	Reference	Reference	Reference
Coal Price		Global Insight	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Generic Resource Cost ($/KW)		PSE market based estimates	Reference	High Resource Costs	Low Resource Costs	High Resource Costs	Reference	Low Resource Costs	Low Resource Costs	Reference	Reference	High or Low Resource Costs	Reference	Reference	Reference
Emissions (Nominal $/Ton)	CO2		Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	Wood Mackenzie Start in 2012 2012: $55 2020: $129 2029: $150	RCW 80.70 - Carbon Mitigation Plan 250 MW or greater $1.60/ton for 20% of total CO2	Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	RCW 80.70 - Carbon Mitigation Plan 250 MW or greater $1.60/ton for 20% of total CO2	Lieberman-Warner Bill (EPA) Start in 2012 2012: $37 2020: $67 2029: $130	2007 Business As Usual	2007 Trends	2007 Business As Usual	2007 Trends	2007 Trends	2007 Trends	2007 Trends
	SO2	Wood Mackenzie 2010: $229 2020: $1390 2029: $3796	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Nox	Wood Mackenzie 2010: $2413 2020: $1865 2029: $2486	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Production Tax Credits ($/MWh)		$21:2010-2013 For all eligible technologies	Reference	$21:2010-2015 For all eligible technologies	Reference	Reference	none	2012	2012	Reference	none	Reference	Reference	Reference	Reference
Investment Tax Credit		Solar: 30% 2010-2016, then 10% Geothermal and Biomass: 10%	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
RPS		Meet Current State RPS through 2029	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Higher RPS Targets	RPS capped at 3%	Reference
Build Constraints		Limited amount of coal and IGCC builds to meet load growth only. No new nuclear builds.	Reference	Reference	Reference	Reference	Higher amount of coal and IGCC builds allowed (AURORA). Changes to RCW 80.80	Reference	Reference	Reference	2007 Business As Usual	Reference	Reference	Reference	Reference
Renewable Energy Credit ($/MWh)		2010: $8.00 Increase at same rate as wind capital cost: 2011-2029	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

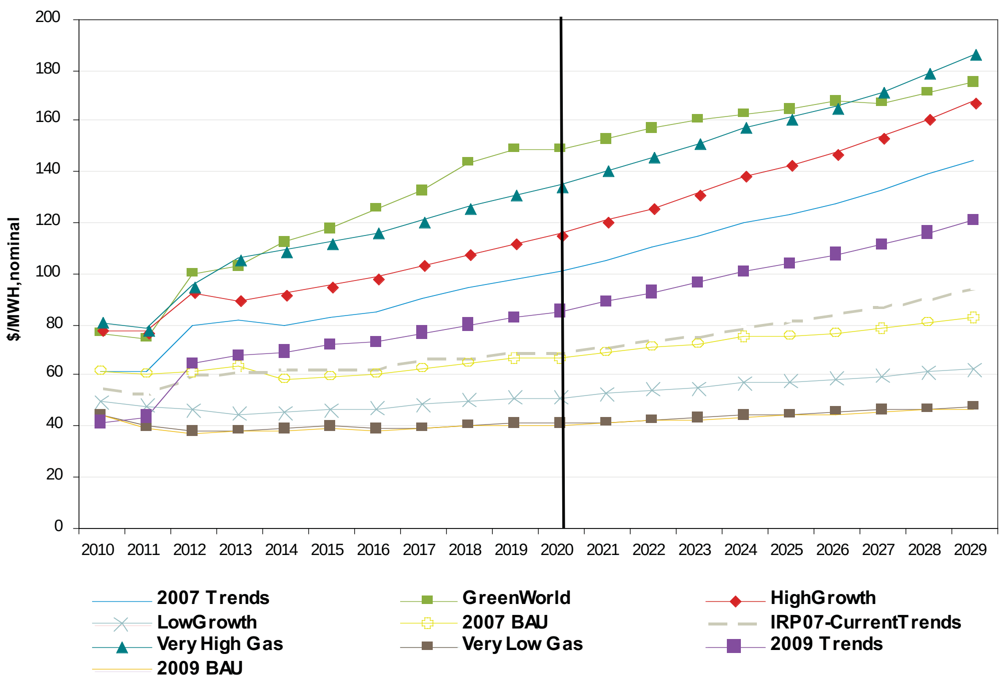
III. Key Assumptions

A. Price Forecasts

Electric price forecasts. Electric market price forecasts for each of the seven scenarios and for the Very High and Very Low Gas Price sensitivities were created using the AURORA model. AURORA calculates these forecasts based on economic, marketplace, and demand assumptions that are specific to each scenario and sensitivity.

The market price forecasts shown in Figure 3-6 below[3] congregate tightly around two key input assumptions: CO_2 costs and natural gas prices. Throughout the analysis, these two factors have the largest influence on overall electric portfolio costs, a reflection of the high proportion of generation that is fueled by natural gas.

Figure 3-6
Comparison of Market Power Price Forecasts

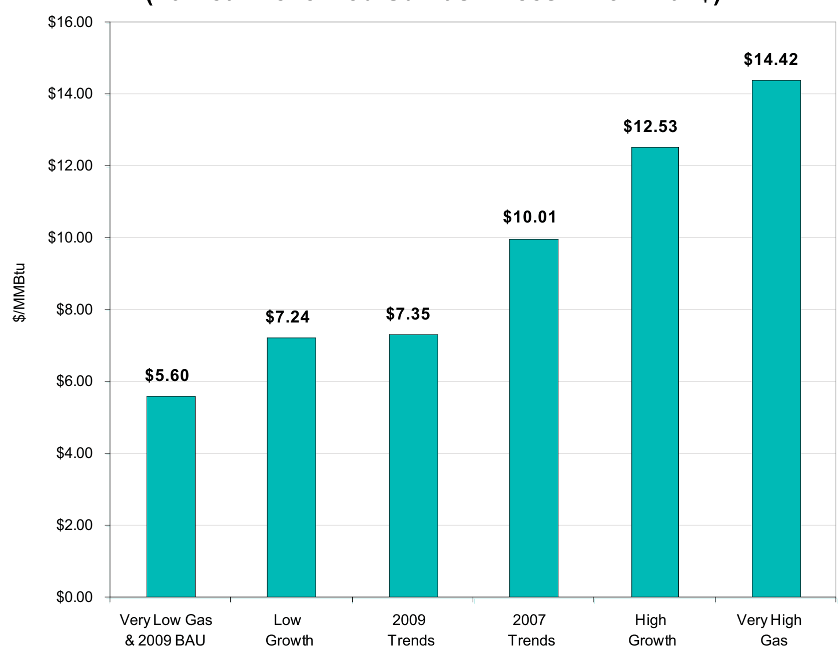


[3] Tables showing the monthly prices for all of the forecasted scenarios appear in the Appendix I, Electric Analysis.

Scenario	Levelized price per MWh	Levelized Gas $/MMBtu	CO_2 cost per ton
Green World	$124	$12.53	$55 to $150
Very High Gas	$120	$14.42	$37 to $130
High Growth	$106	$12.53	$37 to $130
2007 Trends	$91	$10.01	$37 to $130
2009 Trends	$75	$7.35	$37 to $130
2007 BAU	$65	$10.01	$0.32
Low Growth	$50	$7.24	$0.32
Very Low Gas/ 2009 BAU	$41	$5.60	$0.32

Natural gas price forecasts. Gas price assumptions were a combination of forward market prices, followed by fundamental forecasts acquired from Global Insight, a well known macroeconomic and energy forecasting consultancy. Global Insight performs a comprehensive gas market analysis that includes regional, North American, and international factors (including Canadian markets and LNG imports). Figure 3-7, below, illustrates the range of 20-year levelized gas prices used in the analysis.

Figure 3-7
Gas Price Forecasts
(20-Year Levelized Sumas Prices – nominal $)



B. CO_2 Cost Assumptions

Emissions costs, other than the capital and operating costs of certain pollution control equipment, are not a significant energy price factor today; however, in the near future, at least by 2012, we expect new regulations regarding greenhouse gases (CO_2 for modeling purposes). At this time, the people with whom PSE works to track legislative and regulatory issues believe that a regional or national cap and trade system is a reasonable measure and proxy for assumptions concerning future green house gas regulation. To capture a range of uncertainty around CO_2, PSE used a range of estimates as inputs.

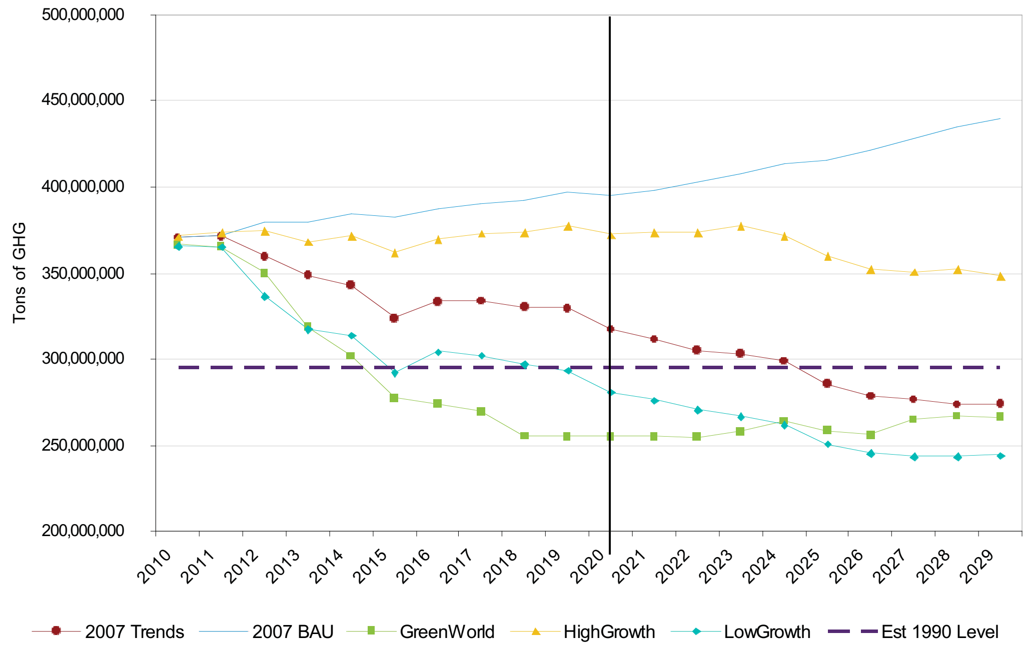
Low CO_2 cost. These assumptions were based on existing Washington law RCW 80.70. This law applies to new fossil fuel fired thermal generation built within the state. For modeling purposes, a reasonable simplification is that compliance requires payment of $1.60 per ton of CO_2 to cover 20% of emissions, or $0.32 per ton. We apply this $0.32 per ton to CO_2 emissions for the entire WECC. Low CO_2 cost was modeled in the Low Growth, 2007 BAU, and 2009 BAU scenarios.

Moderate CO_2 cost. This assumed a cap and trade regulatory scheme and used the CO_2 prices from the ADAGE model published by the Environmental Protection Agency. These prices were then used to develop estimated prices that ranged from $37 per ton in 2012 to $130 per ton in 2029. In this environment, CO_2 costs are reflected in gas prices and power prices. Moderate CO_2 cost was included in 2007 Trends, 2009 Trends, and High Growth scenarios.

High CO_2 cost. This was modeled using a cap and trade regulatory scheme and Wood Mackenzie's "Carbon Casebook 2." These prices were used to develop estimated prices that ranged from $55 per ton in 2012 to $150 per ton in 2029. In this regulatory environment, CO_2 costs are reflected in gas prices and power prices. High CO_2 cost was modeled in Green World.

To find out when (and whether) these CO_2 prices would change dispatch choices enough to reduce emissions in the WECC below 1990 levels, PSE applied the different scenarios across the entire region and used AURORA to calculate the resulting emissions. In Figure 3-8, below, the dashed horizontal line represents an estimate of 1990 emission levels. Here, Green World and Low Growth reach 1990 levels before 2020; 2007 Trends reaches 1990 levels after 2024; and High Growth and 2007 BAU do not reach the target at all.

Figure 3-8
WECC CO_2 Emissions



C. Resource Cost Forecasts

PSE develops forecasts for several resource costs because the differing future economic conditions depicted by scenarios and sensitivities have different implications for resource costs. Included are forecasts for natural gas spot markets, electric spot markets, costs of different kinds of power plants and transmission, and costs of different natural gas transportation and storage alternatives. Table 3-9 below summarizes the supply-side resource costs used in the analysis.

Table 3-9
Resource Cost Assumptions

Generic Resource Costs (2008$)	Units	CCCT	CCCT w CCS	Peaker	Coal SCPC	IGCC	IGCC w CCS	Wind	Long Haul Wind	Solar CST	Biomass	Geothermal
Capacity	MW	275	250	160	250	250	250	100	100	50	20	25
Capital Cost	$/KW	$1,257	$2,470	$1,240	$4,079	$4,527	$5,960	$2,433	$3,753	$4,950	$2,704	$3,449
O&M - Fixed	$/kW-yr	$22.00	$35.07	$23.92	$48.52	$68.14	$80.19	$40.00	$40.00	$63.00	$80.00	$132.00
O&M - Variable	$/MWh	$3.00	$4.27	$1.40	$6.67	$4.24	$6.45	$2.00	$2.00	$0.00	$3.00	$1.80
Availability	%	95%	95%	98%	90%	85%	85%	30%	36%	28%	85%	95%
Capacity Credit	%	93%	93%	93%	93%	93%	93%	5%	5%	5%	93%	93%
Heat Rate - GT	Btu/kWh	7,038	8,424	8,600	8,998	8,573	10,544				14,000	
Heat Rate - Duct Firing	Btu/kWh	8,800										
Fuel Price	$/MMBtu	N/A	N/A	N/A							$5.75	
Fixed Gas Transportation	$/Dth per day	$0.50	$0.50	$0.18								
Fixed Gas Transportation (Conversion)	$/kW-yr	$30.83	$36.90	$4.52								
Fuel Basis Differential	$/MWh	$4.32	$5.18	$5.28								
Electric Transmission - Fixed	$/kW-yr	$3.63	$3.63	$3.63	$86.48	$86.48	$86.48	$56.80	$125.23	$20.94	$3.63	$23.12
Electric Transmission - Variable	$/MWh	$0.00	$0.00	$0.00	$4.53	$4.53	$4.53	$8.32	$16.96	$2.02	$0.00	$2.23
Emissions:												
CO2	lbs/MMBtu	117	0	117	212.67	212.67	0					
SO2	lbs/MMBtu	0.01	0.01	0.01	0.07	0.07	0.06					
NOX	lbs/MMBtu	0	0	0	0.12	0.03	0.03					
Hg	lbs/MMBtu											
Location		*PSE Control*	*PSE Control*	*PSE Control*	*MT/WY/ Alberta*	*MT/WY/ Alberta*	*MT/WY/ Alberta*	*WA/OR*	*MT/WY/ Alberta/BC*	*SE OR*	*PSE Control*	*OR/ID*
First year Available		*2010*	*2025*	*2012*	*2018*	*2020*	*2025*	*2010*	*2018*	*2014*	*2012*	*2018*
Notes								*1 BPA Wheel + Integration*		*Includes 5 hours Storage*		

Demand Forecasts

Demand forecasts are an estimate of how much energy customers will use in the future. When demand forecasts are compared with an assessment of the company's existing resources, the gap between the two identifies "resource need." For this IRP, we developed two sets of demand forecasts, because economic conditions changed so dramatically during the two years in which this analysis was conducted.

I. Methodology

The demand forecast PSE develops for the IRP is an estimate of energy sales, customer counts, and peak demand over a 20-year period. These estimates are designed for use in long-term planning for resources and delivery systems. The 20-year horizon helps us anticipate needs so we can develop timely responses. Updates based on the most current information are used in developing near-term annual revenue forecasts and operational plans.

To produce forecasts of energy demand and customer growth PSE employs econometric models that use historical data to explain changes in energy use per customer and customer counts. Significant inputs include information about regional and national economic growth, demographic changes, weather, prices, seasonality, and other customer usage and behavior factors. Known large load additions or deletions are also included.

In the forecast models, electricity and gas are assumed as inputs into the production of various economic activities. For residential customers, typical energy uses include space heating, water heating, lighting, cooking, refrigeration, dish washing, laundry washing, and various other plug loads. Commercial and industrial customers use energy for production processes, heating, ventilation, and air conditioning (HVAC), lighting, and computers.

To forecast energy sales and customer counts, customers are divided into classes and service levels that use energy for similar purposes and at comparable retail rates. The different classes are modeled separately using variables specific to their usage patterns.

- Electric customer classes include residential, commercial, industrial, streetlights, resale, and transportation.
- Gas customer classes include firm (residential, commercial, industrial, commercial large volume, and industrial large volume), interruptible (commercial and industrial interruptible), and transportation (commercial firm, commercial interruptible, industrial firm and industrial interruptible).

Peak load forecasts are developed using econometric equations that relate observed monthly peak loads to weather-sensitive delivered loads for both residential and nonresidential sectors. They account for deviations of actual peak hour temperature from normal peak temperature for the month; day of the week effects; and unique weather events such as a cold snap or El Nino season.

For a detailed description of electric and gas peak models, and the methodology used to produce the annual energy and hourly electric forecasts, see Appendix E, Load Forecasting Models.

II. Key Assumptions

Economic activity has a significant effect on energy demand. During this 2-year planning cycle, it has been particularly challenging to develop assumptions about national and regional economic trends due to continually changing conditions during 2008. These included a series of abrupt declines throughout the second half of the year.

We adopted the first set of long-term growth assumptions for the national and regional economies in early 2008; these were based on 2007 data and Global Insight reports. By early 2009, we decided it was necessary to develop a second set of assumptions to reflect the possibility of more pessimistic economic conditions persisting into the future. It was not possible to apply the second set of forecasts to all parts of the IRP analysis in the time remaining, but the updated 2009 Low Growth forecast described here was incorporated in the 2009 Trends and 2009 Business As Usual scenarios. We also learned that despite high contrast between the near-term results of the two sets of assumptions, long-term differences in demand were relatively minor.

A. Economic Growth

Because the Puget Sound region is a major commercial and manufacturing center with strong links to the national and state economies, the performance of these economies has a direct affect on the industries in our service territory and the businesses that support them. For this reason, our service territory forecast begins with assumptions about what is happening in the broader U.S. economy. We rely on Global Insight's biannual publication "The 30-Year Focus," a long-term forecast of the U.S. economy, for this information. This forecast is supplemented by a monthly publication, "U.S. Economic Outlook," in which Global Insight updates national economic conditions for a shorter, 10-year forecast time period. Ultimately, PSE forecasts economic and demographic conditions for each county in the service territory using a system of econometric equations that relates national to regional economic conditions.

National Economic Outlook

Global Insight forecasts for U.S. economic growth changed substantially during the two years we were developing demand forecasts for this IRP, especially over the first five years of the planning horizon. The charts below show how gross domestic product (GDP) and employment growth forecasts changed between 2007 and 2009.

Figure 4-1
Global Insight U.S. Unemployment Rate Forecast 2000-2017

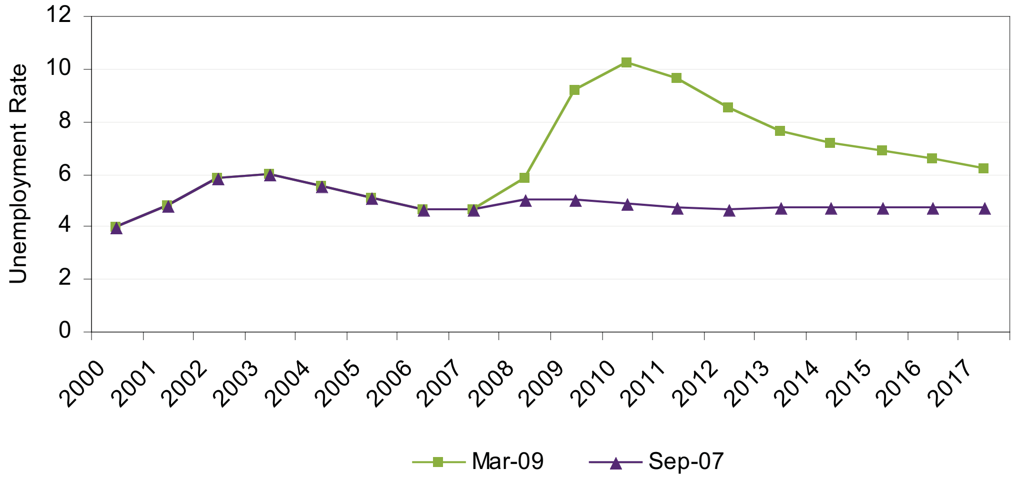


Figure 4-2
Global Insight U.S. Real GDP Growth Forecast 2001-2017

In the fall of 2007, Global Insight forecast that U.S. GDP would grow at an average rate of 2.5% per year over the next 20 years. Growth in equipment spending and advances in technology were projected to result in higher productivity and efficiencies, even though the percentage of employed Americans would decline as the population ages. Oil prices were expected to stay relatively flat at $65 per barrel in the short term, but to increase over the long term to $80 by 2037 because of rising costs to find, produce, process, and distribute product in an environment in which new material was becoming increasingly scarce. The forecast also assumed a decline in the value of the dollar relative to other currencies (depreciating 0.2% annually), raising U.S. exports but increasing the cost of imported goods and services.

By early 2009, Global Insight's macroeconomic forecast had reduced near-term U.S. GDP growth rates to -3.7% for 2009 and 1.4% for 2010. It also projected unemployment of more than 10% for 2010, with no return to 2007 unemployment levels in the next 10 years.

Regional Economic Outlook

The first set of regional economic assumptions PSE developed was based on the 2007 Global Insight forecast described above. These assumptions were used to create the forecast scenario now identified as the 2007 Base Case. It projected employment in the electric service territory to grow at an annual rate of 1.3%, compared to the 15-year historical rate of 1.8%. Factors contributing to the slightly slower long-term growth in employment included slower national employment growth due to lower national population growth, lower regional population growth due to space constraints, and the expectation that The Boeing Company's strong historical employment growth would not necessarily persist into the future. Manufacturing employment growth of -0.5% was projected in this scenario. Despite the slower rate of growth, it projected that local employers would create more than 500,000 jobs between 2007 and 2027, and the inflow of more than 800,000 new residents would increase the population of our service territory to almost 4.5 million.

Corresponding high and low scenarios were developed in June 2008, prior to the worst of the downturn, and were based on assumptions contained in the March, 2008 Global Insight reports. Because they are more reflective of 2007 conditions than 2008, they are identified here as the 2007 High and Low Growth forecast scenarios.

To derive the 2007 Low Growth assumptions, PSE calculated the ratio between Global Insight's March 2008 baseline and pessimistic outlooks for each major national economic variable (such as total U.S. employment). These ratios were then used to scale down the equivalent regional variable (such as regional employment). Then these sets of revised variables were used to calculate the load forecast scenario. A similar approach was taken to calculate the 2007 High Growth scenario, with a ratio calculated between Global Insight's optimistic and baseline projections for each economic variable.

The two new scenarios PSE developed in early 2009, namely the 2009 Base Case Update and the 2009 Low Growth Update, were derived using a similar methodology. For the 2009 Base Case update, the ratio between economic variables in Global Insight's March 2008 30-year baseline forecast and the February 2009 baseline from the U.S. Economic Outlook was used to scale down regional variables. A similar approach was used to calculate the 2009 Low Growth update; here, the ratio between the original baseline scenario economic variables and the February 2009 pessimistic forecast from the U.S. Economic Outlook was used to scale down regional variables.

B. Energy Prices

Retail energy prices—what customers pay for energy—are included as explanatory variables in the demand forecast models because they affect the efficiency level of newly acquired appliances, their frequency and level of use, and the type of energy source used to power them. The energy price forecasts draw on information obtained from internal and external sources.

Although wholesale energy prices have dropped since mid-2008, PSE chose not to revise the energy price forecasts prepared for the original 2007 Base Case scenario after reviewing their influence on results. Declines in wholesale energy prices do affect retail rates, but their impact on energy usage is minor compared to the impacts of the economic recession. Recent estimates of residential price elasticity for both electric and gas are close to -0.05, implying that a 10% change in the retail rates would reduce residential energy consumption by 0.5%. In comparison, the difference between the economic conditions in the 2007 Base Case and 2007 High Growth scenarios lead to an increase of 2.5% in the demand forecast.

Electricity

PSE projects that over the next 20 years, nominal retail electric rates will grow between 2.2% and 2.6% per year. In the near term, the retail price forecast assumes rate increases resulting from PSE's General Rate Cases and from Power Cost Only Rate Cases. For long-term retail rates, each usage class's annual retail rate growth is estimated using Global Insight's forecast of the growth of regional rates.

According to Global Insight, long-term real electricity prices (i.e., nominal prices adjusted for inflation) will remain flat or grow only moderately over time. Slower growth in regional prices is due to competitive pressures moderating nominal costs and an increase in the efficiency of new generation technologies. Global Insight expects that energy-producing fuel costs will vary by region as real natural gas prices are projected to stay relatively flat after 2009, while prices of both coal and oil decline slowly in the long term. The diverging trends for natural gas and coal will cause variations in average fuel cost trends between the regions, depending on the relative weights of coal and gas in each region's generating fuel mix. Most new generation in our region is projected to come from gas-fired facilities, with small amounts from coal and wind. As the region increasingly relies on gas for new generation, marginal electric prices throughout the region will become similar and average electric price differentials across the region will gradually narrow.

Natural Gas

PSE expects the rise in nominal retail gas rates to be slightly higher than the long-term rate of inflation: 2.5% per year over the next 20 years. Two components make up gas retail rates: the cost of gas and the cost of distribution, known as the distribution margin. The near-term forecast of gas rates includes PSE's purchased gas adjustment of October 2006, and an increase due to a General Rate Case in 2007. Forecasted gas costs reflect Kiodex gas prices for the 2007-2011 period and Global Insight projections beyond that. The distribution margin is based on PSE's projection for the near term and Global Insight's for the longer term.

According to Global Insight, long-term real natural gas prices will fluctuate by only small amounts. Major increases in LNG imports are enhancing supply competition and will continue to reduce prices from 2008 levels. Prices will still be strong by historical standards, because of rising costs of new domestic supplies and evolution of gas demand away from the more price-sensitive uses.

C. Other Assumptions

Weather

The billed sales forecast is based on normal weather defined as the average monthly weather using a historical time period of 30 years, ending in 2006.

Loss Factors

Based on current analysis, the electric loss factor remains at 6.7% and the gas loss factor remains at 0.8%.

Major Accounts

The assumptions that went into the 2007 Base Case forecast were that two major corporations in PSE's service area planned to add facilities starting in 2007 that would eventually increase electric consumption by more than 40 aMW. Since then, several large companies in the region have announced layoffs and may be planning to reduce and/or delay previously planned major expansions. Both the 2007 and 2009 Low Growth forecasts model this possibility by estimating the impact that large reductions in employment at Boeing and Microsoft would have on demand.

III. Electric and Gas Demand Forecasts

Demand forecasts starting in 2008 serve as the basis for establishing resource need in this IRP. The charts and tables included herein incorporate demand-side resources implemented prior to 2008 (primarily energy efficiency and conservation) and include estimated conservation acquisition for 2008 and 2009, but do not include anticipated additional demand-side resources thereafter. PSE analyzed the five scenarios described below in order to capture a range of possible economic futures.

2007 Base Case. This scenario assumes that the U.S. economy grows smoothly over time at an annual real GDP growth rate of 2.5% from 2008 to 2027, with no major shocks or disruptions. It projects employment in the electric service territory to grow at an annual rate of 1.3%, and manufacturing employment growth to decline by an annual rate of -0.5%. Despite a slower rate of growth than the 15-year historical rate of 1.8%, it projects that local employers will create more than 500,000 jobs between 2007 and 2027, and that the inflow of more than 800,000 new residents will increase the population of our service territory to almost 4.5 million.

2007 Low Growth assumes a slower national GDP growth rate of 2.0%, higher inflation rates, and lower productivity. It also assumes significant cutbacks in Boeing and Microsoft employment. For PSE's service territory, this scenario projects a 20-year annual employment growth rate of 0.8% and a decline in the manufacturing employment growth rate of -5.4%. Personal income, population, and housing permits assumptions are also lower than in the 2007 Base Case.

2007 High Growth assumes a faster national GDP growth rate of 3.2%, a lower inflation rate, and higher productivity growth. For PSE, this scenario includes a 20-year annual employment growth rate of 1.9% and a manufacturing employment growth rate of 0.5%. In addition, upward adjustments were made to assumptions about personal income, population, and housing permits.

2009 Base Case update assumes that the U.S. economy is in recession during 2009, experiences a mild rebound in 2010, and expands into strong growth in 2011 and 2012. Annual real GDP growth rate is forecast at 2.3% from 2008 to 2019. In this forecast, PSE's electric service territory employment levels drop by a total of -1.6% over the next 2 years, 2008-2010. The 20-year growth rate is projected to be 1.2%, only slightly lower than the 2007 Base Case due to a bounce back in employment beginning in 2011. The decline in 20-year manufacturing employment growth rate averages -0.8%, slightly more than the -0.5% forecast in the 2007 Base Case. This forecast also has slightly lower long-term growth rates for the income and population growth.

2009 Low Growth update assumes that the U.S. economy is in deep recession during 2009, experiences zero growth in 2010, and rebounds in 2011. This forecast assumes a slower average annual GDP growth rate of 1.7% from 2008 to 2019, and assumes significant cutbacks in regional Boeing and Microsoft employment. This forecast estimates an even deeper total drop in employment for PSE's service territory, -2.5%, from 2008 to 2010. Similarly, it forecasts lower personal income, number of households, and building permits in the near term (2008-2010) than either of the 2007 forecasts. However, the long-term 10-year annual employment growth rate of 1.0%, is actually slightly higher than the 2007 Low Growth forecast of 0.9%.

Figure 4-3
Forecast of U.S. GDP Growth Rate by Scenario

	2009	2010	2011	2012	2013	2014	2015	2016
Scenarios								
2007 Base	2.8%	2.8%	2.8%	2.6%	2.4%	2.4%	2.4%	2.4%
2007 Low	0.9%	3.2%	2.8%	2.6%	2.0%	2.0%	2.0%	2.2%
2007 High	3.7%	3.6%	3.7%	3.2%	3.0%	3.0%	2.8%	3.0%
2009 Base	-3.7%	1.4%	3.5%	4.2%	3.4%	2.8%	2.7%	2.8%
2009 Low	-4.7%	-0.6%	3.1%	3.5%	3.1%	2.7%	2.5%	2.6%

Figure 4-4
Forecast of U.S. Unemployment Rate by Scenario

	2009	2010	2011	2012	2013	2014	2015	2016
Scenarios								
2007 Base	5.0	4.8	4.7	4.6	4.7	4.7	4.7	4.7
2007 Low	5.8	5.6	5.2	5.0	5.1	5.1	5.1	5.0
2007 High	5.3	5.2	4.8	4.6	4.6	4.6	4.5	4.4
2009 Base	9.2	10.2	9.6	8.5	7.6	7.2	6.9	6.5
2009 Low	9.4	11.2	10.8	9.8	8.9	8.3	8.0	7.6

A. Electric Forecast

Figures 4-5 and 4-6 show electric sales and peak growth forecasts for all 5 scenarios over the first 10 years of the planning horizon. Highlights with reference to the 2007 Base Case scenario are discussed on the following pages.

Figure 4-5
Annual Electric Sales Forecasts 2008-2017

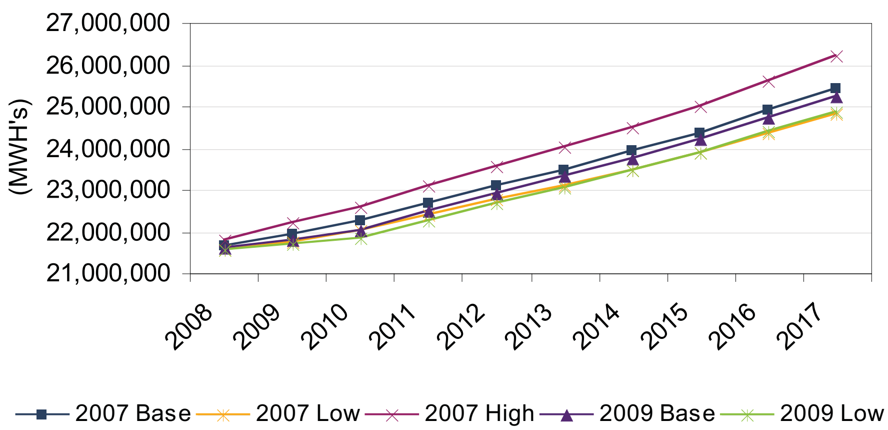
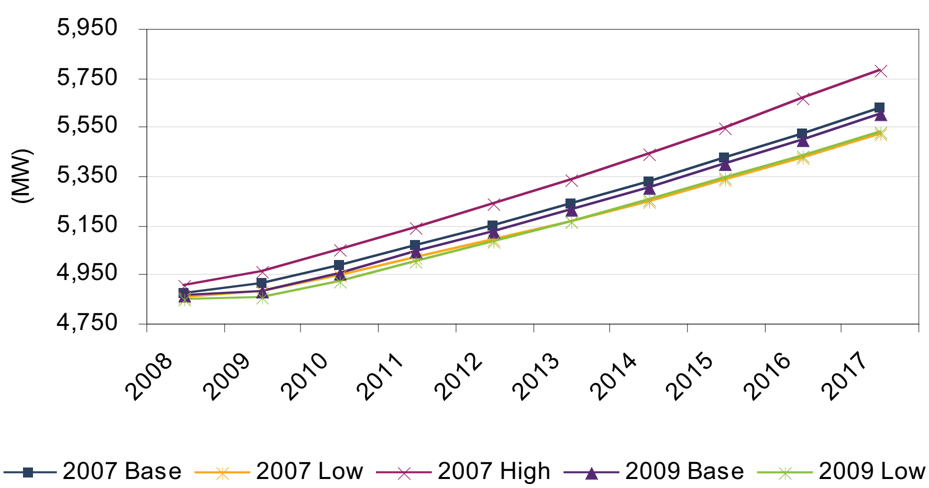


Figure 4-6
Electric Peak (Normal: 23°F) Forecast 2008-2017



Electric Forecast Highlights (2007 Base Case)

1. Total electric firm sales are expected to grow at an average annual rate of 1.95% per year, from 2,471 aMW in 2008 to 3,566 aMW by 2027.

The growth rate is projected to be a moderate 1.8% between 2008 and 2017 due to reduced near-term economic growth, higher retail rates, and increased conservation. The long-term growth rate of sales returns to slightly above 2.1% per year growth for the remainder of the period, 2017-2027.

2. Commercial sales are expected to grow faster than residential sales, increasing from 44% of total sales in 2008 to 48% of total sales in 2027.

Commercial billed sales related to nonmanufacturing employment are expected to grow the fastest in the future, while industrial sales are expected to continue to decline gradually as they have for the past decade (with the exception of 2001) due in part to flat or declining manufacturing employment.

Slower growth in residential sales is caused by several factors: a projected increase in the rate of construction of multifamily housing, which uses less energy per customer compared to single-family housing, the use of more efficient appliances, the expectation that new single-family homes are likely to use gas for space and water heating, and increases in the retail rate. These factors are expected to combine to create a flat or declining average residential use per customer during the forecast period. Residential sales as a percentage of total sales are projected to decline from 49% in 2008 to 47% in 2027.

3. The number of electric customers is predicted to grow at an average rate of 1.9% per year, reaching 1,536,493 by 2027.

Even though commercial customer growth rates are higher, the residential sector is expected to account for the majority of customer growth in absolute numbers. Multi-family residential housing units, which have a lower number of persons per household than single family units, are expected to be constructed at a higher rate in the future. Since multi-family units tend to have a lower average number of persons per household, this leads to a customer growth rate that is higher than the population growth rate. As of December 2007, residential customers accounted for 88% of PSE's total customer base.

4. Peak hourly loads for electric are expected to grow by 1.7% per year over the next 20 years to 6,747 MW from 4,875 MW, slower than the growth in billed energy.

Peak load growth is projected to grow more slowly than total energy use because residential sales (which place the most upward pressure on peak load events) are growing more slowly than commercial sales.

In general, compared to the 2007 IRP, the 2007 Base Case forecast of energy load is lower by about 61 aMW by 2025. It has a lower starting point for 2008 and a lower long-term growth rate than that estimated in the 2007 IRP because of increased near-term conservation, the impacts of higher retail prices, and the fact that even in late 2007, the growth rates experienced in the previous two years were expected to moderate somewhat.

The following tables summarize electric demand forecast results.

Figure 4-7[1]
Electric Sales Forecast Scenarios in aMW

	2008	2009	2010	2015	2020	2025	2027	AARG
Scenarios								
2007 Base	2,471	2,503	2,539	2,782	3,088	3,422	3,566	1.9%
2007 Low	2,462	2,482	2,512	2,726	3,004	3,306	3,436	1.8%
2007 High	2,486	2,537	2,579	2,856	3,201	3,581	3,744	2.2%
2009 Base	2,468	2,489	2,515	2,763	3,067	3,396	3,537	1.9%
2009 Low	2,462	2,474	2,495	2,727	3,016	3,329	3,462	1.8%
2007 IRP	2,519	2,567	2,605	2,852	3,140	3,483	NA	1.9%

Figure 4-8[1]
Electric Sales Forecasts by Class in aMW (2007 Base Case)

	2008	2009	2010	2015	2020	2025	2027	AARG
2007 Base								
Total	2,471	2,503	2,539	2,782	3,088	3,422	3,566	1.9%
Residential	1,219	1,223	1,235	1,352	1,488	1,631	1,690	1.7%
Commercial	1,087	1,120	1,146	1,271	1,443	1,637	1,721	2.4%
Industrial	154	150	147	145	141	138	136	-0.6%
Other	11	12	12	13	15	17	18	2.4%

Figure 4-9[1]
Electric Customer Count Forecast by Class (2007 Base Case)

	2008	2009	2010	2015	2020	2025	2027	AARG
2007 Base								
Total	1,068,658	1,090,671	1,112,801	1,225,931	1,349,180	1,481,346	1,536,493	1.9%
Residential	943,860	962,919	982,042	1,078,921	1,183,801	1,295,233	1,341,358	1.9%
Commercial	117,917	120,747	123,638	139,196	156,693	176,361	184,895	2.4%
Industrial	3,749	3,738	3,715	3,638	3,577	3,512	3,488	-0.4%
Other	3,132	3,268	3,406	4,176	5,109	6,240	6,753	4.1%

[1] AARG means average annual rate of growth.

Figure 4-10[1]
Annual Electric Peak Forecast (2007 Base Case)

	2008	2009	2010	2015	2020	2025	2027	AARG
Normal	4,875	4,910	4,987	5,421	5,945	6,509	6,747	1.7%
Extreme	5,322	5,361	5,442	5,815	6,397	7,014	7,274	1.7%
2007 IRP	4,991	5,054	5,116	5,557	6,047	6,616	6,856	1.7%

Figure 4-11[1]
Residential Normalized Electric Use per Customer in MWh,
Current IRP (2007 Base Case) compared to 2007 IRP (Base Case)

	2008	2009	2010	2015	2020	2025	2027	AARG
Current IRP	11.319	11.128	11.019	10.984	11.020	11.034	11.044	-0.1%
2007 IRP	11.535	11.448	11.332	11.201	11.144	11.103	11.086	-0.2%

B. Gas Forecasts

Figures 4-12 and 4-13 map the gas forecasts for all 5 scenarios to show sales and peak day forecasts, excluding conservation, for the first 10 years of the planning horizon. Highlights are discussed on the following pages.

Figure 4-12
Gas Sales Forecast Scenarios, 2008-2017

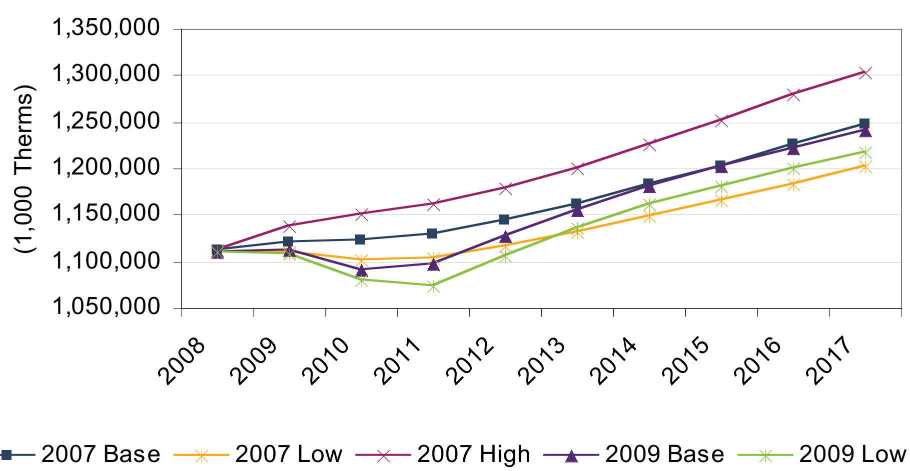
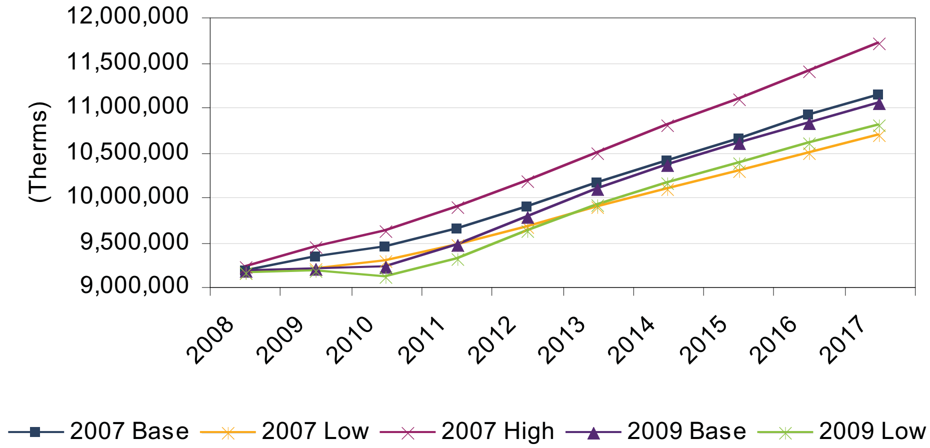


Figure 4-13
Gas Peak Day Forecast Scenarios 2008-2017



Gas Forecast Highlights (2007 Base Case)

1. Natural gas sales are expected to grow at an average rate of 1.5% per year over the next 20 years, from 1.1 billion therms in 2008 to 1.5 billion therms in 2027.

For 2008-2011 we expect a lower growth rate in gas billed sales as customers react to higher retail rates and moderating economic conditions compared to 2006 and 2007. As the long-term gas retail rates approach the rate of inflation and economic conditions normalize, billed sales are expected to return to a long-term growth rate of 1.7% per year.

While overall sales volume will increase over the long-term, some sectors (industrial, interruptible, and transportation) are expected to decline slightly, continuing a 10-year trend of slowing manufacturing employment and increasing retail prices. A slight decline in residential use per customer due to more efficient equipment, a projected increase in multifamily housing, and conservation is offset by a steady increase in the number of customers due to population growth and conversion from electric to gas.

2. The gas customer count is expected to increase at a rate of 2.7% per year over the next 20 years, reaching 1,220,805 by 2027.

This forecast reflects slower population growth (hence slower demand for housing), an increase in the percentage of multifamily units, and a declining pool of potential conversion customers. This leads to a forecast that is lower compared to the 10-year historical growth rate of 3.4%.

Residential accounts are expected to increase at a rate of 2.7% per year over the next 20 years, and to represent 93% of our total customer base in 2027, up 1% from 92% in 2008.

While the number of potential conversion customers is expected to decline, this is expected to be partially offset by increasing penetration of gas into multifamily buildings (townhomes and condominiums) and new single-family homes.

Commercial sector accounts are expected to grow at an average annual rate of approximately 2.3% per year during the next two decades, and to account for roughly 6.6% of the overall customer base in 2027.

3. Peak day firm gas requirements are expected to increase at an average rate of 2.2% per year over the next 20 years, from 9.2 million therms in 2008 to 13.9 million therms in 2027.

Gas peak day growth rates are slightly higher than those for total billed sales because faster sales growth is predicted for the weather-sensitive residential and commercial sectors. The primary drivers of peak growth across all sectors are an expanding customer base and changes in use per customer. Rising base loads are contributing to peak demand because gas is increasingly being used for purposes other than heating (such as cooking, clothes drying, and fireplaces). This effect is slightly offset by higher appliance efficiencies, and by the increasing use of gas in multifamily housing, where per-customer use is lower.

The residential sector accounts for about 68% of the peak daily requirement; the commercial and industrial sectors account for 28% and 4%, respectively. Large-volume commercial and industrial customers are included in this forecast.

Compared to the gas peak day forecast from the 2007 IRP, this forecast is lower for the first part of the 20-year forecast, but approaches the peak forecast of the 2007 IRP by 2026. This deviation is caused by the residential billed sales forecast, the primary driver of the peak day forecast. The residential sales forecast used in the current IRP incorporates a larger increase in the residential rate, driving usage per customer down, as well as the impact of an economic slowdown.

The tables below summarize gas demand forecast results.

Figure 4-14
Gas Sales Forecast Scenarios

(in 1,000 Therms)	2008	2009	2010	2015	2020	2025	2027	AARG
Scenarios								
2007 Base	1,111,254	1,121,613	1,123,839	1,203,114	1,314,592	1,433,345	1,484,798	1.5%
2007 Low	1,109,852	1,110,046	1,101,629	1,165,372	1,262,230	1,359,958	1,403,013	1.2%
2007 High	1,112,567	1,137,602	1,151,642	1,251,654	1,388,043	1,539,144	1,605,294	1.9%
2009 Base	1,110,399	1,112,499	1,091,649	1,201,622	1,307,474	1,419,166	1,469,964	1.5%
2009 Low	1,110,168	1,107,962	1,079,941	1,181,123	1,275,578	1,376,919	1,422,570	1.3%
2007 IRP	1,149,455	1,168,951	1,188,846	1,290,536	1,371,050	1,460,106	NA	1.4%

Figure 4-15
Gas Sales Forecast by Class (2007 Base Case)

(in 1,000 Therms)	2008	2009	2010	2015	2020	2025	2027	AARG
Total	1,111,254	1,121,613	1,123,839	1,203,114	1,314,592	1,433,345	1,484,798	1.5%
Residential	548,203	554,265	560,740	633,674	707,285	784,602	818,050	2.1%
Commercial	248,549	260,381	266,643	290,886	330,076	373,349	391,994	2.4%
Industrial	38,794	38,885	38,715	37,384	36,243	35,090	34,719	-0.6%
Interruptible	65,685	63,120	60,597	53,319	50,973	48,873	48,497	-1.6%
Transportation	210,024	204,961	197,143	187,852	190,016	191,432	191,538	-0.5%

Figure 4-16
Gas Customer Count Forecasts by Class (2007 Base Case)

	2008	2009	2010	2015	2020	2025	2027	AARG
Total	740,006	760,422	782,330	895,389	1,021,462	1,161,457	1,221,680	2.7%
Residential	683,384	702,534	723,163	829,646	948,455	1,080,436	1,137,235	2.7%
Commercial	53,478	54,774	56,084	62,799	70,190	78,329	81,801	2.3%
Industrial	2,588	2,573	2,555	2,462	2,372	2,286	2,254	-0.7%
Interruptible	430	417	405	361	324	285	270	-2.4%
Transportation	125	124	123	121	121	121	121	-0.2%

Figure 4-17
Gas Peak Day Forecast (2007 Base Case)

(in 1,000 therms)	2008	2009	2010	2015	2020	2025	2027	AARG
Total	9,188,260	9,327,545	9,449,453	10,651,234	11,915,522	13,276,635	13,867,904	2.2%
Residential	6,220,587	6,293,857	6,405,370	7,262,438	8,113,093	9,013,734	9,404,215	2.2%
Commercial	2,539,278	2,601,260	2,620,798	2,938,377	3,331,902	3,767,104	3,955,685	2.4%
Industrial	354,889	357,808	358,684	365,209	375,203	390,020	399,453	0.6%
Losses	73,506	74,620	75,596	85,210	95,324	106,213	110,943	2.2%
2007 IRP	9,612,505	9,882,527	10,164,267	11,444,406	12,499,945	13,535,248	NA	2.0%

IV. Comparison of Selected IRP Forecasts with May 2009 Scenarios

The gas and electric portfolios recommended in this IRP were based on the 2009 Low Growth forecast described in this chapter. Due to the severity and suddenness of the economic recession, the company revised its annual baseline load forecast in April and May of 2009, too late for inclusion in this analysis. In summary, for both electric and gas, the newly updated 2009 Revised Base forecast shows slightly lower growth than the 2009 Low Growth scenario used in the IRP in 2009-2010, followed by higher 2011 growth and similar growth in the long-term. The 2009 Revised Base electric forecast is within 15 aMW of the 2009 Low by 2011, and the Revised Base gas forecast exceeds the 2009 Low in 2011.

Below is a brief comparison of the 2009 Revised Base forecast with the 2009 Low Growth forecast used to develop the resource plan in this IRP.

Figure 4-18
Annual Electric Sales Forecast 2008-2017

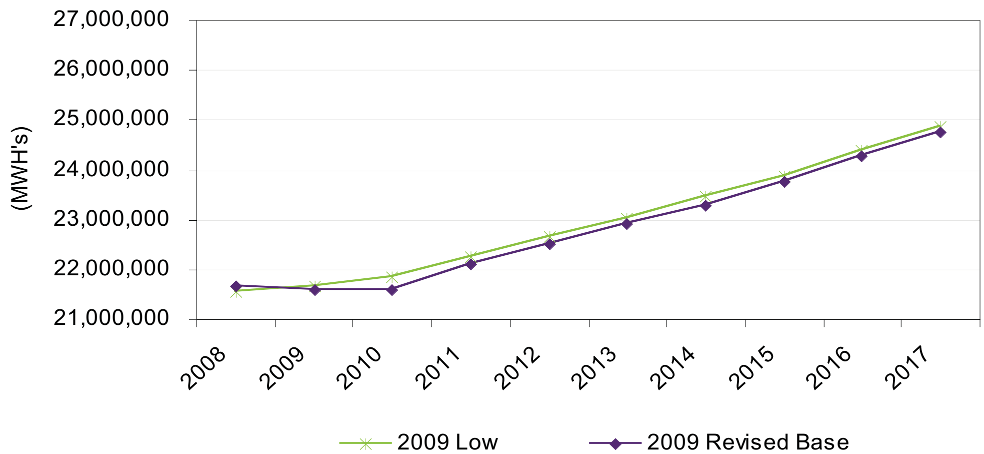


Figure 4-19
Electric Peak Forecast 2008-2017

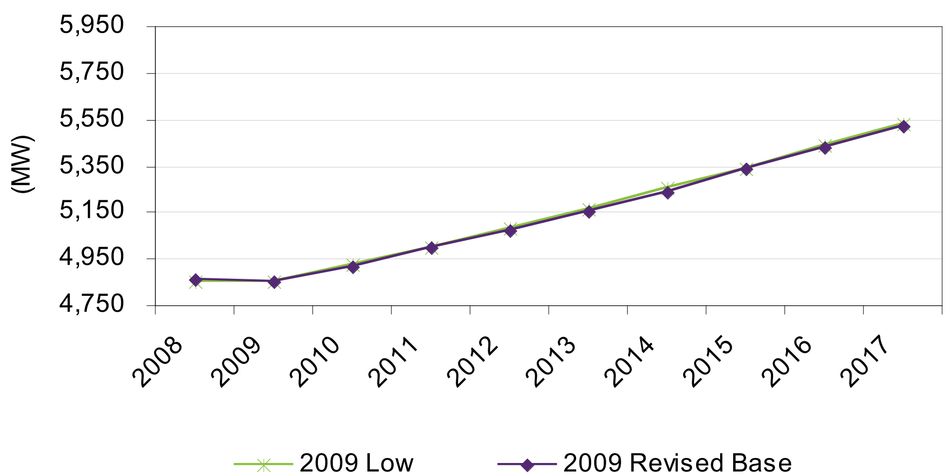


Figure 4-20
Annual Gas Sales Forecast 2008-2017

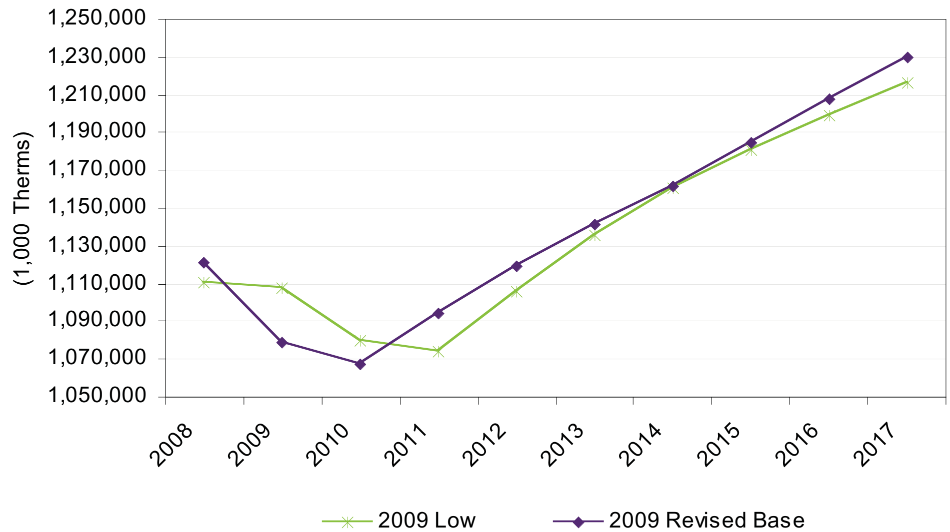
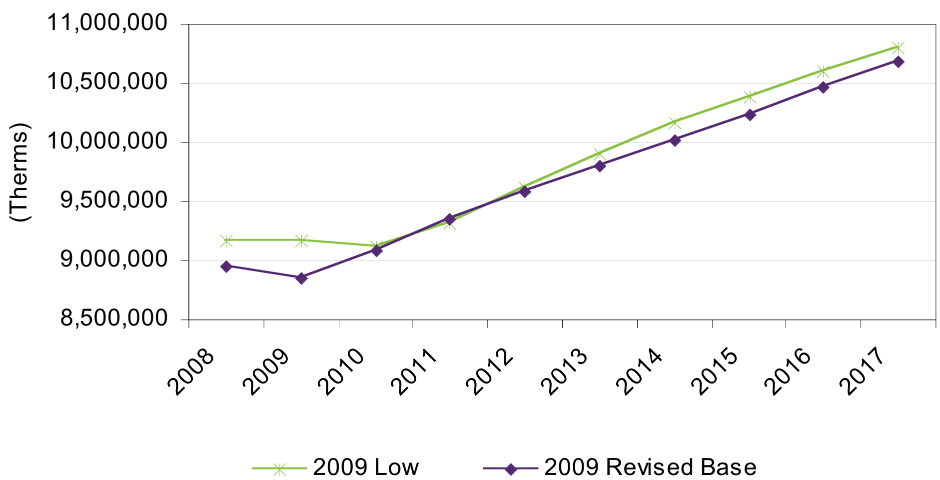


Figure 4-21
Gas Peak Day Forecast 2008-2017



The May 2009 Revised Base load forecast incorporated updated actual regional economic trends that became available after the IRP scenarios were completed. This new data revealed that economic conditions continued to deteriorate for the first few months of 2009. The updated service territory unemployment rate forecast of a maximum of 9.5% in 2010 was slightly higher than the forecast used in the 2009 Low Growth scenario, at 9.0%. Other explanatory variables such as income growth and population growth were also slightly more pessimistic for 2009-2010 in the 2009 Revised Base update.

The 2009 Revised Base also recalibrated 2009 loads and customers to the lower growth seen through the first three months of 2009. PSE experienced negative impacts to year-to-date 2009 load as a result of the current recession. January-May 2009 weather-normalized electric loads were 2% lower than the equivalent time period in 2008. PSE's weather-normalized gas loads were 4% lower during the same time period. As a result, in the 2009 Revised Base, both the electric and gas load growth forecasts are slightly lower for 2009 than those in the 2009 Low Growth forecast.

Although the electric Revised Base forecast is lower than the Low Growth scenario in 2009 and shows relatively flat growth into 2010, an expected economic recovery causes loads to begin to converge to the 2009 Low Growth forecast and loads in the long-term are similar between the two forecasts. There is a similar result in the gas Revised Base forecast; there, loads are expected to be lower in 2009 and 2010 but then converge with and slightly exceed long-term gas loads forecast in the 2009 Low Growth scenario.

Electric Resources

More than a million customers in Washington state depend on PSE for safe, reliable, and affordable electric services. That number will grow over the next 20 years, despite the current economic slowdown, and this growth, combined with the company's expiring resource contracts and the retirement of aging facilities, will drive electric resource need in coming years.

I. Electric Resource Need

At this time, three primary factors are driving PSE's electric resource need over the 20-year planning horizon:

- expiring and retiring contracts and resources
- load growth due to increasing numbers of customers
- renewable portfolio standards

Need for resources to meet peak capacity requirements and RPS requirements are described below.

Capacity Resource Needs

There are two aspects of capacity resource need. One is the load for which the company must plan in order to provide reliable service to customers. The other is the company's existing capacity to generate and supply power (its existing resources, or "resource stack"). Resource need is the difference between the two.

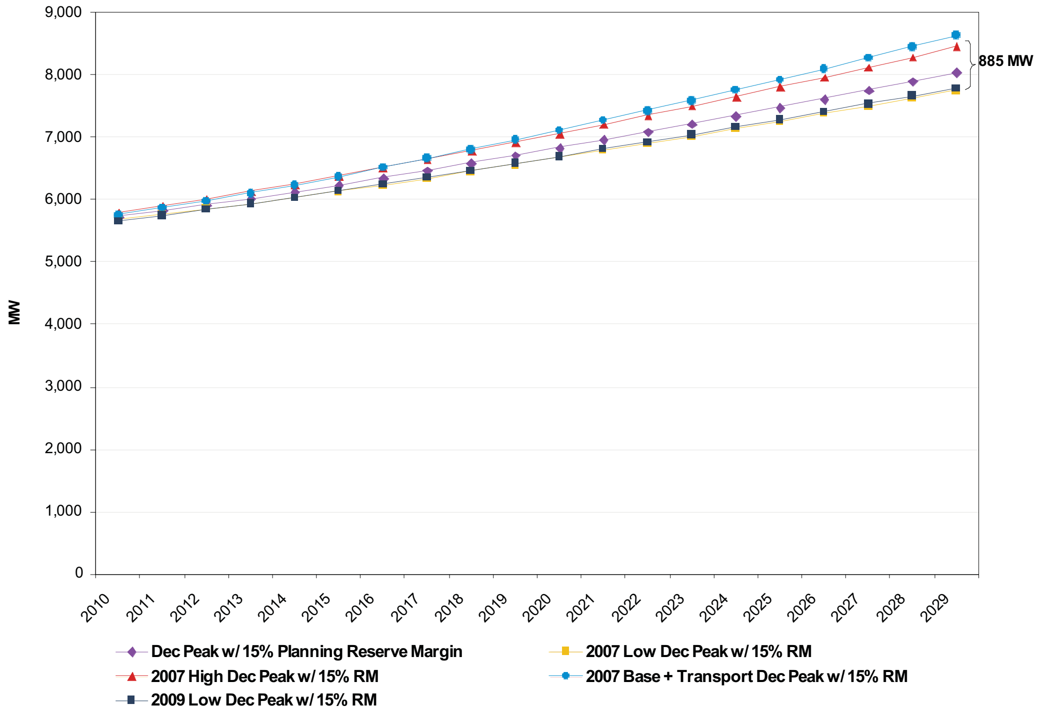
Range of Demand Forecasts Plus Planning Reserve Margins

As a winter peaking utility, PSE experiences the highest demand for electricity when the weather is coldest. This is the peak energy demand that the company must prepare to meet. In addition, we are also required to maintain sufficient reserves to minimize the risk of loss of load in the event of a forced outage or colder-than-expected weather.

Projecting the peak energy demand begins with a forecast of how much power will be used at a temperature of 23^{o} F (a normal winter peak for PSE), plus a 15% planning margin. The 15% planning reserve margin translates to a 5% loss of load probability, a standard reliability metric used in the electric industry. A discussion of how the planning reserve margin was calculated can be found in Appendix I, Electric Analysis. Figure 5-1 illustrates the load plus the planning reserve margin that PSE must meet in each of the scenarios modeled. Five different demand scenarios were considered, as described fully in Chapters 3 and 4.

Figure 5-1

Range of Demand Scenarios Plus Planning Reserve Margins Analyzed



Assessment of Resources Available to Meet Capacity—Treatment of Operating Reserves

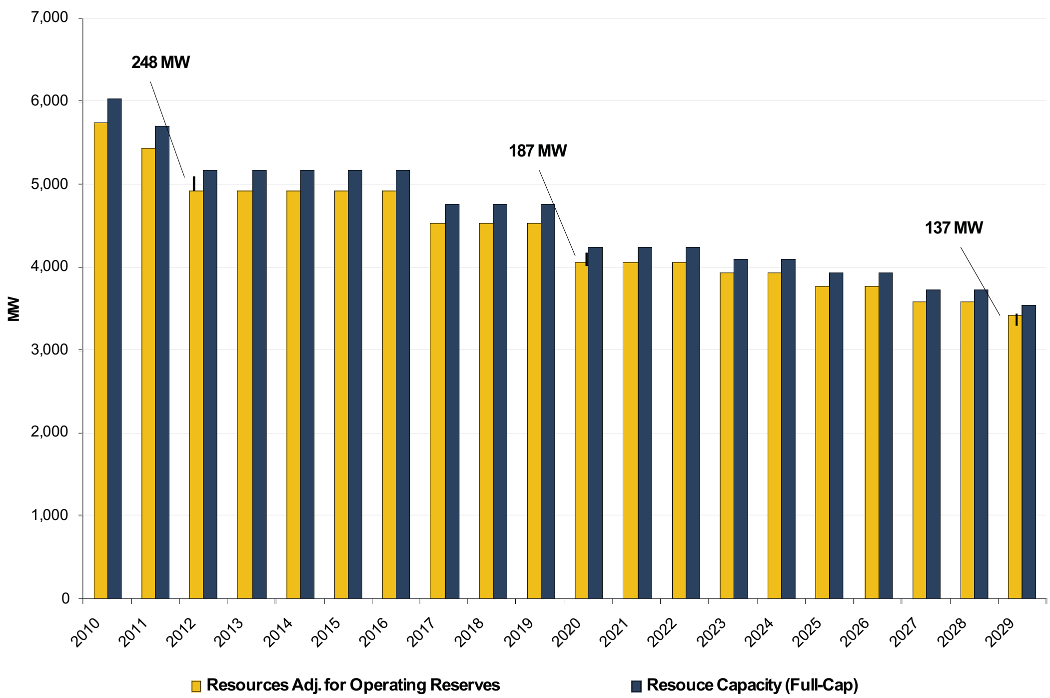
In addition to examining the impact of different load forecasts on resource needs, this IRP also examined the impact of different ways of assessing the existing resources available to meet those loads. This focused on treatment of operating reserve obligations, and whether such operating reserves should be accounted for as part of the planning reserve margin mentioned above or in addition to the planning reserve margin.

Beyond meeting the instantaneous needs of customers, PSE is also required to maintain sufficient reserves to ensure that the utility is prepared to mitigate unplanned generation or transmission outages. This is part of our obligation to maintain the operational reliability of the regional power grid.

PSE has carefully reviewed available literature and discussed this issue with others in the region. However, it is still not entirely clear how operating reserves should or should not be accounted for in a planning reserve margin based on a loss of load probability study.

One way to account for operating reserves is to deduct operating reserves from existing resources; that is, to discount the amount of available capacity by the amount of required operating reserves. The other way is to use the full peak capacity value of resources. This method assumes that required operating reserves are included in the 15% planning reserve margin that the company maintains to achieve a 5% loss of load probability target. The difference in the amount of resources available to meet load under the two approaches is illustrated in Figure 5-2. Note that operating reserves decline over time as resources are assumed to retire.

Figure 5-2
Alternative Assessment of Resources Based on Treatment of Operating Reserves

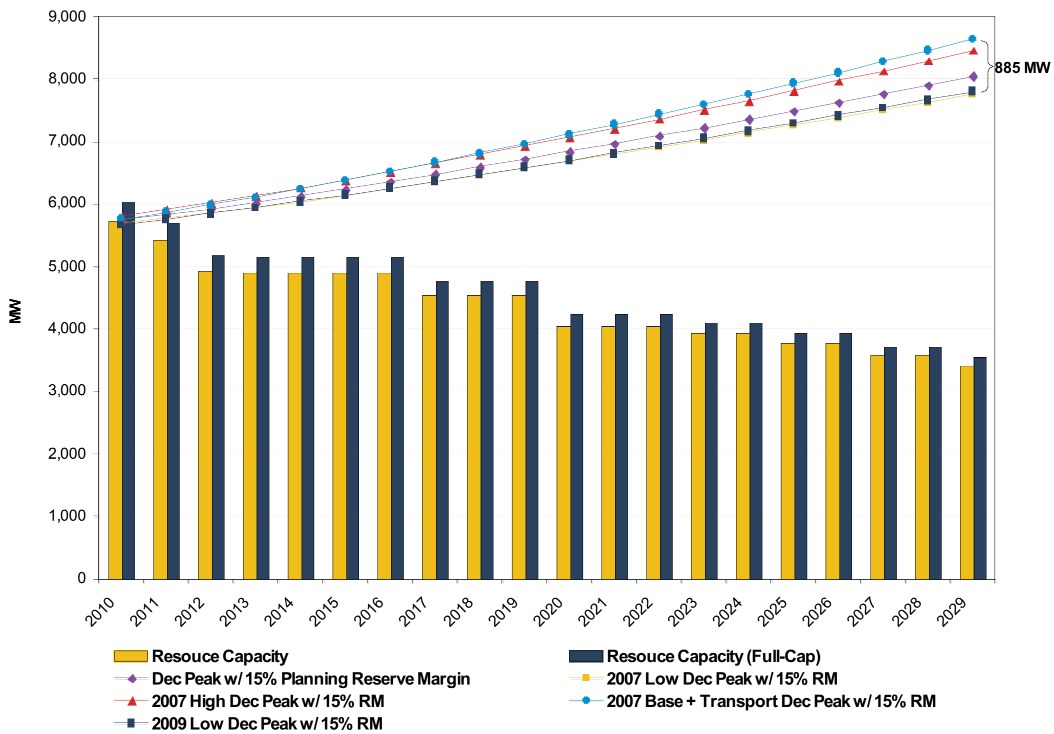


All scenarios and sensitivities in this IRP were modeled using the method that deducts operating reserves from existing resources. Select scenarios were modeled using the full capacity method; these analyses are identified by the notation “Full-Cap” (for Full Capacity) after their name. In other words, results from the analysis of the 2009 Trends scenario reflect existing resources that have been reduced by the amount of operating reserves, whereas resources in 2009 Trends (Full-Cap) have not been reduced for operating reserves.

Range of Resource Needs Considered

As explained above, capacity resource needs in this IRP were affected by changes in load forecasts and alternative assessments of resources available to meet those loads. Figure 5-3 illustrates the full range of electric capacity resource needs analyzed in this IRP.

Figure 5-3
Resource Needs Considered in 2009 IRP



It is important to note that expiring and retiring resources contribute more to future resource need than load growth does. Figure 5-4 shows that by 2029, PSE will need to replace 2,322 MW of resources in addition to meeting an increase in load growth of 2,010 MW. This need is calculated based on the 2007 Low demand forecast and it deducts operating reserves from existing resources. If demand growth reaches the 2007 Base Case forecast, an additional 290 MW will be required. Even if loads remained at today's levels, the amount of resources "falling off" – due to contracts expiring or because generating equipment reached the end of its useful life – means PSE would still need more than 800 MW of resources by 2012.

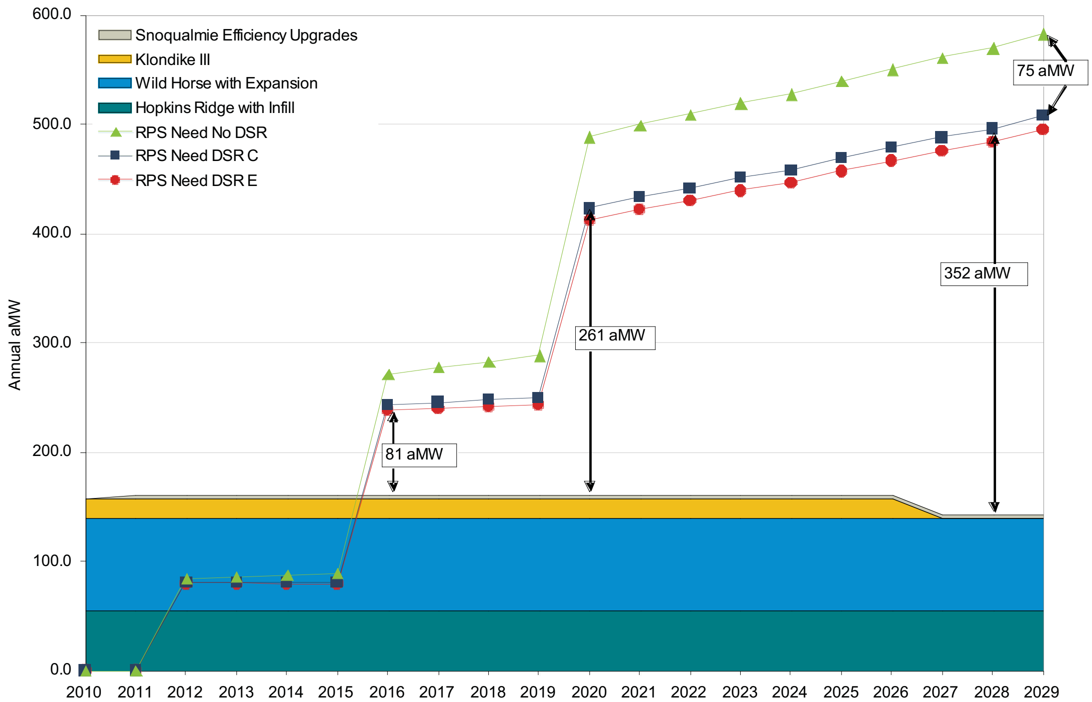
Figure 5-4
Drivers of Electric Resource Need:
Expiring Resources Compared to Demand Growth

	2012	2016	2020	2029
Need from Expiring Resources	819	825	1,685	2,322
Need Due to 2009 Low Growth Load	105	507	955	2,054
Total Need (MW)	924	1,332	2,640	4,376

Renewable portfolio standard (RPS) requirements are also driving resource need. In addition to meeting capacity need, PSE must also meet 3% of load with renewable resources by 2012, 9% by 2016, and 15% by 2020 as required by Initiative 937. Since RPS need is calculated after reducing annual load by the amount of demand-side resources (DSR) achieved, RPS need varies depending on the amount of DSR a portfolio includes. Figure 5-5 illustrates this phenomenon. Higher levels of DSR reduce renewable needs, but by 2029, even the highest DSR levels still result in the need for an additional 352 aMW of renewable energy to fulfill requirements.

Figure 5-5

RPS Need with Different DSR Levels



II. Existing Resources

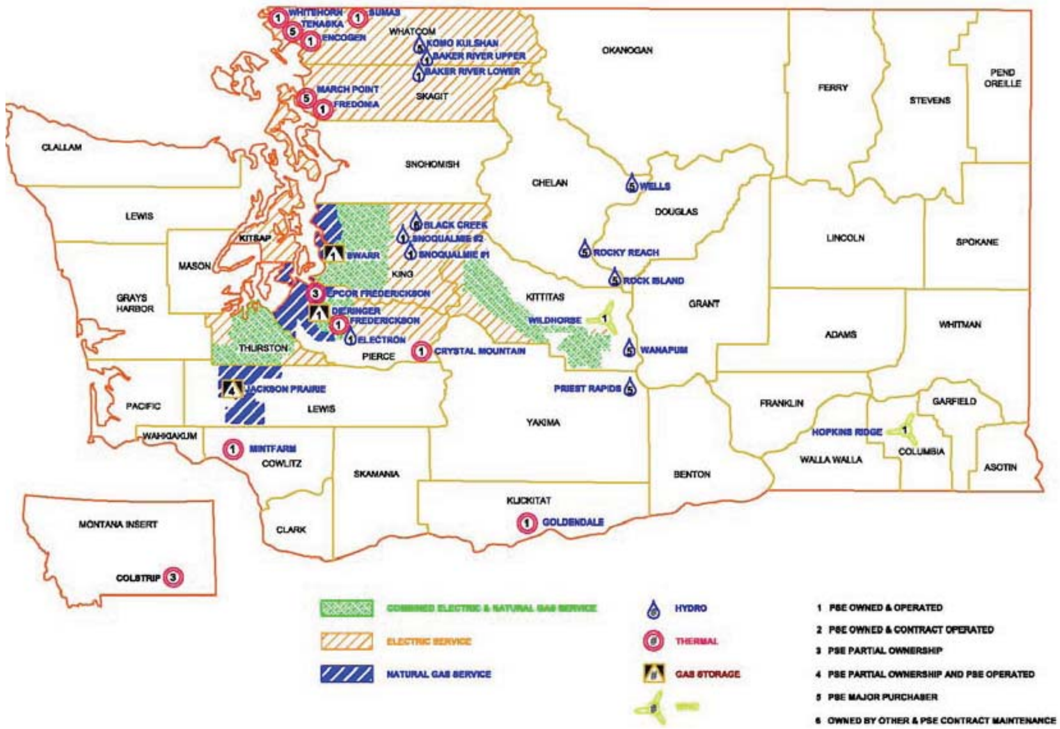
Discussion of PSE's existing electric resources is divided into three parts:

- **Supply-side resources.** These include power generated by PSE-owned and contracted facilities, primarily hydroelectric power, coal-fired plants, natural gas-fueled turbines, and wind resources.
- **Demand-side resources.** These contributions to the resource pool are generated on the customer side of the meter, primarily through energy efficiency programs.
- **Green Power and small-scale renewables.** PSE offers two renewable energy programs, one for customers who want additional renewable energy, and one for customers who produce power from small-scale renewables.

A. Supply-side Resources

PSE's portfolio of supply-side generation resources is diversified geographically and by fuel type (see Figure 5-6). Most of the company's gas-fueled resources are in western Washington. The major hydroelectric contracted resources are in central Washington, outside PSE's service area. Our wind facilities are located in central and eastern Washington. Coal-fired generation is located in eastern Montana.

Figure 5-6
Location of Supply-side Resources



Hydroelectricity

PSE's hydroelectric resources are expected to be capable of producing enough energy to meet approximately 30% of the company's load in 2010. While operating restrictions for endangered species limit operational flexibility, hydroelectric resources are valuable because of their ability to follow load, and because of their lower cost relative to other resources. High precipitation levels generally allow more power to be generated; low-water years produce less power. During low-water years, the utility must rely on more expensive self-generated power or market sources to meet the load. The analysis conducted for this IRP accounts for both seasonality and year-to-year variations in hydroelectric generation. PSE owns hydroelectric projects in western Washington and has long-term contracts with three Public Utility Districts (PUDs) that own and operate large dams on the Columbia River in central Washington. In addition, we contract with smaller hydroelectric generators.

Figure 5-7
Hydroelectric Resources (2008)

PLANT	OWNER	PSE SHARE %	NAMEPLATE CAPACITY (MW)*	EXPIRATION DATE
Upper Baker River	PSE	100	105	n/a
Lower Baker River	PSE	100	85	n/a
Snoqualmie Falls	PSE	100	46	n/a
Electron	PSE	100	22	12/31/2026
Total PSE-Owned			**258**	
Wells	Douglas Co. PUD	29.9	251	3/31/18
Rocky Reach	Chelan Co. PUD	38.9	497	11/1/11
Rock Island I & II	Chelan Co. PUD	50.0	285	6/7/12
Wanapum	Grant Co. PUD	.64**	6	Will tie to new FERC license
Priest Rapids	Grant Co. PUD	.64**	6	Will tie to new FERC license
Mid-Columbia Total			**1045**	
Total Hydro			**1303**	

*Nameplate capacity reflects PSE share only.
**Based on Grant Co. PUD current load forecast for 2010; our share will be reduced to this level.

Baker River Hydroelectric Project. This facility is located in Washington's north Cascade Mountains. It consists of two dams and is the largest of PSE's three hydroelectric power facilities. The project includes a modern fish-enhancement system with a floating surface collector designed to safely capture juvenile salmon in Baker Lake for downstream transport around both dams. In addition to generating electricity, the project provides public access for recreation and significant flood-control storage for people and property in the Skagit Valley. Hydroelectric projects require a license from the Federal Energy Regulatory Commission (FERC) for construction and operation. These licenses normally are for periods of 30 to 50 years and then they must be renewed. In October 2008, after a lengthy renewal process, FERC issued a new 50-year license allowing PSE to generate 707,600 MWh (average annual output) from the Baker River project.

Snoqualmie Falls Hydroelectric Project. Located east of Seattle on the Cascade Mountains' western slope, the Snoqualmie Falls Hydroelectric Project consists of a small diversion dam just upstream from Snoqualmie Falls and two powerhouses. The first powerhouse, which is encased in bedrock 270 feet beneath the surface, was the world's first completely underground power plant. Built in 1898, it was also the Northwest's first large hydroelectric power plant. FERC issued PSE a 40-year license for the Snoqualmie Falls Hydroelectric Project in 2004. The terms and conditions of the license allow PSE to generate an estimated 300,000 MWh per year. The 2004 license requires significant enhancements to both the upper and lower power plants and the diversion dam, and to a number of public amenities such as parks. The new license is being challenged in federal court, and the outcome cannot be predicted at this time.

Electron Hydroelectric Project. Located about 25 miles southeast of Tacoma in the western foothills of Mount Rainier, this facility has a 22.5 MW generating capacity. Completed in 1904, the project draws water from the Puyallup River and funnels it to the power plant via a 10-mile span of wooden flume that runs through the winding river valley.

Mid Columbia Long-term Purchased Power Contracts. Under long-term purchased power agreements with three PUDs, PSE purchases a percentage of the output of five hydroelectric projects located on the Columbia River in Central Washington (see Figure 5-5). PSE pays the PUDs a proportionate share of the operating expenses for these hydroelectric projects. The agreement with Douglas County PUD for the purchase of 29.9% of the output of the Wells project expires in 2018. PSE executed a new 20-year agreement with Chelan County PUD for the purchase of 25% of the output of the Rocky Reach and Rock Island projects. The new agreements take effect upon termination of the current agreements in 2011 and 2012, and extend through October 2031. PSE also executed new agreements with Grant County PUD for a share of the output of the Wanapum and Priest Rapids developments. The terms of the agreements took effect at Priest Rapids in November 2005 and will apply to Wanapum beginning in November 2009. After that, PSE will receive a combined share of power from both projects; this share declines over time as the PUDs' loads increase. PSE's share of the Wanapum Development remains at 10.8% until November 2009 and adjusts annually thereafter. Our share of the Priest Rapids Development declined to 4.3% in 2007. The new agreements with Grant County PUD will continue through the term of any new FERC license to be obtained by the PUD.

White River Project. In January 2004, PSE stopped generating electricity at White River because relicensing and environmental expenses would have driven power costs well above available alternatives. The utility has arrangements with third parties to cover most ongoing postretirement costs, and is working with interested groups to preserve the Lake Tapps reservoir for regional recreation and municipal water supply.

Coal

The coal-fueled generating plants located in Colstrip, Mont., provide low cost baseload energy to PSE, and are expected to be capable of producing enough energy to meet about 22% of our load in 2010. PSE owns a 50% share in Colstrip 1 & 2, and a 25% share in Colstrip 3 & 4. The company receives additional energy from Colstrip under a contract with NorthWestern Energy, which expires at the end of 2010.

Gas-fired Combined-cycle Combustion Turbines (CCCTs)

With the addition of Mint Farm, PSE now has five CCCT resources with a combined nameplate capacity of 975 MW. In 2010 PSE's CCCTs are expected to be capable of producing enough energy to serve 34% of our load. In a CCCT, the heat that a simple-cycle combustion turbine produces when it generates power is captured and used to create additional energy. This makes it a more efficient means of generating power than simple-cycle turbines.

Mint Farm, in Cowlitz County at Longview, Wash., is the company's newest acquisition. Purchased in December 2008, it came online in January 2008 and has a nameplate capacity of 305 MW. PSE's CCCT fleet also includes **Frederickson 1** in Pierce County, **Goldendale** in Klickitat County, and **Encogen** and **Sumas** in Whatcom County. Encogen, our natural gas–fired cogeneration facility in Bellingham, Wash., provides steam to the adjacent Georgia-Pacific mill. To facilitate economic dispatch of the plant, an auxiliary boiler installed in August 2005 provides steam to the mill when market conditions warrant it. We also own 49.85% of **Frederickson 1**, a combined-cycle plant operated by EPCOR.

Wind Energy

PSE is the largest utility owner and operator of wind-power facilities in the Northwest. The two wind projects described here are expected to produce enough energy to serve approximately 5% of the company's overall energy load in 2010. **Hopkins Ridge**, located in Columbia County, has a nameplate capacity of 157 MW and began commercial operation in November 2005. **Wild Horse**, located in Kittitas County near Ellensburg, has a nameplate capacity of 229 MW and came online in December 2006. Combined, the two projects produce 127 aMW of electrical capacity,[1] and have provided over 2.3 million MWh of electrical energy. Both projects have contributed to their respective local economies by providing permanent family-wage jobs, local supply and services procurement, and payment of production royalties to local landowners. In addition, they have increased county tax bases, enabling local government to provide additional services (for example, Columbia County launched a new health clinic). **Wild Horse Expansion** of 49 MW will begin commercial operation in 2010.

PSE's portfolio also includes a power purchase agreement for approximately 50 MW of electricity generated at the **Klondike III** wind farm in Sherman County, Ore. This agreement remains in effect until November 2026.

Figure 5-8 presents details about the company's coal, CCCT, and wind resources.

Figure 5-8
Coal, CCCT and Wind Resources

POWER TYPE	UNITS	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)*	ASSUMED RETIREMENT DATE
Coal	Colstrip 1 & 2	50%	307	Dec 2019
Coal	Colstrip 3 & 4	25%	370	Dec 2024, Dec 2026
Total Coal			**677**	
CCCT	Encogen	100%	159	Dec 2028
CCCT	Frederickson 1**	49.85%	129	N/A
CCCT	Goldendale	100%	261	**N/A**
CCCT	Mint Farm	100%	305	N/A
CCCT	Sumas	100%	121	Jul 2023
Total CCCT			**975**	
Wind	Hopkins Ridge	100%	157	N/A
Wind	Wild Horse***	100%	278	N/A
Wind	Klondike 3	n/a	50	Nov 2026
Total Wind			**436**	

*Nameplate capacity reflects PSE share only. Ratings are at the following ISO conditions: ambient temperature 59˚ F, altitude 0 feet, atmospheric pressure 14.7 psia, relative humidity 60%, fueled by natural gas, 1000 BTU/SCF (HHV) and 900 BTU/SCF (LHV).
**Frederickson 1 CCCT unit is co-owned with EPCOR.
*** Wild Horse includes 228.6 MW of original wind project and 49 MW of expansion project.

[1] The average number of megawatt-hours (MWh) over a specified time period; for example, 295,650 MWh generated over the course of one year equals 810 aMW (295,650/8,760 hours).

Gas-fired Simple-cycle Combustion Turbines

PSE's four simple-cycle combustion turbine plants contribute a total of 606 MW of capacity. Although they typically operate only a few days each year, they provide important peaking capability and help us meet operating reserve requirements. The company displaces these resources when lower-cost energy is available for purchase. The **Fredonia** facility is located near Mount Vernon, about 75 miles north of Seattle in Skagit County. In February 2009 PSE purchased **Whitehorn** units 2 & 3 in northwestern Whatcom County. The **Frederickson Generating Station**, located south of Seattle in the Port of Tacoma, is comprised of two combustion turbine units with a combined nameplate capacity of 149 MW. Details are shown in Figure 5-9 below.

Figure 5-9
Simple-cycle Combustion Turbines

NAME	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)*	ASSUMED RETIREMENT DATE
Fredonia 1 & 2	100%	208	Dec 2019
Fredonia 3 & 4	100%	108	N/A
Whitehorn 2 & 3	100%	149	Dec 2016
Frederickson 1 & 2	100%	149	Dec 2016
Total		**606**	

* Nameplate capacity reflects PSE share only. Ratings are at the following ISO conditions: ambient temperature 59˚ F, altitude 0 feet, atmospheric pressure 14.7 psia, relative humidity 60%, fueled by natural gas, 1000 BTU/SCF (HHV) and 900 BTU/SCF (LHV).

Nonutility Generators (NUGs)

PSE's NUG supply consists of cogeneration plants that use natural gas to supply electricity to the utility, and steam to industrial "hosts" for their production processes. Both are located in Skagit and Whatcom counties, in the northern part of our service area. Their combined nameplate capacity is 387 MW.

Tenaska Cogeneration. Tenaska Washington Partners, L.P. owns and operates this project near Ferndale, Wash. In 1991, PSE contracted to purchase 245 MW beginning in April 1994. We later bought out the project's existing long-term gas supply contracts, which contained fixed and escalating gas prices well above then current and projected future market prices. This made PSE the principal natural gas supplier to the project, and power purchase prices under the Tenaska contract were revised to reflect market-based gas prices. This agreement ends December 31, 2011.

March Point Phases I & II. PSE has contracts through December 31, 2011 to purchase the full output of March Point Phases I & II from the March Point Cogeneration Company, which owns and operates these facilities. The plants are located at the Shell refinery in Anacortes, Wash., and deliver a combined 142 MW.

Other Long-term Contracts

Long-term contracts consist of agreements with independent producers and other utilities to supply electricity to PSE. Fuel sources include hydro, gas, waste products, and system deliveries without a designated supply resource. These contracts are summarized in Figure 5-10. Short-term contracts negotiated by PSE's energy trading group are not included in this listing.

NorthWestern Energy Company. This 20-year, unit-specific, purchased power contract is tied to Colstrip Unit 4. The contract, which expires in 2010, specifies capacity payments for each year, subject to reductions if specific performance is not achieved.

BPA – WNP-3 Bonneville Exchange Power. This is a system-delivery, not a unit-specific, purchased power contract. The agreement resulted from PSE claims against the Bonneville Power Administration (BPA) regarding its action to halt construction on nuclear project WNP-3, in which PSE had a 5% interest. Under the agreement, in effect until June 2017, PSE receives power during the winter months from BPA according to a formula based on the average equivalent annual availability and cost factors of four surrogate nuclear plants similar in design to WNP-3. In exchange, PSE provides power to BPA from its combustion turbines, if requested, except during the month of May.

BPA Snohomish Conservation Contract. This agreement, which runs through February 2010, is a system-delivery, not a unit-specific, purchased power contract. Snohomish County PUD, Mason County PUD, and Lewis County PUD installed conservation measures in their service areas. PSE receives an amount of power equal to the amount saved over the expected 20-year life of the measures. BPA delivered this power through 2001; after that, delivery passed to Snohomish County PUD.

Powerex Purchase for Point Roberts. Powerex delivers electric power to PSE's retail customers in Point Roberts, Wash. The Point Roberts load, which is physically isolated from PSE's transmission system, connects to British Columbia Hydro's electric distribution facilities. We pay a fixed price for the energy during the term of the contract. This agreement ends in September 2009, and PSE has begun discussions with Powerex to extend service.

BPA Baker Replacement. Under a letter of intent signed with the US Army Corps of Engineers (COE) for a 20-year agreement, PSE provides flood control for the Skagit River Valley. Early in the flood control period, we draft water from the Baker Reservoir at the request of the COE. Then, during periods of high precipitation and runoff between October 15 and March 1, we store water in the Upper Baker Reservoir and release it in a controlled manner to reduce downstream flooding. In return, PSE receives power from BPA from November through February; this compensates for the lower generating capability caused by reduced head due to the early drafting at the plant during the flood control months.

Pacific Gas & Electric Company (PG&E) Seasonal Exchange. Each calendar year PSE exchanges 300 MW of seasonal capacity, together with 413,000 MWh of energy, on a one-for-one basis under this system-delivery purchased power contract. PSE is a winter-peaking utility and PG&E is a summer-peaking utility, so we provide power to PG&E from June through September, and PG&E provides power to us November through February.

Canadian Entitlement Return. Under a treaty between the United States and Canada, one-half of the firm power benefits produced by additional storage capability on the Columbia River in Canada accrue to Canada. PSE's benefits and obligations from this storage are based on the percentage of our participation in the Columbia River projects. Agreements with the Mid Columbia PUDs specify PSE's share of the obligation to return one-half of the firm power benefits to Canada until the expiration of the PUD contracts or 2024, whichever occurs first. This is energy that PSE provide rather than receive, so it is a negative number (-58 MW for 2009).

Powerex. Under the terms of this contract, Powerex delivers power to PSE on peak hours during the winter months of December through February until 2012. Peak hours are defined as Monday through Saturday, hour ending 7:00 to hour ending 22:00.

Credit Suisse. This contract replaces a preexisting contract with an alternate counterparty. This is a system delivery, not a unit-specific, purchased power contract.

Under the terms of this agreement, Credit Suisse delivers 50 MW per hour of around-the-clock electric power through the end of March 2013.

RBS Sempra Commodities. This is a system-delivery, not a unit-specific, purchased power contract, which provides seasonally shaped power to PSE. RBS Sempra agrees to deliver 75 MW per hour during the months of July through March, and 25 MW per hour during the months of April through June until the end of the contract term. This contract terminates on March 31, 2013.

Barclays Bank. Under this agreement, which runs through February 2015, Barclays delivers around-the-clock power to PSE during the winter months of November through February. This is a system-delivery of 75 MW per hour, not a unit-specific, purchased power contract.

Figure 5-10
Long-term Contracts for Electric Power Generation

TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)*
NUG	Tenaska	Thermal	12/31/2011	245
NUG	March Point I	Thermal	12/31/2011	80
NUG	March Point II	Thermal	12/31/2011	62
Total NUG				**387**
Other Contracts	Northwestern Energy Company	Colstrip	12/29/2010	97
Other Contracts	BPA- WNP-3 Exchange	System	6/30/2017	82
Other Contracts	Conservation Credit - SnoPUD	Hydro	2/28/2010	18
Other Contracts	Powerex/Pt.Roberts	Hydro	9/30/2009	3
Other Contracts	BPA Baker Replacement	Hydro	10/1/2029	7
Other Contracts	PG&E Seasonal Exchange-PSE	Thermal	Ongoing*	300
Other Contracts	Canadian EA	Hydro	12/31/2025	-58
Other Contracts	Powerex	System	02/29/2012	150

TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)*
Other Contracts	Credit Suisse	System	03/31/2013	50
Other Contracts	RBS Sempra Commodities	System	03/31/2013	75
Other Contracts	Barclays Bank	System	02/28/2015	75
Total Other				**799**
Independent Producers	Spokane Municipal Solid Waste	Biomass-QF	11/15/2011	18
Independent Producers	Twin Falls	Hydro	3/8/2025	20
Independent Producers	Koma Kulshan	Hydro	3/1/2037	14
Independent Producers	North Wasco	Hydro	12/31/2012	5
Independent Producers	Nooksack Hydro	Hydro-QF	01/01/2014	1.5
Independent Producers	Weeks Falls	Hydro	12/1/2022	4.6
Independent Producers	Hutchison Creek	Hydro-QF	9/30/2016	1
Independent Producers	Cascade Clean Energy- Sygitowicz	Hydro-QF	2/2/2014	<1
Independent Producers	Port Townsend Paper	Hydro-QF	06/30/09	<1
Independent Producers	VanderHaak Dairy	Biomass	11/30/2011	<1
Independent Producers	Qualco Dairy	Biomass	11/30/2013	<1
Total Independent				**65**

*Nameplate capacity reflects PSE share only.

B. Demand-side Resources

Demand-side resources are generated or saved on the customer side of the meter. While they include demand-response, fuel conversion, distributed generation, and distribution efficiency, energy efficiency measures are by far the most substantial contributor to resource need. During the 2006-2007 tariff period, the 44.4 aMW contributed by these programs amounted to more than a year's worth of power supplied by the utility's March Point 2 contract, or enough energy to power more than 33,000 homes. Between 1985 and 2007, gains of 299 aMW have accumulated on an investment of $528 million – more than the annual output from our share of Colstrip 1 & 2 and equivalent to the electricity used by about 225,000 homes for a year. As with supply-side resources, PSE evaluates energy efficiency programs for cost-effectiveness and suitability within a lowest reasonable cost strategy.

Our energy efficiency programs serve all types of customers—residential, low-income, commercial, and industrial. Energy savings targets and the programs to achieve those targets are established every two years. The 2006-2007 biennial program period concluded at the end of 2007; current programs operate January 1, 2008 through December 31, 2009. The majority of electric energy efficiency programs are funded using electric "rider" funds collected from all customers.

For the 2008-2009 period, a two-year target of approximately 53.3 aMW in energy savings was adopted. This goal was based on extensive analysis of savings potentials and developed in collaboration with key external stakeholders represented by the Conservation Resource Advisory Group (CRAG) and Integrated Resource Plan Advisory Group (IRPAG).

Current Electric Energy Efficiency Programs

The **Commercial and Industrial Retrofit Program** offers expert assistance and grants to help existing commercial and industrial customers use electricity and natural gas more efficiently via cost-effective and energy efficient equipment, designs, and operations. This program produced the greatest gain in energy savings of all PSE efficiency programs in 2007, producing 7 aMW at a cost of $11 million; it accounted for 27% of all electric savings in 2007. Program savings declined in 2008, but at 19% they still represented the largest portion of all electric energy efficiency programs: 6 aMW was contributed at a cost of $13 million.

The **Energy Efficient Lighting Programs** offer instant rebates for residential customers and builders who purchase Energy Star fixtures and compact fluorescent light bulbs. These programs generated the greatest energy savings gains on the residential side in 2007, producing 10 aMW at a cost of $7 million and accounting for 32% of all electric savings. In 2008, program savings increased, and again it was the dominant contributor, saving 12 aMW at a cost of $8 million. This represented 38% of all electric energy efficiency savings.

Figure 5-11
Annual Energy Efficiency Program Summary, 2006-2008
(Dollars in millions, except MWh)

Program	2006 - 2007 Actual	'06-'07 2-Year Budget./Goal	'06/'07 Actual vs. '06/'07 % Total	2008 Actual	'08-'09 2-Year Budget./Goal	'08 vs. '08/'09 % Total
Electric Program Costs*	$ 65,455,248	$ 67,450,175	97.0%	$ 53,172,241	$ 123,250,000	43.1%
Megawatt Hour Savings	388,563	357,706	108.6%	273,555	467,195	58.6%

*Does not include low-income weatherization O&M funding of $300 thousand per year.

Figure 5-11 shows performance compared to two-year budget and savings goals for the biennial 2006-2007 electric energy efficiency programs, and records 2008 progress against 2008-2009 budget and savings goals.

During 2006-2007, electric energy efficiency programs saved a total of 44.4 aMW of electricity at a cost of $66 million. The company surpassed two-year savings goals while operating at a cost that was under budget. In 2008, these programs saved 31 aMW of electricity at a cost of $53 million. The average cost for acquiring energy efficiency increased from 2007 to 2008 by approximately 51%, while energy savings increased by 23%.

RFPs. In 2007 and 2008 PSE issued four RFPs for energy efficiency and demand-response pilots. We issued two energy efficiency RFPs for resources to be added in 2008-2009. The first, issued in June 2007, targeted specific program areas; the second was an "all-comers" energy efficiency RFP open to all program areas. The RFP process is used to seek out and fill untapped market segments or add under-utilized energy efficiency technologies to complement our ongoing efforts. No significant new opportunities for additional electric energy efficiency were identified. Of the 39 proposals received for both RFPs, four were awarded contracts.

Similarly, PSE issued two demand-response RFPs during 2007 and 2008. The first was a commercial sector pilot issued in August 2007; two proposals were received and one contract was awarded. A second RFP, for the residential sector, was issued in November 2008; nine proposals were received, and one has been selected.

C. Green Power and Small-scale Renewables

PSE's customer renewable energy programs continue to grow. The **Green Power Program** serves customers who want additional renewable energy, and the **Customer Renewables Program** serves those who generate renewable energy on a small scale. Our customers find value as well as social benefits in the programs, and PSE embraces and encourages their use.

Green Power

PSE's Green Power Program, launched in 2001, allows customers to voluntarily purchase retail electric energy from qualified renewable energy resources. Every year since 2005, the National Renewable Energy Laboratory has recognized PSE as one of the top 10 utilities for Renewable Energy Sales and Total Number of Green Power Participants. Between 2006 and 2008, the number of subscribers increased from 17,426 to 21,509, and the number of megawatt-hours purchased increased from 131,742 to 291,167.

To supply green power, the program purchases renewable energy credits (RECs), also called green tags, from a variety of sources. The primary supplier is the Bonneville Environmental Foundation (BEF), a nonprofit environmental organization in Portland, Ore., which provides a portfolio of resources including wind, solar, and biomass. In addition, the Green Power Program purchases RECs directly from producers in order to support the development of new small renewable resources. Examples include the Vander Haak Dairy, Grays Harbor Paper, and the Nooksack Hydro Facility. The program has also been working with two methane digester developers – Farm Power LLC, and Qualco Energy – to finalize the purchase of RECs from their projects upon completion in 2009. In recognition of the high level of program participation in Bellingham, the Green

Power Program has also funded solar demonstration projects at the Bellingham Environmental Learning Center, the Depot Market Square, and Western Washington University's Student Union.

2009 marks the expiration of a three-year agreement with BEF for the purchase of RECs, which has provided PSE with some surety on REC pricing and flexibility in adding small-scale resources to the program. Increased pressure on west coast renewables, due to expanding compliance requirements, means the Green Power Program will consider including some RECs from outside the WECC region when it issues an RFP for a new REC agreement this year.

Figure 5-12 lists the resources that make up PSE's Green Power Portfolio.

Figure 5-12
Green Power Portfolio

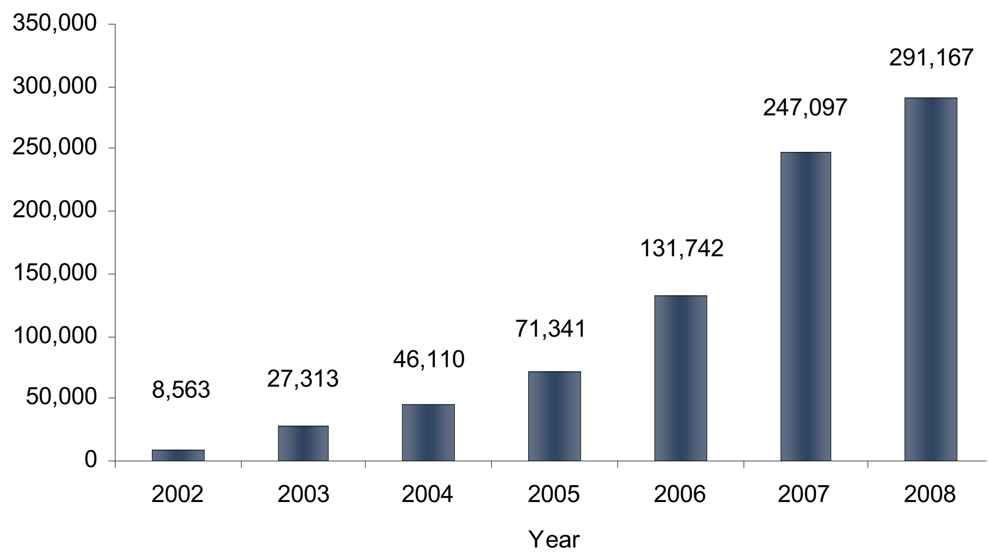
Name	Resource	Location
Condon	Wind	Condon, OR
Stateline	Wind	Walla Walla, WA
White Creek	Wind	Klickitat Co., WA
Klondike II	Wind	Sherman Co., OR
Nine Canyon	Wind	Kennewick, WA
Nine Canyon II	Wind	Kennewick, WA
Wolverine Creek	Wind	Bingham, ID
H.W, Hill LFG	Bio	Klickitat Co., WA
Edgeley/Kulm	Wind	Edgeley, ND
Small Solar	Solar	Various, OR, WA
Vander Haak	Bio	Lynden, WA
Grays Harbor Paper	Bio	Hoquiam, WA
Nooksack Hydro Facility	Low-Impact Hydro	Nooksack, WA

Rates. The standard rate for green power is $0.0125 per kWh. Customers can purchase 160 kWh blocks for $2 per block with a two-block minimum, or they can choose to participate in the "100% Green Power Option." Introduced in 2007, the 100% option adjusts the amount of the customer's monthly green power purchase to match their monthly electric usage. In 2007, the Green Power Program reduced rates from $0.02 per kWh to the $0.0125 per kWh.

The large-volume green power rate—0.6 cent per kWh for customers who purchase more than 1,000,000 kWh annually—has attracted 20 customers since it was introduced in 2005.

In 2008, the Green Power Program issued an RFP for a third-party marketer to help increase participation. As a result, PSE signed a three-year contract with 3Degrees; together we established a goal of increasing residential customer participation from 2% of total to 4% by December 31, 2011. 3Degrees has developed and refined education and outreach techniques while working with other utility partners across the country.

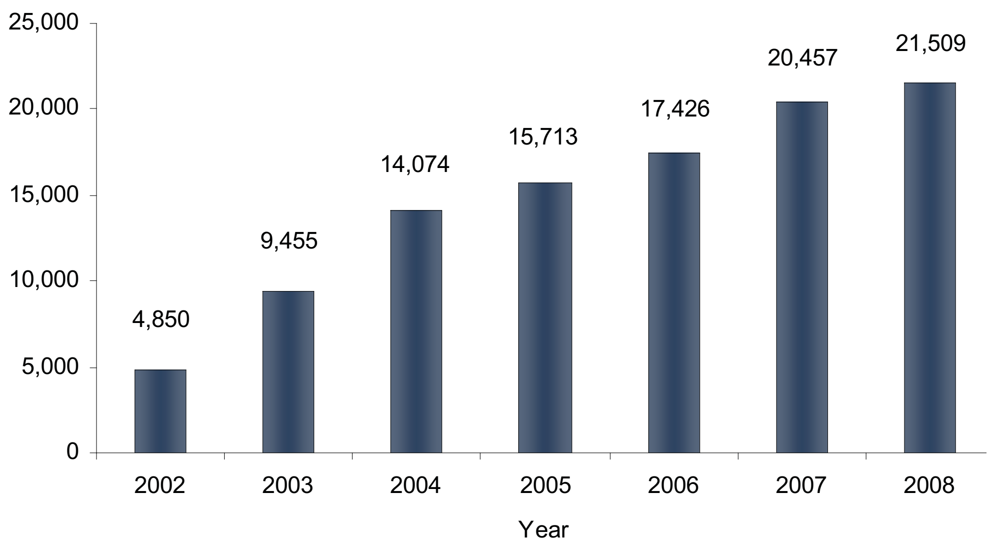
Figure 5-13
Green Power Kilowatt-Hours Sold, 2002-2008



In 2008, the average residential customer purchase was 557 kWh per month, and the average commercial customer purchase was 1,989 kWh. The average 2008 large-volume purchase, by account, under Schedule 136 was 28,690 kWh per month.

Figure 5-14 illustrates the number of subscribers by year. Of our 21,509 Green Power subscribers at the end of 2008, 20,619 were residential customers and 890 accounts were business customers. Cities with the most residential and commercial participants include Bellingham with 2,965, Olympia with 2,410, Bellevue with 1,223, and Kirkland with 970.

Figure 5-14
Green Power Subscribers, 2002-2008

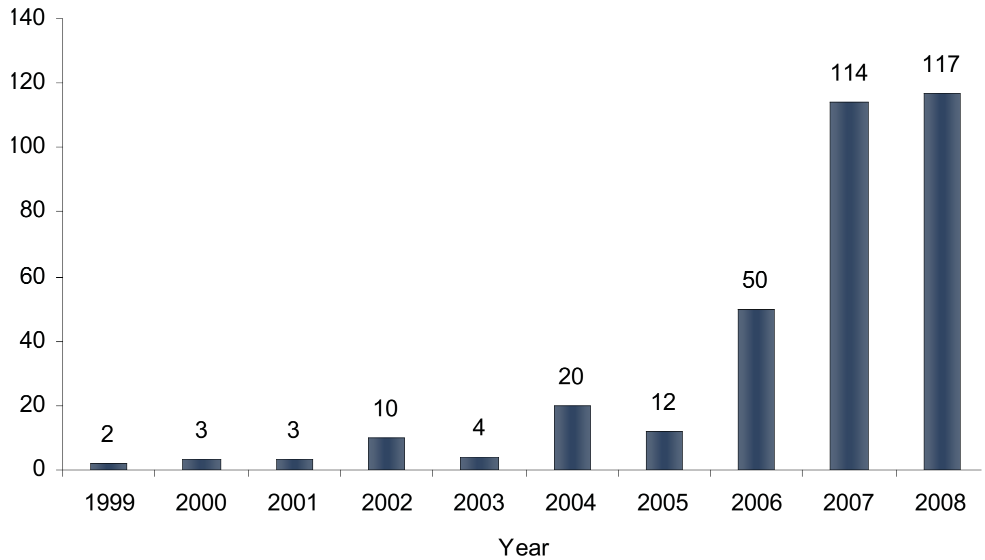


Customer Renewables Programs

PSE's net metering program, which began in 1999, provides a way for customers who generate their own renewable electricity to offset the electricity provided by PSE. The amount of electricity that the customer generates and sends back to the grid is subtracted from the amount of electricity provided by PSE, and the net difference is what the customer pays on a monthly basis. A kWh credit is carried over to the next month if the customer generates more electricity than PSE supplies over the course of a month. The "banked" energy can be carried over until every April 30, when the account must reset to zero according to state law. The interconnection capacity allowed under net metering is 100 kW.

Customer interest in small-scale renewables has increased significantly over the past four years, as Figure 5-15 shows. In 2008, PSE added 117 new net metered customers for a total of 335.

Figure 5-15
Net Metered Customers Added per Year 1999-2008



The vast majority of customer systems are solar photovoltaic (PV) installations with an average generating capacity of 3.6 kW, but there are also small-scale hydroelectric generators and wind turbines. These small-scale renewable systems are distributed over a wide area of PSE's service territory. The average generating capacity of all net metered systems is also 3.6 kW. Overall, the program was capable of producing more than 1.2 MW of nameplate capacity at the beginning of 2009.

Figure 5-16
Interconnected System Capacity by Type of System

System Type	Number of Systems	Average Capacity per System Type (kW)	Sum of all Systems by Type (kW)
Hybrid; solar/wind	3	3.98	11.95
Micro hydro	4	4.63	18.50
Solar array	318	3.61	1148.01
Wind turbine	10	2.91	29.10
Total Number of Systems	**335**	**Total Capacity of All Systems**	**1207.56**

Figure 5-17
Net Metered Systems by County

County	Number of Net Meters
Whatcom	46
King	68
Jefferson	60
Skagit	43
Island	28
Kitsap	42
Thurston	32
Kittitas	6
Pierce	10

Renewable Energy Advantage Program. In 2005, PSE launched a Renewable Energy Advantage Program (REAP) in response to WAC 458-20-273. The program is voluntary for Washington state utilities, but we embraced the opportunity to participate because we have such a large and committed group of interconnected customers. Payments are made to interconnected electric customers who own and operate eligible renewable energy systems including solar PV, wind, or anaerobic digesters (the four micro hydro customers are not eligible under the current law). Annual amounts range from 15 cents to 18 cents per kWh produced by their system. PSE receives a state tax credit equal to the aggregate incentive payments made to customers. By the end of 2008, the Renewable Energy Advantage Program had enrolled 300 of our 331 eligible customers for production payments. The tariff governing REAP is Schedule 151.

III. Electric Resource Alternatives

Even though dozens of electric resource alternatives are discussed in the media today—from wiregrass-fueled biomass generators to fuel cells and tidal technology—very few are capable of generating "utility scale" power. This chapter presents an overview of the most relevant possible additions to PSE's portfolio. It is a brief discussion of what resources were modeled and not modeled in the analysis. A comprehensive list of alternatives, and detailed information on their current development status, is included in Appendix F, Electric Resource Alternatives.

Our consideration of both demand- and supply-side options is informed by PSE's active participation in the marketplace, our close observation of developing market trends, and information obtained from a variety of public resources such as the Northwest Power and Conservation Council (NPCC) and the Energy Information Administration (EIA).

Thermal Resources

Coal

It is hard to consider new coal plants a "commercially viable" resource in today's market. While Washington state's emissions standard (RCW 80.80) does not currently prohibit importing new coal power from out of state, it appears unrealistic to think that a new coal plant could be constructed anywhere in the Western United States, even if a developer or utility wanted to build one.

Though the coal resources that are already part of PSE's portfolio offer valuable resource diversity and a low-cost, stable fuel source, existing plants are no longer capable of providing enough generation to meet growing long-term need reliably. Adding more coal would expose the utility to a number of substantial risks.

- Activity at state and federal levels suggests that the potential cost of mitigating the level of CO_2 emissions produced by coal-fired plants may reduce the economic advantage of lower fuel costs.
- Carbon capture and sequestration technologies – key to managing coal risks – have not been proven, and there is no reliable estimate of when commercial viability may be achieved.

- The cost of permitting, constructing, and operating new coal plants has increased enormously.
- The regulatory framework needed to address siting and permitting for sequestration projects has only just begun.

Natural Gas

Natural gas-fired generation has several benefits.

- Proximity: A gas-fired generator can be located within or adjacent to PSE's service area, which avoids potential costly transmission investments required for long distance resources.
- Timeliness: Gas-fired resources are dispatchable, meaning they can be turned on when needed to meet loads, unlike intermittent resources such as wind and run-of-the-river hydropower.
- Versatility: Different kinds of gas-fired generators have varying degrees of ability to ramp up and down quickly in response to variations in loads and variations in wind generation.
- Scalability: Gas plants are more scalable and less capital intensive than coal plants and thus avoid some of the long-lead risks associated with the development of remote coal mines and coal plants.
- Environmental burden: Natural gas resources produce significantly lower emissions than coal resources (approximately half the CO_2).

However, natural gas resources do have drawbacks. There are concerns about long-term availability, especially as the region becomes increasingly dependent on natural gas for generation fuel. Lack of diversity in supply basins and lack of diversity in gas transportation alternatives also create concern, as do long-term price risks and short-term market price volatility.

Natural Gas-fired Combined-cycle Combustion Turbines (CCCTs). Combined-cycle combustion turbine power plants consist of one or more gas turbine generators equipped with heat recovery steam generators that capture heat from the gas turbine exhaust. This otherwise wasted heat is then used to produce more electricity via a steam turbine generator. CCCT plants currently entering service can convert about 50% of the chemical energy of natural gas into electricity. Because of their high thermal efficiency and reliability, relatively low initial cost, and low air emissions, CCCTs have been the resource of choice for power generation for well over a decade.

Natural Gas-fired Simple-cycle Combustion Turbines. One of the benefits of simple-cycle combustion turbines is that they can be built in ten months or less. They can also be brought online quickly to serve peak need. While simple-cycle units can be brought online more quickly than combined-cycle units, simple cycles are less efficient and have higher heat rates than combined cycles, rendering them more expensive to run. Additionally, these units have relatively high capital costs, and are subject to significant risks related to rising gas costs, as well as fuel supply and delivery diversity issues.

Natural Gas Fueled Reciprocating Engines. Like simple-cycle combustion turbines, reciprocating engines can be built in ten months or less, and they can be brought online quickly to serve peak loads. Unlike gas turbines, reciprocating engines demonstrate consistent heat rate and output during all temperature conditions. Generally these units are small and are constructed in power blocks with multiple units. Reciprocating engines are less efficient than simple-cycle combustion turbines, but the small size of the units allows a better match with peak loads thus increasing operating flexibility relative to the simple-cycle combustion turbine.

Natural Gas Peaker. The "peaker" unit is meant to represent both the simple-cycle combustion turbine (SCCT) and the reciprocating engines, recips. The peaker does not distinguish between operating characteristics of a recip and a SCCT. PSE had the most up-to-date information on the recips, so we chose those assumptions as the basis for the peaker.

Renewable Resources

Most renewable technologies are not yet commercially viable – that is, they are not able to economically generate power on a scale large enough to make meaningful contributions to meeting utility-scale needs. Brief overviews of resources modeled in this IRP appear below. A more comprehensive list with a fuller discussion of their development status appears in Appendix F, Electric Resource Alternatives.

Solar. Solar has seen significant growth internationally, driven by subsidies in select markets, notably Germany, Spain, France, and California. This has led to improved manufacturing and installation technologies, which has in turn driven down costs.

Improved understanding and comfort with the technology has improved financing conditions. Though the recent economic downturn has led to some scaling back of solar expansion plans, overall, the market is expected to continue to grow. PSE began to develop the Wild Horse Solar Facility in 2007, and continues to collect data from this facility to evaluate equipment performance and fit with our resource portfolio. The company will continue to explore different financial structures and technologies for solar development in the Northwest, including concentrating solar thermal (CST) with thermal storage.

Geothermal. Proven geothermal resources in the Northwest are generally clustered in Oregon and Idaho, and so would require transmission to bring power to PSE's service territory. Several new developments are moving forward with test wells in Oregon, and more are proposed for Oregon and Idaho. In addition to traditional geothermal technologies, the Department of Energy has restarted funding for Enhanced Geothermal Research. PSE will continue to monitor technology developments in geothermal, as well as entertain proposals for geothermal projects and power.

Biomass. Most existing biomass in the Northwest is tied to steam hosts, typically in the timber, pulp, and paper industries. This has limited the size of available power to export to date, and exposed biomass projects to fuel supply and fuel management risks. Some new models of biomass sourcing are emerging, with some companies exporting biomass specifically for power generation and new longer-term supply contracts being considered. PSE will continue to seek biomass projects with stable fuel sources and high reliability.

Wind. The Renewable Portfolio Standard (RPS) established in Washington state by Initiative 937 requires that an increasing portion of renewable resources make up the portfolio of the largest utility providers. While the RPS contemplates several distinct types of renewable resources, wind energy is the primary producer in our region due to its technical maturity, reasonable lifecycle cost, acceptance in various regulatory jurisdictions, and large "utility" scale compared to other technologies. Renewable portfolio standards are being adopted in Oregon, California, and other states across the country, increasing overall demand for wind resources throughout the region and the nation. As a result, PSE expects competition for experienced wind developers, viable sites, and wind turbine equipment to remain robust.

Wind is also a variable generating resource, meaning that daily and hourly power generation patterns may not correlate well with customer demand. Because of this, more flexible baseload resources must be available to "fill the gaps." Further, integrating a variable generation resource into the transmission system poses challenges. For a detailed discussion of wind integration issues, refer to Appendix H, Wind Integration Studies.

Finally, remotely located wind projects may face long-haul transmission constraints resulting from increased demand on a near fully subscribed system. Many of these constraints are covered in Appendix G, Regional Transmission Resources.

Demand-side Resources

Demand-side resources include energy efficiency, fuel conversion, and distributed generation. Each of these alternatives enables PSE to make less energy do the same amount of work.

Energy efficiency is defined as a technology that demonstrates the same performance for a given task as competing technologies, but requires less energy to accomplish the task. Energy efficiency resources count toward meeting the company's energy efficiency requirement under the state's renewable portfolio standard (RPS).

Fuel conversion takes place when a customer switches from electricity to natural gas, particularly in the case of space and water heating. Electrical savings are gained from the reduction in electrical energy use.

Distributed Generation refers to small-scale electricity generators located close to the source of the customer's load.

Distribution Efficiency consists of energy efficiency and peak load management opportunities and practices on the utility's distribution system that will save energy and capacity. Distribution efficiency is implemented on utility owned components such as substations and transformers. Its contribution as a resource alternative is similar to any customer owned or implemented demand side alternative and is the reason it is grouped with other demand side resources.

Demand Response is comprised of flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. The acquisition of demand response resources may be based on reliability considerations or economic or market objectives.

Short-term Resource Alternatives

In order to effectively balance the power supply portfolio, PSE actively engages in short-term energy markets including balance of the month, cash, and real time markets. The company actively monitors energy supply, capacity requirements, and merchant transmission availability, and engages in short-term market transactions that meet reliability, economic, and compliance obligations as necessary. In the recent past, PSE has focused on managing short-term positions with tools such as temporal exchanges, ancillary energy products, and energy products with various points of physical delivery.

Resources Not Modeled

Nuclear. Development and construction costs for nuclear power plants are so much higher than the next highest baseload resource option as to be prohibitive to all but a handful of the largest capitalized utilities. In addition, permitting, public perception, and waste disposal pose substantial risks.

Tidal and wave. PSE has been a supporter of two Northwest ocean energy studies (one tidal assessment and one wave demonstration project) because we believe that tidal and wave resources merit further attention and monitoring; however, commercial production of such resources is not possible at this time. Also, additional work is necessary to clarify permitting processes, evaluate environmental impacts, and develop generation technologies. We will continue to monitor the development of these resources in the northwest and internationally.

Hydroelectric. There are few new hydroelectric generating opportunities in the region, and none without significant environmental and permitting risk. Further, recent federal court decisions seem to raise risks for existing large hydroelectric projects. (Hydroelectric power may not be counted toward fulfilling RPS requirements in Washington state.)

Power Purchase Agreement (PPA). This plan did not evaluate the potential alternative of PPAs because costs and terms are market driven and known only at the time of the offer. While PPAs were not evaluated for the plan, they will certainly be considered and evaluated as alternatives to meet PSE's resource needs.

PPAs are a useful resource strategy because they are an alternative to the risk and expense associated with new plant development, construction, and operation; however, they are not a physical asset and do not have an equity component. Therefore, PPAs generally do not contribute to earnings. In addition, rating agencies such as Standard and Poor's view electric utility PPAs as fixed commitments that affect a company's ability to cover debt obligations. Consequently, the agencies calculate (impute) debt associated with the capacity portion of payments made under these agreements.

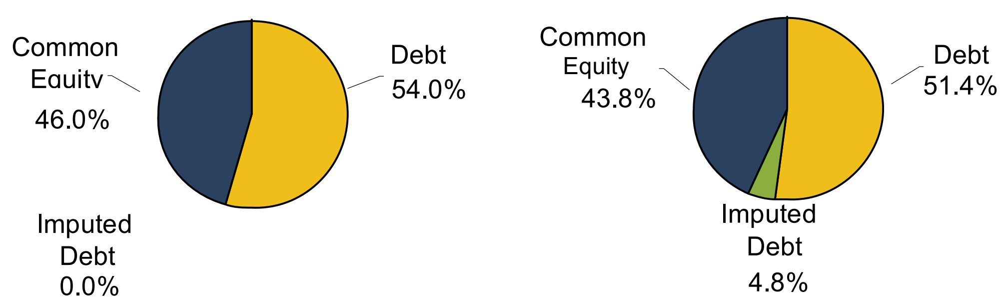
Applying imputed debt to PPAs degrades credit ratios and is thus a negative factor in determining credit rating. When PSE evaluates long-term PPAs to fill the resource need, we will include an equity offset cost that reduces the impact to credit ratios.

PSE's reliance on PPAs has added more than $300 million of imputed debt to PSE's year-end 2007 capital structure used in credit metrics analysis.

As Figure 5-18 shows, including $300 million of imputed debt in the capital structure allowed by the WUTC in the 2008 General Rate Case settlement reduces the equity component from 46% to less than 44%.

The extent of PSE's reliance on PPAs increases the challenge of strengthening our credit rating.

Figure 5-18
Capital Structure With and Without Imputed Debt



Plant ownership, as compared with PPAs, provides the operational flexibility of choosing to maintain and run the plant in a way that maximizes the plant's useful life. PPA sellers, on the other hand, choose the maintenance schedule that is best for them and could offer their plant at current fair market value, giving PSE the choice of buying the plant outright. That opportunity to purchase the plant provides some flexibility to a PPA, but there is a perception that purchasing the plant means PSE is paying for the facility twice—once by purchasing the power through the PPA, and again at contract termination.

PSE has mixed experiences with counterparty risk. Most counterparties have fulfilled their commitment to deliver, but some have defaulted. The default requires that PSE replace the power supply or gas supply that is lost, and the price and terms of the replacement resource may be either detrimental or helpful to PSE customers. Thus default on a PPA creates risk of replacement price and terms.

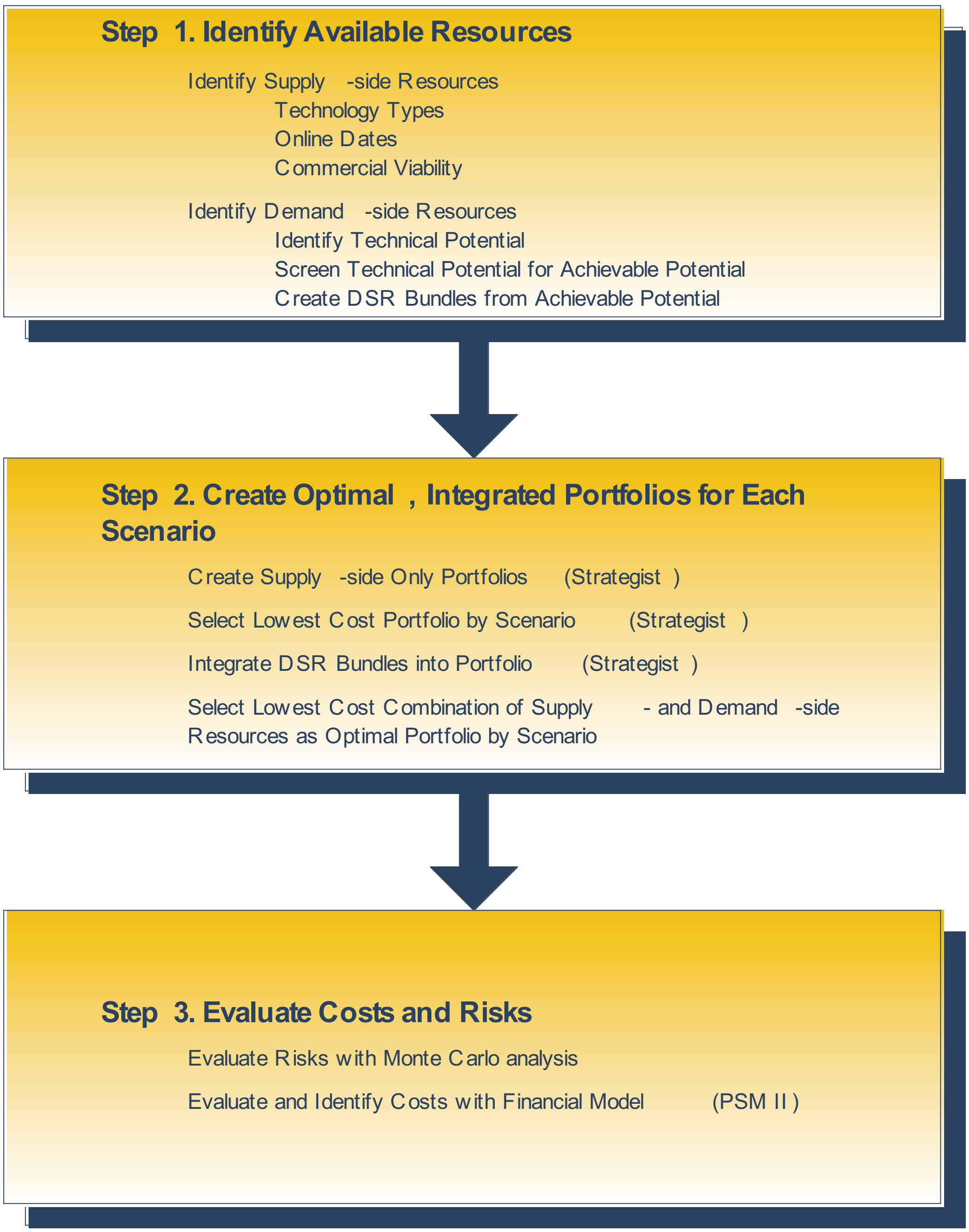
IV. Electric Analytic Methodology

This section describes the quantitative analysis of electric demand- and supply-side alternatives. It explains how portfolios were created in response to a variety of key economic assumptions expressed as scenarios, and how these portfolios were evaluated for cost and risk. The resulting analysis allowed the company to quantify how sensitive portfolios were to the planning assumptions, and provided insight into how adding different types of generation would affect PSE ratepayers' costs. Among the critical questions posed were the following:

- How might economic conditions and load growth affect resource decisions?
- How sensitive are the demand-side portfolios to different levels of avoided costs?
- What are the key decision points and most important uncertainties in the long-term planning horizon, and when should we make those decisions?
- What impact might very different levels of natural gas prices have on resource decisions?
- Would different power plant costs in the future significantly impact our resource decisions?
- How might future carbon regulation affect the relative value of resource alternatives?
- What carbon emissions are produced by portfolios under different scenarios?

Electric analytic methodology followed the three basic steps illustrated in Figure 5-19. A detailed technical discussion of these models and methods is included in Appendix I, Electric Analysis.

Figure 5-19
Methodology Used to Create and Evaluate Portfolios



Step 1: Identify Available Resources

First, all resources that are available to fill unmet need were identified.

Supply-side resources included coal-fired generation, natural gas-fired generation, wind, solar, geothermal, and biomass. Their selection is described in Section III of this chapter.

Selection of demand-side resources followed the process illustrated in Figure 5-20. First, each demand-side measure was screened for technical potential. This step assumed that all opportunities could be captured regardless of cost or market barriers, so that the full spectrum of technologies, load impacts, and markets could be surveyed.

A second screen eliminated any resources not considered achievable. To gauge achievability, we relied on customer response to past PSE energy programs, the experience of other utilities offering similar programs, and the Northwest Power Planning and Conservation Council's most recent energy efficiency potential assessment. (For this IRP, PSE assumed economic electric energy efficiency potentials of 85% in existing buildings and 65% in new construction.)

The remaining measures were considered to have "achievable technical potential." These were combined into bundles based on levelized cost for inclusion in the optimization analysis conducted in Step 2. (A detailed discussion of demand-side resource evaluation and the development of DSR bundles can be found in Appendix L, Demand-side Resource Analysis.)

Figure 5-20
General Methodology for Assessing Demand-side Resource Potential

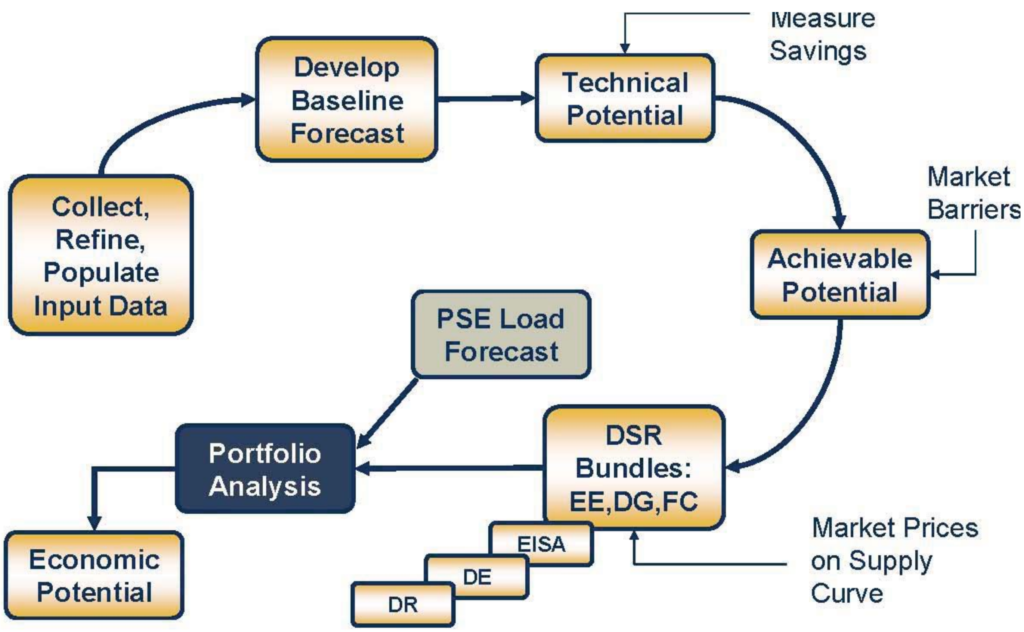
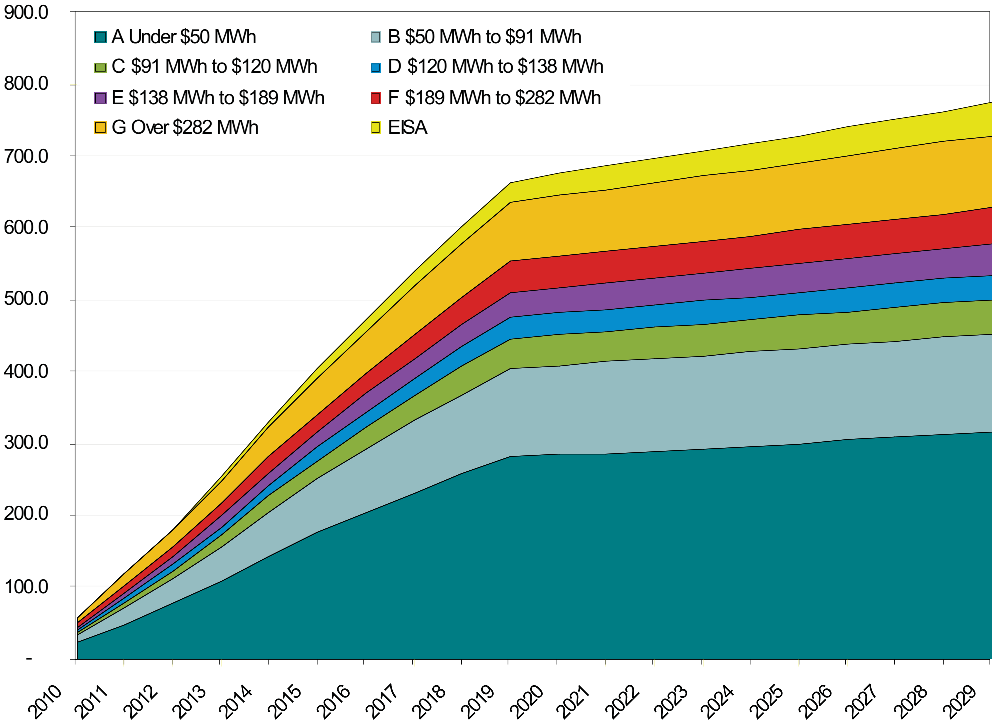


Fig 5-21 shows the achievable potential of all DSR bundles tested in the IRP. The effect of these bundles is to reduce load, so the costs of achieving the savings are added to the cost of the electric portfolios.

Figure 5-21
Achievable Technical Potential by Demand-side Cost Bundles (aMW)



Step 2: Create Optimal, Integrated Portfolios for Each Scenario

An optimal, integrated portfolio for each scenario and sensitivity was created using the Strategist portfolio optimization model to combine 11 supply-side resources with 5 demand-side bundles. This is a general description of the process; for a detailed description of Strategist, see Appendix I, Electric Analysis.

- First, each scenario was combined with all available supply-side resources in the Strategist model.
- Strategist then produced all possible supply-side-only resource combinations capable of filling the resource need defined in that scenario.
- Next, these No-DSR portfolios were ranked in order of cost.
- The lowest-cost, No-DSR portfolio became the starting point for integrating demand-side resources.
- Finally, DSR bundles were added to the lowest-cost, No-DSR portfolio one by one until they no longer reduced portfolio cost.

The results in Figure 5-22 show how DSR bundle C completes the optimal, integrated portfolio for the 2007 Business As Usual scenario.

Figure 5-22
Selection of DSR Bundle for 2007 Business as Usual Portfolio

Scenario	No DSR	DSR A	DSR B	DSR C	DSR D	DSR E
2007 Business as Usual	27.35	23.94	23.17	22.95	23.04	

DSR A < No DSR test DSR B	DSR B < DSR A test DSR C	DSR C < DSR B test DSR D	DSR D > DSR C DSR C "optimal"

For comparison purposes, PSE also constructed one portfolio to the specifications of the B2 Energy Standard adopted in 2003. Resource planning conditions have changed significantly since that time, and we wanted to test whether this energy standard still reduced cost and risk. It did not.

Figures 5-23, 5-24, and 5-25 display the MW additions for the 11 optimal portfolios in 2015, 2020, and 2029. See Appendix I, Electric Analysis, for more detailed information.

Figure 5-23
2015 Resource Builds by Scenario (Cumulative Additions by Nameplate)

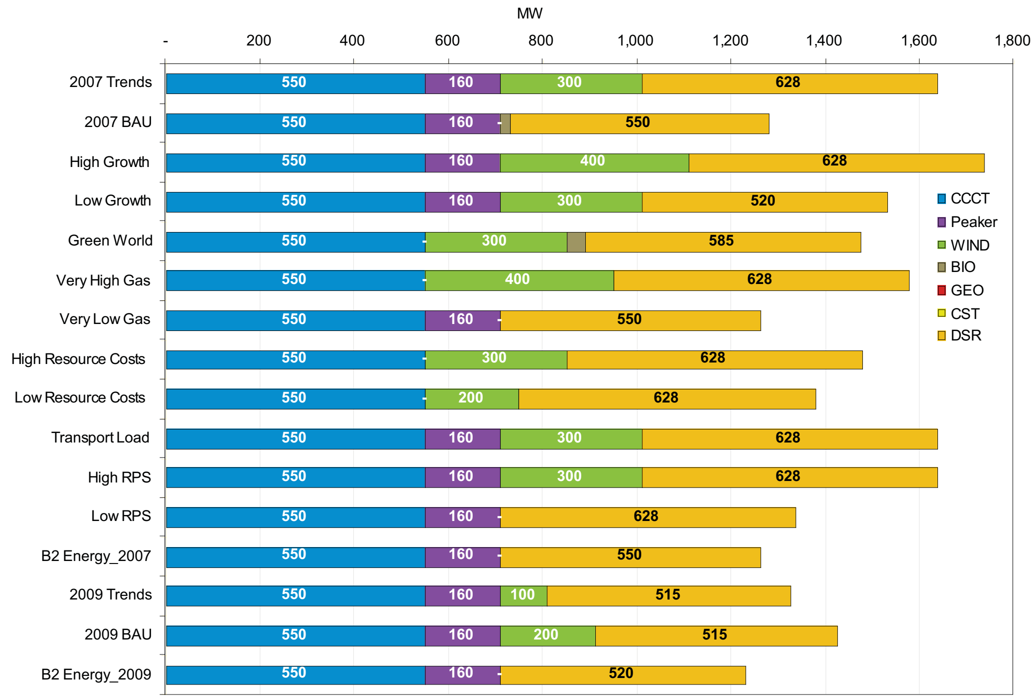


Figure 5-24
2020 Resource Builds by Scenario (Cumulative Additions by Nameplate)

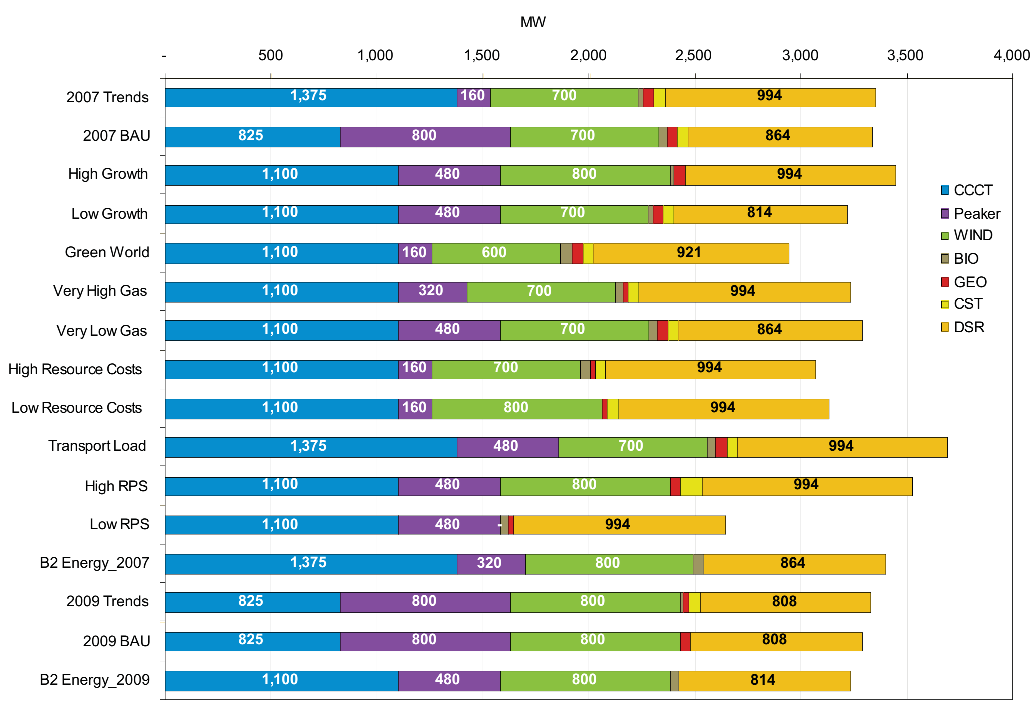
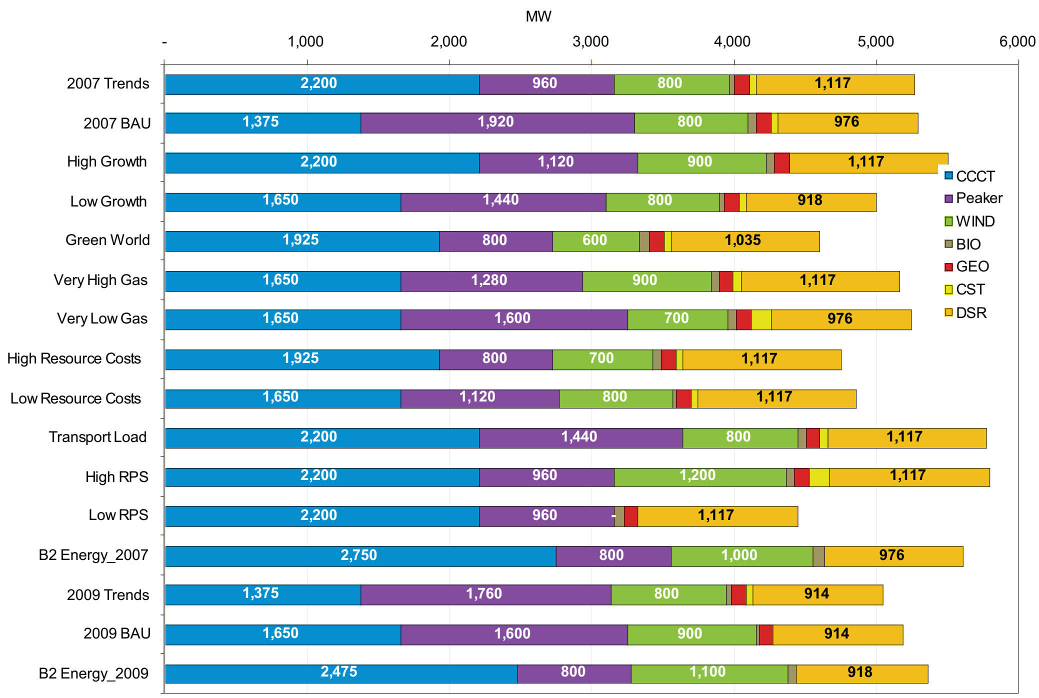


Figure 5-25
2029 Resource Builds by Scenario
(Cumulative Additions by Nameplate)



As explained at the beginning of this chapter, PSE considered two ways of looking at resource need during development of this IRP. In the portfolios illustrated above, the resource need was constructed by deducting short-term operating reserves from existing resources before making the need calculation. In the selected portfolios illustrated below, the resource need was calculated assuming full capacity, with no reduction to account for operating reserves, and are therefore identified as “Full-Cap.” Figures 5-26 to 5-28 represent the builds for these “Final” portfolios. (The difference between the two methods of calculating need is discussed more fully in Section I of this chapter.)

Figure 5-26
2012 Full-Cap Resource Builds for Selected Scenarios
(Cumulative Additions by Nameplate)

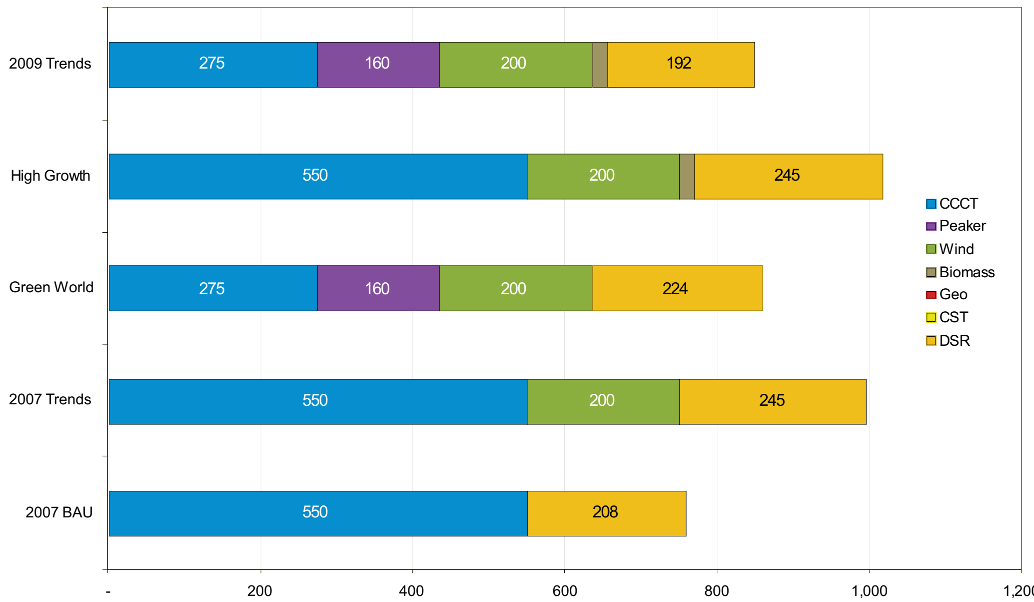


Figure 5-27
2020 Full-Cap Resource Builds for Selected Scenarios
(Cumulative Additions by Nameplate)

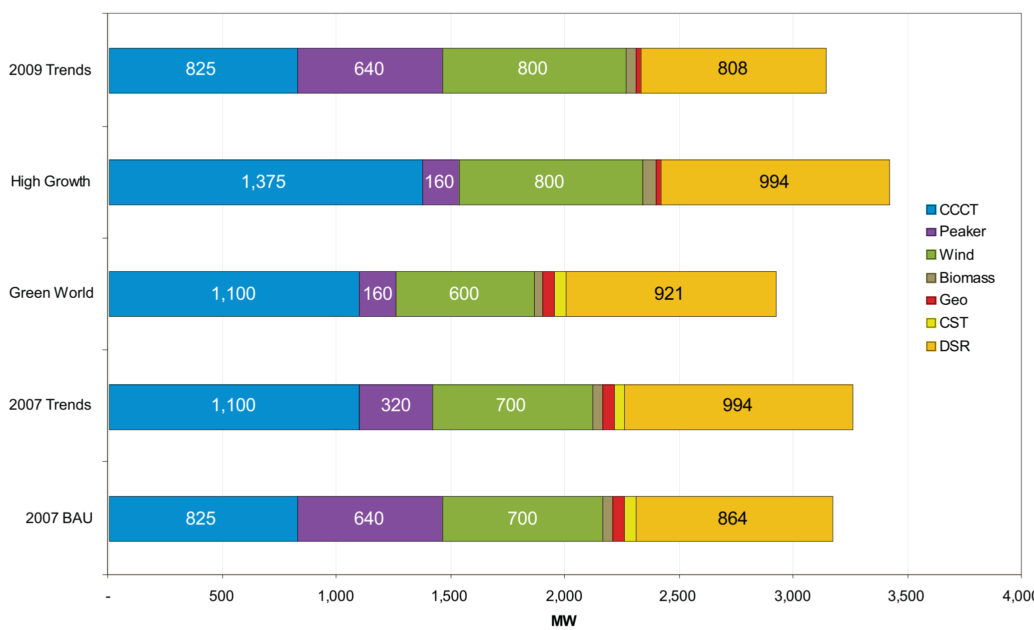
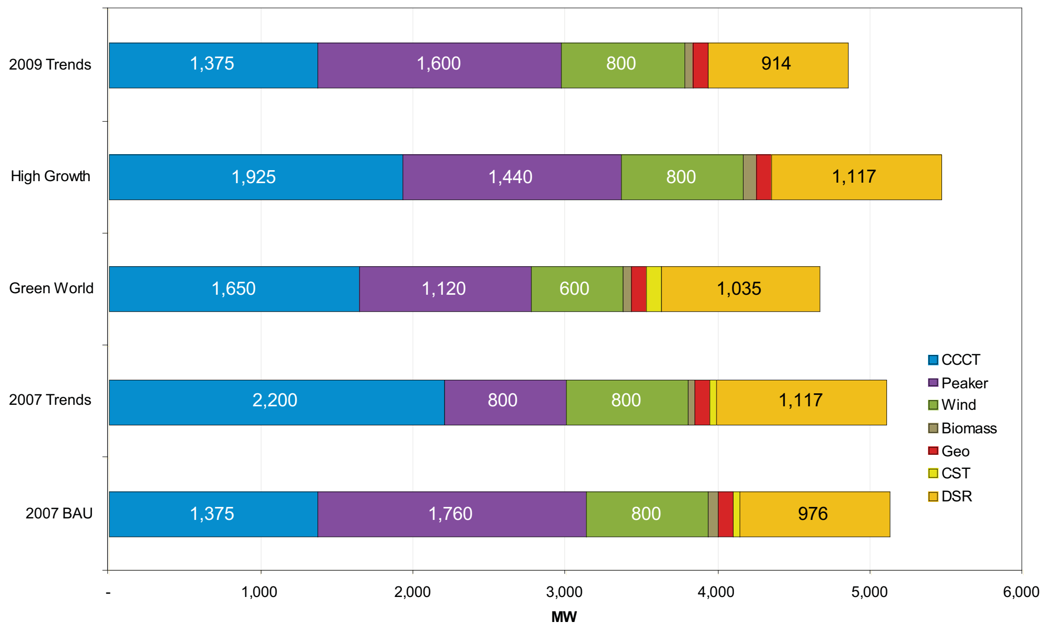


Figure 5-28
2029 Full-Cap Resource Builds for Selected Scenario
(Cumulative Additions by Nameplate)



Step 3: Evaluate Costs and Risks

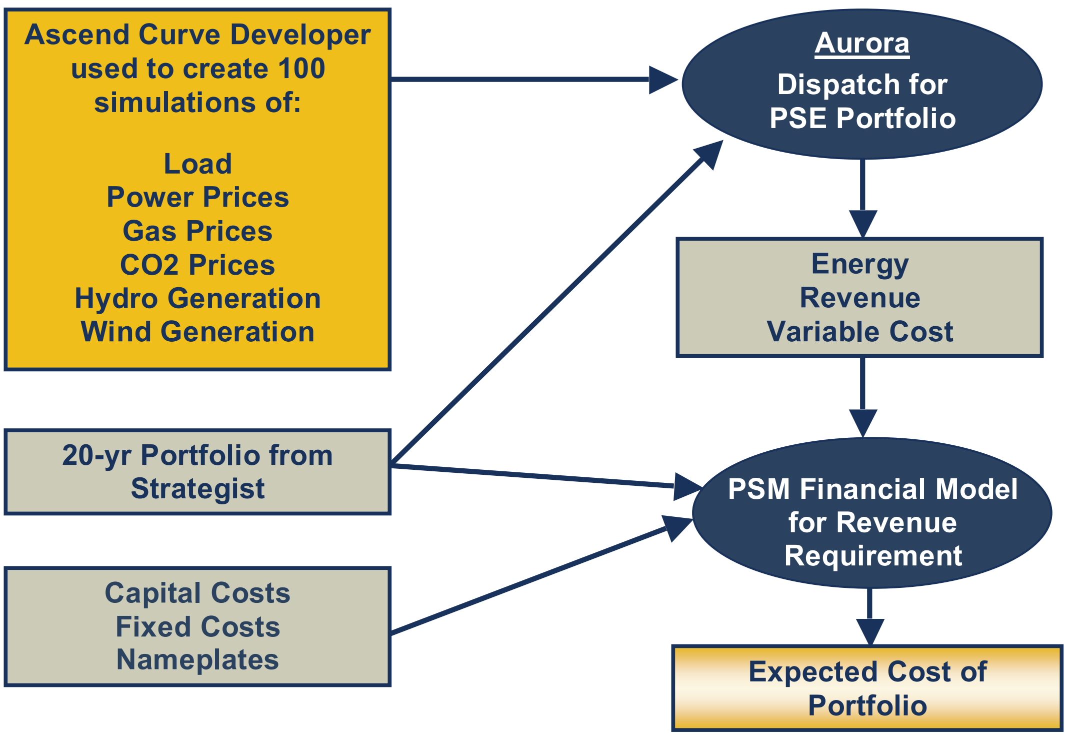
Once the optimal portfolio for each scenario was identified, PSE conducted Monte Carlo analysis on select portfolios. The PSM II process illustrated in Figure 5-29 was used to calculate the revenue requirements for portfolios. Since the Full-Cap portfolios are effectively subsets of the non-Full-Cap portfolios, PSE can apply all the cost and risk conclusions from one set of builds to the corresponding set of Full-Cap builds. PSE confirmed this by comparing 2009 Trends and 2009 Trends (Full-Cap); the comparison found that the only difference between the portfolios was a small reduction of costs that coincides with the small change in resource builds.

Ascend Curve Developer was used to create 100 simulations of input variables for the 2007 Trends scenario, and 100 simulations for the 2007 Business As Usual scenario. These variables, along with the optimal portfolios for the two scenarios, were loaded and dispatched in AURORA. The dispatch results were then loaded into the PSM financial model, and PSM calculated revenue requirements. This allowed us to fully understand risks associated with differing gas prices, power prices, and weather conditions that affect loads, and hydropower and wind generation levels.

In addition, static analysis was used to test the 2007 Trends Portfolio and 2007 Business As Usual Portfolio in the other six scenarios. These results enabled the company to examine how they performed against each other under different conditions, and how they performed against the optimal portfolio for that scenario.

The key quantitative results and insights from this analysis are described in Section V of this chapter. For detailed results, go to Appendix I, Electric Analysis.

Figure 5-29
PSM II Analysis Process



V. Key Findings and Insights

The quantitative results produced by this extensive analytical and statistical evaluation led to several key findings that guided the long-term resource strategy presented in this IRP. The data generated by the analysis are presented in the Appendix I, Electric Analysis; detailed descriptions of each portfolio also appear there.

1. Portfolio costs are tightly grouped together.

When different portfolios are tested in the same scenario, their costs are tightly grouped. Figure 5-30 illustrates this result. When PSE tested the portfolios for 2007 Trends, 2007 Business As Usual, and 2009 Trends in the 2007 Trends scenario, their costs differed by only about 1%. When we tested the same portfolios in the 2009 Trends scenario, the absolute portfolio costs changed, but differences between them remained very small. This tells us that portfolio costs are being driven by scenario assumptions; resource mix has little influence.

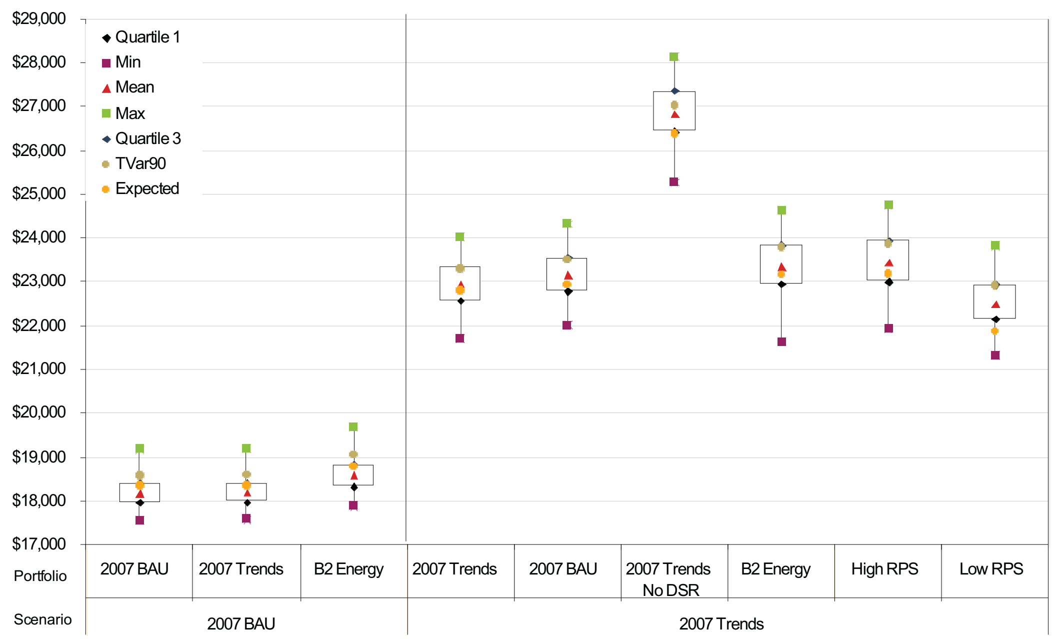
Figure 5-30
Relative Portfolio Costs in 2007 and 2009 Scenarios

Portfolio Costs in Millions	2007 Trends Scenario	2009 Trends Scenario
Optimal 2007 Trends Portfolio	$ 23,292	$ 20,222
Optimal 2007 BAU Portfolio	$ 23,424	$ 20,159
Optimal 2009 Trends Portfolio	$ 23,513	$ 20,186

2. Portfolio risk depends on scenario assumptions, not resource builds.

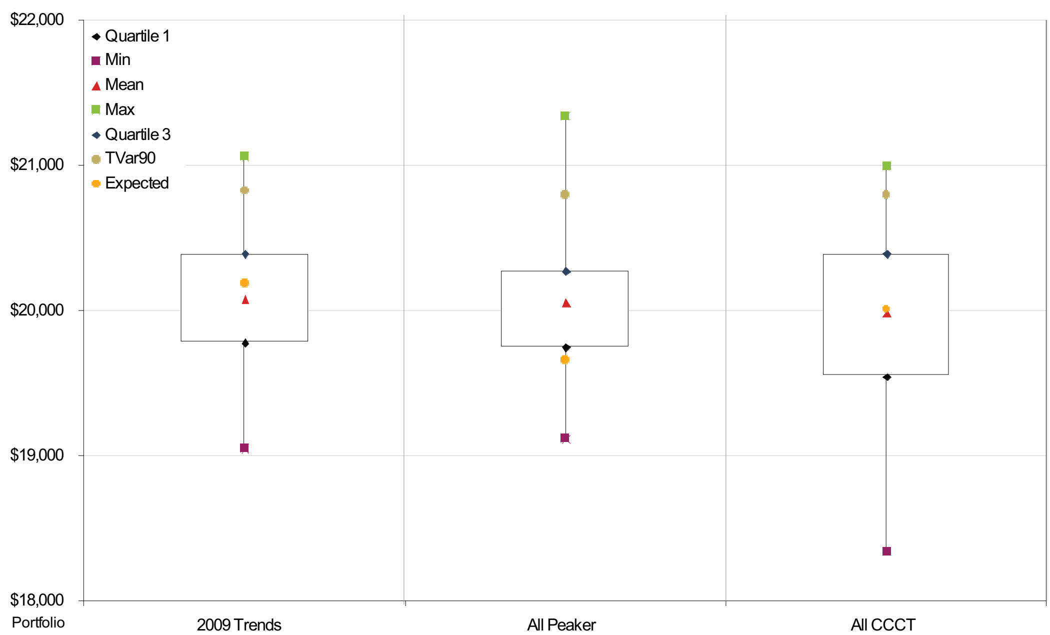
Figure 5-31 shows box plots that represent the range of cost results produced by several portfolios in both the 2007 Trends and 2007 Business As Usual scenarios. Within each scenario, the portfolio ranges are quite compact. The magnitude of expected costs changes dramatically, however, when the scenario changes. It is notable that increasing the amount of renewable resources built within a portfolio, as in the High RPS Portfolio, actually increases cost risk; conversely, decreasing the amount of renewables, as in the Low RPS Portfolio, actually decreases cost and risk.

Figure 5-31
Effects of Scenario Assumptions on Portfolio Costs
Cost Ranges for Select Portfolios in 2007 Trends and 2007 BAU Scenarios
(Expected Cost for 100 Simulations, $ in Millions)



PSE also designed two extreme portfolios to test how the balance of thermal builds affects cost and risk. Both portfolios built the same level of DSR and renewable generation; the remaining resource need was met by building only peaking plants for Portfolio A and only CCCT plants for Portfolio B. These were compared to each other and to the 2009 Trends Portfolio in the 2009 Trends scenario. Figure 5-32 shows that in this scenario, expected costs and Tail Var 90 costs for the three portfolios are tightly grouped. The results tell us that the balance of peakers to CCCT resources built in a portfolio has very little effect on expected costs or risk.

Figure 5-32
Balance of Thermal Builds and Portfolio Cost and Risk
Comparison of All-CCCT and All-peaker Portfolios in the 2009 Trends Scenario
(Expected Portfolio Cost for 100 Simulations, $ in Millions)



3. RPS requirements drive renewable builds.

The amount of wind resources to include in portfolios is driven by RPS requirements. Figure 5-33 shows results of portfolio comparisons performed to test how changes in CO_2 costs, RPS requirements, load growth, and demand-side resources would affect wind additions to the portfolios. Except for very high load growth, which increased the need for all resources, and higher RPS requirements, no variable increased wind additions as part of the lowest reasonable cost portfolio.

Figure 5-33
The Effect of Variables on Wind Additions in 2029

Variable	Portfolio's to Compare	Effects of Change
Change in CO_2 Costs	2007 Trends Portfolio vs. 2007 BAU Portfolio	Increased CO_2 costs did not add wind to the portfolio
Change in RPS Requirement	2007 Trends Portfolio vs. High RPS vs. Low RPS	More or less wind added depending on the direction of RPS change
Change in Load	2009 Trends (low demand) vs. 2007 Trends (mid demand) vs. High Growth (high demand)	No significant change in wind builds until High Growth is reached, then 100 MW added
Change in DSR	No-DSR 2007 Trends Portfolio vs. 2007 Trends Portfolio	Adding the optimal amount of DSR in 2007 Trends reduced the amount of wind built
Change in PTC	2007 Trends vs. 2007 BAU	2007 Trends builds the same amount of wind as 2007 BAU, however the extension of the PTC accelerates the timing of the wind builds

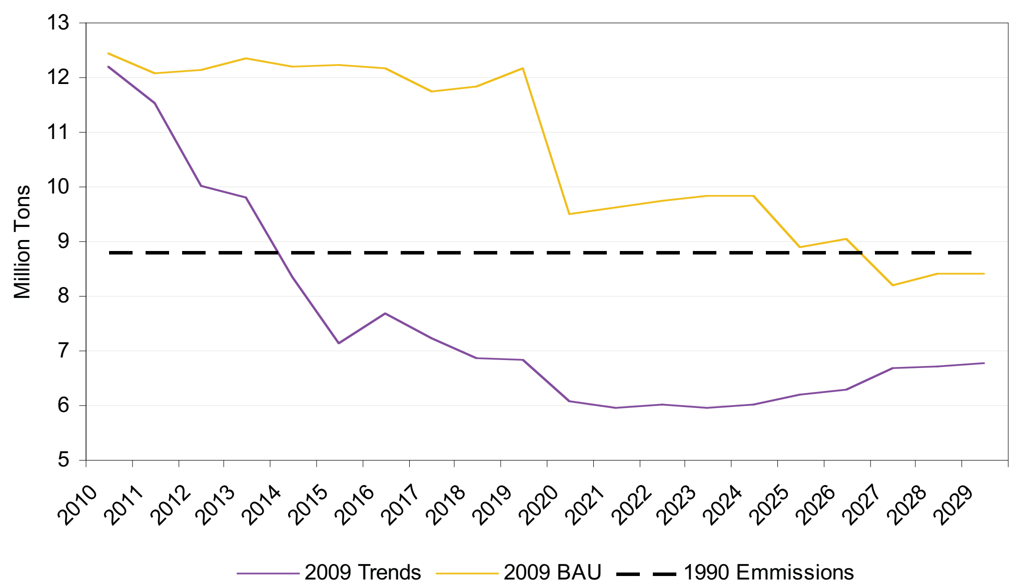
4. Emissions are declining.

Relative to current levels, CO_2 emissions are falling throughout the study period. All portfolio emissions fall below 1990 levels of 8.8 million tons per year by the end of the study period except for the No-DSR portfolios. CO_2 costs influence the timing of reductions, but the assumed retirement of PSE's coal-fired generation at the Colstrip facility has the biggest effect.

Figure 5-34 compares the annual emissions of the 2009 Trends Portfolio with the 2009 Business As Usual Portfolio. Essentially, this is a comparison of portfolios with and without CO_2 costs. (2009 Trends includes CO_2 costs of $37 per ton in 2012 that rise to $130 per ton by 2029; 2009 Business As Usual includes a negligible $0.32 per ton.) Even the 2009 Business As Usual Portfolio, with nearly no emissions costs, falls below 1990 levels in 2020. The 2009 Trends Portfolio emits less total CO_2 over the study period, but by 2029, thanks to the retirement of Colstrip, the difference between the two is only about 1.6 million tons per year. By the end of the planning period, the 2009 Trends Portfolio emits about 29 milliion tons of C02 less than the 2009 Business As Usual Portfolio, at a cost of about $4.15 billion. Note that this amount is only a reflection of the CO_2 costs.

Emissions profiles for select portfolios can be found in Appendix I, Electric Analysis.

Figure 5-34
Annual Emission Rates for 2009 BAU and 2009 Trends Portfolios



5. Cost-effective DSR is the only way to reduce cost and risk.

Demand-side resources are the only resource that reduces both cost and risk in portfolios, because they reduce need. All other resources – including renewables – expose the portfolio to the risks inherent in the power and gas markets. A portfolio heavy in wind resources, for instance, must rely on market power purchases to balance wind variability, while a portfolio's thermal resources are subject gas price volatility. Figure 5-35 shows the expected cost and risk ranges for the No-DSR 2007 Trends Portfolio and the optimal 2007 Trends Portfolio, which includes 1,117 MW of DSR by 2029.

The amount of cost-effective conservation varies from scenario to scenario. Moving from a No-DSR portfolio to one that includes DSR Bundle A produces the most savings; after that, savings accumulate incrementally. At a minimum, all scenarios identified DSR Bundle B to be cost effective; bundles C, D, and E became cost effective only when certain scenario assumptions were present. Figure 5-36 shows how portfolio costs change as incremental bundles of DSR are added. Going from No-DSR to Bundle A in 2007 Trends reduces costs by 12.13%, going to Bundle B reduces costs by 3.08%, by the time we add bundle E the savings are only .2% of portfolio costs.

Figure 5-35
Effect of DSR on Portfolio Cost and Risk
Comparison of Expected Costs and Cost Ranges for No-DSR and Optimal 2007 Trends Portfolios (Expected Portfolio Cost for 100 Simulations, $ in Millions)

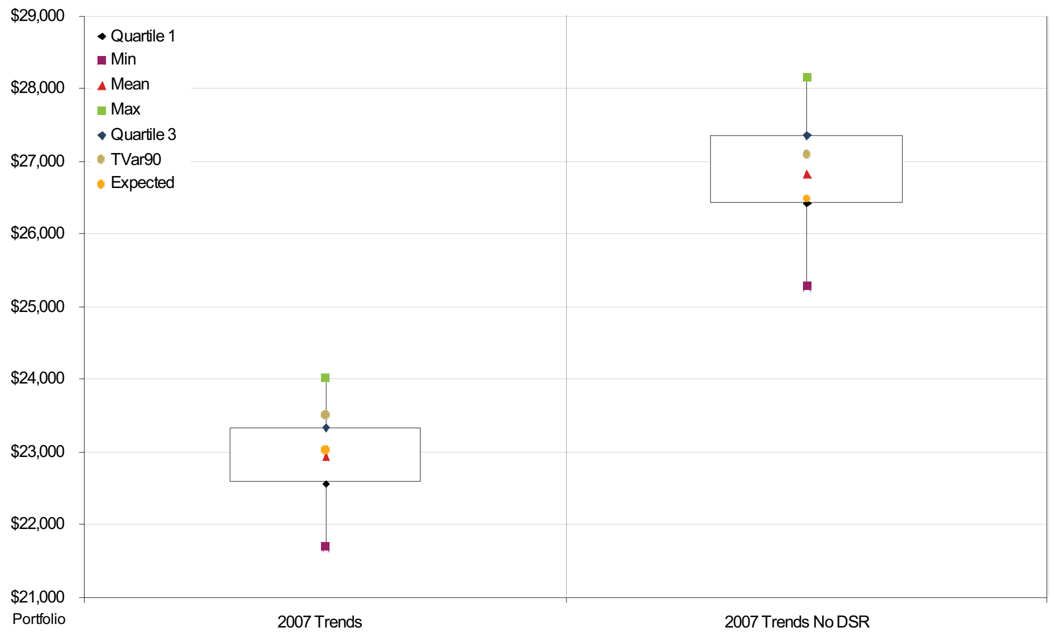


Figure 5-36
Percentage Change in Portfolio Costs by DSR Bundle in Different Scenarios

Scenario	No DSR to A	A to B	B to C	C to D	D to E
2007 Trends	-12.13%	-3.08%	-0.48%	-0.79%	-0.20%*
Green World	-10.64%	-1.25%	-2.89%	-0.36%	1.30%
2007 Business As Usual	-12.47%	-3.22%	-0.95%	0.39%	
Low Growth	-11.58%	-2.57%	0.32%		
High Growth	-10.32%	-3.40%	-0.65%	-0.42%	-0.84%
Very High Gas	-11.94%	-3.27%	-0.64%	-0.63%	-0.78%
Very Low Gas	-10.24%	-2.93%	-1.01%	0.69%	
2007 Trends_ High Resource Cost	-11.29%	-3.74%	-1.25%	-0.68%	-2.14%
2007 Trends_ Low Resource Cost	-10.61%	-3.50%	-1.42%	-0.24%	-1.39%
2007 Trends_ Transport Load	-11.01%	-3.72%	-1.15%	-0.31%	-2.85%
2009 Trends	-12.07%	-3.28%	2.60%	-4.78%	2.89%
2009 Business As Usual	-13.60%	-2.39%	-0.70%		

*Note highlighted Bundles represent the optimal "cost effective" bundle by scenario

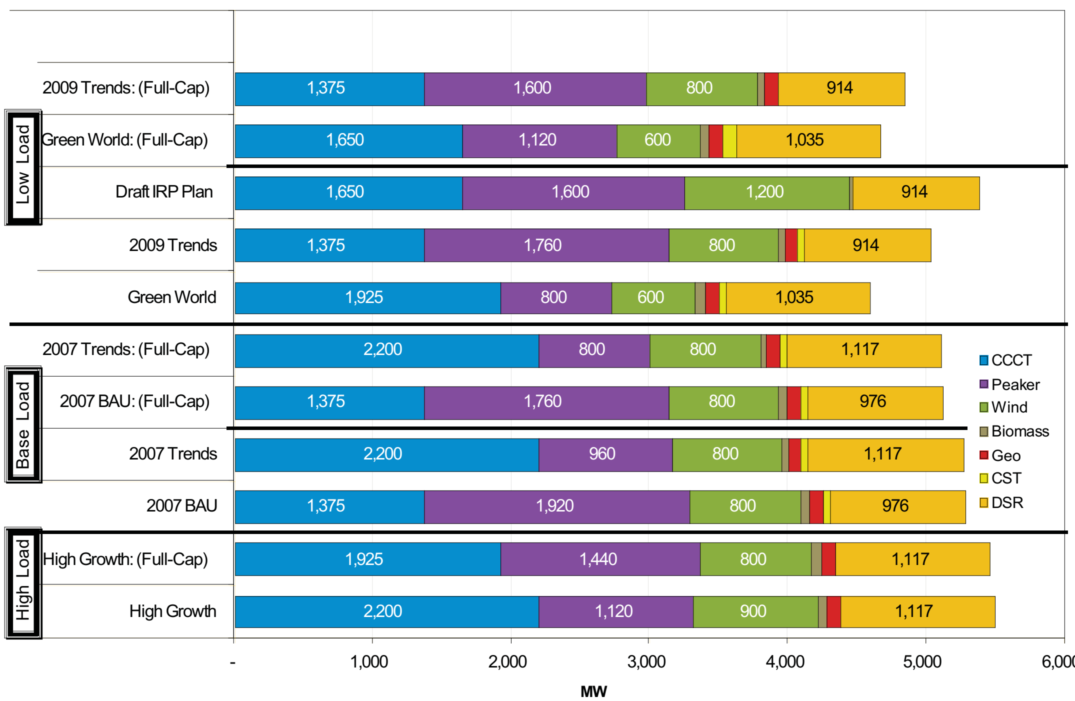
6. The results of the analysis were not significantly affected by changes in resource need arising from the method used to account for operating reserves.

PSE analyzed the 2009 Trends (Full-Cap) Portfolio in order to test how the results of the analysis would be changed by the reduced resource need that was generated by changing assumptions about operating reserves. Figure 5-37 shows that the scale of costs remains fairly consistent despite lower need, and that the portfolio selects the same level of demand-side resources. Figure 5-38 illustrates the effect that the change has on portfolio builds for selected scenarios. It is important to note that relative portfolios – Green World and Green World (Full-Cap), for example – select the same level of DSR. As described above, DSR is the only resource that reduces both cost and risk. Therefore, PSE can conclude that the change in the operating reserve assumption minimally changes the costs and builds of the portfolios, but not the relative risk profiles of the portfolios.

Figure 5-37
Comparison of Optimal DSR Bundle

	Bundle B	Bundle D
2009 Trends	20.19	19.73
2009 Trends (Full-Cap)	19.67	19.52

Figure 5-38
Comparison of Select Portfolios in 2029



Gas Resources

PSE provides natural gas directly to 750,000 customers in Washington state. We also rely on natural gas to fuel increasing amounts of electric generation. As the need for this resource grows ever larger, so do our concerns about supply diversity. To develop a complete picture of the challenges that will confront us in the coming years, this IRP examines the gas sales portfolio as well as the combined gas sales and gas for generation portfolio.

I. Gas Resource Need

Consistent with PSE's previous IRPs and with the Washington state integrated resource planning requirements for natural gas utilities (WAC 480-90-238), this IRP develops an integrated resource plan for our gas sales customers. However, natural gas has become an increasingly important resource for PSE. Not only do we supply it for end use to more than 750,000 gas sales customers, we also use it as fuel to generate electricity.

Because our reliance on this resource is so significant – and growing – we believe that looking at the combined resource need for "gas sales" and "gas for generation" is crucial to developing an accurate perspective on the challenges and decisions that must be made in the years ahead. We are obligated to secure reliable supplies for both purposes.

Figure 6-1 illustrates total gas resource need over the 20-year planning horizon. The lines rising toward the upper right corner indicate the increasing (combined) demand for gas sales and gas for generation; the bars below represent current contracts for the pipeline transportation, storage, and peaking capacity. These resources enable PSE to transport gas from points of receipt to customers and generating plants. Where the demand lines rise above the existing resources bars – as they begin to do after the heating season of 2010-2011 – additional resources are required to meet peak capacity.

A wide range of variability is displayed among the seven demand scenarios plotted here. By 2029, a 200 MDth per day difference in need arises between the demand in 2007 Trends (the original reference scenario developed for this IRP in 2007) and the demand in 2009 Business as Usual (BAU) scenario (which was developed in early 2009). This reflects the high degree of uncertainty that exists today concerning future economic and regulatory conditions as well as commodity prices. Further, developing detailed long-term plans to supply gas for generation is difficult since gas transportation needs are highly dependent on the specific location of the generating plants. For example, plants located near a gas trading hub or storage facility need less pipeline capacity to transport fuel. On the other hand, generation plants located close to PSE loads need less electrical transmission. For gas transport planning purposes we assumed that all new gas-fired generating plants are located in the Puget Sound area.

Figure 6-1
Combined Gas Resource Need (Gas Sales and Gas for Generation)
Existing Resources Compared to Peak Day Demand

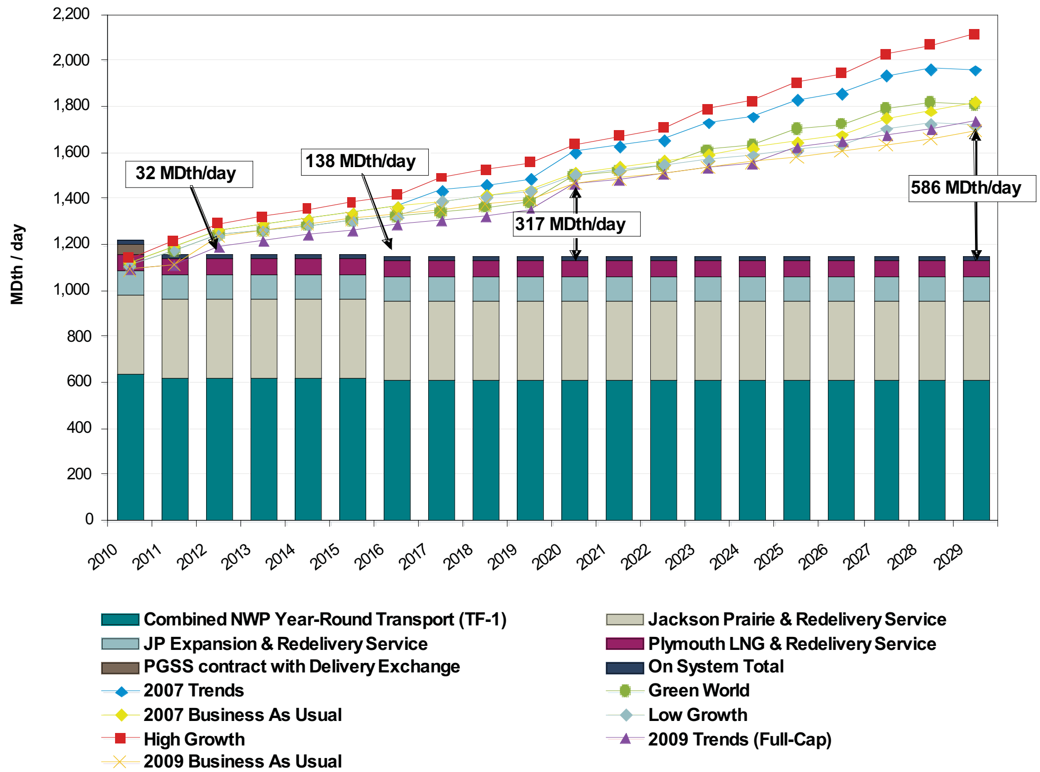
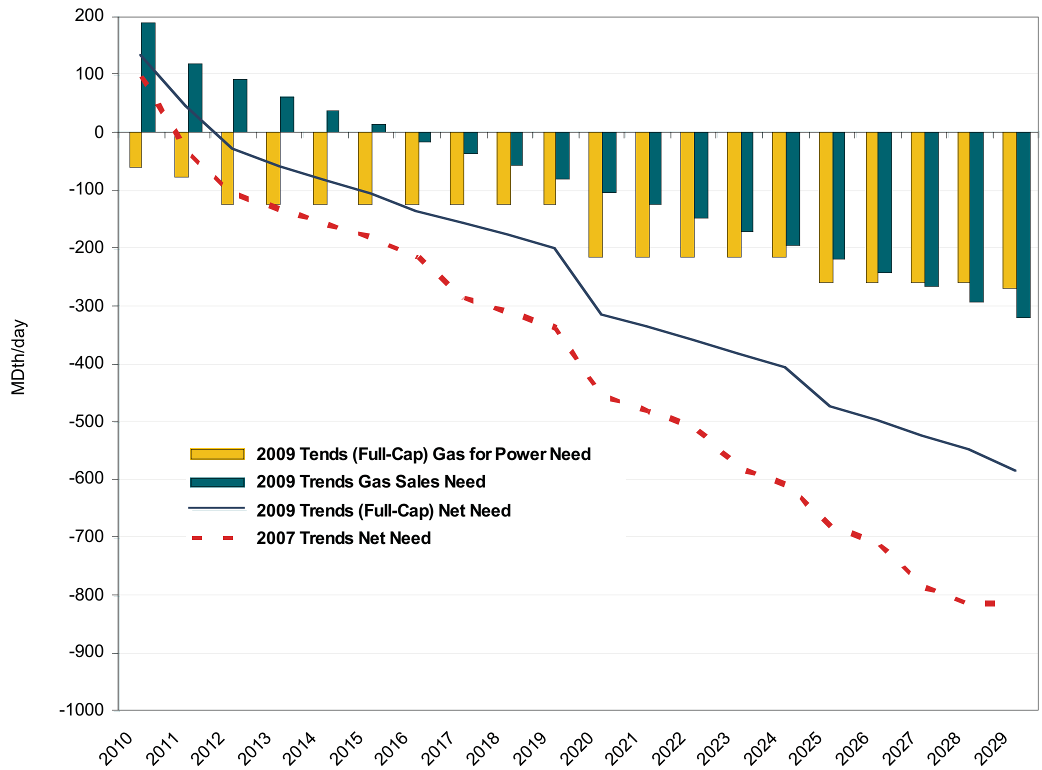


Figure 6-2 illustrates the gap between demand and existing resources shown in Figure 6-1, but also identifies which portion of that need originates with the gas sales portfolio and which portion from the electric generation portfolio. A closer look reveals that different needs are more pressing at different points in time.

Figure 6-2
Sources of Resource Need: Gas Sales Compared to Gas for Generation
Generation fuel is the most immediate and pressing need.



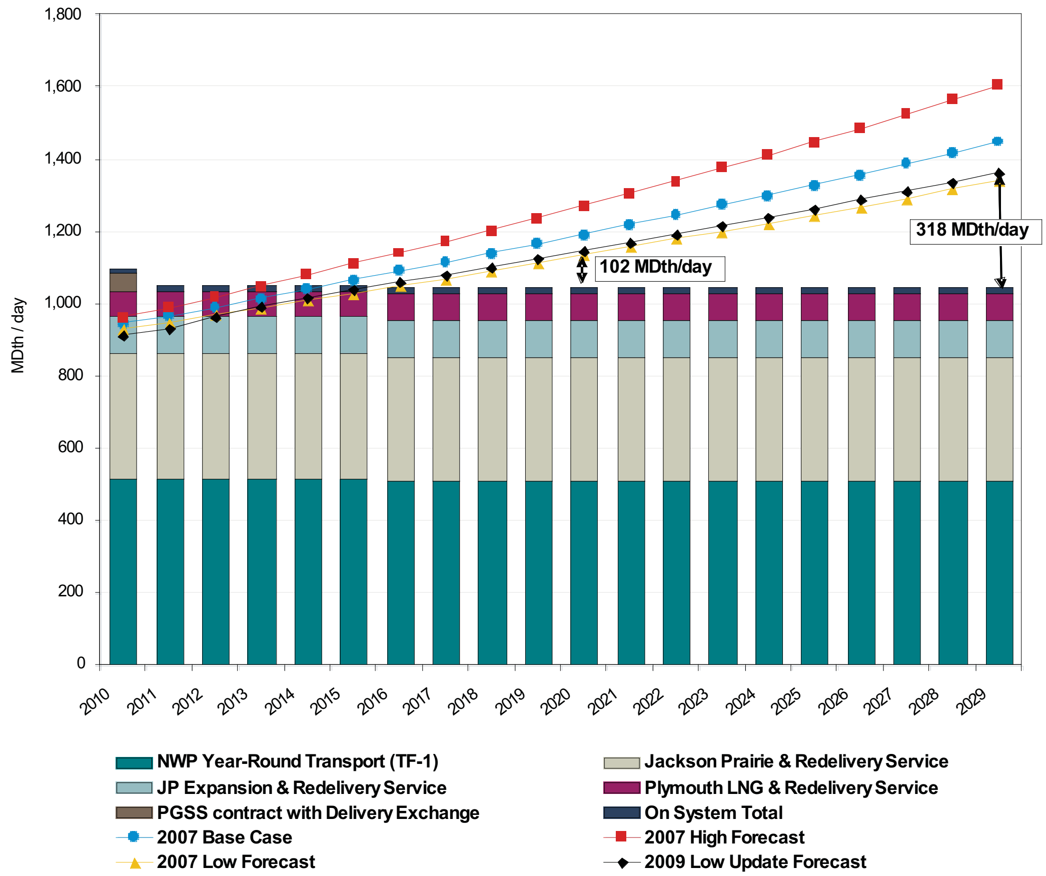
When the origin of need is examined, several points become clear.

- Fuel for electric generation is the most immediate and pressing need for approximately the first five years of the planning horizon. Additions are required starting in 2010.
- Gas sales need begins after the 2015-16 heating season.
- Generation fuel makes up the majority of the additional resource needed for the duration of the planning horizon (however, absolute amounts required for generation fuel are less than absolute amounts required for gas sales).

Gas Sales Resource Need

Figure 6-3 illustrates gas capacity need for direct sales customers under four different demand forecasts for the 20-year planning horizon. Again, the lines rising to the right represent demand forecasts; the bars below represent existing resources.

Figure 6-3
Gas Sales Resource Need
Existing Resources Compared to Peak Day Demand



Variation in the demand forecast has a strong influence on the timing of resource additions:

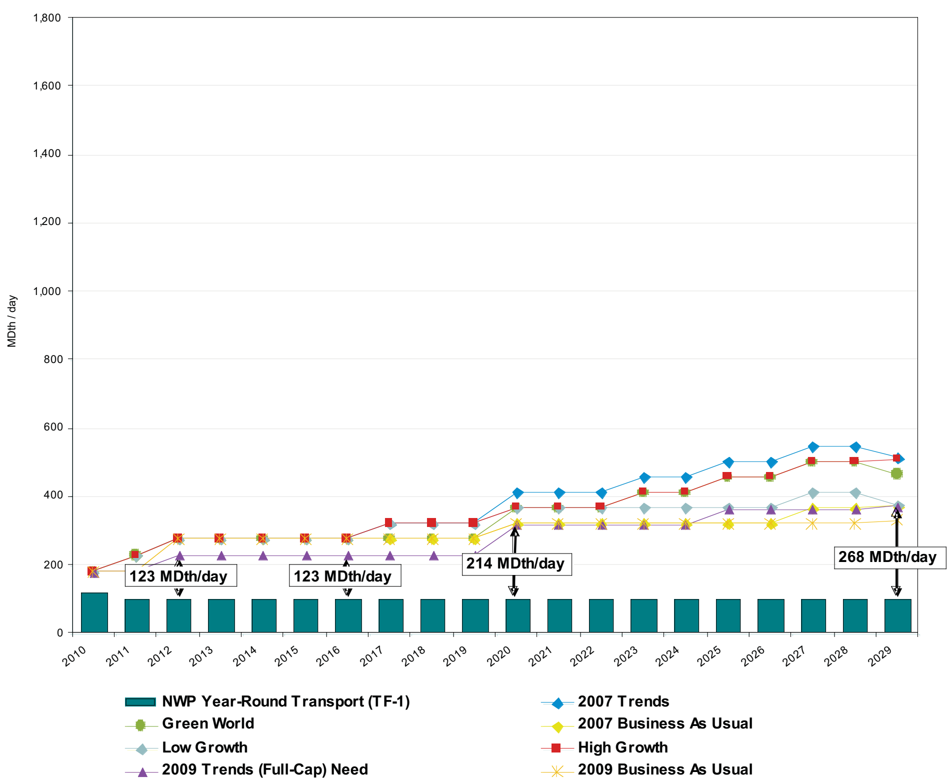
- Under the 2007 Base forecast, additional resources will be needed beginning with the winter of 2014-2015.
- Under the 2007 High demand forecast, additional resources will be needed by the 2013-2014 heating season.
- Under the 2007 Low and 2009 Low Update forecasts, additional resources will not be needed until the winter of 2016-2017.

Resource Need for Generation Fuel

All of the portfolios considered in the electric analysis contain higher levels of gas-fired generation than previous IRPs and Least Cost Plans, and this trend will continue for the foreseeable future.

Figure 6-4 illustrates gas for generation resource need by comparing existing resources with projected peak demand under all seven electric scenarios modeled.

Figure 6-4
Gas for Generation Resource Need
Existing Resources Compared to Peak Day Demand



Natural gas resource needs for electric generation are more immediate and increase more rapidly than resource need for gas sales, reflecting the addition of gas-fired generation in all possible futures.

- There are substantial increases in the amount of gas-fired generation during the first five years of the planning horizon in all seven electric scenarios.
- After five years, gas-fired generation continues to increase but the rate of increase begins to separate depending on the scenario.
- Note that Figures 6-3 and 6-4 are drawn to the same scale: While the gas required for electric generation is anticipated to increase faster than for the gas sales portfolio, the absolute amounts required are less than for gas sales, and are projected to remain so over the 20-year planning horizon.

The Need for Supply Diversity

As PSE's combined reliance on natural gas grows, diversifying the company's supply sources becomes more important. Here we outline PSE's concerns about concentration, identify potential advantages, and describe new opportunities that may make it possible to increase options. This IRP analyzes the combined gas portfolio in two ways – with, and without meeting a diversity requirement – in order to identify the cost of increasing supply options.

Currently, PSE's source of supplies is concentrated in the Western Canadian Sedimentary Basin (WCSB) in Northern British Columbia and Alberta. Figure 6-5 summarizes pipeline and storage capacity for the gas sales, gas for generation, and combined portfolios. The WCSB currently supplies

- nearly 70% of the pipeline capacity for the combined portfolio
- 65% of the gas sales portfolio
- 86% of the gas for generation portfolio

When the existing contracts for Rocky Mountain basin supplies expire in June 2011, the gas for generation portfolio will become 100% reliant on WCSB supplies.

Figure 6-5
Summary of Combined Gas Supply Sources
Existing Pipeline and Storage Capacity

	Current Capacity Jan. 2009 (MDth/day)					
Gas Source and Route	**Gas Sales**		**Gas for Generation**		**Total**	
British Columbia (Stn2 via Westcoast and NWP)	97	19%	47	39%	144	22%
British Columbia (from Sumas via NWP)	163	31%	57	47%	220	34%
Alberta (via TC-AB, TC-BC, GTN and NWP)	76	15%	-	0%	76	12%
Total Western Canadian Sedimentary Basin	**336**	**65%**	**104**	**86%**	**440**	**69%**
US Rockies (via NWP) (includes Clay Basin)	184	35%	17	14%	201	31%
Total US Rocky Mountains	**184**	**35%**	**17**	**14%**	**201**	**31%**
Total from Supply Regions	**520**	**100%**	**121**	**100%**	**641**	**100%**
Jackson Prairie (via NWP)	404	41%	50	29%	454	39%
Plymouth LNG (via NWP)	70	7%	-	0%	70	6%
Total from Storage	**474**	**48%**	**50**	**29%**	**524**	**45%**
Grand Total	**994**		**171**		**1,165**	

PSE is concerned about the following:

- **Concentration of risk.** As annual volume needs continue to rise, the concentration of PSE's already high exposure to WCSB market hubs will intensify.
- **Reliability.** Such a high reliance on one supply basin leaves PSE vulnerable to supply interruptions should well freeze-offs, forced outages, or pipeline disruptions occur.
- **Declining supplies.** Under some projections, the amount of gas available for export from WCSB will decline due to expanded needs for oil shale processing, which could result in upward pressure on prices.

Greater access to the Rocky Mountain basin offers several potential advantages:

- **Increased reliability.** In the event of supply interruptions from any one basin, more alternatives are available.
- **Access to lower cost supplies.** Currently, and at least through 2013, Rockies market hub supplies are priced significantly lower than Sumas hub supplies (for a more detailed discussion of price differentials, see page 6-13).
- **Purchasing flexibility.** Diversifying supply increases the ability to take advantage of short-term price differentials (volatility) between the Canadian market hubs (Sumas and AECO) and Rockies supplies.
- **Increased access to existing storage.** Increased access to PSE's existing Clay Basin storage would also increase the company's ability to supply the highly variable needs of gas-fired generation on daily and intra-day bases.

Until recently, potential sponsors showed little interest in construction of new pipelines across the Cascades. Now, new interest and plans are opening up new opportunities.

- Construction of new pipelines between the Rockies and the GTN pipeline in eastern Oregon (specifically to the Stanfield and Malin hubs) has drawn increased interest, and firm plans have been drawn up. The Ruby pipeline proposal is the furthest along in the process.
- Transport of Rockies gas from eastern Oregon to the I-5 corridor including into PSE's service territory has attracted interest and preliminary planning by PSE and others.
- The need for increased peak day supplies and pipeline capacity to deliver gas to the Northwest and the I-5 corridor is being recognized by other utilities and utility

organizations such as the Northwest Gas Association (NWGA). (see the NWGA's Fall 2008 Northwest Gas Outlook at www.nwga.org)

PSE strives to balance low cost and "reliability in diversity" in meeting both gas sales and gas for generation needs. The need for diversification is growing more urgent as the amount of gas used for electric generation increases.

II. Existing Gas Resources

A. Gas Sales Resources

1. Supply-side Resources, Gas Sales

Supply-side gas resources include pipeline capacity, storage capacity, peaking capacity, and gas supplies.

Existing Pipeline Capacity

There are two types of pipeline capacity. "Direct-connect" pipelines deliver supplies directly to PSE's local distribution system from production areas, storage facilities, or interconnections with other pipelines. "Upstream" pipelines deliver gas to the direct pipeline from remote production areas, market centers, and storage facilities.

Direct-connect Pipeline Capacity. All gas delivered to our gas distribution system is handled last by PSE's only direct-connect pipeline, Northwest Pipeline (NWP). We hold the following capacity with NWP.

- 520,053 dekatherms per day (Dth per day) of firm, year-round TF-1 transportation capacity
- 110,704 Dth per day of special winter-only firm TF-1 transportation capacity
- 413,557 Dth per day of firm TF-2 capacity

TF-1 transportation contracts are firm contracts, available 365 days each year. TF-2 service is for delivery of storage volumes during the winter heating season only, and therefore has significantly lower annual costs than the year-round service provided under TF-1. The special winter-only TF-1 service has similar characteristics and pricing as TF-2 service.

Receipt points on the NWP contracts access supplies from four production regions: British Columbia, Alberta, the Rocky Mountain area, and the San Juan Basin. This provides valuable delivery point flexibility, including the ability to source gas from different regions on a day-to-day basis in some contracts.

Upstream Pipeline Capacity. To transport gas supply from production basins or trading hubs to the direct-connect NWP system, PSE holds capacity on several upstream pipelines.

Figure 6-6 provides a general picture of existing pipeline transportation resources in the Pacific Northwest.

Figure 6-6
Northwest Regional Gas Pipeline Map

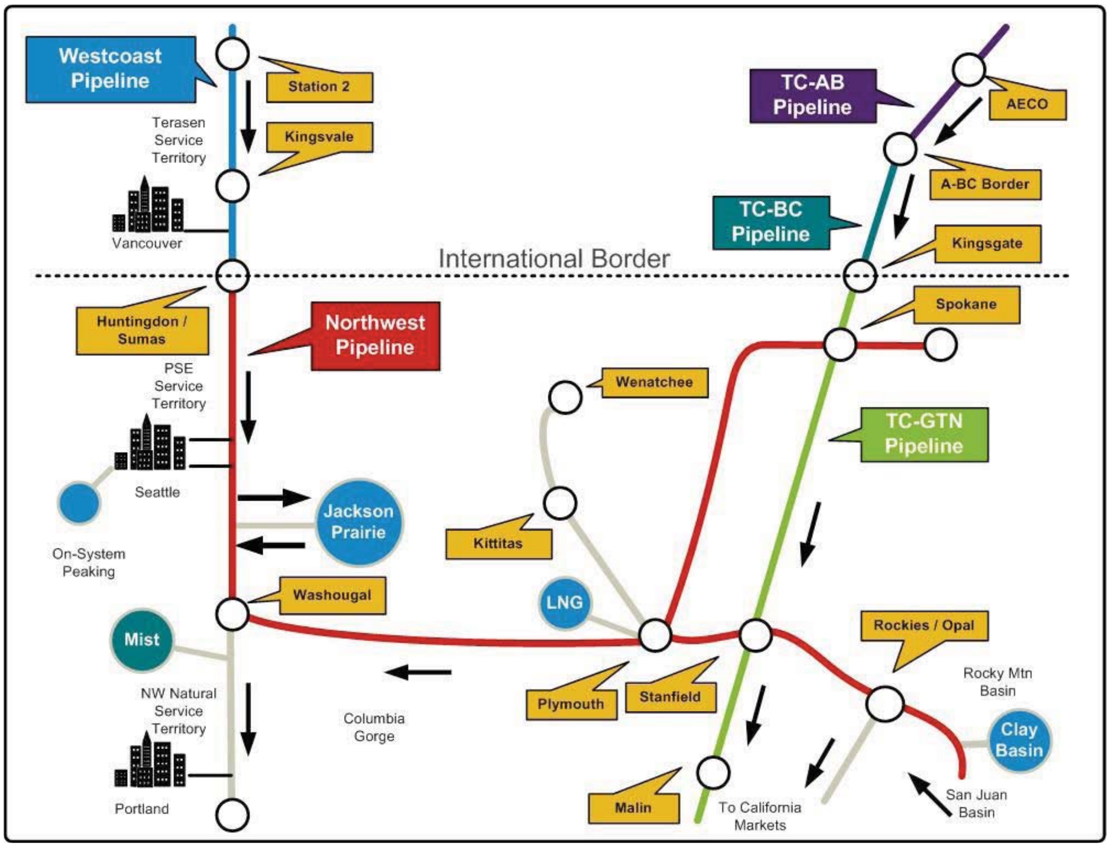


Figure 6-7 summarizes our direct-connect and upstream pipeline capacity position.

Figure 6-7
Gas Sales Pipeline Capacity (Dth/Day)

Pipeline/Receipt Point	Note	Total	Year of Expiration 2011	2013	2014	Other
Direct Connect						
NWP/Westcoast Interconnect (Sumas)	1	259,761	-	108,830	77,875	18,056 (2016) 55,000 (2018)
NWP/TC-GTN Interconnect (Spokane)	1	75,936	-	-	75,936	
NWP/various Rockies	1	184,356	616	47,400	126,436	8,056 (2016) 1,848 (2018)
Total TF-1		520,053	616	156,230	280,247	82,960
NWP/Jackson Prairie	1,2	110,704	-	-	-	110,704 (2028)
NWP/Jackson Prairie	1,2	343,057	343,057	-	-	
NWP/Plymouth LNG	1,2	70,500	70,500	-	-	
Total TF-2/Special TF-1		524,261	413,557	-	-	110,704
Total Capacity to City Gate		**1,044,314**	**414,173**	**156,230**	**280,247**	**193,664**
Upstream Capacity						
TC-Alberta/from AECO to TC-BC Interconnect (A-BC Border)	3	79,744	79,744			
TC-BC/from TC-Alberta to TC-GTN Interconnect (Kingsgate)	4	78,631	70,604			8,027 (2023)
TC-GTN/from TC-BC Interconnect to NWP Interconnect (Spokane)	5	65,392	-	-	-	65,392 (2023)
TC-GTN/from TC-BC Interconnect to NWP Interconnect (Stanfield)	5,6	25,000	-	-	-	25,000 (2023)
Westcoast/from Station 2 to NWP Interconnect (Sumas)	4,7	95,000	-	-	-	25,000 (2014) 55,000 (2018) 15,000 (2019)
Total Upstream Capacity	**8**	**345,392**				

Notes:

1) *NWP contracts have automatic annual renewal provisions, but can be canceled by PSE upon one year's notice.*
2) *TF-2 and special TF-1 service is intended only for delivery of storage volumes during the winter heating season; these annual costs are significantly lower than year-round TF-1 service.*
3) *Converted to approximate Dth per day from contract stated in gigajoules per day.*
4) *Converted to approximate Dth per day from contract stated in cubic meters per day.*
5) *TCPL-GTN contracts have automatic renewal provisions, but can be canceled by PSE upon one year's notice.*
6) *Capacity can alternatively be used to deliver additional volumes to Spokane.*
7) *The Westcoast contracts contain a right of first refusal upon expiration.*
8) *Upstream capacity is not necessary for a supply acquired at interconnects in the Rockies and for some supplies available at Sumas.*

Firm and Interruptible Capacity. Firm pipeline transportation capacity carries the right, but not the obligation, to transport up to a maximum daily quantity (MDQ) of gas from one or more receipt points to one or more delivery points in accordance with the pipeline's published tariff. Tariffs define the scope of service and are approved by the Federal Energy Regulatory Commission (FERC) in the United States, or the National Energy Board in Canada. The scope of service includes the number of days that the transportation service is available, along with the rates, rate adjustment procedures, and other operating terms and conditions. Firm transportation capacity requires a fixed payment, whether or not that capacity is used.

Firm capacity on NWP and TC-GTN may be "released" and remarketed to third parties under the FERC-approved pipeline tariffs. Firm capacity on Westcoast can also be remarketed under recently instituted "streamlined capacity assignment" provisions. PSE aggressively releases capacity when we have a surplus and when market conditions make such transactions favorable for customers. The company also uses the capacity release market to access additional firm capacity when it is available.

Interruptible service is subordinate to the rights of shippers who hold and use firm transportation capacity; when firm shippers do not use their pipeline capacity, they may release it for limited periods of time. Interruptible service is available to PSE from NWP under TI-1 rate schedules, but because it cannot be relied on to meet peak demand, it plays a limited role in PSE's resource portfolio. The rate for interruptible capacity is negotiable, and is typically billed as a variable charge.

Existing Storage Resources

PSE's natural gas storage capacity is a significant component of the company's gas resource portfolio. It confers advantages that improve system flexibility and create significant cost savings for both the system and customers.

- Ready access to an immediate and controllable source of firm gas supply enables PSE to handle many imbalances created at the interstate pipeline level without incurring balancing or scheduling penalties.
- Access to a pooling point makes it possible for the company to store gas that was purchased but not consumed during off-peak seasons, and to buy additional gas during the lower-demand summer season at significant cost savings.
- Combining storage capacity with seasonal TF-2 (or special winter-only TF-1) transportation allows us to eliminate the need to contract for year-round pipeline capacity to meet winter-only demand.

PSE also uses storage to balance city-gate gas receipts with the actual loads of our gas transportation customers. Industrial and commercial customers who elect gas transportation service (rather than gas sales service) make nominations directly or through marketer-agents to move city-gate gas deliveries to their respective meters. When these customers or marketers have imbalances between scheduled and actual gas consumption, PSE's storage capacity allows us to manage these imbalances on a daily basis.

We have contractual access to two underground storage projects. Each serves a different purpose. Jackson Prairie storage, in Lewis County, is an aquifer-driven storage field designed to deliver large quantities of gas over a relatively short period of time. Clay Basin in northeastern Utah provides supply-area storage and a winter gas supply. Figure 6-8 presents details about storage capacity.

Figure 6-8
Gas Sales Storage Resources

	Storage Capacity (Dth)	Injection Capacity (Dth/Day)	Withdrawal Capacity (Dth/Day)	Expiration Date
Jackson Prairie – Owned (1)	7,713,040	147,334	398,667	N/A
Jackson Prairie – Owned (2)	(500,000)	(25,000)	(50,000)	2010
Jackson Prairie – NWP SGS-2F (3)	1,181,021	24,195	48,390	2011
Jackson Prairie – NWP SGS-2F (4)	140,622	3,352	6,704	2009
Clay Basin	13,419,000	55,900	111,825	2013/19
Total	**21,953,683**		**515,586**	

Notes:
1) *Storage capacity at 12/31/2008. Storage capacity at this facility will continue to grow through 2011.*
2) *A portion of PSE's Jackson Prairie capacity has been made available for electric generation needs through March 31, 2010.*
3) *NWP contracts have automatic annual renewal provisions, but can be canceled by PSE upon one year's notice.*
4) *Obtained through capacity release market, negotiations for an extension are under way.*

Jackson Prairie Storage. PSE uses Jackson Prairie and the associated NWP TF-2 and Special TF-1 transportation capacity primarily to meet the intermediate peaking requirements of core customers—that is, to meet seasonal load requirements, balance daily load, and eliminate the need to contract for year-round pipeline capacity to meet winter-only demand. As shown in Figure 6-8, we have 453,761 Dth per day of TF-2 and special winter-only TF-1 transportation capacity from Jackson Prairie.

PSE, NWP, and Avista Utilities each own an undivided one-third interest in the Jackson Prairie Gas Storage Project, operated by PSE under FERC authorizations. In addition to firm daily deliverability and firm seasonal capacity, we have access to deliverability and seasonal capacity through a contract for SGS-2F storage service from NWP and from a third party through the capacity release market. The NWP contract is automatically renewed each year but we have the unilateral right to terminate the agreement with one year's notice. We have interruptible withdrawal rights of up to 58,000 Dth per day, plus interruptible transportation service.

To meet growing peaking requirements, the three owners of Jackson Prairie recently increased the deliverability from 884,000 Dth per day to 1,196,000 Dth per day. Our share of this expansion (104,000 Dth per day) entered service in November 2008. We will continue to expand the Jackson Prairie Storage reservoir through about 2011.

Clay Basin Storage. Questar Pipeline owns and operates the Clay Basin storage facility in Daggett County, Utah. This reservoir stores gas during the summer for withdrawal in the winter. PSE has two contracts to store up to 13,419,000 Dth and withdraw up to 111,825 Dth per day under a FERC-regulated agreement.

We use Clay Basin as a pooling point for purchased gas, and as a partial supply backup in the case of well freeze-offs or other supply disruptions in the Rocky Mountains during the winter. This supply provides a reliable source throughout the winter, including on-peak days; it also provides a partial hedge to price spikes in this region. Gas from Clay Basin is delivered to PSE's system (and other markets) using firm TF-1 transportation.

Treatment of Storage Cost. Similar to firm pipeline capacity, firm storage arrangements require a fixed charge whether or not the storage service is used. Charges for Clay Basin service (and the non-PSE-owned portion of Jackson Prairie service) are billed to PSE pursuant to FERC-approved tariffs, and recovered from customers through a purchased gas adjustment (PGA), while costs associated with the PSE-owned portion of Jackson Prairie are recovered from customers through base rates. PSE pays a variable charge for gas injected into and withdrawn from Clay Basin.

Existing Peaking Supply and Capacity Resources

Firm access to other resources provides supplies and capacity for peaking requirements or short-term operational needs. Liquefied natural gas (LNG) storage, LNG satellite storage, vaporized propane-air (LP-Air) and a peak gas supply service (PGSS) provide firm gas supplies on short notice for relatively short periods of time. Generally a last resort due to their relatively higher variable costs, these sources typically meet extreme peak demand during the coldest hours or days. LNG, PGSS, and LP-Air do not offer the flexibility of other supply sources.

Figure 6-9
Gas Sales Peaking Resources

	Storage Capacity (Dth)	Injection Capacity (Dth/Day)	Withdrawal Capacity (Dth/Day)	Transport Tariff
Plymouth LNG	241,700	1,208	70,500	TF-2
Gig Harbor LNG (1)	5,250 10,500 (06-07) 15,750 (10-11)	1,500 3,000 (06-07)	2,000 3,000 (06-07) 4,000 (08-09) 5,250 (10-11)	On-system
Swarr LP-Air	128,440	16,680 (2)	10,000	On-system
PGSS	NA	NA	48,000	City-gate delivered, via TF-1 or commercial arrangement
Total	**375,390**	**19,388**	**131,500**	

Notes:
1) *Withdrawal capacity will grow as the load on the distribution system grows, allowing more supply to be absorbed.*
2) *Swarr holds 1.24 million gallons. At a refill rate of 111 gallons/minute, it takes 7.7 days to refill, or 16,680 Dth/day.*

Plymouth LNG. NWP owns and operates an LNG storage facility located at Plymouth, Washington, which provides a gas liquefaction, storage, and vaporization service under its LS-1 and LS-2F tariffs. PSE's long-term contract provides for seasonal storage with an annual contract quantity (ACQ) of 241,700 Dth, liquefaction with an MDQ of 1,208 Dth per day, and a withdrawal MDQ of 70,500 Dth per day. The ratio of injection and withdrawal rates means that it can take more than 200 days to fill to capacity, but only 3-1/2 days to empty. Therefore, we use LS-1 service to meet needle-peak demands, with LS-1 gas delivered to PSE's city gate using firm TF-2 transportation.

Gig Harbor LNG. In the Gig Harbor area, a new satellite LNG facility ensures sufficient supply during peak weather events for a remote but growing region of our distribution system. The facility receives, stores, and vaporizes LNG that has been liquefied at other LNG facilities; the LNG comes by tanker truck from third-party providers. Because the LNG source is outside PSE's distribution system, this facility represents an incremental supply source and is therefore included in the peak day resource stack, even though the plant was justified based on distribution capacity need. Daily deliverability is limited by hourly deliverability, total storage capacity, and the ability of the distribution system to absorb the supply. Although this facility directly benefits only areas adjacent to the Gig Harbor plant, its operation indirectly benefits other areas in PSE's service territory since it allows gas supply from pipeline interconnects or other storage to be diverted elsewhere.

A second tank, substantially completed in the fall of 2006, doubled on-site storage capacity and increased operational flexibility (one tank can be filled while the other is used). Space has been allocated for a third tank, but no installation date has been projected. It will cost substantially more than the second tank because of additional site preparation requirements, so any expansion decision will be based on distribution capacity need rather than supply need.

Swarr LP-Air. The Swarr LP-Air facility has a net storage capacity of 128,440 Dth equivalent, and can vaporize approximately 30,000 Dth per day – a little more than four days of supply at maximum capacity. Swarr connects to PSE's distribution system, requiring no upstream pipeline capacity. It is typically used to meet extreme hourly or daily peak demand, or to supplement distribution pressures during pressure declines on NWP. PSE operates this facility to meet peak early morning and evening demand periods; given its operational flow characteristics, it is highly unlikely the company will operate it for more than eight hours per day. Therefore, for peak-day planning purposes, we consider this facility capable of supplying only 10,000 Dth per day.

Third-party Suppliers. Under our PGSS agreements, PSE can call on third-party gas supplies during peak periods for up to 12 days during the winter season. Currently, these amount to 48,000 Dth per day at a price tied to the replacement cost of distillate oil. The supply would be delivered to PSE city gates from Sumas on a firm basis through TF-1 capacity (when such capacity is not needed for other supplies) or by a commercial best-efforts exchange agreement with a third party. The PGSS agreement expires after the 2011-2012 heating season, and renewal options appear unlikely at this time.

Existing Gas Supplies

Within the limits of this transportation and storage network, PSE maintains a policy of sourcing gas supplies from a variety of supply basins. Avoiding concentration in one market helps to increase reliability; if a supplier defaults, PSE can source gas from another place along the pipeline. We can also mitigate price volatility somewhat; the company's capacity rights on NWP provide some flexibility to buy from the lowest-cost basin. While the majority of PSE's current supplies come from northern British Colombia in Canada, we also maintain pipeline capacity access to producing regions in the Rockies and San Juan, and Alberta.

Price and delivery terms tend to be very similar across supply basins, though shorter-term prices at individual supply hubs may “separate” due to pipeline capacity shortages. This separation cycle can last one to three years and is alleviated when additional pipeline infrastructure is constructed. We expect generally comparable pricing across regional supply basins over the 20-year planning horizon, with differentials primarily driven by differences in the cost of transportation.

We have always purchased our supply at market hubs or pooling points. In the Rockies, the transportation receipt point is Opal; but alternate points, such as gathering system interconnects with NWP, allow some purchases directly from producers as well as from gathering and processing firms. In fact, PSE has a number of supply arrangements with major producers in the Rockies to purchase supply at or close to the wellhead, or point of production. Adding upstream pipeline transportation capacity on Westcoast, TC-AB, and TC-BC to the company’s portfolio has increased our ability to access supply at the wellhead in Canada as well.

Gas supply contracts tend to have a shorter duration than pipeline transportation contracts, with terms to ensure supplier performance. We meet average loads with a mix of long-term (more than two years) and short-term (two years or less) gas supply contracts. Long-term and medium-term contracts typically supply baseload needs and are delivered at a constant daily rate over the contract period. We also contract for seasonal baseload firm supply, typically for the winter months. Forward-month transactions supplement baseload transactions, particularly for November through March; we estimate average load requirements for upcoming months and enter into month-long transactions to balance load. PSE balances daily positions using storage (from Jackson Prairie), day-ahead purchases, and off-system sales transactions. Because our markets are liquid, long-term contracts do not offer significant advantages (other than reliability) at this time. PSE will continue to monitor gas markets to identify trends and opportunities to fine-tune our contract policies.

Like many local distribution companies (LDCs), PSE is somewhat at a buying disadvantage because of our very low load-factor market compared to industrial and power-generation markets, which may make access to additional supply more difficult over time. Our general policy is to maintain firm supply commitments equal to approximately 50% of expected seasonal demand, including assumed storage injections in summer and net of assumed storage withdrawals in winter.

Figure 6-10 summarizes PSE's long-term gas contracts as of March 2009. Termination dates are spread out over a number of years. The company will renew, extend, or replace contracts as they expire.

Biogas Supplies

PSE has purchased biogas from King County's wastewater treatment plant in Renton, Wash. since 1985 (see Contract 1 in Figure 6-10).

Recently, we joined with King County and Bio-Energy-Washington to use methane gas produced at the Cedar Hills Regional Landfill to fuel PSE's gas-fired generating plants. The gas will be transported to NWP (which is adjacent to the landfill) and from there to the generating plants. Cedar Hills is expected to supply an average of approximately 5.5 MDth per day of methane.

Figure 6-10
Gas Sales Long-term Supply Contracts

Contract	Basin	Summer Volume (Dth/d)	Winter Volume (Dth/d)	Primary Term Start Date	Primary Term Termination Date
Core Gas					
Contract 1	System	750	750	05/15/1985	
Contract 2	BC/Sumas	20,000	20,000	11/01/2004	10/31/2009
Contract 3	BC/Sumas	10,000	10,000	11/01/2004	10/31/2009
Contract 4	BC/Sumas	10,000	10,000	11/01/2004	10/31/2009
Contract 5	BC/Sumas	0	10,000	11/01/2007	03/31/2010
Contract 9	BC/Sumas	0	10,000	10/01/2007	04/30/2010
Contract 6	BC/Stn 2	0	10,000	10/01/2007	04/30/2010
Contract 7	BC/Stn 2	0	10,000	10/01/2007	04/30/2010
Contract 8	BC/Stn 2	0	10,000	10/01/2007	04/01/2010
Contract 9	BC/Stn 2	0	10,000	11/01/2009	03/31/2012
Contract 10	BC/Stn 2	0	10,000	11/01/2009	11/01/2012
Subtotal	**BC**	**40,000**	**110,000**		
Contract 12	Alberta	10,000	10,000	11/01/2004	10/31/2009
Contract 13	Alberta	10,000	10,000	11/01/2008	11/01/2009
Contract 14	Alberta	0	10,000	10/01/2006	04/30/2010
Contract 15	Alberta	0	10,000	10/01/2006	04/30/2010
Contract 16	Alberta	0	10,000	02/01/2007	04/30/2010
Contract 17	Alberta	0	10,000	10/01/2009	05/01/2011
Subtotal	**Alberta**	**20,000**	**60,000**		
Contract 18	Rockies	20,000	20,000	11/01/2004	10/31/2014
Contract 19	Rockies	10,000	10,000	04/01/2005	10/31/2009
Contract 20	Rockies	10,000	10,000	04/01/2005	03/31/2010
Contract 21	Rockies	30,000	30,000	04/01/2008	03/31/2013
Contract 22	Rockies	10,000	10,000	05/01/2008	05/01/2009
Contract 23	Rockies	0	10,000	11/01/2004	03/31/2014
Contract 24	Rockies	0	10,000	10/01/2006	04/30/2010
Contract 25	Rockies	0	10,000	10/01/2006	04/30/2010
Subtotal	**Rockies**	**80,000**	**110,000**		
Electric					
Contract 26	Alberta	10,000	0	7/1/2010	10/1/2012
Total		**150,750**	**280,750**		

B. Demand-side Resources, Gas Sales

PSE has provided demand-side resources (that is, resources generated on the customer side of the meter) since 1993. Energy efficiency measures installed through 2007 have saved a cumulative total of 1.9 million Dth – more than half of which has been achieved since 2002. Through 1998, these programs primarily served residential and low-income customers. In

1999 the company expanded to add commercial and industrial customer facilities. PSE has spent more than $31 million for natural gas conservation programs from 1997 to 2007. PSE's energy efficiency programs operate in accordance with requirements established as part of the stipulated settlement of our 2001 General Rate Case.

Our energy efficiency programs serve all types of customers—residential, low-income, commercial, and industrial. Energy savings targets and the programs to achieve those targets are established every two years. The 2006-2007 biennial program period concluded at the end of 2007; current programs operate January 1, 2008 through December 31, 2009. The majority of gas energy efficiency programs are funded using gas "tracker" funds collected from all customers.

For the 2008-2009 period, a two-year target of approximately 530,000 Dth in energy savings has been adopted. This goal was based on extensive analysis of savings potentials and developed in collaboration with key external stakeholders represented by the Conservation Resource Advisory Group (CRAG) and Integrated Resource Plan Advisory Group (IRPAG).

Current Gas Energy Efficiency Programs

2007 marked the conclusion of a 2-year conservation tariff period. Figure 6-11 shows performance compared to two-year budget and savings goals for the biennial 2006-2007 electric energy efficiency programs, and records 2008 progress against 2008-2009 budget and savings goals.

During 2006-2007, the programs saved a total of 504,172 Dth at a cost of $14.5 million. This exceeded the two-year goal of 445,612 Dth, and represented enough gas to supply 7,500 homes. In 2008, savings have already reached 69% of the two-year goal at 367,000 Dth, on expenditures of $12.6 million (or 50% of the two-year budget). 2006-2007 results include one-time savings of approximately 750,000 therms from continuation of a program to replace commercial spray heads (the program contributed 2 million therms to 2004-2005 savings). Savings from this program are not repeatable, but PSE continues to seek projects of such magnitude through internal channels and the RFP process. After considering the effect of the spray head program on savings achievement in 2006-2007, our 2008 levels track in alignment with our previous accomplishments.

Figure 6-11
Gas Sales Energy Efficiency Program Summary

Tariff Programs	2006- 2007 Actuals	'06–'07 Budget/ Goal	'06 vs. '06/07 % Total	2008 Actual	'08 –'09 2- Year Budget/ Goal	'08 vs. '08/'09 % Total
Gas Program Costs*	$14,497,432	$12,595,460	44.8%	$12,630,383	$25,268,000	50.0%
Dth Savings	504,172	445,613	47.2%	367,230	530,000	69.3%

** Does not include low-income weatherization O&M funding of $297,000 per year.*

PSE's **Commercial/Industrial Retrofit Program** is a custom incentive program that achieves energy savings through improvements to HVAC systems, boilers, and process gas modifications such as efficiency gains in radiator steam trap systems. In 2008, these efforts produced savings of 2.3 million therms at a cost of $3.6 million, and this program was the largest generator of gas sales energy efficiency savings.

The **Gas Weatherization** program generated the most energy efficiency savings on the residential side. A variety of insulation measures (among them wall, floor, and ceiling insulation, as well as duct sealing) and other gas conservation measures were eligible for rebates; the program saved 500,000 therms at a cost of $2.8 million, and accounted for 14% of all gas sales energy efficiency savings in 2008.

RFPs. Two RFPs were issued for gas sales energy efficiency resources to be added during the 2008-2009 program cycle. The first, issued in June 2007, targeted specific energy efficiency markets. The second, issued in January 2008, was an "all-source" RFP. The RFP process is used to seek out and fill untapped market segments or add under-utilized energy efficiency technologies to complement ongoing efforts. No significant new opportunities were identified as a result of this RFP process.

C. Supply-side Resources, Electric Generation

Figure 6-12 summarizes the firm pipeline transportation capacity for delivery of fuel to PSE's gas-fired generation plants.

Figure 6-12
Power Generation Gas Pipeline Capacity (Dth/Day)

Direct-connect Capacity						
Plant	**Transporter**	**Service**	**Capacity (Dth/day)**	**Primary Path**	**Year of Expiration**	**Renewal Right**
Whitehorn	Cascade Natural Gas	Firm	(1)	Westcoast (Sumas) to Plant	2000	Yr. to Yr.
Tenaska	Cascade Natural Gas	Firm	(1)	Westcoast (Sumas) to Plant	2000	Yr. to Yr.
Encogen	Cascade Natural Gas	Firm	(1)	NWP (Bellingham) to Plant	2008	Yr. to Yr.
Fredonia	Cascade Natural Gas	Firm	(1)	NWP(Sedro-Wooley) to Plant	2021	Yr. to Yr.
Mint Farm	Cascade Natural Gas	Firm	(5)	NWP (Longview) to Plant	2011	Yr. to Yr.
Freddy 1	NWP	Firm	21,747	Westcoast (Sumas) to Plant	2018	Yr. to Yr.
Goldendale	NWP	Firm	45,000	Westcoast (Sumas) to Everett (3)	2018	Yr. to Yr
Upstream Capacity						
Plant	**Transporter**	**Service**	**Capacity (Dth/day)**	**Primary Path**	**Year of Expiration**	**Renewal Right**
Various	Westcoast	Firm	21,794	Station 2 to Sumas	2014	Yes
Various	Westcoast	Firm	25,461	Station 2 to Sumas	2018	Yes
Various	NWP	Firm (4)	16,884	Rockies to Bellingham	2011	No
Various	NWP	Firm (4)	6,600	Sumas to Bellingham	2011	No
Mint Farm & Various	NWP	Firm	10,710	Sumas to Stanfield	2044	Yes
Mint Farm & Various	NWP	Firm	500	Sumas to Longview	2044	Yes
Mint Farm & Various	NWP	Firm	9,000	Sumas to Longview	2015	No
Storage Capacity						
Plant	**Transporter**	**Service**	**Deliverability (Dth/day)**	**Storage Capacity (Dth)**	**Year of Expiration**	**Renewal Right**
Jackson Prairie	PSE	Firm	50,000	500,000	2010	No

Notes

(1) Plant requirements.
(2) Converted to approximate Dth/day from contract stated in cubic meters /day.
(3) Gas transported from Everett to Goldendale under NWP flex rights, backed by displacement agreement with PSE's gas sales portfolio.
(4) Capacity held by third party, controlled by PSE under grandfathered agreement.
(5) Firm for approximately ½ plant requirements, remainder interruptible. PSE is in the process of securing additional firm capacity and extending term.
(6) Storage capacity made available (for market-based price) from PSE gas sales portfolio. Renewal may be possible, depending on gas sales portfolio needs.

PSE has firm upstream pipeline capacity to serve our combined-cycle generating plants (Freddy1, Goldendale and Mint Farm). Several of our combustion turbine generation units (Whitehorn, Fredonia, and Frederickson) have backup fuel-oil firing capability and thus do not require firm pipeline capacity. The Tenaska generating facility also has backup fuel-oil firing capability.

III. Gas Resource Alternatives

The gas resource alternatives presented in this IRP address long-term capacity challenges rather than the shorter-term optimization and portfolio management strategies PSE uses in our daily conduct of business to minimize costs. They also include consideration of the increasing need to diversify gas supplies explained in the first section of this chapter.

Diversity of Supply Considerations

Direct-connect pipelines. PSE's exclusive reliance on NWP to connect to upstream natural gas supplies is a matter of geography, not preference. Until recently potential sponsors have shown little interest in the construction of new pipelines because of high construction costs and limited need. New construction cannot compete financially with the inherently lower cost of expanding or rebuilding infrastructure in an existing right-of-way.

Because PSE retains the unilateral right to cancel NWP contracts upon one year's notice, pending contract expirations in 2013, 2014, 2016, and 2018 create opportunities to make alternative resource decisions; however, maintaining current NWP capacity at "vintage" rates will most certainly be the company's most cost-effective alternative. To accommodate growth, future expansions of NWP between Sumas and PSE's city gate, in combination with acquiring uncontracted Westcoast capacity between Sumas and Station 2, likely will be the next most cost-effective alternative. Currently, approximately 20% of the Westcoast pipeline capacity to Sumas is not under long-term contract.

However, while expansion of the NWP segment between Sumas and PSE's city gate is probably the lowest-cost alternative for increased access to any market hub, the decision to expand access to the Sumas or Station 2 hubs would have to be balanced with the risks of further increasing the portfolio's reliance on British Columbia (or any WCSB) sourced supplies.

Gas Supplies. There have been reports of significant discoveries of shale gas supplies in northeast British Columbia. While the high cost of shale gas development in a remote area of British Columbia, coupled with the lack of infrastructure will delay development, this would appear to provide additional supplies at Station 2 and Sumas. Westcoast open season results suggest that as much as 300 MDth per day of incremental supply may be available for bidding by PSE and others at Station 2. However, the apparent success of the Nova Gas Transmission Limited (TC-AB) open seasons might also suggest that the vast majority of new

British Columbia shale supplies are intended for the Alberta market and committed to a pipeline route that completely bypasses the Westcoast system, making it impossible for PSE to even bid to acquire the gas.

While increased supplies from British Columbia (and eventually Alaska and Mackenzie) may be available into the AECO market, a significant decline in net export supplies is forecast. Substantial increases in demand within Alberta, primarily due to fuel oil sands production, are forecast to more than offset the increased supplies.

Recent development of conventional resources as well as the expected development of shale and tight formations based on new horizontal drilling and fracturing technologies have resulted in an increase in production in the Rocky Mountain region. Between 2007 and 2030, Global Insight forecasts a 22% increase in Rocky Mountain production. Gas production increases in the Rocky Mountain region have resulted in Rockies forward market prices (Opal Hub) that are significantly lower than both Sumas and AECO Hub prices.

Figure 6-13
Forward Market Supply Hub Prices and Basis Differentials 2010 - 2013
($/MMBtu)

	Sumas	Rockies	AECO	Sumas - Rockies Basis Diff.	AECO - Rockies Basis Diff.
2010 - Q1	7.40	5.66	6.40	1.74	0.74
Q2	5.94	4.12	5.89	1.82	1.77
Q3	6.24	4.31	6.12	1.93	1.81
Q4	7.43	5.28	6.59	2.15	1.31
2011 - Q1	7.97	6.09	7.05	1.88	0.96
Q2	6.19	4.66	6.19	1.52	1.53
Q3	6.44	4.78	6.35	1.66	1.57
Q4	7.66	5.64	6.75	2.02	1.11
2012 - Q1	8.14	6.43	7.14	1.71	0.71
Q2	6.22	5.29	6.23	0.92	0.93
Q3	6.48	5.42	6.38	1.05	0.95
Q4	7.75	6.09	6.77	1.66	0.68
2013 - Q1	7.93	6.88	7.16	1.04	0.28
Q2	6.36	5.54	6.23	0.81	0.69
Q3	6.61	5.68	6.38	0.93	0.70
Q4	7.90	6.27	6.80	1.63	0.53
			4 year average =	**1.53**	**1.02**
			Minimum =	**0.81**	**0.28**
			Maximum =	**2.15**	**1.81**

For example, as shown in Figure 6-13, the average forward market prices for Rockies gas during over the 2010-2013 period is $1.53 per MMBtu lower than Sumas prices, and $1.02 lower than AECO prices.

Pipeline expansion projects between the Rockies and PSE's service territory could be largely justified based solely on basis differentials if such differentials were guaranteed to continue over the 20-year planning period. However, long-term price forecasts do not show such large basis differentials continuing. Differentials are expected to decline as new pipelines are built to carry gas from the Rockies to markets, thereby balancing the supply and demand for Rockies gas. The irony is that unless the new pipelines are built, the price differential may continue to expand. Yet, if the pipelines are built, the price differential may shrink – but those connected to the pipeline will have access to the new source of gas and that access could serve to lower relative prices at alternate sources.

A Commercially Viable Route to the Rocky Mountain Basin. The proposed Ruby pipeline extending from the Rockies area to interconnect with the TC-GTN pipeline at Malin, Ore., will expand the availability of Rockies gas at Malin. This pipeline is currently scheduled to be completed in 2011.

To provide access to the increased supply of gas at Malin, PSE and other utilities are evaluating pipeline alternatives to transport gas between Malin and the I-5 corridor. PSE and NWP have jointly proposed the Blue Bridge expansion of the existing NWP system between Stanfield and the Puget Sound area. NW Natural and TransCanada have proposed the Palomar pipeline to expand the supply of gas to NW Natural from TransCanada's GTN pipeline. The Palomar pipeline (from TC-GTN's system in central Oregon to NW Natural's system near Molalla, Ore.) offers an alternative route through the Columbia Gorge, but would also require upgrades to the NWP system along the I-5 corridor in order to serve PSE. Further complicating the analysis is an expectation that the Palomar project would result in approximately 100,000 Dth per day of uncontracted capacity on the existing NWP system.

At this point it is unclear which of these pipeline proposals, if any, will be completed. For this IRP, an alternative with costs and capacity representative of the Blue Bridge and Palomar proposals is included in the analysis. This alternative, the Cross Cascades Pipeline, is shown in Figure 6-14 below.

Alternatives Considered

As shown earlier in Figures 6-3 and 6-4, the gas sales portfolio has sufficient resources through the winter of 2014-2015 (in the 2007 Base Case demand forecast); the need for additional resources to supply gas for electrical generation is more immediate, beginning in 2010.

Transporting gas from production areas or market hubs to PSE's service area generally entails assembling a number of specific pipeline segments and gas storage alternatives. Purchases from specific market hubs are joined with various upstream and direct connect pipeline alternatives and storage options to create combinations that have different costs and benefits.

In this IRP, the alternatives have been gathered into five broad combinations for analyses. These combinations are illustrated in Figure 6-14.

- Combination #1 provides for an increased supply of Alberta (AECO hub) gas delivered via expanded upstream pipeline capacity on the TC-AB, TC-BC, and TC-GTN pipelines with final delivery to PSE via the Cross Cascades pipeline.

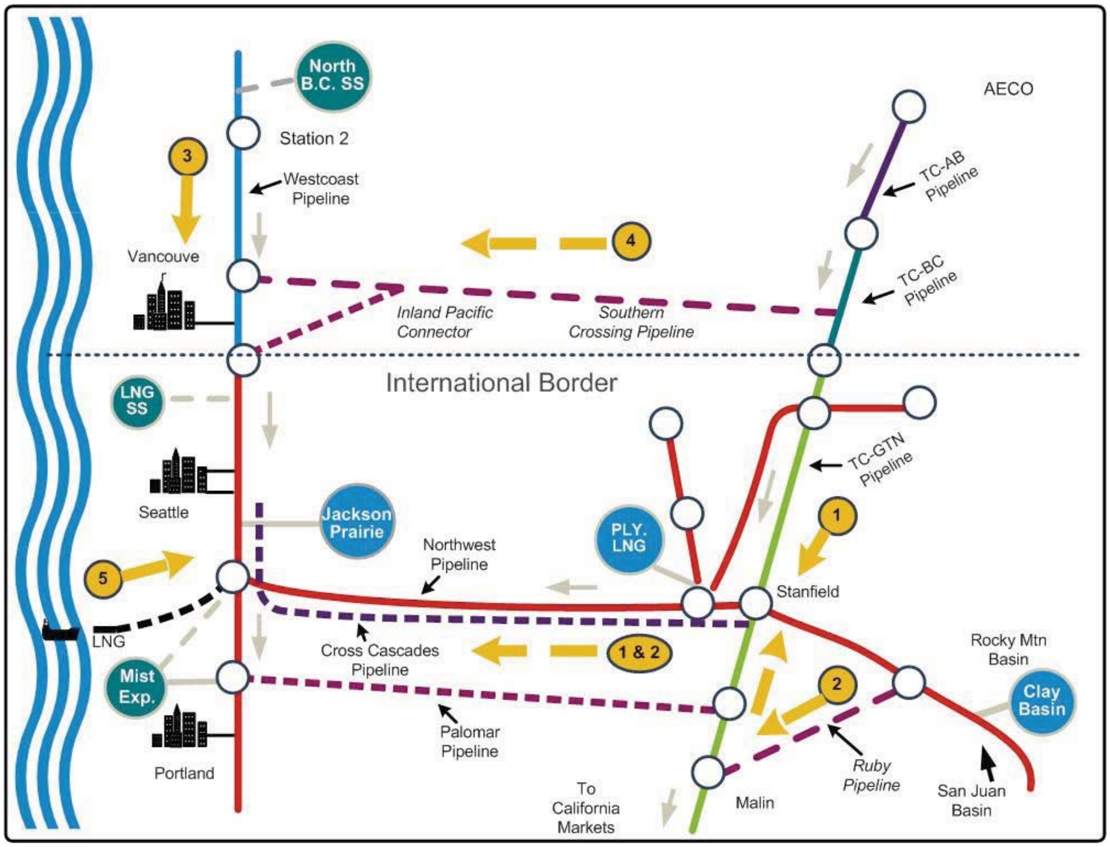
- Combination #2 provides for an increased supply of Rockies gas delivered to Malin on the Ruby pipeline, then on TC-GTN to the Cross Cascades pipeline.

- Combination #3 illustrates the option of expanding access to northern British Columbia gas (Station 2 hub) with expanded transport capacity on Westcoast pipeline to Sumas and then on expanded NWP to PSE's service area.

- Combination #4 represents the Southern Crossing pipeline option. This option would allow delivery of AECO gas to PSE via expanded capacity on the TC-AB and TC-BC pipelines, an expanded Southern Crossing pipeline across southern British Columbia to Sumas, and then on expanded NWP capacity to PSE.

- Combination #5 provides delivery of gas imported at an LNG import terminal located near the lower Columbia River. Delivery of gas would require construction of a pipeline between the terminal and NWP as well as the expansion of NWP to PSE's service area.

Figure 6-14
PSE Gas Transportation Map Showing Supply Alternatives



In addition to the five primary pipeline combinations, Figure 6-14 shows the three gas storage alternatives included in the analysis.

A. Pipeline Capacity Alternatives

The direct-connect pipeline alternatives considered in this IRP are summarized in Figure 6-15 below.

Figure 6-15
Direct-connect Pipeline Alternatives Analyzed

Name	Description
NWP - Sumas to PSE city gate	Expansions considered only in conjunction with upstream pipeline/supply expansion alternatives (Southern Crossing or additional Westcoast capacity).
Cross Cascades – Stanfield/TC-GTN to PSE city gate	Representative of costs and capacity of either the proposed Blue Bridge expansion of NWP or the Palomar pipeline with delivery on NWP to PSE city gate.
NWP - Washougal to PSE city gate	Expansion considered in conjunction with a Columbia River LNG import terminal or expansion of the Mist storage facility.

Upstream Pipeline Capacity Alternatives

In some cases, a tradeoff exists between buying gas at one point, and buying capacity to enable purchase at an upstream point closer to the supply basin. PSE has faced this tradeoff with our supply purchases at the Canadian import points of Sumas and Kingsgate. For example, previous analyses led the company to acquire capacity on Westcoast Pipeline, which allows us to purchase gas at Station 2 rather than Sumas allowing us to take advantage of the greater supplies available at Station 2. Similarly, acquisition of additional upstream pipeline capacity on TransCanada's Canadian and U.S. pipelines would enable us to purchase gas directly from suppliers at the very liquid AECO trading hub and transport it to interconnect with the Southern Crossing or Cross Cascades pipelines on a firm basis.

Figure 6-16
Upstream Pipeline Alternatives Analyzed

Name	Description
Increase Westcoast Capacity (Station 2 to Sumas)	Acquisition of currently uncontracted Westcoast capacity is considered to increase access to gas supply at Station 2 and a northern B.C. storage alternative for delivery to PSE on expanded NWP capacity from Sumas.
TransCanada Pipeline Expansion (AECO to Stanfield)	Expansion of TransCanada pipeline capacity in Canada (TC-AB & TC-BC) and acquisition of currently uncontracted capacity on TC-GTN to increase deliveries of AECO gas to Stanfield for delivery to PSE city gate via the Cross Cascades pipeline.
Southern Crossing Pipeline	Expansion of the existing Terasen gas pipeline across southern B,C., a new lateral connecting to Huntingdon B.C, (Sumas), plus a commensurate expansion of the capacity on TC-AB and TC-BC for delivery to PSE on expanded NWP capacity from Sumas.

The Southern Crossing alternative includes (1) PSE participation in the existing (or an expansion of the existing) Terasen pipeline across southern British Columbia, and (2) a new connector pipeline connecting this pipeline to Huntingdon, B.C. (Sumas), completely bypassing Westcoast facilities upstream of Sumas. Acquisition of this capacity, as well as additional capacity on the TCPL-Alberta and TCPL-BC lines, would improve access to the AECO trading hub. While not inexpensive, such an alternative would increase geographic diversity and reduce reliance on British Columbia-sourced supply.

PSE currently has access to gas sourced at AECO via three layers of TransCanada pipeline to Stanfield and then to the PSE city gate via NWP. The addition of the Cross Cascades pipeline in conjunction with the acquisition of additional capacity on these pipelines would increase access to AECO gas and increase supply diversity.

B. Storage and Peaking Capacity Alternatives

As described in the existing resources section, PSE is a one-third owner and operator of the Jackson Prairie storage facility, and contracts for capacity at the Clay Basin storage facility located in northeastern Utah. At this time, however, neither offers PSE the possibility of expanding capacity beyond existing arrangements. For this IRP, the company considered the following storage alternatives:

The owner and operator of the Mist underground storage facility near Portland, Ore., is investigating potential expansion projects. PSE is assessing the cost-effectiveness of such possibilities; however, Mist expansions are also expected to have relatively high costs and limited firm access to PSE's city gate.

Participation in a regional LNG storage facility is also being considered. PSE's evaluation assumes costs and operating characteristics similar to the Mount Haynes LNG storage project currently under construction on Vancouver Island by Terasen Gas. LNG storage projects offer "needle peaking" capability; i.e. delivery of stored gas over a relatively short period of time (this analysis assumes approximately 10 days).

Contracting for storage service at the Aitken Creek storage facility in northern British Columbia is the final alternative under consideration. The Aitken Creek facility is similar to the Clay Basin storage project in that it offers "seasonal" storage; however, Clay Basin has cost-based rates, while Aitken Creek has market-based rates; market-based rates often erase a sizable portion of the savings potential that makes seasonal storage attractive.

Figure 6-17
Storage Alternatives Analyzed

Name	Description
Northern B.C. Storage Service	Based on estimated market price of existing Aitken Creek services.
Expansion of Mist Storage Facility	Based on estimated cost and operational characteristics of expanded Mist storage.
Regional LNG Storage Facility	To be cost effective, such a facility should be located to allow firm exchange delivery to PSE's city gate. The returns to scale of LNG storage imply that joint participation would be attractive. These analyses assume a 10-day supply at full deliverability.

C. Gas Supply Alternatives

As described earlier, gas supply and production are expected to continue to expand in both northern British Columbia and the Rockies production areas as shale and tight gas formations are developed using horizontal drilling and fracturing methods. PSE anticipates that adequate gas supplies will be available to support pipeline expansion from northern British Columbia or from the Rockies basin (our preferred alternative). Appendix K, Long-term Fundamental Gas Market Overview, contains a detailed discussion of future gas supplies.

Major pipeline projects have been proposed to transport gas from the Arctic to the North American markets, but these projects are too distant to provide short- or medium-term relief. The Alaska Natural Gas Transmission System would transport natural gas from the North Slope through Canada and to Chicago, and provide 4.5 Bcf per day starting between 2017 and 2019. The Mackenzie Valley Pipeline would transport natural gas from the Tablus, Parsons Lake, and Niglintgak fields to the northern border of Alberta and eventually deliver 800 Mcf per day.

Currently there are at least three proposals to construct LNG import terminals in the region. Two proposals, the Oregon LNG and the Bradwood Landing projects are located near the mouth of the Columbia River, while a third project, the Jordan Cove project is located at Coos Bay, Ore. Construction of an LNG import terminal could significantly increase the availability of gas in the region, depending on the commitment of suppliers to the terminal. At today's gas prices, LNG can be competitively transported, stored, and marketed. Many experts believe that significant LNG imports into North America will be required at some point in the future to balance supply and demand in the future—though few predict any of the import terminals will be located on the West Coast.

LNG production costs are within current and anticipated market prices. LNG projects typically have low exploration and technology risks, and very high capital costs. Projects generally require an experienced sponsor with a strong balance sheet, a secure source of natural gas, a large immediate market or an extensive infrastructure capable of consuming the entire output, and long-term off-take agreements to support the project's financing costs.

The market for LNG is worldwide and prices are typically based on world oil prices. Given the volatility of crude oil and natural gas prices over the past year, future LNG prices are uncertain. For purposes of this analysis, LNG import prices are based on the crude oil price forecasts from the same Global Insight long-term energy price forecasts as the natural gas prices. The Global Insight crude oil price forecasts tend to decline over the 2010-2029 time period, resulting in similarly declining LNG prices, while domestic natural gas prices are projected to increase over this period. In general, imported LNG becomes price competitive during the 2017-2022 period.

For this IRP, PSE assumed that supply may be available from an LNG import facility located on the mouth of the Columbia River beginning in 2017.

Figure 6-18
Gas Supply Alternatives Analyzed

Name	Description
LNG import facility located on lower Columbia River interconnected with NWP south of PSE service territory	Flows over NWP north to PSE on incremental transport capacity.
Conventional gas supply purchase contracts	Assume current mix of term contracts and spot purchases. Recent estimates of gas reserves indicate that supplies from the WCSB and Rockies will be sufficient to meet needs.

D. Demand-side Resource Alternatives

There were several steps in evaluating cost-effectiveness of demand-side resource measures.

Demand-side measures were first screened for technical potential. This step assumed that all opportunities could be captured regardless of cost or market barriers, so that the full spectrum of technologies, load impacts, and markets could be surveyed.

A second screen eliminated any resources not considered achievable. To gauge achievability, PSE relied on customer response to past PSE energy efficiency programs, and the experience of other utilities offering similar programs. For this IRP, the company assumed that 75% and 55% of gas demand-side resource potentials in existing buildings and new construction markets, respectively, are likely to be achievable over the planning period.

The remaining measures are considered to have “achievable technical potential.” These measures were next combined into cost bundles and the bundles were arranged from lowest to highest cost (savings for all measures in each group were adjusted for interactive effects).

PSE currently seeks to acquire as much cost effective gas demand-side resource (DSR) as quickly as possible.

The acquisition rate, or "acceleration" rate, of gas DSR modeled in the IRP is consistent with this strategy and held static through the analysis. PSE, however, is interested in examining how it can overcome the obstacles that may allow it to change the acquisition rate at a future date. The primary obstacles currently faced are:

- Gas measures also are relatively long-lived, the replacement cycles tend to be longer, and there are a relatively higher proportion of "lost opportunity" measures. This means that a program that increases the acquisition rate would have to pay a premium to replace or install a measure before the useful life of an existing measure has ended, which limits the program's cost-effectiveness.
- Gas measures are costly. Even with utility incentives at the maximum avoided cost, the owner bares the major part of the project costs.
- There is no cost data available to reflect the higher cost of ramping measures, and hence the effect on cost effectiveness
- Gas measures typically require specialized knowledge to install, which means the necessity of hiring and managing a specialized contractor.

Finally, SENDOUT was used to test the optimal level of demand-side resources in each scenario. To format the inputs for SENDOUT analysis, the demand-side resource inputs consisting of the cost bundles were further sub-divided by market sector and weather/ nonweather sensitive measures. To determine the optimal demand-side resource, increasingly expensive bundles were added to each scenario until SENDOUT rejected bundles as not cost effective. The bundle that reduced the portfolio cost the most was deemed the appropriate level of demand-side resources for that scenario.

Figure 6-19 illustrates the methodology described above.

Figure 6-20 shows the range of achievable technical potential among the seven cost bundles used in SENDOUT. It selects an optimal combination of each bundle for each market sector to determine the overall optimal level of demand-side gas resource for a particular scenario.

Figure 6-21 shows a sample input format sub-divided by market sectors for Bundle AU (<$4.0 per Dth) used in the SENDOUT portfolio optimization model for all the bundles.

Figure 6-19
General Methodology for Assessing Demand-side Resource Potential

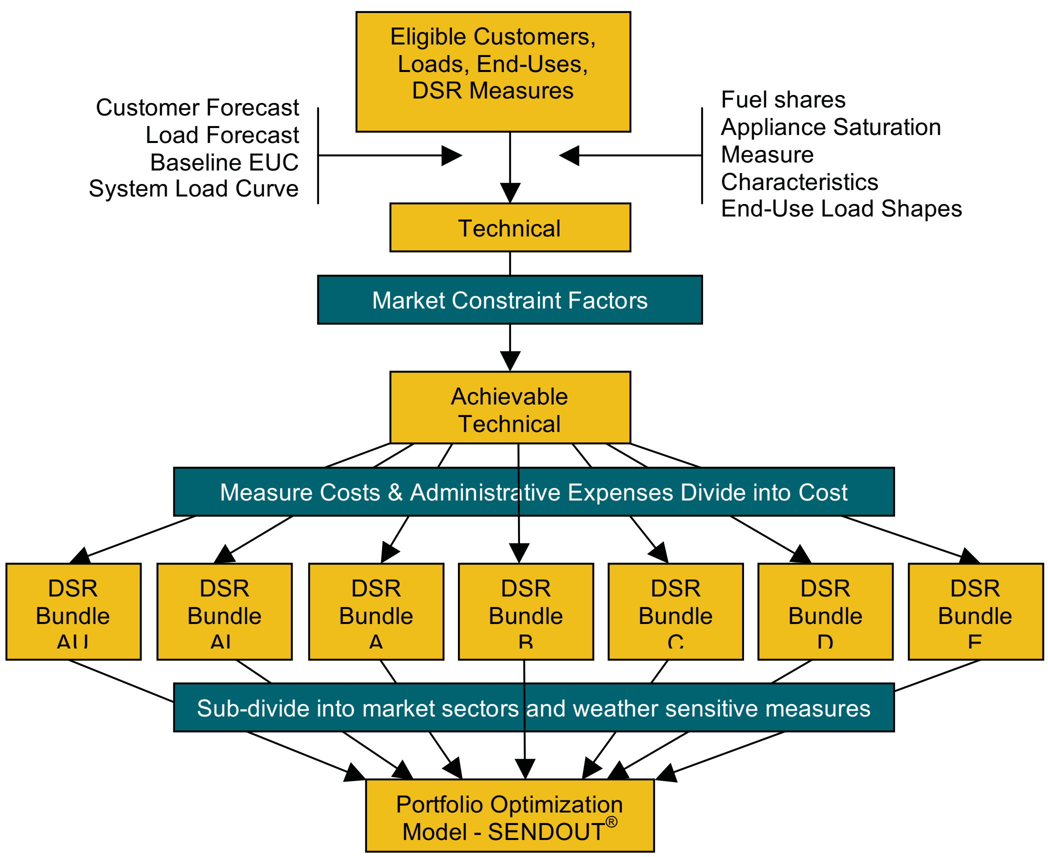


Figure 6-20
Achievable Technical Potential Bundles

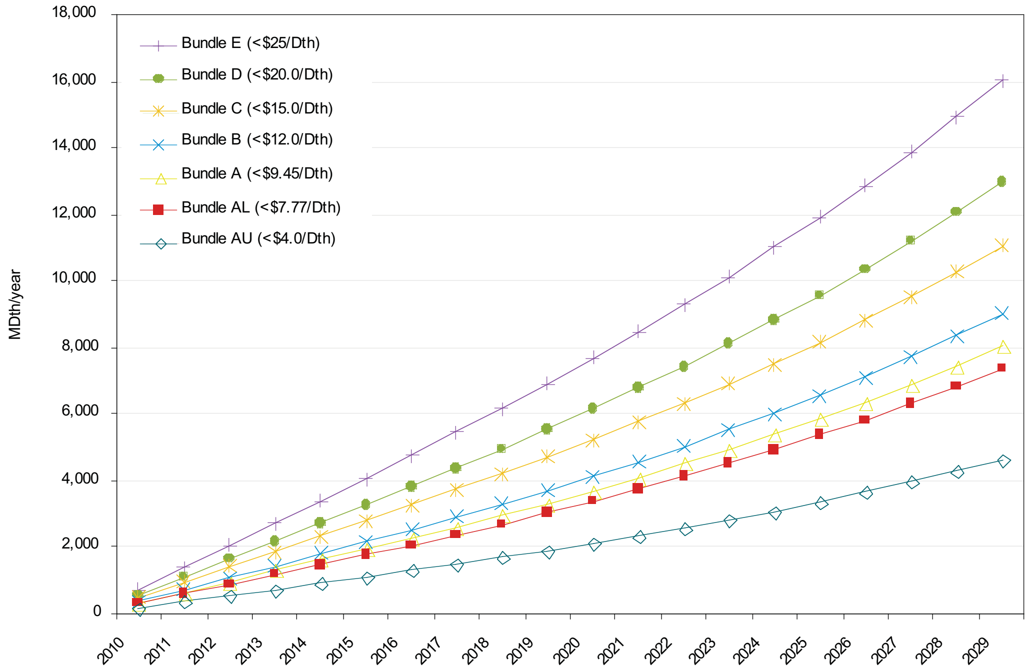
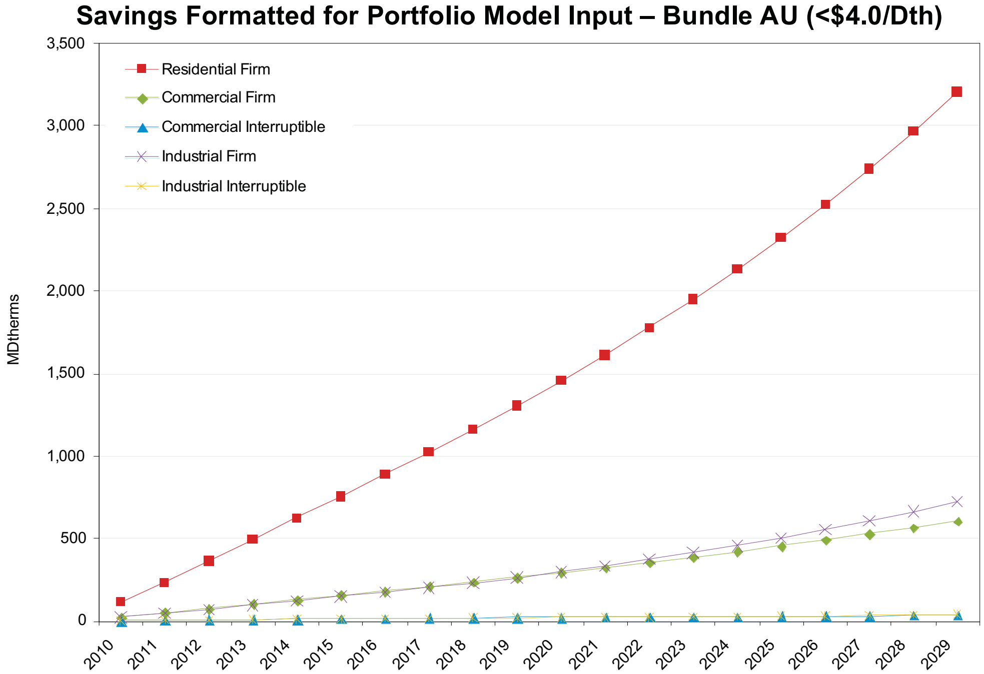


Figure 6-21
Savings Formatted for Portfolio Model Input – Bundle AU (<$4.0/Dth)



IV. Gas Analytic Methodology

In general, analysis of a gas supply portfolio begins with an estimate of resource need that is derived by comparing 20-year demand forecasts with existing resources. Once need has been identified, a variety of planning tools, optimization analyses, and input assumptions help PSE identify the lowest-reasonable-cost portfolio of gas resources within a variety of scenarios. Demand forecasts are discussed in detail in Chapter 4. Scenarios and sensitivities are explained in Chapter 3. Here we describe three important analysis tools.

A. Optimization Analysis Tools

PSE uses SENDOUT, from Ventyx, to model gas resources for long-term planning and long-term gas resource acquisition activities. SENDOUT is widely used and employs a linear programming algorithm to help identify the long-term, least-cost combination of resources that will meet stated loads. SENDOUT also has the capability to integrate demand-side resources with supply-side resources to determine an optimal resource portfolio. While the deterministic linear programming approach used in this analysis is a helpful analytical tool, it is important to acknowledge this technique provides the model with "perfect foresight," meaning that its theoretical results may not really be achievable. For example, the model knows the exact load and price for every day throughout a winter period, and can therefore minimize cost in a way that is not possible in the real world. In the real world, numerous critical factors about the future will always be uncertain. Linear programming analysis can help inform decisions, but it should not be relied on to make them.

To incorporate uncertainty about future gas prices and weather-driven loads, PSE acquired the add-in product VectorGas to use with SENDOUT. In 2008, installation of SENDOUT Version 12.1.1 integrated VectorGas's Monte Carlo capability into SENDOUT itself. Monte Carlo analysis of physical supply risk indicates whether a portfolio that meets our design-day peak forecast is sufficient, in an otherwise normal-temperature winter, to meet our obligations under a variety of possible conditions. See Appendix J, Gas Analysis, for a more complete description of SENDOUT.

B. Deterministic Optimization Analysis

As described in Chapter 3, PSE developed seven gas sales scenarios to examine the impact of a range of possible future demand and price conditions on resource planning. Scenario analysis allows the company to understand how different resources perform across a variety of economic and regulatory conditions. Scenario analysis clarifies the robustness of a particular resource strategy. In other words, it helps determine if a particular strategy is reasonable under a wide range of future circumstances.

C. Monte Carlo Analysis

PSE performed two kinds of Monte Carlo analyses to test different dimensions of uncertainty. The first tested how well a single resource portfolio performs under gas price and load uncertainty over the 20-year planning horizon. For example, this approach can tell under what percentage of the Monte Carlo draws a specific resource portfolio meets design peak day loads.

The second application of the Monte Carlo analyses develops optimal resource portfolios in each of the 100 scenario draws. This approach can be used to generate probability distributions for each potential resource addition; i.e. in what percentage of the Monte Carlo draws is a specific resource added. A deterministic analysis often overemphasizes the importance of the “optimal” portfolio. This analysis showed how resource alternatives available in the 2007 Trends scenario are sensitive to the underlying price and demand assumptions.

PSE used Monte Carlo analyses to generate 100 daily price and temperature scenarios – or draws – for the 20-year planning horizon. For additional details of the SENDOUT analyses, see Appendix J, Gas Analysis.

V. Gas Analysis Results

For the gas sales portfolio, PSE analyzed seven scenarios and three sensitivities. For the combined portfolio (gas sales and gas for generation), two views were examined: one included a requirement for supply diversity, the other did not. Our purpose was to identify the costs associated with increasing diversity. Gas sales analysis results are presented first, then the combined portfolio results.

A. Gas Sales Portfolio Analysis and Results

Comparison of Resulting Average Annual Portfolio Costs

Figure 6-22 should be read with caution. Its value is comparative rather than absolute. It is not a projection of average purchased gas adjustment (PGA) rates; instead, costs are based on a theoretical construct of highly incrementalized resource availability. Also, average portfolio costs include items that are not included in the PGA. These include rate-base costs related to Jackson Prairie storage and costs for energy efficiency programs, which are included on an average levelized basis rather than a projected cash flow basis. It should also be noted that the perfect foresight of a linear programming model creates theoretical results that cannot be achieved in the real world.

Figure 6-22
Cost Projections for Gas Scenarios & Sensitivity Analyses

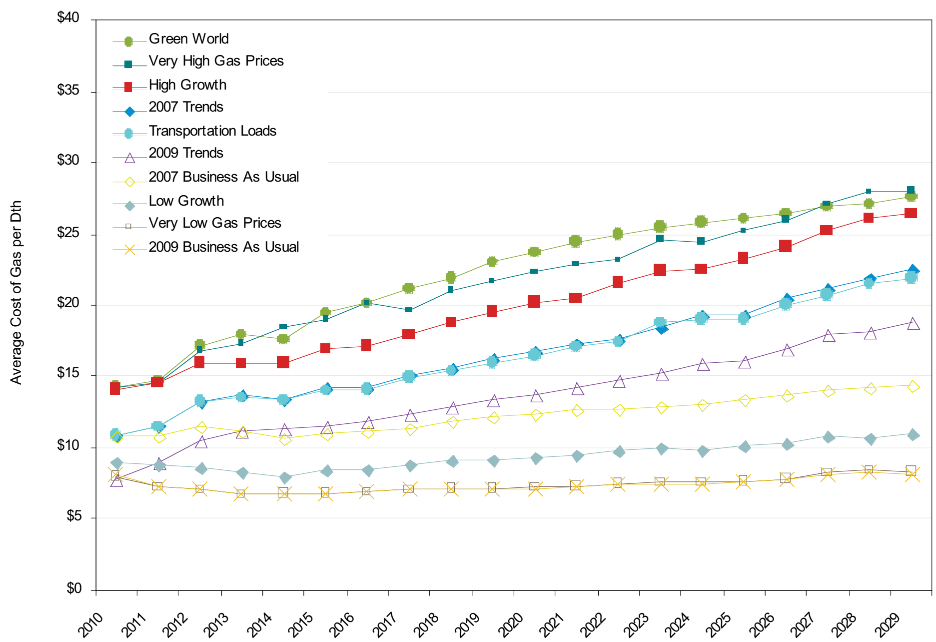


Figure 6-22 shows that average optimized portfolio costs are largely based on the gas and CO_2 cost assumptions included in each scenario.

- 2007 Trends scenario costs are about $10.90 per Dth in 2010 and increase to about $22.00 per Dth by 2029. 2007 Business as Usual costs also start at $10.90 per Dth, but rise to about $14.40 per Dth by 2029. The difference is due to CO_2 emissions costs (the only difference between the two scenarios).
- The Very Low Gas Price sensitivity and 2009 Business As Usual scenarios have the lowest portfolio prices; these reflect very low gas price assumptions and the absence of any CO_2 costs in either scenario.
- Green World costs are the highest, reflecting high CO_2 cost assumptions and a high gas price forecast.
- High Growth costs are somewhat lower, reflecting the lower CO_2 prices assumptions than Green World.

To test for Transportation Load sensitivity, the gas transportation load was included in the 2007 Trends scenario; its addition had little impact on the average cost of the portfolio. The Very High Gas Price sensitivity test also used 2007 Trends assumptions except for gas prices; this sensitivity significantly increased average portfolio costs. The Very Low Gas Price sensitivity was modeled using 2007 Business As Usual scenario assumptions except for gas prices.

Comparison of Resource Additions

Differences in resource additions are primarily driven by load growth and the gas and CO_2 price assumptions. Demand-side resources are influenced directly by gas and CO_2 price assumptions because they avoid commodity and emissions costs by their nature. However, the absolute level of efficiency programs is also affected by load growth assumptions.

The optimal portfolio resource additions in each of the seven scenarios and three sensitivity tests are illustrated in Figures 6-23 through 6-26 for 2015, 2020, 2025, and 2029 respectively.

Figure 6-23
Gas Resource Additions in 2015

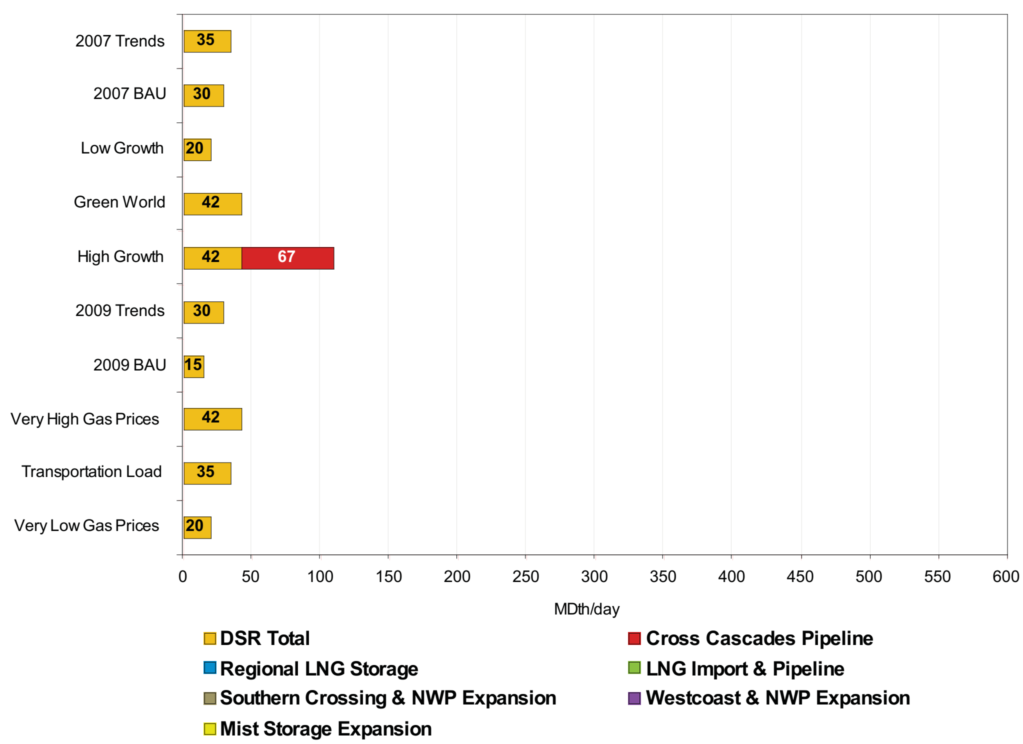


Figure 6-24
Gas Resource Additions in 2020

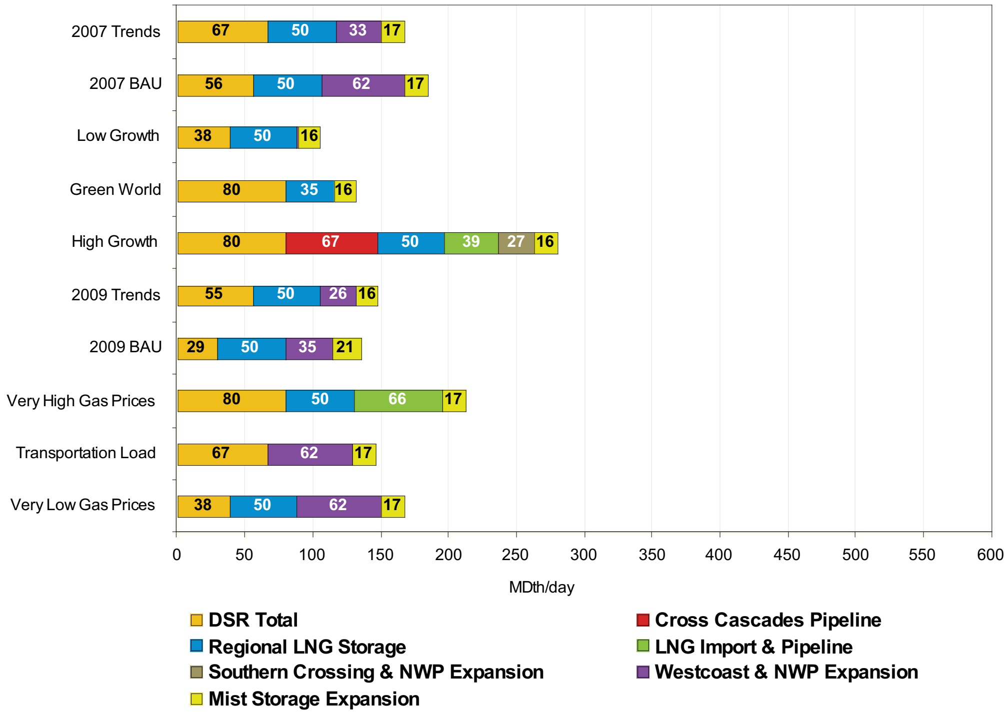


Figure 6-25
Gas Resource Additions in 2025

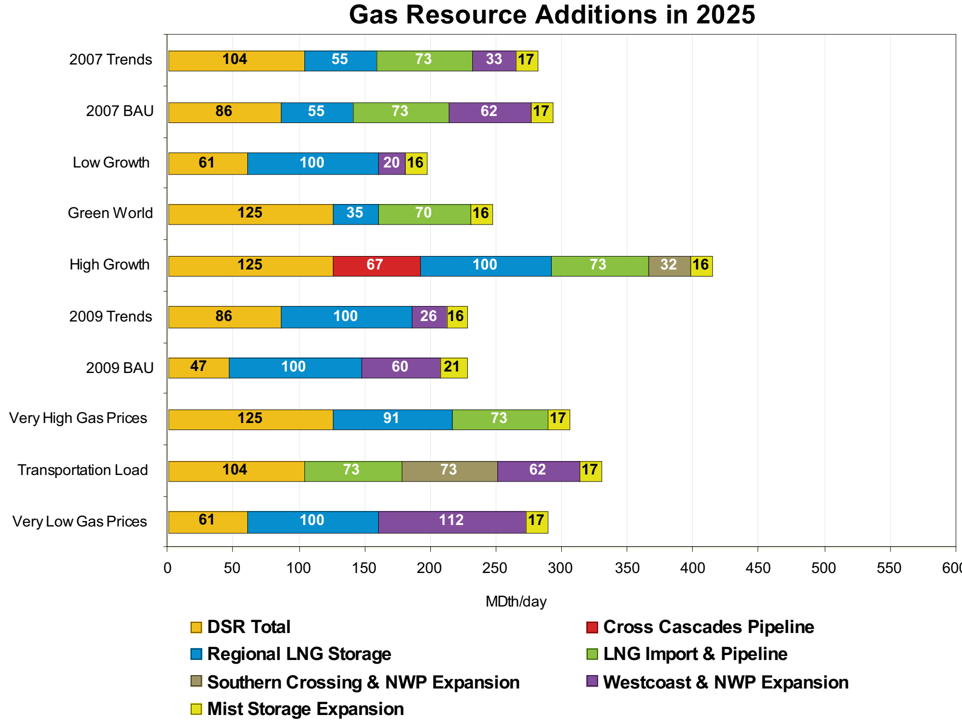
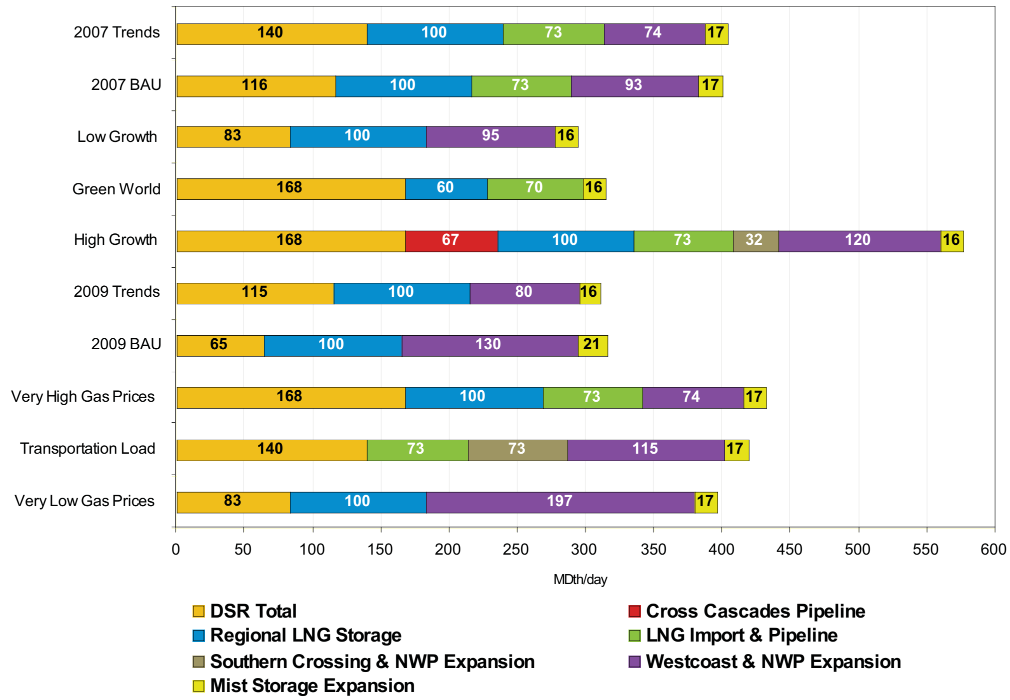


Figure 6-26
Gas Resource Additions in 2029



Pipeline Capacity Additions

The analysis includes the Cross Cascades and Southern Crossing alternatives only in the High Growth scenario. The Green World scenario doesn't include any of these pipeline alternatives.

Storage Additions

The results indicate that PSE should continue to consider a regionally located LNG storage facility as well as a limited amount of storage at the Mist facility between 2015 & 2020. The northern British Columbia storage alternative was not selected in any of the scenarios.

Supply Additions

In the real world, PSE continues to rely on acquisition of natural gas from creditworthy and reliable suppliers at major market hubs or production areas. For the IRP SENDOUT model, we assumed continuation of geographically diverse, long-term supply contracts (currently about two-thirds of annual requirements) throughout the planning horizon. The optimal portfolio would contain additional gas supply from various supply basins or trading locations, along with optimal utilization of existing and new capacity.

An imported LNG supply terminal built on or near the mouth of the Columbia River with new and/or expanded pipeline capacity for delivery to PSE's service territory was also considered. LNG imports were included in the Very High Gas Price test and High Growth scenarios by 2020 and in additional scenarios by 2025 and 2029. As mentioned earlier, the future of LNG imports into the Pacific Northwest is unclear. Capital costs of building the supply infrastructure (liquification, transportation, and vaporization facilities) is very high, and the delivered gas costs advantages over domestic supplies is not apparent – at least over the next few years.

Energy Efficiency Additions

The optimal level of energy efficiency resources for the integrated gas sales portfolios was determined by SENDOUT, as described earlier.

Demand-side bundles demonstrated sensitivity to avoided costs, as illustrated in Figure 6-27, responding to various scenario assumptions about load growth, carbon costs, gas prices, resource costs, etc. In addition, gas price sensitivities were tested and showed an impact on the amount of efficiency potential.

Figure 6-27
Gas Energy Efficiency Savings by Scenario

Compared to the previous plan, this IRP analysis revealed an upward shift in the gas energy efficiency potentials consistent with the upward trend in gas prices. Higher gas prices resulted in higher avoided costs, so scenarios assuming higher gas prices generally resulted in more energy efficiency potential. The amount of achievable energy efficiency resources selected by the SENDOUT analysis in this plan ranged from roughly 6000 MDth in 2029 for the 2009 Business As Usual scenario to more than double that in the Green World and High Growth scenarios and the Very High Gas Price sensitivity.

The optimal market sector level of demand-side resources selected by the SENDOUT analysis is shown in Fig 6-28 below. For discussion on the bundles, see the “Demand-side Resource Alternatives” section above, and for details on the breakout by end use and measure types in each bundle see Appendix L, Demand-side Resources Analysis.

Figure 6-28
Gas Efficiency Sector Level Savings Bundles By Scenario

	2007 Trends	2007 BAU	Low Growth	Green World	High Growth	Very High Gas Price	Trans Load	Very Low Gas Price	2009 Trends	2009 BAU
Residential Bundle	D	C	B	E	E	E	D	B	C	B
Commercial Firm Bundle	D	B	AL	E	E	E	D	AL	C	AU
Commercial Interruptible Bundle	B	A	AL	D	D	D	B	AL	AL	AU
Industrial Firm Bundle	E	E	E	E	E	E	E	E	E	E
Industrial Interruptible Bundle	E	E	E	E	E	E	E	E	E	E

When higher gas prices are adjusted for, the economic potential of energy efficiency in this IRP is only slightly higher than in 2007. The gas price assumption in the Very Low Gas Price sensitivity was slightly lower than the reference case assumption in the 2007 IRP; the 2009 assumption resulted in a gas energy efficiency potential of 8,000 MDth, compared to 7,000 MDth for the 2007 case. New energy efficiency measures in the 2009 IRP are responsible for the difference.

Figure 6-29 compares PSE's energy efficiency accomplishments, current targets, and our new range of gas efficiency potentials. In the short term, this IRP indicates an economic potential range of 700,000 to 2,000,000 Dth of savings for the 2010-2012 period. This is significantly greater than the historical achievement rate, however, it provides guidance to attain as much cost-effective gas efficiency resources as possible within the constraints of economic and market factors.

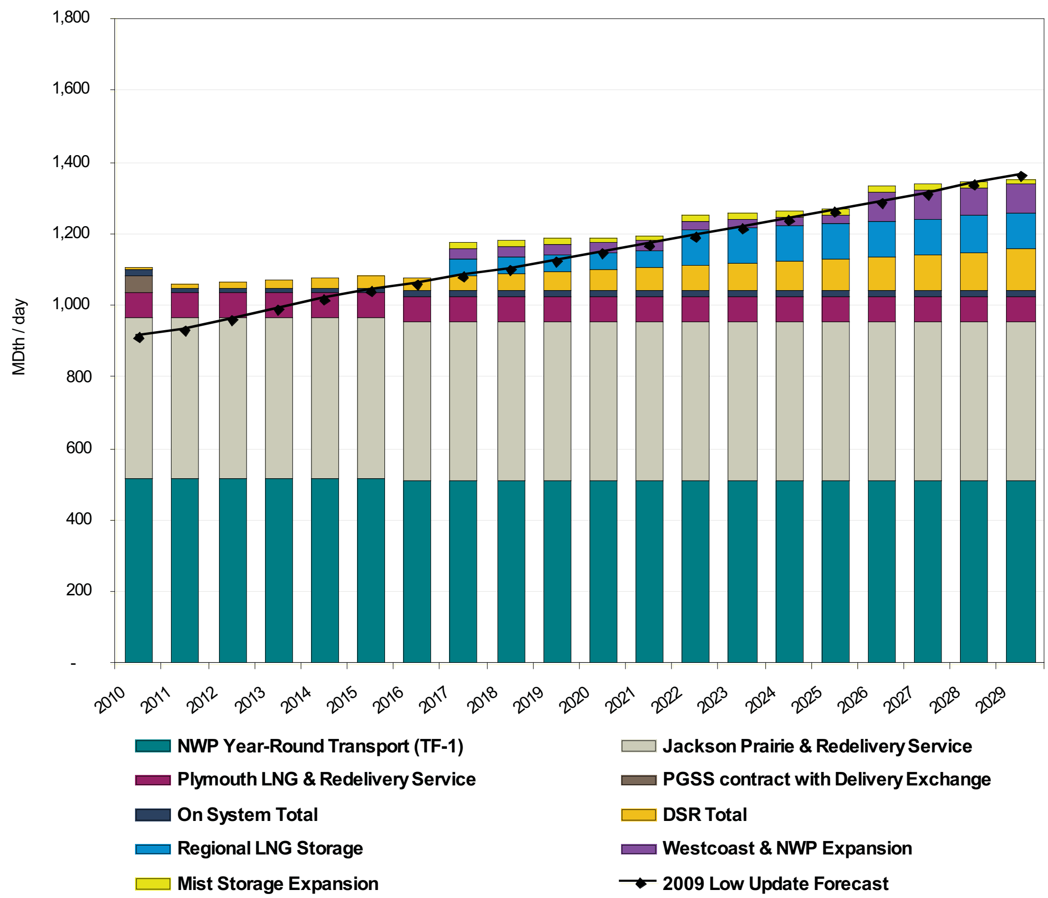
Figure 6-29
Short-term Comparison of Gas Energy Efficiency

Short-Term Comparison of Gas Energy Efficiency	Dth
2006-2007 Actual Achievement	504,000
2008-2009 Target (Updated Jan 2009)	657,000
2010-2012 Range of Economic Potential	700,000 – 2,000,000

Complete Picture: 2009 Trends Scenario

A complete picture of the 2009 Trends scenario optimal resource portfolio is presented below in Figure 6-30. Additional scenario results are included in the Appendix J, Gas Analysis.

Figure 6-30
2009 Trends Gas Resource Portfolio



B. Results of Monte Carlo Analysis on 2009 Trends Portfolio

Monte Carlo analyses on the 2009 Trends scenario optimal resource portfolio provided a reasonable test of whether the company's planning standard (using normal weather with one design peak day per year) creates a portfolio that will meet firm demand under a wide range of different temperature conditions. Results indicate that the 2009 Trends resource portfolio, based on PSE's planning standard, will meet firm demands in over 90% of the draws.

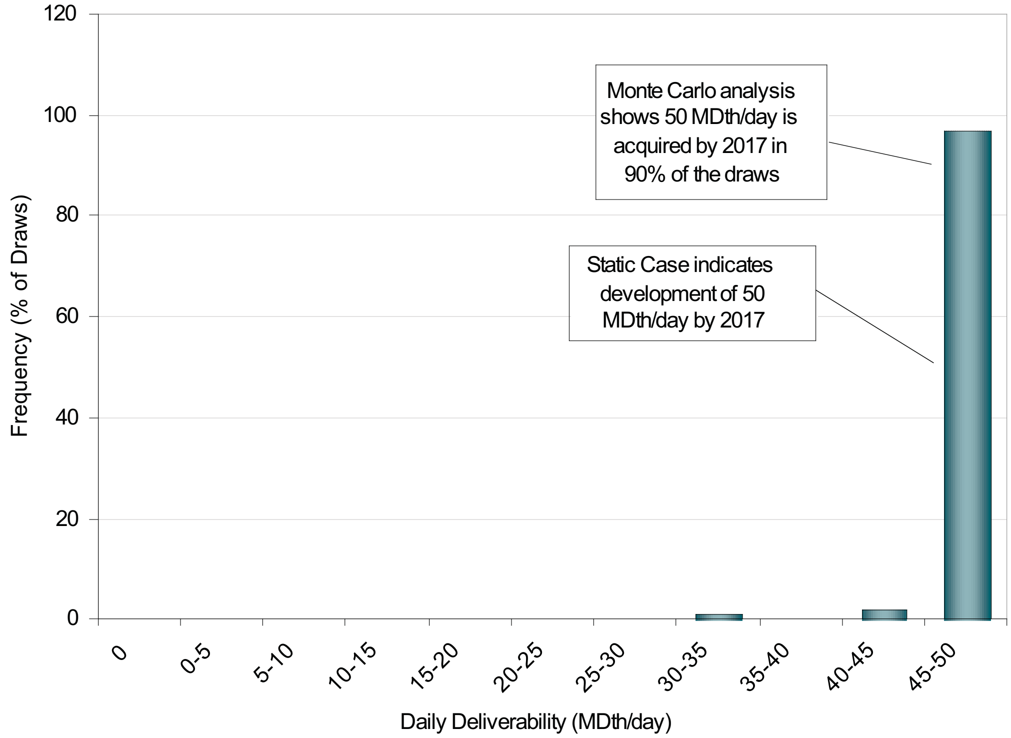
The Monte Carlo analysis also tested the sensitivity of resource additions in the 2009 Trends scenario. Analyses examined six specific resource addition alternatives: the regional LNG storage alternative, the LNG import option, the Southern Crossing/Inland Pacific connector pipeline alternative, the Cross Cascades pipeline alternative, the Mist storage option, and the Northern B.C. storage option. This discussion compares the results from the deterministic analysis with the results from the Monte Carlo resource optimization analysis.

The acquisition of 250 MDth of expanded storage capacity at the Mist facility and 11,250 MDth of capacity in northern British Columbia was selected in all 100 of the draws by 2017. The LNG import alternative was not selected in any of the 100 draws at any time in the analyses.

Regional LNG Storage – Monte Carlo Optimization Results

The regional LNG storage alternative included in the deterministic analysis appears to be sensitive to the specific underlying assumptions. Figure 6-31 shows the frequency distribution with which the regional LNG storage alternative is selected across the 100 scenarios by the year 2017. The Monte Carlo analysis demonstrates that in 17% of the 100 draws, the full regional LNG storage deliverability of 100 MDth per day is developed by 2015, while in 80% of the draws no regional LNG storage is included.

Figure 6-31
Frequency Distribution of Regional LNG Storage Development by 2017

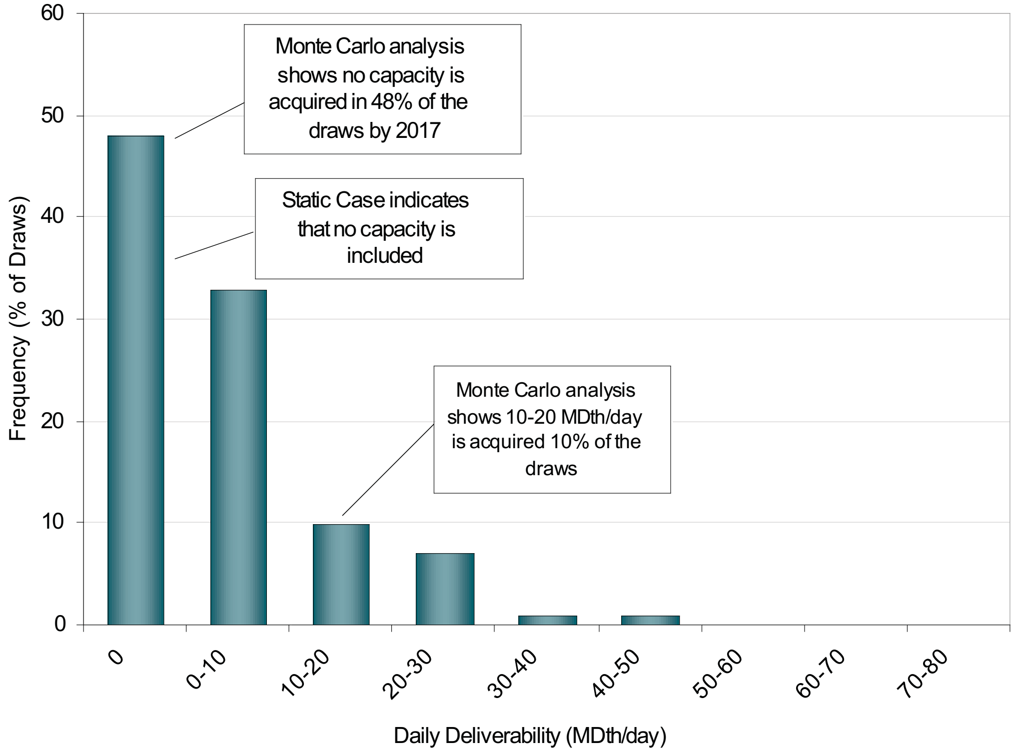


The Monte Carlo analysis indicates that the decision to acquire regional LNG storage capacity is attractive in both the deterministic and Monte Carlo analyses.

Cross Cascades Pipeline – Monte Carlo Optimization Results

Figure 6-32 illustrates the frequency distribution for the Cross Cascades pipeline alternative. As shown, in approximately 48% of the Monte Carlo draws, no Cross Cascades pipeline capacity was selected as part of the optimal resource portfolio. Between 10 and 20 MDth per day of capacity was acquired in 10% of the draws. Note that this option was not selected in the deterministic analyses. These results support the conclusion that PSE may want to acquire a limited amount of Cross Cascades pipeline capacity for the gas sales portfolio if 2009 Trends conditions continue.

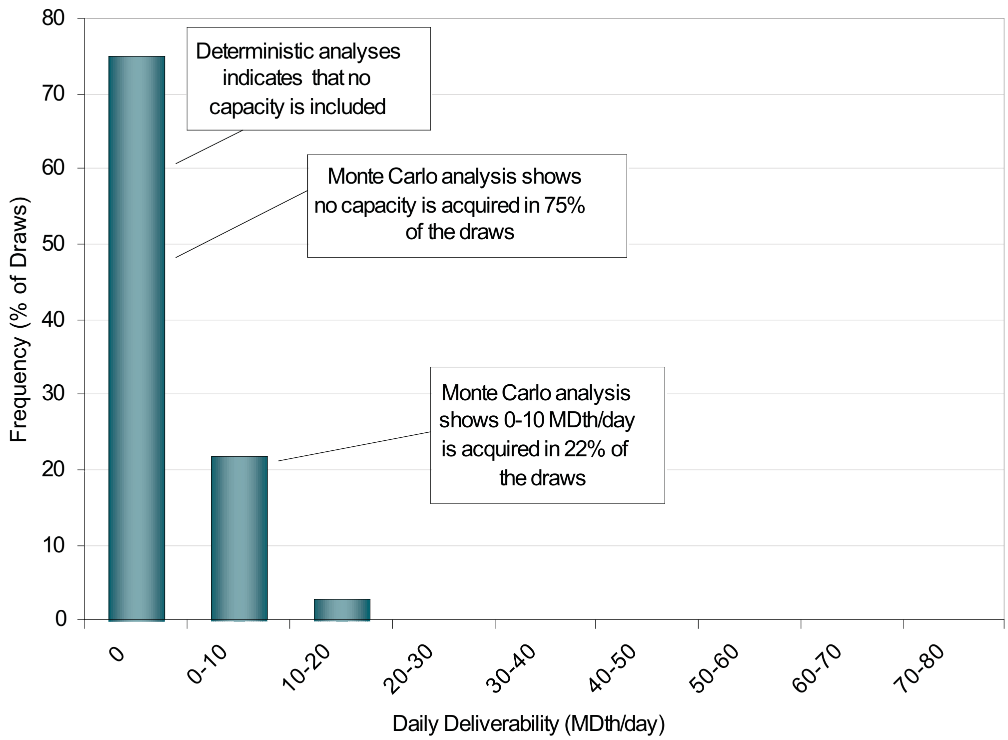
Figure 6-32
Frequency Distribution for Cross Cascades Pipeline by 2017



Monte Carlo Optimization Analysis—Southern Crossing/Inland Pacific Connector

Figure 6-33 shows the frequency distribution for the Southern Crossing/Inland Pacific Connector alternative as well as the results of the deterministic analysis of the 2009 Trends scenario. In 75% of the Monte Carlo scenarios, no Southern Crossing alternative capacity is selected while some, although limited, capacity is selected in the other 25% of the results. No capacity was included in the deterministic analysis.

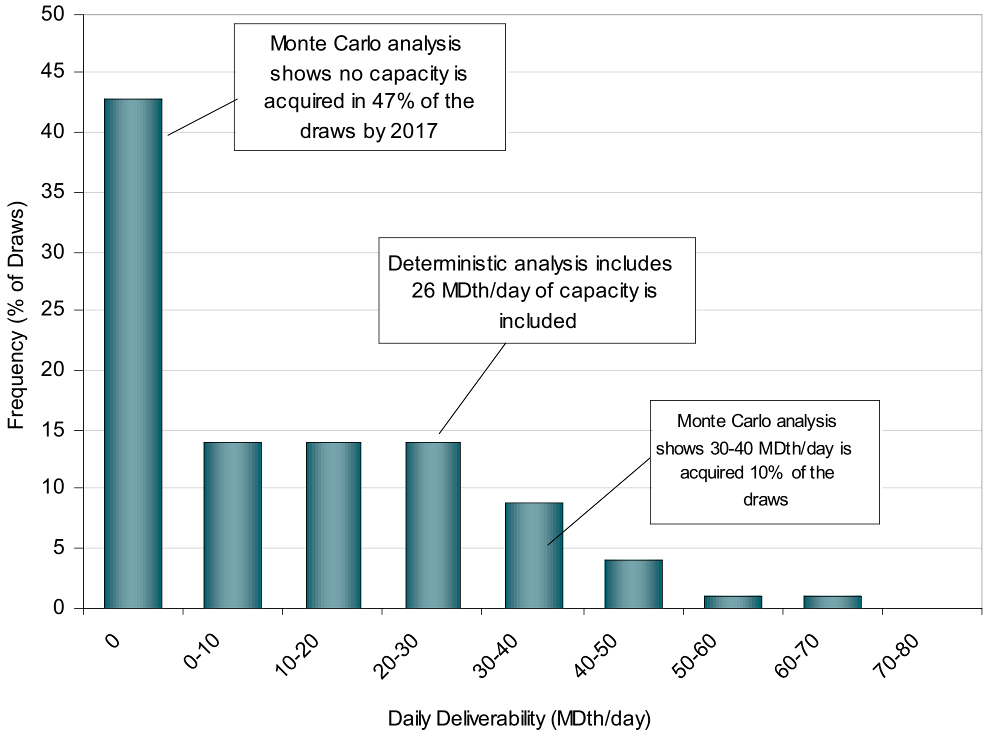
Figure 6-33
Frequency Distribution for Southern Crossing Pipeline Development by 2017



Monte Carlo Optimization Analysis—Summary Conclusion

Figure 6-34 shows the frequency distribution for the NWP alternative from Sumas to PSE's service territory, as well as the results of the deterministic analysis of the 2009 Trends scenario. In 47% of the Monte Carlo scenarios, no NWP Sumas to PSE is selected, while some capacity is selected in the other 25% of the results. Twenty-six MDth per day of capacity was included in the deterministic analysis.

Figure 6-34
Frequency Distribution for NWP Sumas to PSE Service Area by 2017



C. Combined Portfolio and Diversity of Supply Analyses Results

PSE's increasing reliance on natural gas-fueled electric generation makes supply diversity an important issue. Currently, western Canada supplies nearly 70% of the company's combined gas sales and gas for generation portfolios. With time, the need for generation fuel will continue to increase, and exposure to this supply basin could grow even more concentrated. For this reason, PSE is actively investigating acquiring additional Cross Cascades pipeline capacity. Such capacity would allow delivery of gas from the Rockies basin to PSE's service area. The specific routing, design, and costs of this pipeline have not been finalized at this time.

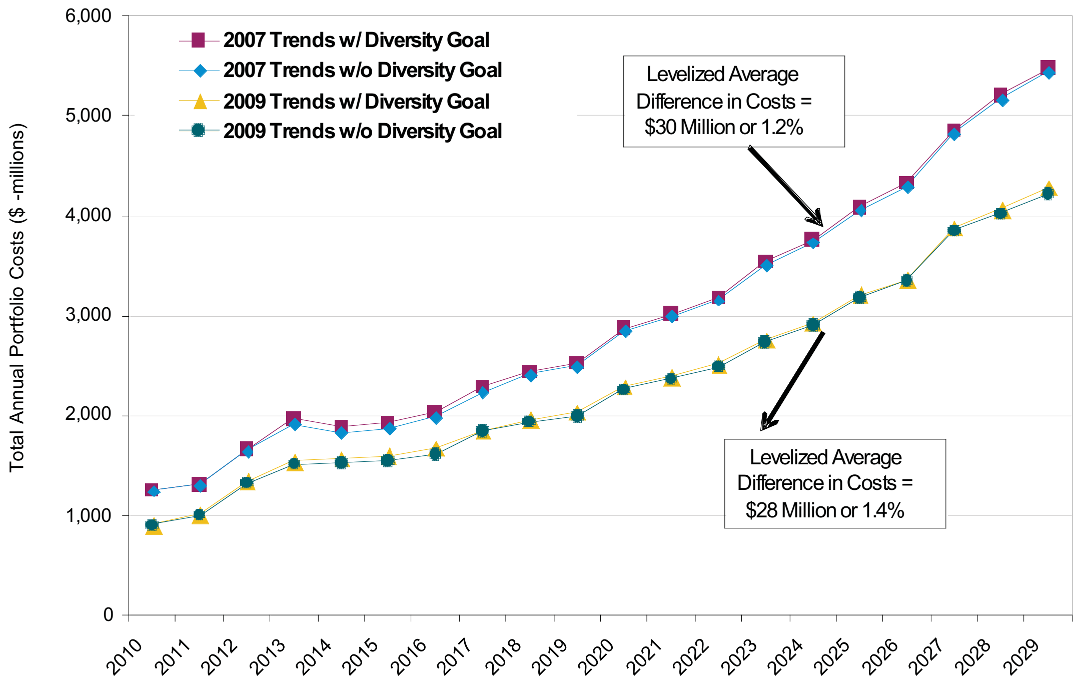
The focus of the combined portfolio analyses was to estimate the direct costs of PSE's acquisition of Cross Cascades pipeline capacity that would increase access to the Rocky Mountain supply basin. The company modeled two scenarios – the 2007 Trends scenario and the 2009 Trends scenario. Two views of each scenario were analyzed: one contained a diversity requirement that constrained access to Canadian supplies beyond a certain percentage of the total, the other did not limit Canadian supplies.

Comparison of Resulting Average Annual Portfolio Costs

The results are shown in Figure 6-35. The upper two lines show the average annual portfolio costs for the 2007 Trends scenario with and without the diversity, i.e. with and without the Cross Cascades alternative. The difference in the costs is relatively small – the annual levelized cost difference over the 20-year period is about $30 million or about 1.2% of the total portfolio cost. The levelized cost of the portfolio including the diversity goal is about $2,463 million compared to $2,433 million for the portfolio without the diversity goal.

The lower two lines show the same data for the 2009 Trends scenario. Again, the costs are relatively close – the levelized cost difference is about $28 million, or about 1.4% of the total portfolio cost ($1,954 million compared to $1,926 million). The difference between the costs for each scenario is largely due to the difference in pipeline transportation costs and the basis differential between Canadian and Rockies market hubs.

Figure 6-35
Cost Projections for Combined Portfolios – Diversity of Supply Analyses



Comparison of Resource Additions

The optimal portfolio resource additions with and without the diversity goal for the 2007 Trends scenario are shown below in Figure 6-36.

Figure 6-36
2007 Trends Scenario
Comparison of Resource Additions With and Without Diversity Requirements

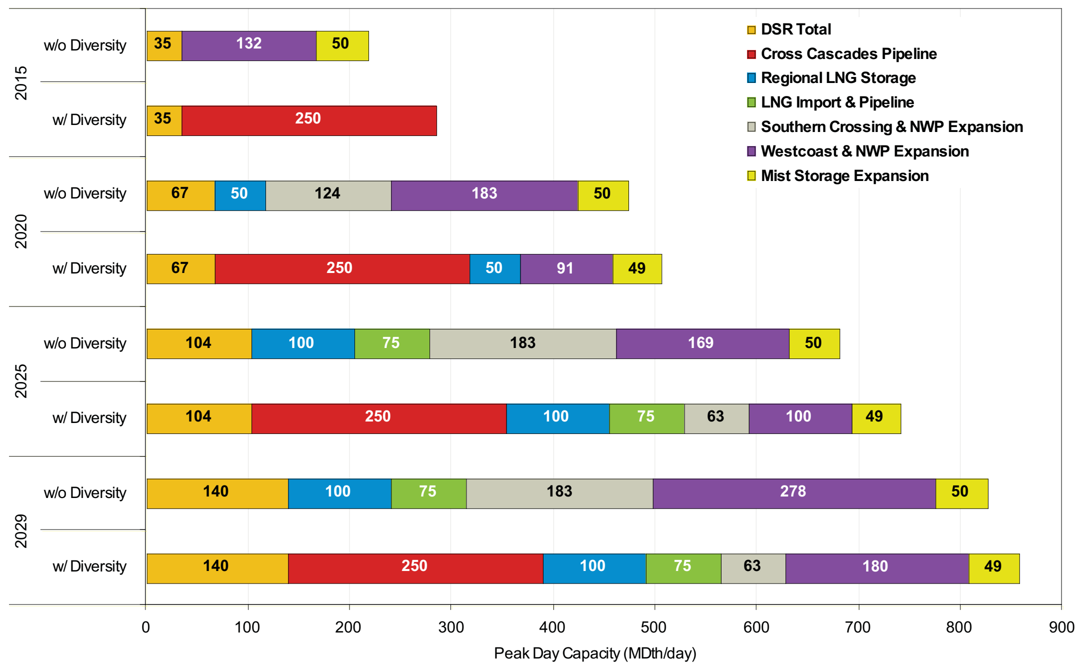
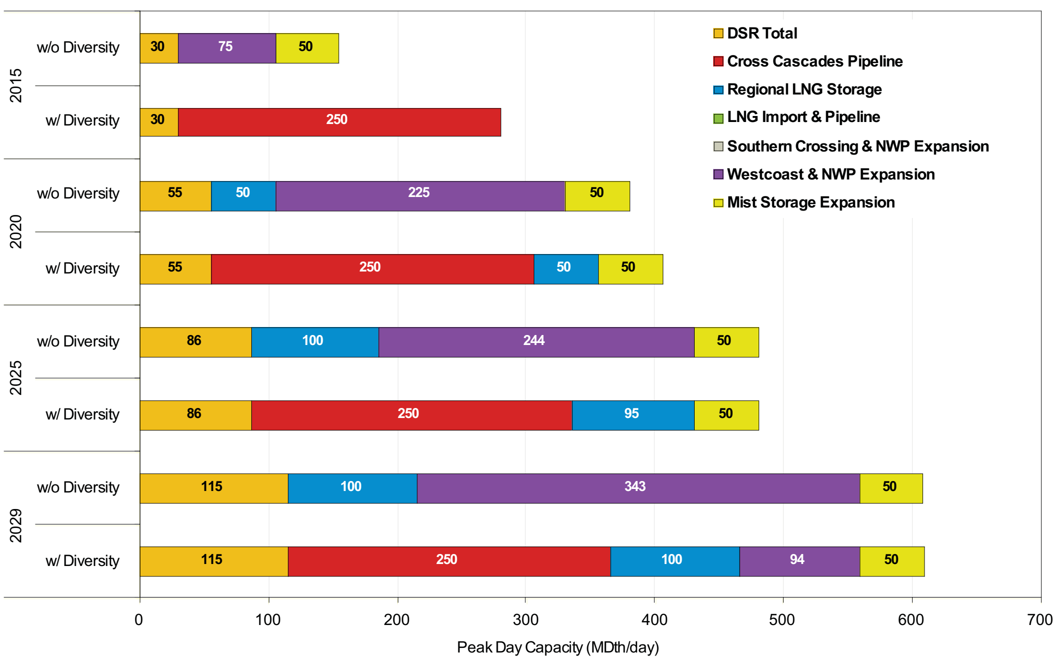


Figure 6-37 contains similar results for the 2009 Trends scenario.

Figure 6-37
2009 Trends Scenario
Comparison of Resource Additions With and Without Diversity Goal



As shown in both cases, the optimal portfolio with the diversity goal includes the addition of the Cross Cascades pipeline alternative with a peak capacity of approximately 250 MDth per day by 2015. Other resource alternatives including DSR, regional LNG storage, Mist storage, and LNG imports are added in later years. Note that some Westcoast pipeline capacity is also added in later years.

In the optimal portfolio without the diversity goal, Southern Crossing and additional Westcoast pipeline capacity essentially replaces the Cross Cascades capacity. The other resource additions are similar to those added in the portfolio with the diversity goal.

D. 2009 Trends (Full-Cap) Combined Portfolio

As discussed earlier in Chapter 5, modification of the electric planning reserve margin calculation changed the gas-fired electrical generating plant additions across all scenarios. In the 2009 Trends scenario, the modified planning reserve margin reduces the CCCT plant additions from 550 MWs (two generating plants including duct firing) to 275 MW (one plant with duct firing) over the 2011-2012 time period. This in turn reduces the peak day gas for generation loads by about 47 MDth per day – the peak day gas loads for a 275 MW plant. This reduction in peak day loads continues until later in the planning horizon. Figure 6-38 compares the peak day gas for generation loads for 2009 Trends and the 2009 Trends (Full-Cap) alternatives.

Figure 6-38
Compare 2009 Trends & 2009 Trends (Full-Cap) Gas for Generation Need (MDth/day)

	2012	2016	2020	2029
2009 Trends	170	170	216	270
2009 Trends (Full-Cap)	123	123	214	268
Change	-47	-47	-2	-2

The gas for generation needs were updated to reflect the reduced need in the 2009 Trends scenario to test the impact of the updated need on the optimal resource additions developed by Sendout. The resource additions from the 2009 Trends and the Final 2009 Trends scenario are shown in Figure 6-39 below. The difference in total resource additions are also shown at the bottom of Figure 6-39. As shown, the difference in Westcoast/NWP resource additions reflect the difference in peak day loads.

Figure 6-39
2009 Trends and Final 2009 Trends Scenario Optimal Resource Additions

2009 Trends

	Additions in MDth/day				
	Cross Cascades Pipeline	Regional LNG Storage	Westcoast/ NWP	Mist Storage & Pipeline	DSR
2012			75	50	14
2017		50	150		26
2022		50	19		27
2026			99		26
2029					22
Total Additions	**0**	**100**	**343**	**50**	**115**

2009 Trends (Full-Cap)

	Additions in MDth/day				
	Cross Cascades Pipeline	Regional LNG Storage	Westcoast/ NWP	Mist Storage & Pipeline	DSR
2012			50	50	14
2017		50	129		26
2022		50	19		27
2026			144		26
2029					22
Total Additions	**0**	**100**	**342**	**50**	**115**
Difference	**0**	**0**	**-1**	**0**	**0**

As discussed earlier in Chapter 5, the change in the reserve margin assumption appears to have a consistent impact across all portfolios with similar load assumptions. There is no evidence to support that the impacts due to the modified planning reserve margin will not change the relative costs or risks of the portfolios.

The quantitative analyses presented in this chapter are based largely on the results of optimization models. While quantitative analyses delivers a great deal on information about how resources will perform over time, developing resource strategies also involves applying judgment based on customer preferences, utility operations in the marketplace, and observation of regulatory developments. The final gas sales and combined portfolios presented in Chapter 8 are based on these analyses as well as the additional considerations discussed in Chapter 8.

VI. Key Findings

The key findings from this analytical and statistical evaluation will provide guidance for development of PSE's long-term resource strategy, and also inform consideration of specific resource development activities over the next two years.

1. The growth in the need for generation fuel will outpace the growth in need for gas sales.

The increase in both peak capacity and annual volumes of gas for generation fuel will exceed the increases in need for the gas sales portfolio.

2. Investigate expanding gas energy efficiency programs.

The economic potential for gas efficiency in the lowest scenario is close to the current acquisition rate but in every other scenario it extends higher. Although the acquisition rate is often constrained by economic and market factors, the best way forward is to attempt to acquire as much gas efficiency resources as feasible.

3. Determine the most cost-effective Cross Cascades pipeline alternative and investigate joint participation and sponsorship in order to diversify PSE's supply alternatives to include additional Rockies supply.

At this point, it appears that the benefits of the increased supply diversity associated with the Cross Cascades pipeline outweigh the additional costs. If the Rockies gas supplies continue to be significantly lower cost (about $1.50 lower through 2013 at this point) than Canadian supplies, gas supply savings will largely offset the additional pipeline transportation costs. The I-5 corridor region will need additional pipeline capacity at some point over the next three to seven years.

4. Investigate participation in or development of a jointly owned LNG storage facility located to take advantage of locational displacement for low-cost withdrawal transportation to PSE's service area.

This alternative appears to be a feasible and low-cost alternative to meet future peak load growth.

5. Monitor the development of regional LNG import facilities.

Imported LNG may be an attractive supply alternative later in the planning horizon. At this time, the terms for supply of gas to the LNG terminal have not been developed, nor has PSE had the opportunity to discuss what form such a supply agreement might take. The final terms and conditions of the gas supply agreement will largely determine the attractiveness of this alternative.

Delivery System Planning

PSE manages two types of delivery systems. One is company-owned and delivers electricity and natural gas *within* our local service area to more than 1.7 million customers. The other is "merchant-based" and involves arrangements made with outside companies and organizations to transport power and natural gas *to* our service area. The two are governed by different rules and planned under separate processes and toolkits. This chapter addresses planning for the PSE-owned delivery system within the company's service area, while merchant-based delivery systems are discussed in Chapter 5, Electric Resources. This chapter is organized in five parts:

PSE's delivery system planning process is designed to balance safety, cost, and operational requirements while considering environmental management, regulatory requirements, and changing customer demands. The purpose is to identify the most cost-effective solutions to the needs that the company faces. Safety, capacity, and reliability are our most important performance criteria. Simply put: How will PSE safely and continuously deliver enough energy through the pipes or wires to meet demand on the other end?

- PSE must operate the system as safely and efficiently as possible on a year-by-year, day-by-day and even hour-by-hour basis.
- The utility must accomplish needed maintenance and improvements as cost effectively as possible.
- We must anticipate future needs so that infrastructure will be in place to meet that need when it arrives.

PSE's goal is to fulfill these responsibilities at the lowest reasonable cost.

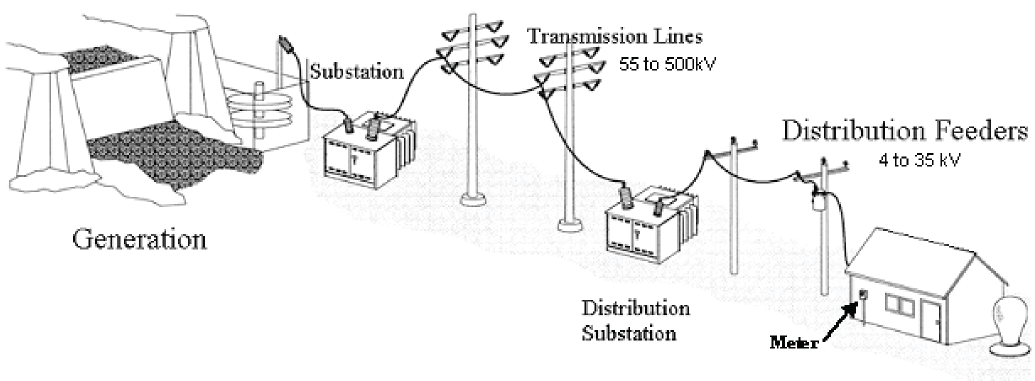
I. System Mechanics and 5-year Infrastructure Plan

Familiarity with the mechanics of the gas and electric systems is helpful to understanding PSE's delivery system planning process.

A. Electric Delivery Systems

Electricity is transported from power generators to consumers over wires and cables, using a wide range of voltages and capacities. The voltage at the generation site must be stepped up to high levels for efficient transmission over long distances (generally 55 to 500 kilovolts). Substations receive this power and reduce the voltage in stages to levels appropriate for travel over local distribution lines (between 4 and 34.5 kV). Finally, transformers at the customer's site reduce the voltage to levels suitable for the operation of lights and appliances (under 600 volts). Wires and cables in the system carry electricity from one place to another. Substations and transformers change its voltage to the appropriate level. Circuit breakers prevent overloads and meters measure how much power is used.

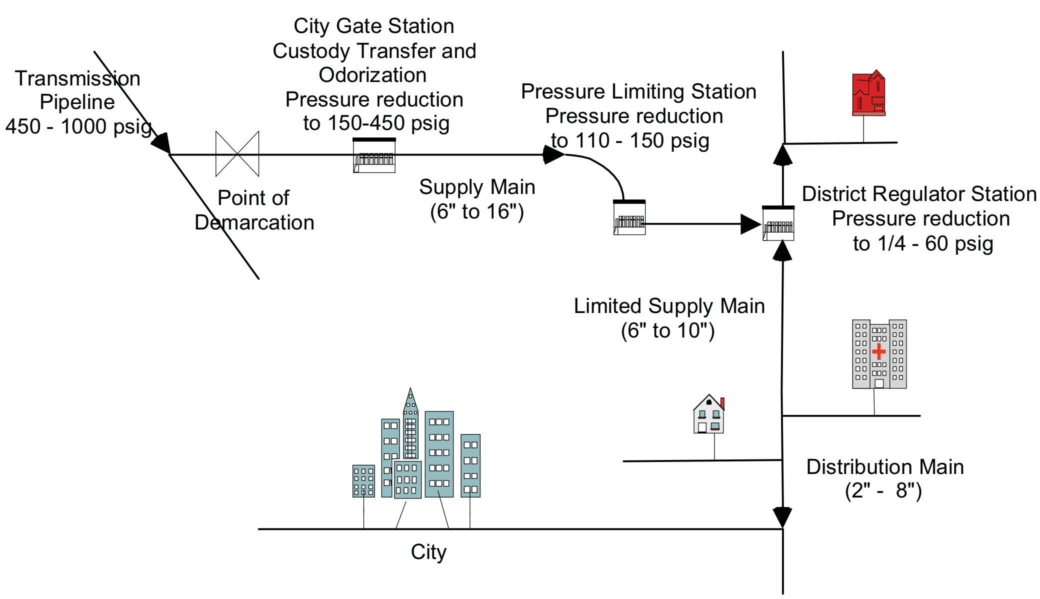
Figure 7-1
Electric Delivery System



B. Natural Gas Delivery Systems

Natural gas is transported at a variety of pressures through pipes of various sizes. Large transmission pipelines deliver gas to city gate stations at high pressures, generally 450 to 1,000 pounds per square inch gauge (psig). There, pressure is reduced to 150 to 450 psig for travel through supply main pipelines to district regulator stations which further reduce the pressure to less than 60 psig. From this point the gas flows through a network of piping (mains and services) to a meter set assembly at the customer's site. There the pressure is reduced to what is appropriate for the operation of the customer's equipment (0.25 psig for a stove or furnace) and the gas is metered to determine how much is used. As gas flows through the distribution system, the system pressure will drop due to friction. This friction and resulting pressure drop depends on the diameter, material, roughness and length of the pipe that is used; it is also impacted by the type and number of fittings that are included in the system. As a result, each of these items is carefully considered when designing the system.

Figure 7-2
Gas Delivery System



C. PSE's Existing Delivery System

The table below summarizes the transmission and distribution infrastructure owned and operated by PSE as of December 31, 2008.

Figure 7-3
PSE-owned Transmission and Distribution System

Electric	Gas
Customers: 1,078,629	Customers: 750,164
Service territory: 4,500 square miles	Service territory: 2,800 square miles
Substations: 349	City gate stations: 40
Miles of transmission line: 2,614	Pressure regulating stations: 652
Miles of overhead distribution line: 10,392	Miles of pipeline: 11,930
Miles of underground distribution line: 9,794	Transmission pipeline pressure: 450-1,000 psig
Transmission line voltage: 55-500 kV	Supply Main pressure: 150–450 psig
Distribution line voltage: 4-34.5 kV	Distribution pipeline pressure: 45-60 psig
Customer site voltage: less than 600 V	Customer meter pressure: 0.25 psig

D. 5-year Infrastructure Plan

The maps and lists that follow show PSE's proposed 5-year infrastructure plan for meeting predicted capacity and reliability needs. The plan is reviewed annually and remains dynamic. As the plan year gets closer, the company refines plan projections based on new developments or information, and performs additional analyses to reveal and evaluate additional alternatives. The plan may change as a result of these investigations.

Figure 7-4
Map of Electric Substation Construction Plans, 2009–2013

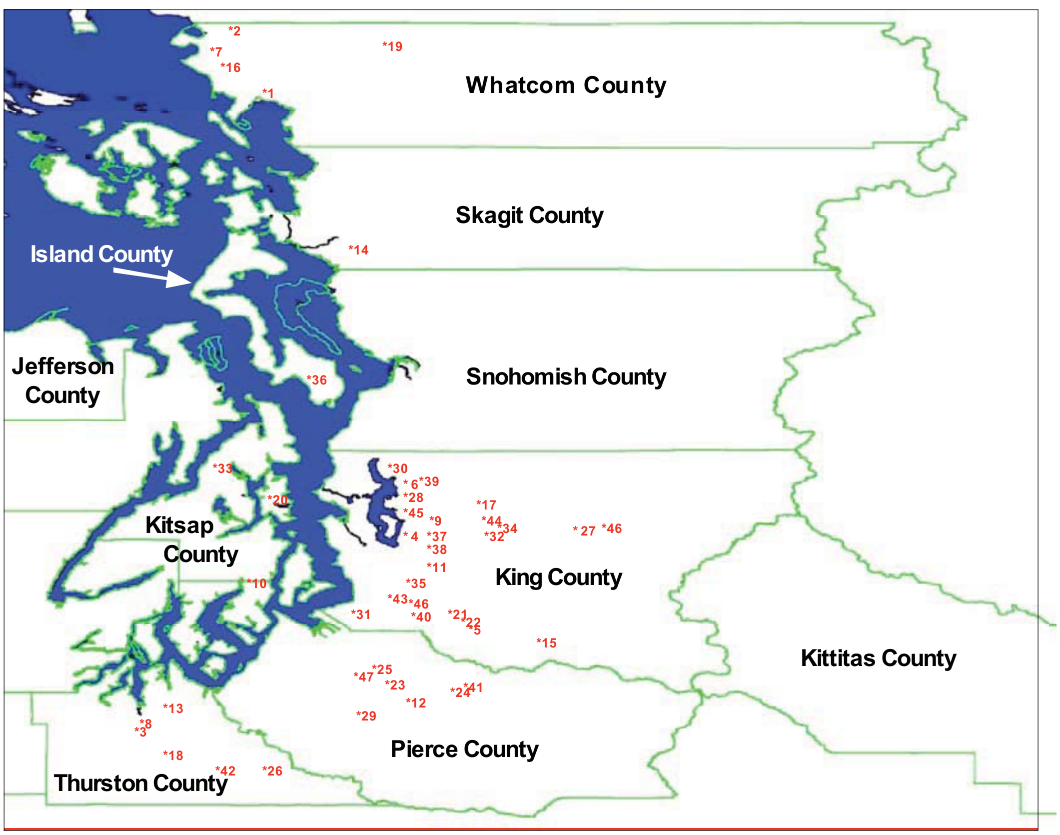


Figure 7-5
List of Electric Substation Construction Plans, 2009-2013

No.	Year	Substation	County	Description
1	2009	Bellis	Whatcom	Replace existing transformer with 115 kV, 25 MVA transformer
2	2009	Berthusen	Whatcom	Construct new 115 kV substation with 25 MVA transformer
3	2009	Capital	Thurston	Rebuild existing 55 kV substation to 115 kV. Replace existing transformer with 115kV, 25 MVA transformer
4	2009	Factoria Bank #2	King	Rebuild existing 115 kV substation. Install second 115 kV, 25 MVA transformer
5	2009	Four Corners	King	Construct new 115 kV substation with 25 MVA transformer
6	2009	Juanita Sub #2	King	Install second 115 kV, 25 MVA transformer
7	2009	Semiahmoo	Whatcom	Construct new 115 kV substation with 25 MVA transformer
8	2009	Thurston	Thurston	Rebuild existing 55 kV substation to 115 kV. Replace existing 2 transformers with 115kV, 25 MVA transformers.
9	2010	Ardmore	King	Construct new 115 kV substation with 25 MVA transformer
10	2010	Bethel	Kitsap	Construct new 115 kV substation with 25 MVA transformer
11	2010	Boeing Aerospace	King	Purchase and rebuild existing 115kV substation. Install new 115 kV, 25 MVA transformer
12	2010	Buckley	Pierce	Construct new 115kV substation, retire old substation, 25 MVA transformer
13	2010	Carpenter	Thurston	Construct new 115 kV substation with 25 MVA transformer
14	2010	Eaglemont	Skagit	Construct new 115 kV substation with 25 MVA transformer
15	2010	Greenwater	Pierce	Replace existing transformer with 115 kV, 25 MVA transformer
16	2010	State St	Whatcom	Replace existing transformer with 115 kV, 25 MVA transformer
17	2010	Sterling Bk#1 and #2	King	Construct new 115 kV substation with 2 - 25 MVA transformers
18	2010	Spurgeon	Thurston	Construct new 115 kV substation with 25 MVA transformer
19	2011	Kendall	Whatcom	Construct new 115 kV substation with 25 MVA transformer
20	2011	Bainbridge	Kitsap	Construct new 115 kV substation with 25 MVA transformer
21	2011	Briscoe Park	King	Construct new 115 kV substation with 25 MVA transformer

No.	Year	Substation	County	Description
22	2011	Jenkins	King	Construct new 115 kV substation with 25 MVA transformer
23	2011	Kelly/Dingo	Pierce	Construct new 115 kV substation with 25 MVA transformer
24	2011	Krain Corner	Pierce	Install 115 kV, 25 MVA transformer at existing 115 kV Switching Station
25	2011	Lakeland	Pierce	Construct new 115 kV substation with 25 MVA transformer
26	2011	Longmire Bank #2	Thurston	Rebuild existing 115 kV substation. Install second 115 kV, 25 MVA transformer
27	2011	Mt. Si	King	Construct new 115 kV substation with 25 MVA transformer
28	2011	North Bellevue #3	King	Install third 115 kV, 25 MVA transformer
29	2011	Thrift	Pierce	Construct new 115 kV substation with 25 MVA transformer
30	2012	Duvall Bk #2	King	Install second 115 kV, 25 MVA transformer
31	2012	Enchanted Sub	King	Construct new 115 kV substation with 25 MVA transformer
32	2012	Goodes Corner Bank #2	King	Install second 115 kV, 25 MVA transformer
33	2012	Holly	Kitsap	Construct new 115 kV substation with 25 MVA transformer
34	2012	Issaquah Highlands	King	Construct new 230 kV substation with 25 MVA transformer
35	2012	Kent Bank #3	King	Install third 115 kV, 25 MVA transformer
36	2012	Maxwelton	Island	Construct new 115 kV substation with 25 MVA transformer
37	2012	Northrup Bank #2	King	Install second 115 kV, 25 MVA transformer
38	2012	Renton Junction Bank #3	King	Install third 115 kV, 25 MVA transformer
39	2012	Totem Lake Bk #2	King	Install second 115 kV, 25 MVA transformer
40	2013	Alpac	King	Replace existing transformers with 115 kV, 2 - 25 MVA transformer
41	2013	Cumberland	Pierce	Replace existing transformer with 115 kV, 25 MVA transformer
42	2013	Hobby Acres Sub	Thurston	Construct new 115 kV substation with 25 MVA transformer
43	2013	Lake Holm	King	Construct new 115 kV substation with 25 MVA transformer
44	2013	Lakemont	King	Construct new 115 kV substation with 25 MVA transformer
45	2013	Norkirk Bk #2	King	Install second 115 kV, 25 MVA transformer

No.	Year	Substation	County	Description
46	2013	North Bend Bk #2	King	Install second 115 kV, 25 MVA transformer
47	2013	Pioneer Sub	Pierce	Construct new 115 kV substation with 25 MVA transformer

Figure 7-6
Map of Gas System Infrastructure Plans 2009-2013

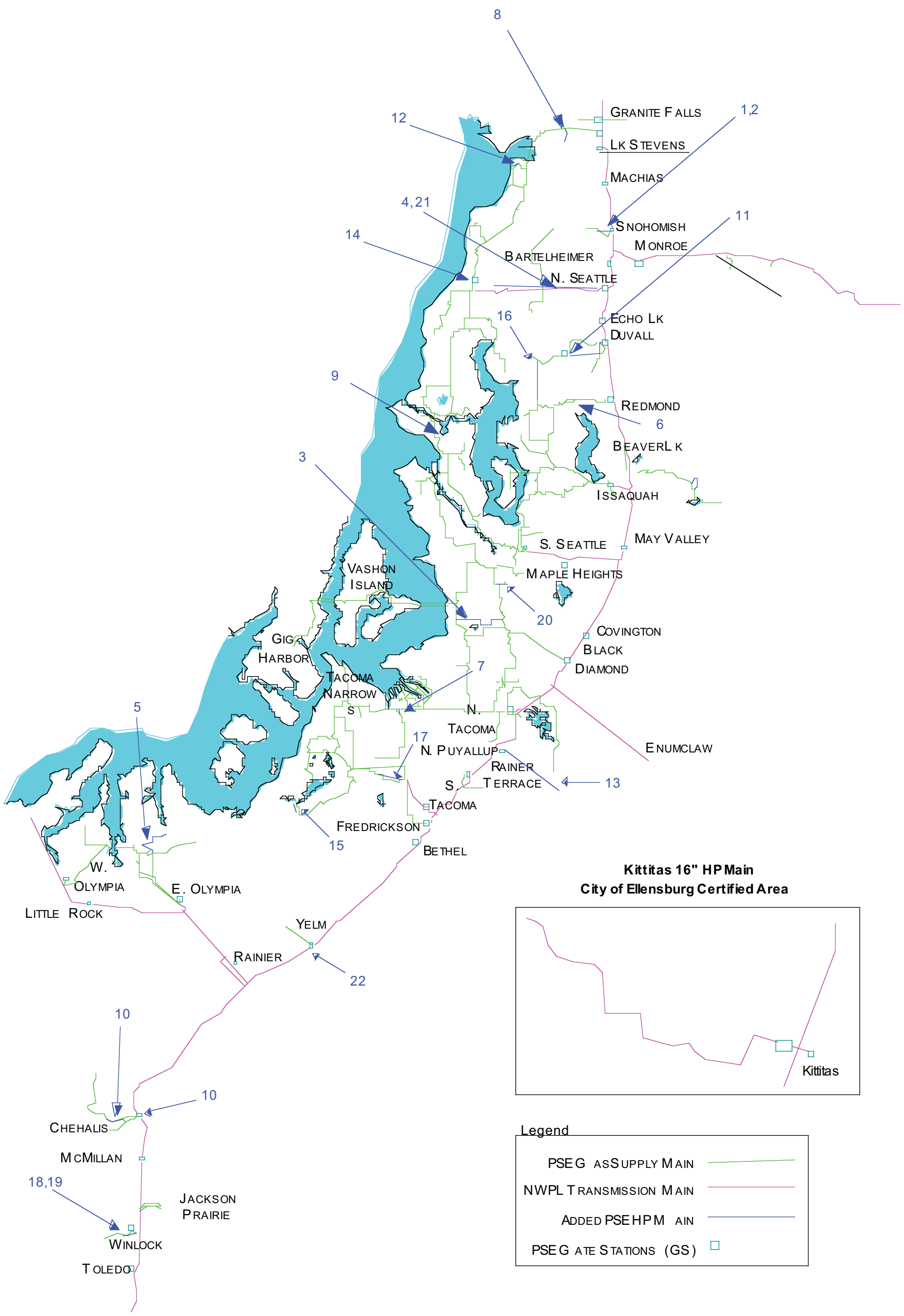


Figure 7-7
List of Gas System Infrastructure Plans 2009-2013

No.	Year	Name of Project	City	Description
1	2009	Snohomish 8" HP	Snohomish	Install ~11,000 feet of 8" HP to replace 4" HP out of Snohomish GS.
2	2009	Snohomish Gate Station Rebuild	Snohomish	Rebuild a portion of the Snohomish GS improve capacity.
3	2009	Kent Black Diamond Ph. II & GS Rebuild	Kent	Install ~ 27,000 feet of 16" HP from the end of Ph 1b to the Vashon Lateral. Include a small GS Modification by Williams to match mainline capacity.
4	2009	N. Seattle Lateral Pressure Increase	Seattle/Lynnwood	Increase Williams lateral pressure from 500 psig to 525 psig. Install heater at N Seattle TBS prior to increase.
5	2009	N. Lacey Supply Extension	North Lacey	Install ~25,000 feet of 8" and 12" HP to serve N. Lacey.
6	2009	Evans Creek Bridge Replacement	Redmond	Install 16" HP pipe on new bridge.
7	2009	I-5 Tacoma HOV Relocate	Tacoma	Install new 12" HP due to bridge demolition across I-5.
8	2009	Soper Hill Rd. 8 Inch IP Reinforcement	Lake Stevens	Install 6000 feet of 8" IP from Soper Hill DR to Lake Stevens.
9	2009	SDOT Mercer Corridor Relocates	Seattle	Install new 12" HP and 8" IP due to Mercer construction activities.
10	2010	Chehalis GS1360 Rebuild	Chehalis/Centralia	Rebuild Chehalis GS for new HP project capacity.
10	2010	Chehalis HP Supply Ph 2	Chehalis/Centralia	Install ~18,000 feet of 12" HP to replace 4" HP out of Chehalis GS
11	2010	Tolt Corridor HP Install & Gate Station	Woodinville/Duval	Install ~34,000 feet of 16" HP from Duval to Woodinville. Modify/construct gate station as required.
12	2010	Everett Supply Loop	Everett	Complete the HP loop with 16" HP near the Everett Delta LS.
13	2011	Bonney Lake/Cascadia HP Supply	Bonney Lake/Cascadia	Install 36,000 feet of 16" HP to the Cascadia area and associated pressure regulation facilities.

No.	Year	Name of Project	City	Description
14	2011	N Seattle Lateral to Everett Delta Control Valve	North Seattle/Lynnwood	Install control valve to limit flow to Everett area during heavy loads.
15	2011	Dupont HP Lateral Uprate to 250 psig	Dupont	Remove LS and uprate to 250 psig MAOP.
16	2011	Woodinville/Tolt to Kirkland 12" HP Connector	Woodinville/Redmond/Kirkland	Install 25,000 feet of 12" HP from Woodinville south to Kirkland area.
17	2011	Frederickson/S Tacoma 16" HP Lateral Expansion Ph I	Tacoma/Frederickson	Install 12,000 feet of 16" HP.
18	2012	Winlock GS1362 Rebuild	Winlock	Williams to rebuild Winlock GS for additional capacity.
19	2012	Winlock Lateral HP Uprate	Winlock	Complete an uprate from 150 to 250 psig.
20	2012	LS1996 HP Uprate from 100 to 150 or 250 psig	Renton	Uprate from 100 psig to 150 or 250 psig
21	2013	N. Seattle Lateral 8" HP Replcmt w/16' HP	Seattle/Lynnwood /Everett	Williams to replace 5 miles of the N Seattle lateral with 16" or 20" HP.
22	2013	Yelm GS1354 Rebuild	Yelm	Rebuild GS to maintain capacity and pressure.

II. Changes and Challenges

Aging infrastructure, changes in the industry, and increasing sensitivity to energy costs, electric system reliability, and environmental impact all make planning delivery systems an evolving and complicated process. The electric planning process itself is subject to increasing regulation under the North American Electric Reliability Corporation (NERC), which enforces regulations for the reliability of the bulk power system in North America. Gas pipeline safety regulations are changing. Throughout the industry, infrastructure investments are rising as infrastructure nears the end of its usable life, and in response to the industry's limited spending during the push for utility deregulation (when facility ownership and cost recovery were uncertain). These changes, combined with the region's strong growth rate and PSE's commitment to keeping gas and electric networks flexible enough to meet changing operating conditions and future needs, are resulting in significant delivery system investments by PSE.

A. General Infrastructure Needs

Electrical and gas equipment installed many years ago are aging PSE's infrastructure. Some components of our gas delivery system have been operating since 1899, and some electric-related equipment since 1923. The company reviews the performance and reliability of these systems continually to ensure safe and reliable operation and to reduce leaks and outages. We have developed programs and processes to maintain existing facilities and add new components as necessary. In addition, aging bare steel mains, power poles, underground cables, substation transformers and circuit breakers are being systematically replaced under multiyear replacement programs. Finally, the company makes investments to respond to changing conditions and needs. Annual performance issues for smaller distribution systems can often be resolved within a year or two, but large distribution or transmission issues take much longer to resolve. For example, securing substations and transmission facilities can take more than a decade.

B. Changing Regulations

The blackouts that affected the Northeast and Midwest in 2003 continue to generate changes for electric utilities. New regulations, mandated by The Energy Policy Act of 2005 and developed by NERC, became effective in 2007. Triggered by concern about the electrical grid's reliability, they move the industry into an era in which system planning, performance and operating requirements are mandated and take place under increasing scrutiny. The Federal Energy Regulatory Commission (FERC) selected NERC as the nation's Electric Reliability Organization (ERO). Per the Act, the ERO is responsible for enforcing the new standards. NERC has delegated enforcement of the western region to the Western Electricity Coordinating Council (WECC).

In 2007, PSE formalized the NERC Reliability Standards Compliance program in alignment with the guidelines set forth by FERC. The NERC Program outlines methods and procedures through which PSE monitors, assesses, and ensures compliance with NERC's Reliability Standards

PSE complies with more than 85 NERC Reliability Standards and Regional Standards. While the majority of these standards were voluntary prior to June 2007, many if not all are undergoing revision over the next 3 to 5 years and new ones are being developed. This necessitates a continual review of process and practice to ensure compliance with the changes. For example, with the Critical Infrastructure Protection Standards, PSE formalized many new and changed processes and implemented technologies to secure the critical cyber assets that ensure reliable operation of the Bulk Electric System. Documentation of compliance with these and all the standards is now a significant on-going effort, and is an important component of the regional enforcement agency, or WECC's audits.

The Pipeline Safety Improvement Act (PSIA) of 2002 enacted stricter pipeline integrity requirements for the natural gas industry. In response, PSE implemented our own transmission integrity management program in 2005 in order to comply with the act and to place additional focus on the transmission pipelines.

In December 2006, the Pipeline Inspection, Protection, Enforcement and Safety Act was signed into law. The Act reauthorizes and amends the Department of Transportation's pipeline safety programs, and directs the Pipeline and Hazardous Materials Safety Administration to implement a distribution integrity management program (DIMP). Under the rule, concepts from the PSIA of 2002 will be applied to place additional focus on natural gas distribution systems. PSE anticipates the need to develop and implement our own DIMP by the end of 2010.

C. Right-of-way Issues

PSE expects right-of-way issues to become more challenging in the future. The cost and effort to acquire these new rights-of-way is rising, and communities are increasingly concerned about their impacts. For these reasons, PSE strives to maximize our use of existing company-owned and public rights-of-way before considering creation of new ones. When the utility must seek new acquisitions, we believe it is crucial to seek input from the communities and jurisdictions they will affect before finalizing line routing and design. Maintenance of rights-of-way is an ongoing responsibility, and PSE has implemented more stringent vegetation standards for certain right-of-way corridors in accordance with NERC requirements and in response to the record-breaking windstorm of December 2006.

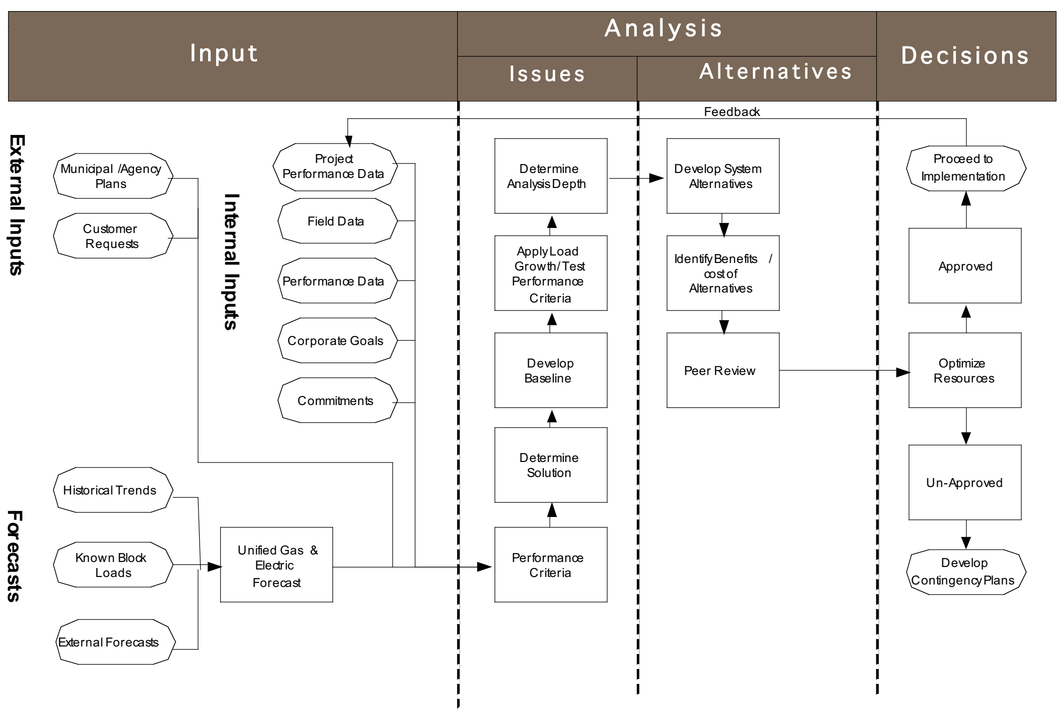
D. Emerging Alternatives

PSE is closely watching the development of Smart Grid and new technologies that offer possible "non-wires" solutions to transmission and distribution challenges. Distributed energy resources technology has the potential to increase capacity on the system by incorporating power that is generated closer to, or at, the customer's location. It has promise, despite a variety of operating characteristics and complexities that must be addressed before it can be reliably integrated into the larger delivery system. Also, regardless of a customer's ability to self-produce generation, PSE must maintain a system equipped to meet use and capacity requirements if the distributed resource is unable to meet the customer's needs. See Section 5 of this chapter for a more detailed discussion of emerging alternatives.

III. Planning Process

The goal of the delivery system planning process is to find cost-effective ways to meet constituent needs. The process begins with an analysis of the current situation and an understanding of the existing operational and reliability challenges. Planning considerations (inputs) include both internal and external factors, load forecasts, customer expectations, and the impact of one energy type on the other. An analysis is conducted to identify alternatives that will address the challenge. Benefits and costs are then forecasted for each alternative that meets the performance criteria. Lastly, planners select and plan for the alternative that best balances customer needs, company economic parameters, and local and regional plan integration. Figure 7-8 diagrams the planning process.

Figure 7-8
Diagram of Delivery System Planning Process



A. Inputs

Internal planning considerations, or inputs, include system performance, company goals and commitments, and load forecasts.

PSE gathers system performance information from field charts, remote telemetry units, supervisory control and data acquisition equipment (SCADA), employees, and customers. Some information is analyzed over multiple years rather than a single year to normalize the effect of variables that can change significantly from year to year, such as weather. For near-term load forecasting at the local city, circuit, or neighborhood level, PSE uses system peak-load and customer growth trends augmented by permitted construction activity for the next two years. For longer-term forecasting, we use a corporate econometric forecasting method, which includes population growth and employment data by county (see Chapter 3).

External inputs include regulations, municipal and utility improvement plans, and customer feedback.

Reviewing municipal and utility improvement plans regularly enables us to minimize costs by scheduling upgrades or installation of new infrastructure when the ground is already being impacted by other construction work. PSE coordinates with other utilities whenever possible, and works with other outside entities as well to find mutually beneficial schedules. Although our intent is to fully use existing assets before adding new ones, sometimes cost advantages can be gained from early installation for future needs.

PSE collects customer feedback in many ways. The utility continually investigates customer complaints, and tracks ongoing service issues as they are communicated to us. Customers receive follow-up correspondence to discuss their concern, as well as plans for resolution. This communication provides valuable information that field data or statistical modeling may not have revealed.

In July 2007, PSE completed an extensive performance review prior to, during and following the record-breaking windstorm that hit the Pacific Northwest in mid-December 2006. In addition to seeking customer and employee feedback through focus groups, telephone and Web surveys, and internal debriefings, the company hired KEMA, an 80-year-old energy consulting firm, to provide an independent, third-party, five-month analysis of the utility's pre-storm readiness and post-storm response. The KEMA analysis concluded that "PSE, its employees, and service providers performed well restoring power after this record-breaking storm." It also recommended actions PSE could take immediately to provide improved customer communications and improved outage response during future storms and other natural disasters. PSE accepted and implemented most of the KEMA recommendations and continues to refine and improve our processes in response to storms through post event reviews.

The company has identified a number of system enhancements that may improve the electric system's resilience to minor or major storm events. To analyze the benefits of these strategies, PSE engaged a consultant to review these tactics and relative costs, and to identify additional techniques with cost information that should be considered in the system planning process. The consultant completed his study in August 2008 and provided a roadmap for targeting reliability improvements. PSE will be incorporating consideration of these projects in our budgeting process.

B. Performance Criteria

PSE primarily categorizes system needs as "capacity" and "reliability." These performance criteria lie at the heart of our planning process, and along with state and federal requirements provide the foundation for planning our infrastructure improvements.

Figure 7-9
Performance Criteria for Electric and Gas Delivery Systems

Electric delivery system performance criteria are defined by:	Gas delivery system performance criteria are defined by:
Safety and compliance	Safety and compliance
The temperature at which the system is expected to perform	The temperature at which the system is expected to perform
The nature of service and level of reliability that each type of customer is contracted for	The nature of service each type of customer is contracted for (interruptible vs. firm)
The minimum voltage that must be maintained in the system	The minimum pressure that must be maintained in the system
The maximum voltage acceptable in the system	The maximum pressure acceptable in the system
The cost customers are willing to pay for target levels of performance	The cost customers are willing to pay for target levels of performance
The interconnectivity with other utility systems and resulting requirements; including compliance with NERC Planning Standards	

All PSE facilities that are part of the Bulk Electric System (BES) and the interconnected western system are planned and designed in accordance with the latest approved version of the NERC Reliability Standards, and the WECC standards and reliability criteria. These standards outline the performance expectations that affect how PSE's transmission system – 100 kV and above – is planned, operated and maintained. The criteria by which the transmission system is measured are:

1. Its ability to maintain load service during normal operations (no outages, N-0) and,
2. Its ability under certain common contingencies where one element of the system is not in service (N-1).

For other less common contingencies --where two elements or more of the system are not in service-- the minimum reliability performance targets allow for planned, controlled load interruptions. There are several detailed contingency events specified in the NERC and WECC standards and reliability criteria that influence the planning of PSE's transmission system.

Modeling Tools

PSE relies on many different tools during the planning process to help identify and weigh the benefits of alternative actions. To evaluate both our gas and electric system performance, the company uses sophisticated modeling software that incorporates field data, including real-time information. Figure 7-10 provides a brief list of these tools, the planning considerations (inputs) that go into each, and the results (outputs) that they produce.

Figure 7-10
Summary of Delivery System Planning Tools

Tool	Use	Inputs	Outputs
Advantica SynerGEE	Network Modeling	Gas and Electric distribution infrastructure and load characteristics	Predicted system performance
Power World Simulator - Power Flow	Network Modeling	Electric transmission infrastructure and load/generation characteristics	Predicted system performance
PSS/E Power Flow & Stability	Network Modeling	Electric transmission infrastructure and load/generation characteristics	Predicted system performance
PSLF Power Flow & Stability	Network Modeling	Electric transmission infrastructure and load/generation characteristics	Predicted system performance
Probabilistic Spreadsheet	Probabilistic Analysis	Outage history, equipment failure probabilities	Outage savings based on probability of occurrence
Estimated Unserved Energy (EUE)	Unserved Energy	Growth/load at specific conditions, annual load profile	Annual unserved energy, O&M costs as a result, value of service in cost terms
Investment Decision Optimization Tool (iDOT)	Project Data Storage & Portfolio Optimization	Project scope, budget, justification, alternatives and benefits; Resources/financial constraints	Optimized project portfolio, benefit cost ratio for each project, project scoping document
Area Investment Model (AIM)	Financial Analysis	Project costs, 8760 load data; and load growth scenarios	NPV; Income statement; Load Growth vs. Capacity comparisons; EUE

PSE's gas system model is one of the largest integrated system models in the United States. It uses an Advantica SynerGEE software application that is continually updated to reflect new customer loads and system and operational changes. The accuracy of its results is validated by comparing them to actual system performance data. This model helps predict capacity constraints and subsequent system performance on a variety of degree days and under a variety of load growth scenarios. Where issues surface, the model can be used to evaluate alternatives and their effectiveness in resolving the issues. PSE augments these alternatives with cost estimates and feasibility analysis to identify the lowest reasonable cost solution for both current and future loads.

For our electric distribution system, PSE also uses Advantica SynerGEE software. Here, the feeder system is modeled regionally rather than as a single large model. This is due to the limited connectivity between regions and the complexities with the management of a single large system model. Again, PSE uses the model to evaluate system performance and predict capacity constraints on a variety of degree days and under a variety of load growth scenarios.

Modeling begins with building a digital map of the infrastructure and its operational characteristics. For gas, these include the diameter, roughness and length of the pipe, connecting equipment, regulating station equipment and operating pressure. For electric infrastructure, these include conductor cross-sectional area, resistance, length, construction type, connecting equipment, transformer equipment and voltage settings. Next, the company identifies customer loads, either specifically (for large customers) or as block loads for address ranges. Existing customer loads come from PSE's customer information system (CLX) or actual circuit readings. Finally, we vary temperature conditions, types of customers (interruptible vs. firm), time of peak daily usage, and the status of components (valves or switches closed or open) to model scenarios of infrastructure or operational adjustments to find the optimal solution to a given issue.

To simulate the performance of the electric transmission system, PSE uses three different programs: Power World Simulator, PSS/E (from Power Technologies Inc.), and PSLF (from General Electric). These simulation programs use a transmission system model that spans 11 western states, 2 provinces in western Canada, and parts of northern Mexico. The power flow and stability data for these models is collected, coordinated, and distributed through regional organizations including Northwest Power Pool (NWPP) and WECC, one of 8 regional reliability organizations under NERC. These power system study programs support PSE's planning process and facilitate demonstration of compliance with WECC and NERC reliability performance standards.

C. System Alternatives

A variety of approaches are available to address delivery system capacity and reliability issues. Each alternative has its own costs, benefits, challenges, and risks. These alternatives include the following.

Figure 7-11
Alternatives for Addressing Delivery System Capacity and Reliability Issues

Electric

- Add energy source
  - Substation
- Strengthen feed to local area
  - New conductor
  - Replace conductor
- Improve existing facility
  - Substation modification
  - Expanded right-of-way
  - Uprate system
  - Rebalance load
  - Modify automatic switching scheme
- Load Reduction
  - Distributed Energy Resource
  - Fuel Switching
  - Conservation
  - Load control equipment
  - Possible new tarriffs
- Do nothing

Gas

- Add energy source
  - City-gate station
  - District regulator
- Strengthen feed to local area
  - New high pressure main
  - New intermediate pressure main
  - Replace main
- Improve existing facility
  - Regulation equipment modification
  - Uprate system
- Load Reduction
  - Fuel Switching
  - Conservation
  - Load Control Equipment
  - Possible new tarriffs
- Do nothing

When issues are short term, like peaking events or meeting needs until a construction project is finished, energy flow can be managed temporarily with some of the same alternatives. Examples include:

- Temporary adjustment of regulator station operating pressure, as executed through PSE's Cold Weather Action Plan.
- Temporary adjustment of substation transformer operating voltage, as done using load tap changers to alter turn ratios.
- Automatic capacitor bank switching to optimize VAR consumption and maintain adequate voltage.

- Temporary siting of mobile equipment such as compressed natural gas injection vehicles, liquid natural gas injection vehicles, mobile substations, and portable generation.

D. Optimizing Value

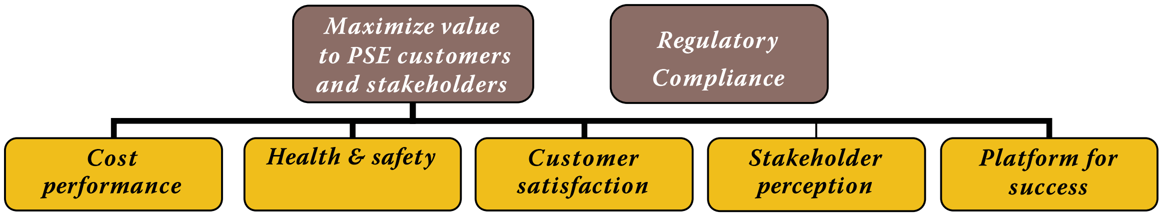
Making prudent investment decisions for hundreds of gas and electric projects requires an objective way to synthesize, analyze, and optimize projects to maximize value to the company, customers, and the community. For this purpose, PSE uses value-based budget prioritization.

In 2005, PSE updated the T&D Asset Investment Optimization System to better reflect our objectives, strategy and goals in light of the changing business environment, and to more efficiently and accurately quantify the value of projects, justify funding needs, prioritize projects, and account for risk and uncertainty. Formal "value modeling" refines and integrates existing tools to prioritize projects based on a measure of project value. Project value is estimated by simulating project impacts over the asset life or duration of maintenance funding and applying multi-attribute utility theory. The model we use, Investment Decision Optimization Tool (iDOT), identifies—from any portfolio of possible delivery system capital and maintenance projects, and any constraints on budget-year costs—the set of projects that will create maximum value.

Project costs are calculated using a variety of tools, including historical cost analysis and unit pricing models based on service provider contracts. As projects move through detailed scoping, cost estimates are refined. Planners use Area Investment Model (AIM) software to calculate a wide range of financial performance indicators for each project—including net present value and rate of return—as well as future revenue potential from capacity gained by a particular solution. This allows further comparisons for infrastructure that will be in service for 30 to 50 years.

The diagram below shows PSE's benefit structure to evaluate delivery system projects.

Figure 7-12
Benefit Structure to Evaluate Delivery System Projects



The results of the process are a portfolio of projects. This portfolio is ultimately reviewed and may be refined to ensure the utility's ability to execute the projects (are there adequate resources to execute; is the work dispersed geographically to maintain crew presence for rapid response to outages and emergencies) and may be limited by budget.

IV. Case Studies

To illustrate the planning process through example, below we describe three situations and show how PSE addressed them.

A. Lake Stevens/Marysville Intermediate Pressure (IP) Distribution System

PSE currently serves the Lake Stevens area and southern Marysville areas with two existing gate stations (Lake Stevens and Machias) and a large district regulator known as the Soper Hill DR. The two gate stations are fed by the Williams lateral, while the Soper Hill DR is fed by the Everett Delta lateral. This means there are currently three separate feeds into these areas. The growth in these areas has ranged from 4% to 5.5% (and greater) in the most recent years. Due to this past growth and anticipated future growth, the existing two gate stations are approaching their capacities and this area will require additional supply capacity to maintain service to the existing and future customers.

During this investigation, multiple solutions were proposed and studied to determine the least-cost option to solve this capacity issue.

PSE explored three options as follows:

- A. Add additional capacity through the Lake Stevens gate station (GS) and the Machias gate station.
- B. Connect the intermediate pressure system to the existing Snohomish intermediate system to the south.
- C. Install 6,000 feet of intermediate pressure pipe from the outlet of the existing Soper Hill DR towards the Lake Stevens area.

All three of these potential solutions were evaluated through the utility's planning process to help determine the option that would provide the most value at the least cost.

Option (A) would have solved the problem for the foreseeable future. Unfortunately, the Lake Stevens gate station is currently approaching design capacity of 113,000 scfh, and will require approximately a $300,000 rebuild to extend its capacity as required by Williams. The Machias GS is also at capacity and will need a complete rebuild and PSE to take over regulation to extend its capacity. The Machias option would solve the problem, but at a very high cost of more than $2 million. Other alternatives were much less costly.

Option (B) also would have solved the problem by connecting the Lake Stevens system to the Snohomish system to the south. This project would have required approximately 10,000 feet of 6” or 8” intermediate pressure pipe (difficult route), and the replacement of a 4” IP pipe across the Pilchuck River (also difficult construction). However, difficult permitting issues posed a high risk for non-completion. These unknown risk factors and the estimated cost of at least $1 million lead to alternative (C).

Ultimately, PSE selected Option (C) because of its low cost and its solution to the problem. This project entails installing 6,000 feet of 8” IP pipeline out of the existing Soper Hill DR, along Soper Hill Road into the town of Lake Stevens. The existing Soper Hill DR has significant unused capacity and will require no work to supply additional capacity to the area. Because the cost for this project is estimated at $500,000 and the risks are low, PSE funded Option (C) for construction in 2009.

After completing this project and as opportunities and needs arise, PSE will continue to build out the IP system to the south towards the Machias GS and towards the town of Snohomish. We also anticipate many opportunities ahead to partner with public improvement and new customer construction, which should decrease the installation costs for some future projects.

Figure 7-13
Lake Stevens/Marysville Intermediate Pressure (IP) Distribution System Alternatives

Alternatives	Capital	Comments
Replace/Rebuild 2 Gate Stations	$2.3M	Not cost competitive with other options.
Connect IP system to Snohomish System to the South	$1M	Project option abandoned due to reliance on 2 other separate projects with high risk of completion. Cost also greater than option below and adds less capacity.
Install 6000 feet of IP System to Lake Stevens	$500,000	Least cost alternative that provided low risk solution

B. Novelty Hill 230-115 kV Transformer

In a 1994 planning study, PSE forecast the need for additional transformation in North King County by the year 2000. Subsequent planning studies have updated growth rates, timing of the project, and alternatives to be studied.

Sammamish Substation, with two 230-115kV transformers, is fed by three transmission lines originating at the Seattle Bothell, BPA Monroe and BPA Maple Valley Substations. There are no other 230-115 kV transformers in North King County. The next closest PSE 230-115 kV transformers are located at Talbot Hill Substation in Renton.

Under high winter loads, loss of one transformer at Sammamish Substation would lead to overload of the other Sammamish transformer. This is a violation of the Category B outage requirements under NERC's TPL standards.

PSE considered five alternatives for the North King Transformation:

A. Triple Banking at Sammamish Substation
B. 115 kV Ties at BPA Sno King Substation 115 kV Bus
C. Novelty Hill Substation 230-115 kV Development
D. Sammamish-Lakeside 230 kV Development
E. Lake Tradition Substation 230-115 kV Development

Option (A) was not desirable because bus section breaker failure scenarios (that were not studied in 1994) would still cause overloads, and because the 115 kV system would not be adequate to load the three transformers. The company rejected Option (B) because it would require new agreements with BPA and Snohomish PUD, would increase the load on BPA's transformers, would require easements from Seattle City Light, and was more expensive than the Novelty Hill project. We also rejected Option (D), since it would require upgrading of the Sammamish-Lakeside 115 kV line to 230 kV, where permitting and construction may not be feasible, and it was significantly more expensive than Option (C). Option (E) was not selected because the Novelty Hill project would defer the need for the Lake Tradition project for an estimated seven years, while the Lake Tradition project would defer the Novelty Hill project for only an estimated five years; it is possible that by the seven-year timeframe the 230 kV line from Wind Ridge will be constructed, connecting at Lake Tradition.

Option (C) proved optimal from cost/performance measures. The Novelty Hill 230-115 kV transformer addition increases capacity in North King County, while meeting NERC's reliability requirements. The project was completed and energized in late 2008.

C. Frederickson High Pressure (HP) Gas Distribution System

At present, the greater Tacoma, Puyallup, Lakewood, Dupont, Steilacoom and McChord Air Force Base are served essentially by the N Tacoma GS lateral and the South Tacoma GS and lateral. These 250 psig MAOP systems are separated by a 150 psig MAOP system (that both also feed). The southern half of this system being fed by the South Tacoma GS lateral has exceeded its capacity and cold weather actions and curtailments are required to ensure system stability during cold weather. Because potential gas outages could be so large, and growth is widespread, a solution providing a significant source of supply gas is necessary to reinforce this system for the current and future requirements.

During this investigation, multiple solutions were proposed and studied to determine the least cost option to solve this capacity issue.

Three options were explored and are as follows:

A. Install 24,000 feet of 16” HP supply pipe from 128th St East and 98th Ave E to 128th St East and Waller Road. Install a new GS in the vicinity of 128 St E and 98th Ave E.

B. Uprate the existing S Tacoma lateral to 620 psig MAOP and provide a one mile long HP lateral to allow this uprate to be accomplished. The one mile long lateral would allow shutdown of S Tacoma lateral for hydro-test (to enable 620 psig MAOP). Replace the existing S Tacoma Gate Station. The existing S Tacoma lateral is a Williams-owned facility.

C. Install 29,000 feet of 16” HP supply pipe from the existing Frederickson GS to the intersection of 128th St East and Waller Road. The Frederickson GS has existing capacity available for this project.

PSE studied Option (A) in detail, and determined that installing 24,000 feet of HP lateral would be very difficult and risky. In addition, the project team was unable to secure a suitable parcel of land or easement for a new gate station that was necessary to complete the project. Ultimately, PSE abandoned this option because of the routing difficulties and the inability to obtain a practical site for the new gate station.

Option (B) required Williams Pipeline to uprate its existing 8” HP lateral to 620 psig and replace its existing S Tacoma GS. In order to complete the uprate, the lateral necessitated a temporary shut-down, which would have required PSE to build a one mile HP pipeline to backfeed the system during a short period in the summer. Even with this “temporary” lateral, it would have been difficult to “hold” the system for the hydro-test. After the test, this temporary lateral would have been “shut-in,” as it provides no benefits to the area of concern. The capacity gained from this option was not satisfactory even for the near term. This project did not solve the capacity issues in this area and was therefore abandoned.

Option (C) was selected because of its ability to solve the problem for the long term, add a separate third supply feed into the area, and utilize the existing capacity of the Frederickson GS. All other options were not feasible or did not solve the problem. PSE reviewed many different routes for connecting the existing Frederickson GS and 128th St. East/Waller Road intersection, and selected the most feasible and cost-efficient option. When completed, this project will have significant future capacity to serve the greater Tacoma, Puyallup, Lakewood, Dupont, Steilacoom and McChord Air Force Base areas.

After completing this project, the downstream HP system will eventually be built-out to take full advantage of this future capacity as the Tacoma area continues to grow.

Figure 7-14
Frederickson High Pressure (HP) Gas Distribution System Alternatives

Alternatives	Capital	Comments
Install 24,000 feet of 16" HP and new Gate Station	N.A.	Project option abandoned - infeasible
Uprate the existing lateral to 620 psig, install 1 mile of HP pipe and replace GS	$5M	Project option abandoned due to lack of benefit and feasibility of hydro-test
Install 29,000 feet of 16" HP and utilize existing GS capacity	$13.86M	Least cost alternative that was feasible

V. Emerging Alternatives

In the last 20 years, electricity consumption has increased by 2% to 2.5% annually in North America, though transmission infrastructure expansions have not kept pace. The resulting strain on the North American transmission system includes the Pacific Northwest, where the main grid transmission system has operated at or near capacity because of little transmission construction between 1987 and 2003.

PSE and the region's utilities have a vested interest in finding an optimal solution to this problem, and we are studying several emerging alternatives to meet today's transmission and distribution challenges. They include distributed energy, demand-response alternatives, and the development of a "smart grid."

A. Distributed Energy Resources

Distributed energy is a way of incorporating small-scale generation into the grid close to where the power is used. Many such sources exist: internal combustion engines, fuel cells, gas turbines and micro-turbines, hydro and micro-hydro applications, photovoltaics, wind energy, solar energy, and waste/biomass. The challenge for the delivery system is how to integrate this power into a system that was designed to transport power from large generating plants located far away.

For much of the 20th century, small-scale customer-based generation could not compete economically with centralized, utility-owned power plants, but those economics have begun to change. Though not yet cheaper than the conventional system in most cases, an increasing variety of customers find small-scale solutions desirable. Some industrial customers want to meet their heating and electrical needs with one system. Hospitals and computer-based internet service firms now require higher levels of power quality and would suffer significant consequences if a service interruption were to occur. Some customers want renewable or green power.

Distributed energy resources (DER) is the formal name for distributed energy solutions, and it includes all technologies in distributed generation (DG), distributed power (DP) and demand-response applications. Unlike the conventional system through which power generally flows in one direction, DER configurations allow power to travel in both directions: Customers who generate electricity for their own use (or have back-up generators standing by) can sell power back to the grid. PSE already has more than 100 such “interconnected” customers. Demand-response applications build two-way communications into the system that enable customers and the company to calibrate actual usage much more closely.

Although a host of regulatory, business practice, technical and market barriers continue to challenge the full-scale implementation of DER technology, PSE believes that it has the potential to provide cost-effective, appropriate and meaningful solutions. The company is already incorporating DER elements into the planning process, and has developed guidelines to identify projects most likely to serve as the lowest reasonable cost solution. To ensure no adverse effects on customers, we require that such solutions be as reliable as traditional “wires-based” projects.

PSE has past experience in the implementation of some DER solutions, and is testing others to find out if they can provide benefits that justify their costs.

B. Demand Response Alternatives

PSE began testing a conservation voltage reduction pilot program in 2006 in conjunction with the Northwest Energy Efficiency Alliance (NEEA). The homes of 10 customers in two locations were fitted with meters capable of monitoring energy usage at the residence and transmitting that information back to PSE every 15 minutes over telephone lines. On alternate days, PSE reduced substation transformer control voltage from a range of 123 volts to a range of 119 volts. This results in a feeder voltage reduction of 3%. Two-way communication helped PSE determine whether the reduced voltage adversely affected any customers. Results from the study were favorable, indicating a 2% energy savings at both pilot locations with no adverse effects.

PSE continues to evaluate locations where conservation voltage reduction may be practical to implement and similar energy savings may be realized.

C. Modernizing the Grid

Smart grid is a movement to integrate intelligent devices and new technologies into the electrical grid to optimize the system to a degree not possible with existing infrastructure. It is less well developed than DER technologies, but has the potential to integrate all parts of the electric power system—production, transmission, and distribution—in ways that would be extremely beneficial. The smart grid will:

- Enable active participation by consumers
- Accommodate all generation and storage options
- Enable new products, services and markets
- Provide power quality for the digital economy
- Optimize asset utilization and operate efficiently
- Anticipate and respond to system disturbances (self-heal)
- Operate resiliently against attack and natural disaster

PSE is monitoring and researching smart grid devices, and participating with various governmental, regional, industry and utility groups in workshops and summits. When these devices become commercially available, the company will integrate them into our cost-benefit analysis.

Choosing a Resource Plan

Quantitative analysis delivers a great deal of information about how resource choices will perform over time and under different assumed conditions, but choosing a resource strategy also involves applying what the company has learned from listening to customers, operating in the marketplace, and observing regulatory developments. Here PSE explains the reasoning behind the specific resource additions in this IRP.

I. Overview

Here we explain the reasoning behind the specific resource additions in this IRP, but it is helpful to understand that the reasoning is more important than the plan itself. The real value of the IRP is in what we learn through the planning process. The specific 20-year plan serves to focus the investigation, rather than predict the future. When the time for actual resource acquisitions comes, the strategic and analytical insights gained from thinking through these problems will make a far more valuable contribution than a list of resources in the plan.

Planning horizons as long as this one – a 20-year outlook – can be considered to have two distinct parts: a near-term "action window," and the longer period that follows. The action window is characterized by decisions and commitments that must be made in the near future to ensure reliable service for PSE's customers. The later, longer term reveals the consequences of those choices and the impact they may have on decisions the company will have to make in the future.

The length of the action window differs depending on which resources are being discussed. For example, the action window for some energy efficiency measures may be fairly short (one to two years), because programs can be ramped up quickly. But the action window for wind generation that requires new transmission to be constructed may be as long as five to seven years. (It can take three to four years to site and build the generation facilities, and up to seven years to build the transmission.) In general, the following discussion considers the next three to five years to be the action window.

II. Electric Resource Plan

Figure 8-1 illustrates PSE's 2009 Electric Resource Plan. The plan integrates demand-side resources with renewable and nonrenewable supply-side resources to arrive at the lowest reasonable cost portfolio capable of meeting PSE customer needs reliably and responsibly over the next 20 years. Because wind power contributes only 5% of its capacity to meet peak, it is barely discernable on the chart in Figure 8-1. The table in Figure 8-2 lists the nameplate capacity additions by resource type.

Figure 8-1
2009 Electric Resource Plan
with Cumulative Peak Capacity Additions in MW

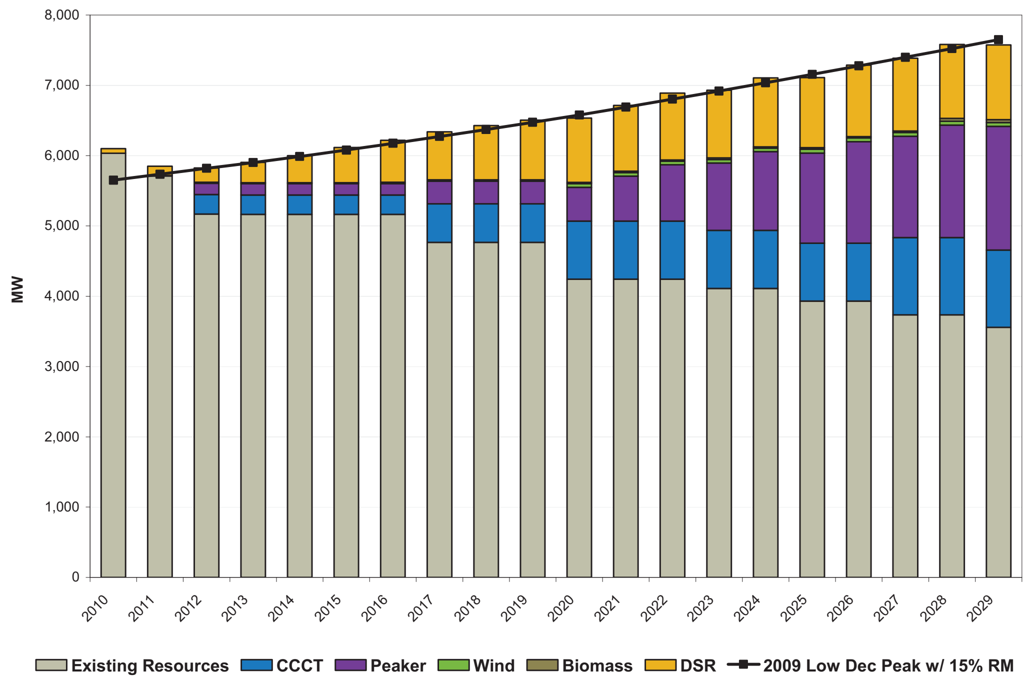


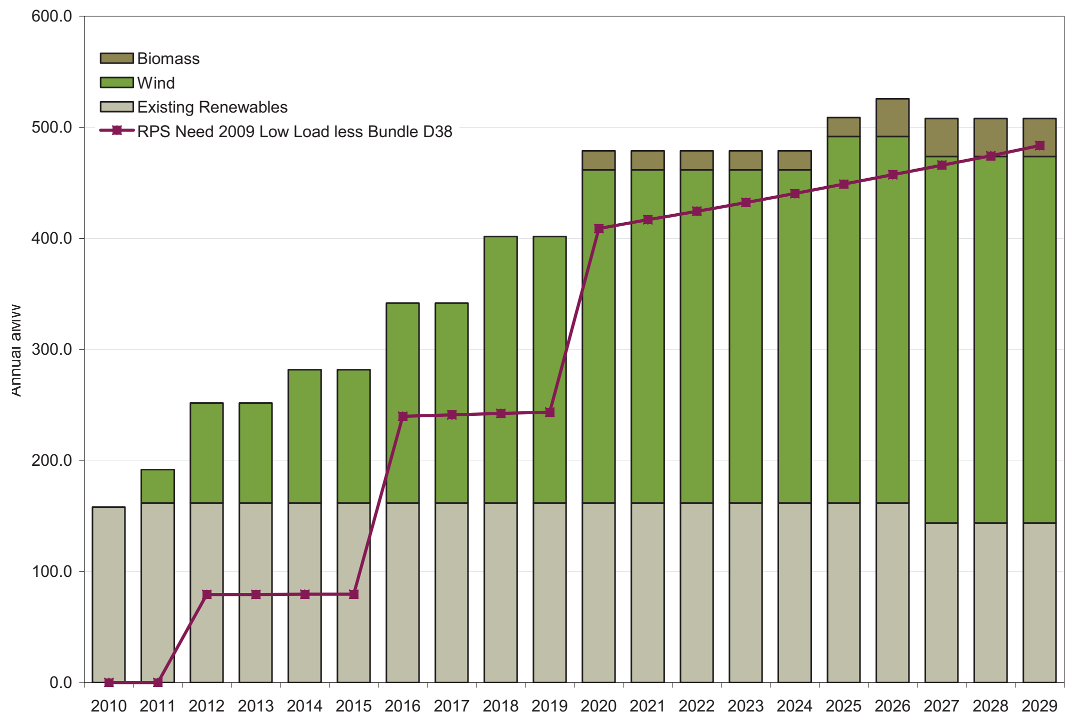
Figure 8-2
Cumulative Nameplate Capacity Additions by Resource Type in MW

	2012	2016	2020	2029
Demand-side Resources	205	597	917	1064
Wind	300	600	1000	1100
Biomass	0	0	20	40
CCCT w/Duct Firing	275	275	825	1100
Peakers	160	160	480	1760

Renewable resources reflected in this IRP are consistent with requirements of Washington's renewable portfolio standard (RPS) in RCW 19.285, Energy Independence Act. PSE also has set a voluntary, internal goal to achieve a higher level of renewable resources in the portfolio, 10% of load by 2013, to the extent these renewable resources are reasonably commercially available, necessary to meet load, and cost effective.[1] Results of analysis in this IRP demonstrate that it is cost effective to acquire wind resources to meet this goal, but Figure 8-3 illustrates the resource plan does not quite achieve that 10% goal—the IRP cost effectively reaches 9% by 2013 under current assumptions.

[1] Note: The cost effectiveness analysis reflects selling renewable energy credits into the wholesale market in excess of those needed to comply with RCW 19.285.

Figure 8-3
Renewable Resources in the Resource Plan
(Annual Average MWh)

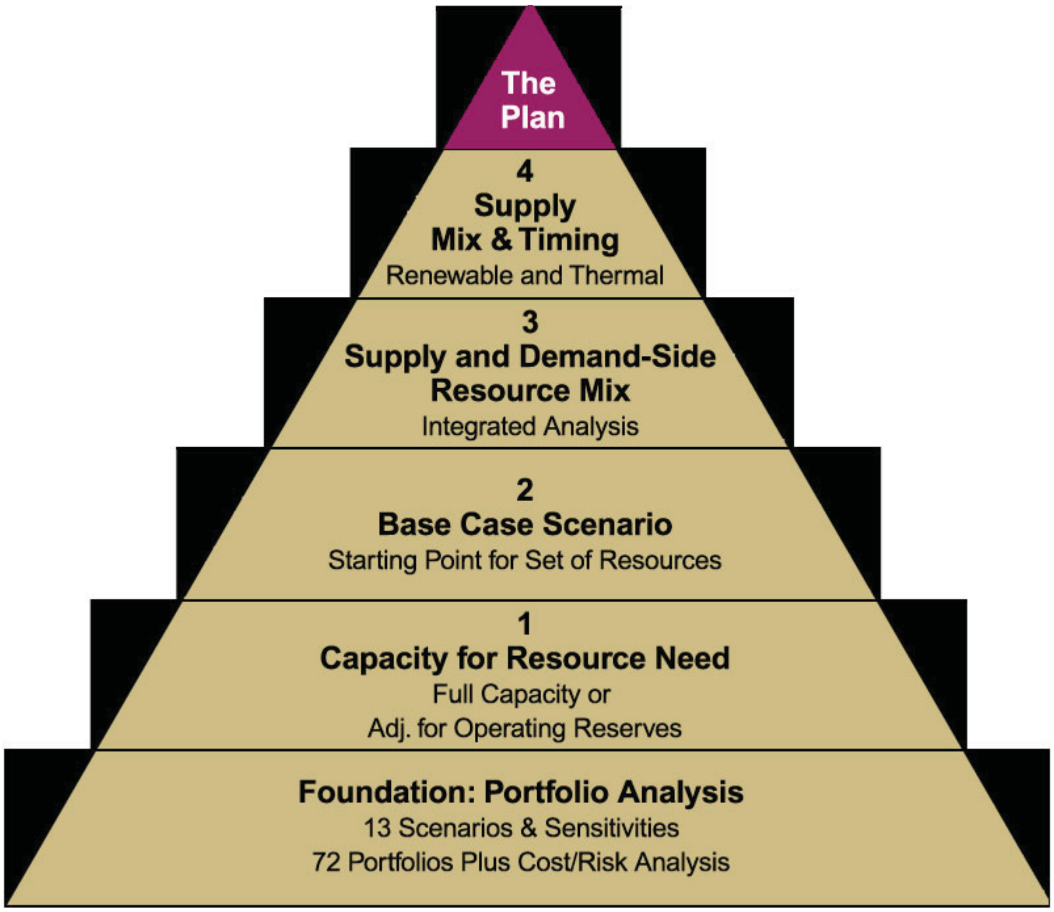


Summary of Electric Resource Plan Decisions

This plan is informed by the analysis performed on all the scenarios and sensitivities modeled for this IRP. However, it draws most heavily on the least cost resource plan analysis for the 2009 Trends scenario described in Chapter 5 to develop the specific set of resource builds.

Figure 8-4, below, illustrates how judgment was applied in developing the plan. The following text summarizes the decisions made at each step, while the issues involved in those decisions are discussed in more depth thereafter.

Figure 8-4
Development of the Resource Plan



Summary of Resource Plan Decisions

1. Assessment of capacity. Resources available to meet customer capacity needs were assessed in two ways for this IRP. One method used the full peak capacity value of existing resources to describe the "resource stack." The other deducted operating reserves from resources. PSE chose to use the full peak capacity to calculate need, because we believed that deducting resources for operating reserves that are intended to address extremely short-term, unplanned outages of one hour or less may overstate long-term resource need. The abbreviation "Full-Cap" appears where this method was used.

2. Selection of a starting point. Worldwide, economic conditions changed radically during the development of this IRP analysis. In the spring of 2009, PSE developed new scenarios that allowed the company to incorporate post-downturn information about economic conditions into our assumptions. The 2009 Trends scenario was selected as the starting point and basis for the plan because it offered the most up-to-date assumptions. Among them were the following:

Load forecast: The 2009 Low Growth Update forecast reflects macroeconomic data available as of February 2009.

Natural gas prices: For 2010 through 2013, natural gas prices use three-month average forward prices for the period ending March 2, 2009; thereafter, Global Insight's long-run low forecast is applied.

Production tax credits (PTCs): PTC availability is based on the American Recovery and Reinvestment Act (Federal Stimulus Bill) passed in February 2009, which extends credits for wind through 2012 and biomass through 2013.

Resource costs: Low resource costs are expected to result from lower demand for energy.

CO_2 emission costs: CO_2 cost assumptions appear to approximately achieve 1990 emissions for the Western Electric Coordinating Council (WECC) by 2020, which is reasonable considering on-going activity on this front at the federal level.

3. Mix of demand-side and supply-side resources, and the pace of DSR additions. The demand-side resources target for this plan is 533 aMW at the generator over the next 20 years, with an accelerated ramp-in rate of 38 aMW (at the meter) for the first 11 years. This matches the total amount recommended by the optimization analysis, but slightly modifies the ramp-in rate because we have concerns about the practicality of achieving more than 38 aMW per year. We need to be able to count on that number, because the amount of DSR achieved has a significant impact on supply-side resources that must be developed or acquired.

4. Timing of renewable resource additions. This plan assumes that nearly all of the renewable energy for the electric portfolio will come from wind power, and that the timing of wind resource additions will proceed at a steady pace to achieve approximately 1,000 MW by 2020 to satisfy RPS requirements. The extension of production tax credits makes addition of wind resources in advance of RPS minimums part of a least cost portfolio through 2012. Thereafter, the plan continues additions at a measured pace while the optimization model proposes "just in time delivery" to meet RPS deadlines. We believe there are substantial benefits to be gained by PSE and its customers from a steady program, especially in a marketplace crowded by states that are urgently trying to assemble the resources to meet their own RPS requirements.

5. Timing of thermal resource additions. The primary factor influencing the mix and timing of peakers and combined cycle combustion turbine (CCCT) plants is the resource need assumption. Through 2016, this plan's recommendations match the least cost optimization analysis.

Discussion of Resource Plan Decisions

The least cost portfolio produced by the optimization model is a theoretical and ideal one based on specified inputs. The ways in which PSE modified the least cost "optimized" portfolio for the 2009 Trends Full-Cap scenario to better address real-world considerations is illustrated in Figure 8-5, and described in the following pages.

Figure 8-5
Resource Additions

Optimal 2009 Trends Full-Cap Portfolio vs. 2009 Resource Plan

2009 Trends Full-Cap Portfolio Cumulative Resource Additions

	DSR	Wind	Other Renewable (Geothermal & Biomass)	Peakers	CCCT
2012	192	200	20	160	275
2016	605	300	40	160	275
2020	808	800	65	640	825
2029	914	800	160	1,600	1,375

***2009 Electric Resource Plan* Cumulative Resource Additions (MW)**

	DSR	Wind	Other Renewable (Biomass)	Peakers	CCCT
2012	205	300	0	160	275
2016	597	600	0	160	275
2020	917	1000	20	480	825
2029	1,064	1100	40	1,760	1,100

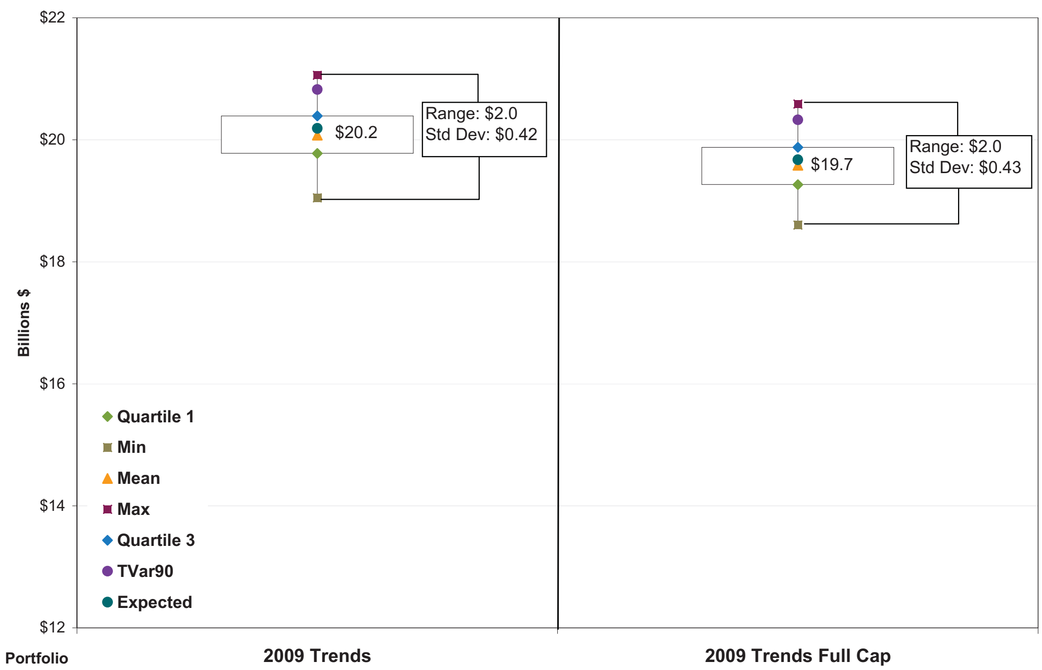
Capacity Assessment and Resource Need

Resource need is determined by subtracting the company's existing capacity to generate and supply power (its existing resources or "resource stack") from the capacity required to serve customer demand reliably. Therefore, different ways of assessing the capacity of existing resources can produce different calculations of resource need. This IRP considered two methods of assessing the capacity of existing resources. They differed in their treatment of operating reserves.

One method used the full peak capacity value of existing resources to describe the "resource stack." This method assumes that required operating reserves are included in the 15% planning reserve margin that the company maintains to achieve a 5% loss of load probability target. The other method deducts operating reserves from existing resources; in other words, it discounts the amount of available capacity by the amount of required operating reserves. For example, under existing North American Electric Reliability Council (NERC) Contingency Reserve obligations, a 275 MW CCCT operating at full capacity would require contingency reserves (which are a subset of total operating reserves) of19 MW (7%). The second method would assess the plant as only having an effective capacity of 256 MW of effective capacity available, while the first method would assess it at its full capacity of 275 MW.

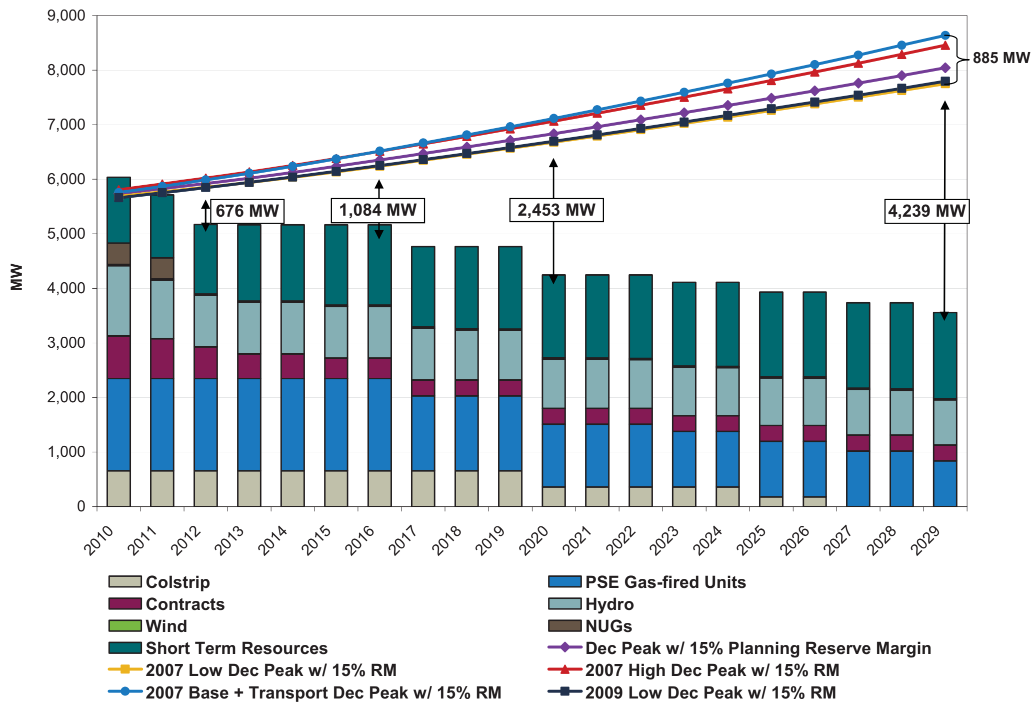
Ultimately, the different capacity assessments influence whether PSE needs to include one additional 275 MW gas CCCT plant in the resource plan by 2012. Figure 8-6 illustrates the box-plot depiction of costs and risks between the two approaches. This figure shows that the expected cost and range of costs are shifted down slightly without the additional power plant, but the shape of the risk profile is the same.

Figure 8-6
Long-term Impact of Alternate Capacity Assessments on Portfolio Cost and Risk



PSE elected to use the full peak capacity value of resources to calculate resource needs for this plan. This approach is reasonable and consistent with the way other utilities have addressed the question, and reasonable in that it avoids overstating PSE's long-term resource needs while we continue to refine this aspect of our analysis. As stated in the Action Plan discussed in Chapter 9, the company will be working with other utilities and stakeholders in the region to further refine this approach. Figure 8-7 illustrates resource need based on the 2009 Trends scenario using full peak capacity of resources.

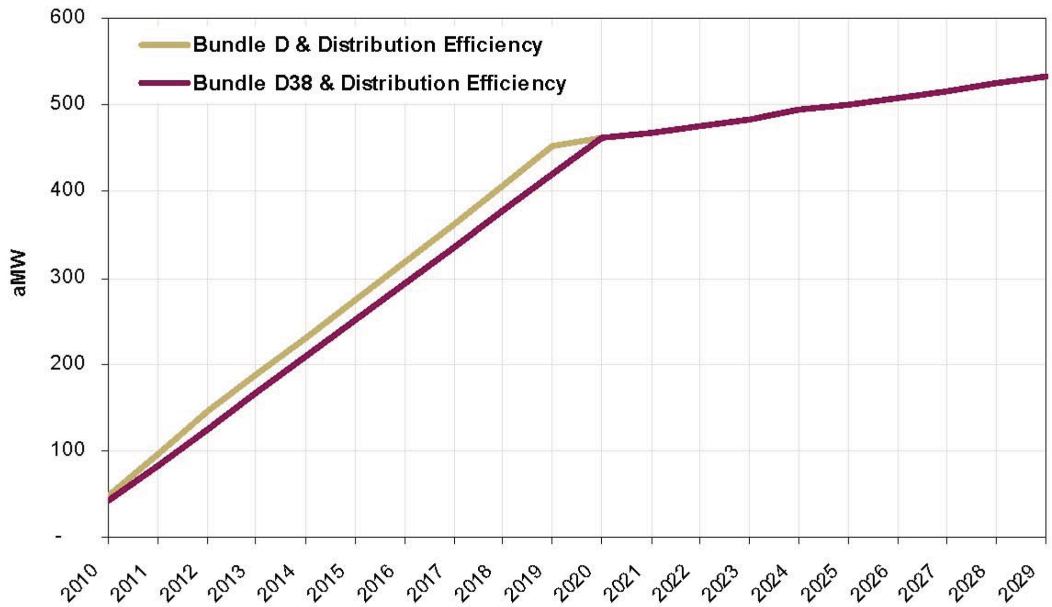
Figure 8-7
Electric Peak Capacity Resource Need
Full Peak Capacity Value of Resources & 2009 Low Load Forecast Update



Mix and Timing of Demand-side Resources

This resource plan adopts the same amount of demand-side resource (DSR) additions identified as least cost for the 2009 Trends scenario – 533 aMW (at the generator) over the next 20 years – but slightly modifies the timing of additions reflected in the optimization analysis. The optimization model proposed a ramp-in rate of 41 aMW (at the meter) per year for 10 years for those resources; instead, the resource plan adopts a ramp-in rate of 38 aMW per year for 11 years. (This adjustment was made to energy efficiency, demand response, and fuel conversion, but not distribution efficiency.) Figure 8-8 compares the cumulative annual energy savings reflected in the resource plan with the annual savings produced by the optimization model. This level of demand-side resources was labeled Bundle D in the analysis presented in Chapter 5. It is referred to as Bundle D38 in the resource plan, as we plan to attain bundle D at the pace of 38 aMW per year.

Figure 8-8
Bundle D38 Achieves Bundle D Savings in 11 Years



The accelerated ramp-in rate was adjusted for the resource plan because of concerns about the practicality of achieving 38 aMW of demand-side resources in today's marketplace. Thirty-eight aMW per year represents a significant expansion of PSE's existing programs. Because the people and resources capable of implementing such programs are highly sought-after, it will be challenging to achieve these savings. While the company believes that we *can* achieve them cost-effectively, we are *not* confident that we can achieve *greater* energy savings cost-effectively on an annual basis, especially in the next few years. Bundle D38 is also consistent with the lowest level of cost-effective DSR across all the scenarios. The analysis illustrated that at least 38 aMW per year of DSR was cost effective in every scenario examined. There is little risk that this amount would provide too much DSR to be cost effective. Therefore, Bundle D38 is practical and reasonable.

The level of achieved DSR affects the amount of supply-side resources for which PSE must plan and also the level of renewable resources the company is required to build. This means that PSE must be able to count on the amount of supply-side resources our program planners can reliably deliver in order to plan appropriately for supply-side resources. PSE may attempt to achieve higher rates of demand-side resource acquisitions, but we must be confident about the amount we *can* achieve because DSR has such a significant impact on other resources that must be acquired.

Mix of Renewable Resources

Renewable resource decisions include the amount of renewable resources to build, the mix of renewable resources, and the timing of additions. Figure 8-9 compares the optimization model's least cost mix of renewable resources across all scenarios and sensitivities presented in Chapter 5 (including the high and low RPS) with the resource plan. The following discussion explains why PSE selected the specific renewable resource additions in the resource plan.

Figure 8-9
Comparison of Cumulative Renewable Resource Builds in MW of Capacity (Range of Least Cost Plans Across Scenarios vs. Resource Plan)

	Range of Cumulative Additions Across All Scenarios			2009 Resource Plan		
	Wind	Other Renewable	Total Renewable	Wind	Biomass	Total Renew
2012	0 – 300	0	0 – 300	300	0	300
2016	300 – 400	0 – 90	0 – 450	600	0	600
2020	0 – 800	65 – 160	65 – 950	1000	20	1020
2029	0 – 1200	160 – 310	160 – 1510	1100	40	1140

For the electric portfolio in this plan, nearly all renewable energy will come from wind power, with a small amount of biomass. This is the case even though the optimization model indicated that the least cost resource plan across different scenarios included varying amounts of biomass, concentrating solar thermal and geothermal resources. PSE chose this course because the company's experience in the marketplace leads us to question when non-wind renewable resources will be truly commercially available and capable of delivering utility-scale power As with DSR, the company must be able to count on the resources for which we will plan and build infrastructure.

Despite PSE's reputation among utilities for aggressive pursuit of renewable resources, our efforts to attract geothermal and biomass resources through the 2003, 2005, and 2007 RFP processes (and outside those processes) have not resulted in actual acquisitions. The company will continue to seek opportunities to acquire or develop commercial-scale, cost-effective non-wind renewable resources (including biomass, geothermal, and concentrating solar thermal), but we cannot rely upon them at this time to deliver the energy or capacity needed.

Mix and Timing of Resource Additions

Once it was determined that the geothermal and concentrating solar thermal resources were not practical alternatives, an additional sensitivity was developed to inform the overall schedule of resource additions. The "2009 Trends Constrained" sensitivity incorporated the judgments made so far.

- It assumed the full peak capacity value of resources.
- It adopted DSR Bundle D38.
- It excluded geothermal and concentrating solar as alternatives.

The optimization model then showed how these constraints would affect the least cost combination of renewable and thermal resources. Results for wind and biomass additions are presented in Figure 8-11; results for thermal builds are presented in Figure 8-12.

Timing of Renewable Resource Additions. The timing of wind resource additions in the plan proceeds at a steady pace to achieve approximately 1,000 MW by 2020 to satisfy RPS requirements. First PSE summarizes the important impact of the PTC extension on the timing of renewable additions during the near-term action window, and then we describe the basis for the overall schedule of wind additions.

The extension of the PTC provided for in the American Recovery and Reinvestment Act supports acceleration of wind additions sooner than needed to comply with RPS requirements. Figure 8-10, below, shows that wind resource additions from 100 to 300 MW by 2012 would be cost effective with the current RPS and extension of the PTC through 2012 or 2013. The figure also illustrates that without the PTC extension, additional wind by 2012 would not be cost effective, based on the assumptions in this IRP. Recall the 2009 Trends scenario includes a PTC extension for wind through 2012 and current RPS requirements.

Figure 8-10
Impact of PTC Extension on Acceleration of Wind Additions

	Range of Wind Additions (MW)	
	Additions in Scenarios With PTC Extension	Additions inScenarios Without PTC Extension
2012	100 – 300 MW	0

Figure 8-11 illustrates that wind power additions in the resource plan are consistent with the least cost 2009 Trends Constrained portfolio through 2012, reflecting the accelerated development of wind power above. Between 2014 and 2020, the schedules diverge; both arrive at 1,000 MW of wind power by 2020.

Figure 8-11
Comparison of Annual Renewable Resource Builds (in MW)
(2009 Trends Constrained Sensitivity vs. Resource Plan)

	2009 Trends Constrained (DSR Bundle D38, No Geothermal or Concentrating Solar Thermal)		2009 Resource Plan	
	Wind	Biomass	Wind	Biomass
2010	-	-	-	-
2011	100	-	100	-
2012	200	-	200	-
2013	-	-	-	-
2014	-	-	100	-
2015	-	-	-	-
2016	100	-	200	-
2017	-	-	-	-
2018	-	-	200	-
2019	-	-	-	-
2020	600	20	200	20
Total	*1000*	*20*	*1000*	*20*

The timing of wind power additions in the plan from 2014 through 2020 is based on the benefits that accrue from a steady, disciplined acquisition and development program, consistent with prior resource plans. Such an approach allows PSE to retain a team of experienced wind acquisition and development professionals capable of taking advantage of opportunities as they occur in the marketplace. The "just-in-time" development of 600 MW of wind in 2020 proposed in the 2009 Trends Constrained portfolio exposes the company and its customers to the risks and uncertainties of a boom-bust cycle that would create periodic scrambles to assemble qualified personnel and development opportunities, just so that requirements could be met at the last minute.

Mix and Timing of Nonrenewable Resource Additions. The backbone of PSE's supply portfolio for the next 20 years is composed of gas-fired combined-cycle combustion turbines for baseload needs, and gas-fired peakers with fuel-oil backup for peaking needs. The timing and mix of thermal resources in the resource plan is consistent with the least cost 2009 Trends Constrained portfolio described above. (Again, that sensitivity was developed to reflect the full capacity of existing resources, and examine how DSR Bundle D38 and the exclusion of geothermal and concentrating solar would affect the least cost combination of renewable and thermal resources.) Figure 8-12 compares a summary of thermal resource additions in the resource plan with those from the least cost 2009 Trends Constrained portfolio.

Figure 8-12
Cumulative Thermal Additions in MW

Least Cost 2009 Constrained Portfolio vs. 2009 Resource Plan

	Least Cost 2009 Trends Constrained		2009 Resource Plan	
	Peakers	CCCT w/ Duct Firing	Peakers	CCCT w/ Duct Firing
2012	160	275	160	275
2017	320	550	320	550
2020	480	825	480	825
2029	1,760	1,100	1,760	1,100

Additional Considerations

Implications of Near-term Decisions on Future Options

An important part of resource planning is consideration of how decisions made in the near term may limit opportunities in the longer term. This plan's near-term decisions do not appear to foreclose on future options. Figure 8-13 illustrates that resource additions through 2012 are part of the long-term least cost path across a broad range of futures considered in this IRP. All scenarios examined include at least 275 MW of CCCT w/Duct Firing by 2020, for example. The one exception is wind power in the low RPS sensitivity, which tested implications of RCW 19.285 being changed to require that just 3% of load be met by renewables for the entire study period. In that case, no additional wind power appeared cost effective. However, since RCW 19.285 recently passed through a legislative session unchanged, it seems unlikely that it would be so dramatically revised by 2012.

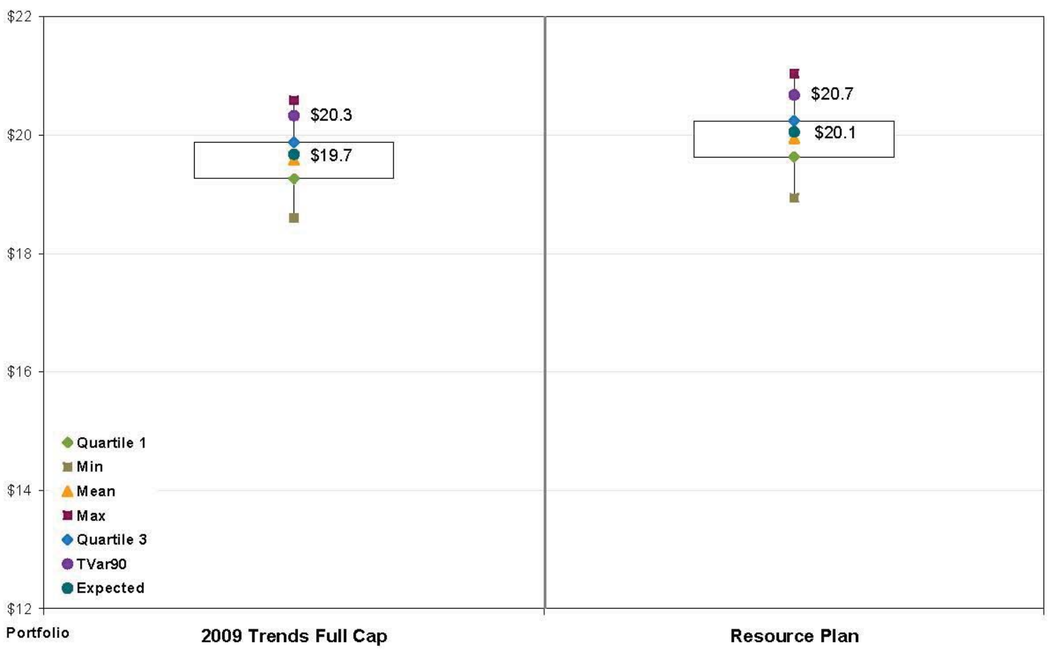
Figure 8-13
Resources in Action Window Are Part of All Future Least Cost Plans
(Cumulative Resource Additions in MW)

		DSR	Wind	Other Renewable	Peaker	CCCT w/ Duct Firing
2012	Resource Plan	205	300	-	160	275
2020	2009 Trends-Full-Cap	808	800	65	640	825
	Green World-Full-Cap	921	600	140	160	1,100
	2007 Trends-Full-Cap	994	700	140	320	1,100
	2007 BAU-Full-Cap	864	700	140	640	825
	High Growth-Full-Cap	994	800	85	160	1375
	2009 Trends	808	800	75	800	825
	2009 BAU	808	800	65	800	825
	High RPS	994	800	150	480	1,100
	Low RPS	994	-	65	480	1,100
	Transport Load	994	700	140	480	1,375

Costs and Emissions

Cost and Cost Risks. The analysis described in Chapter 5 led to a key finding: Future scenario conditions (specifically natural gas prices and carbon costs) have a significantly greater impact on costs than the specific set of resources contained in the portfolio. However, since the resource plan was not simply selected from among those produced by the optimization model but instead developed as described, it is important to report on the plan's costs and cost risks here. Figure 8-14 uses box-plot diagrams to illustrate the costs and cost-risk profiles of the resource plan and the optimal 2009 Trends Full-Cap portfolio that was used as a starting point. This demonstrates that the decisions to use Bundle D38, to avoid relying on geothermal and concentrating solar, and to change the timing of wind power additions from 2014 to 2020, have little impact on the cost and risk profile of the resource plan relative to the least cost 2009 Trends Full-Cap portfolio.

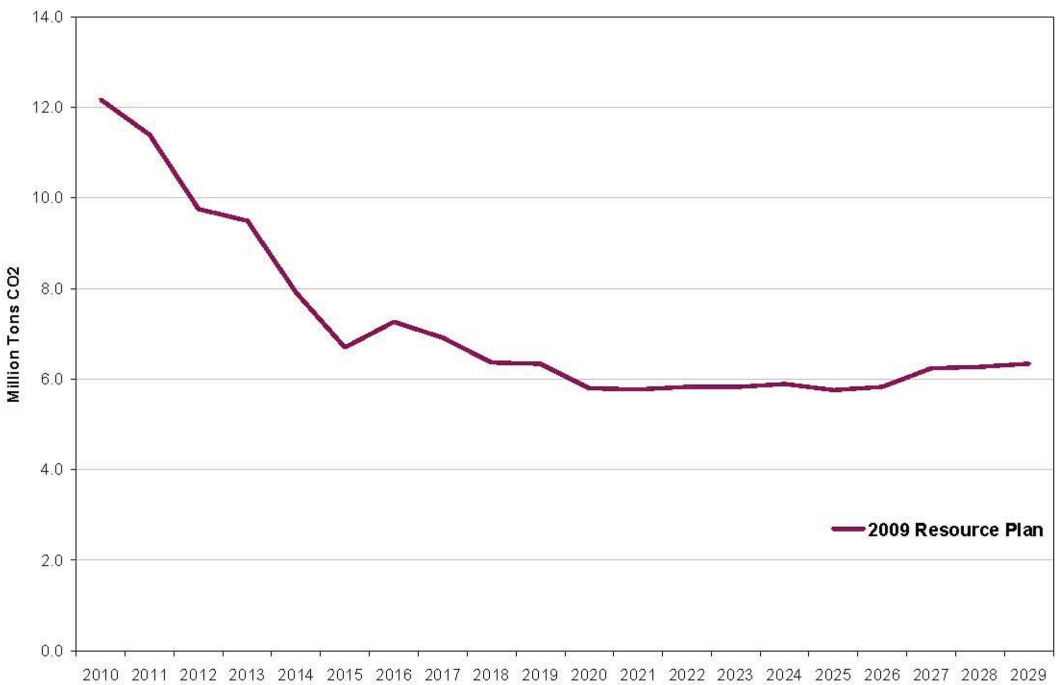
Figure 8-14
Cost/Risk Profiles Compared
Least Cost 2009 Trends Full-Cap vs. Resource Plan



(20-year NPV in $Billions)

Carbon Dioxide Emissions. Chapter 5 demonstrated that the primary factor affecting carbon emissions was cost of carbon from potential new regulations. Figure 8-15 illustrates CO_2 emissions from the resource plan within the 2009 Trends scenario (carbon costs start at $37 per ton in 2012 and increase to $130 per ton by 2029). The significant decline in CO_2 emissions by 2015 is caused by falling capacity factors at Colstrip, which is driven by increasing carbon costs. By 2020, Colstrip units 1 and 2 are retired. After 2020, Colstrip units 3 and 4 are still available, but they would be utilized for reliability purposes to provide capacity for colder than normal cold spells, rather than dispatched on a routine basis.

Figure 8-15
CO_2 from Resource Plan Decline Significantly



III. Gas Resource Plans

PSE developed two gas resource plans for this IRP; one for gas sales, and one for the company's combined gas needs, which reflected needs of gas-fired generation for the electric resource plan identified above. Electric generation will require increasing amounts of natural gas in the future, so looking at total gas resource need presents a more comprehensive picture of the challenges that will face the company and its customers in the years ahead.

The combined need perspective highlights the fact that a large majority of current PSE gas supplies come from a single supply basin, and that diversifying the source of supplies may be in the best interest of customers over the long term. However, a diversity strategy is not included in the final plans presented below, because analysis indicated that it would increase portfolio costs. PSE will continue to evaluate the costs and benefits of increasing pipeline capacity to diversify supply sources. A full discussion of this issue is included in Chapter 6, Gas Resources.

The gas resource plans integrate demand-side resources with supply-side resources to arrive at the lowest reasonable cost portfolio capable of meeting PSE needs reliably and responsibly over the next 20 years. They are based on the 2009 Trends scenario. This scenario includes load forecasts and gas price forecasts that were updated in February and March 2009.

Gas Sales Resource Plan

Figures 8-16 and 8-17 illustrate PSE's 2009 Gas Sales Resource Plan. The following discussion explains the reasoning that supports the specific elements of the plan, with an emphasis on resources needed early in the planning horizon.

Figure 8-16
2009 Gas Sales Resource Plan

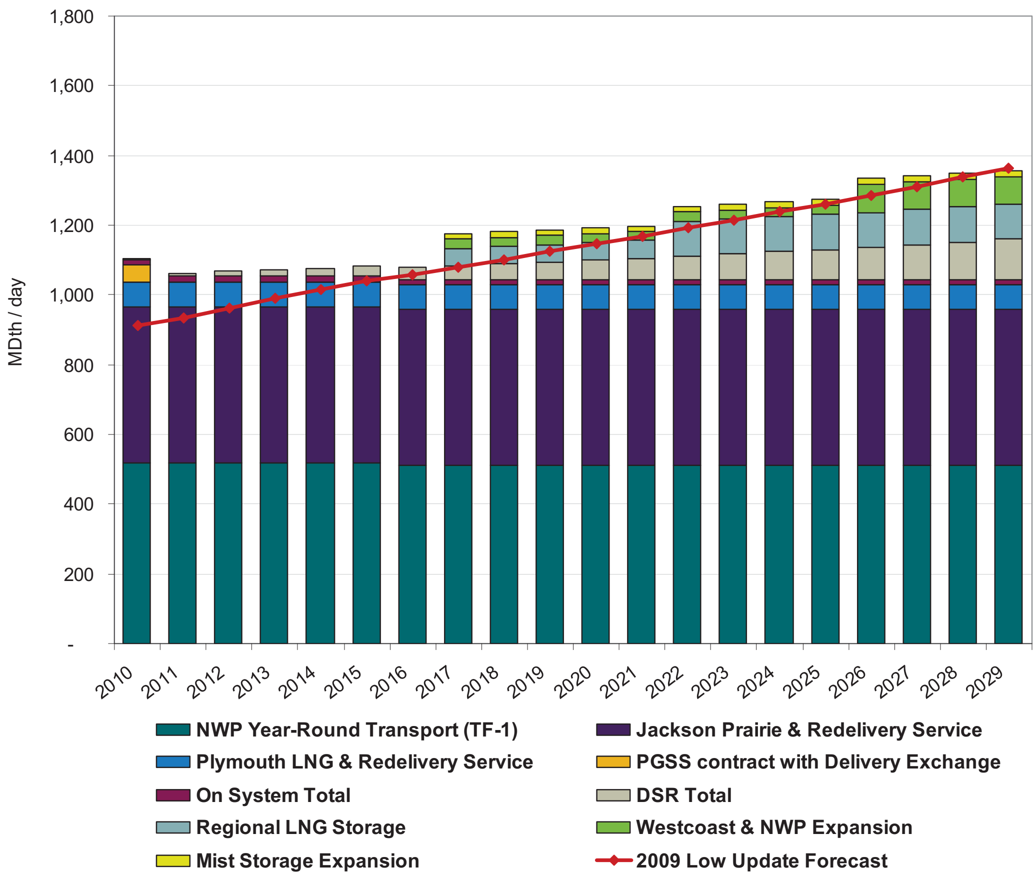


Figure 8-17
2009 Gas Sales Resource Plan Additions

	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012				14
2017	50	30	16	26
2022	50			26
2026		62		20
2029				14
Total Additions	**100**	**92**	**16**	**100**

Combined Gas Resource Plan

The 2009 Combined Gas Resource Plan, summarized in Figures 8-18 and 8-19, addresses PSE's total natural gas need – gas required to fuel electric generation plus gas for retail sales customers.

Figure 8-18
2009 Combined Gas Resource Plan

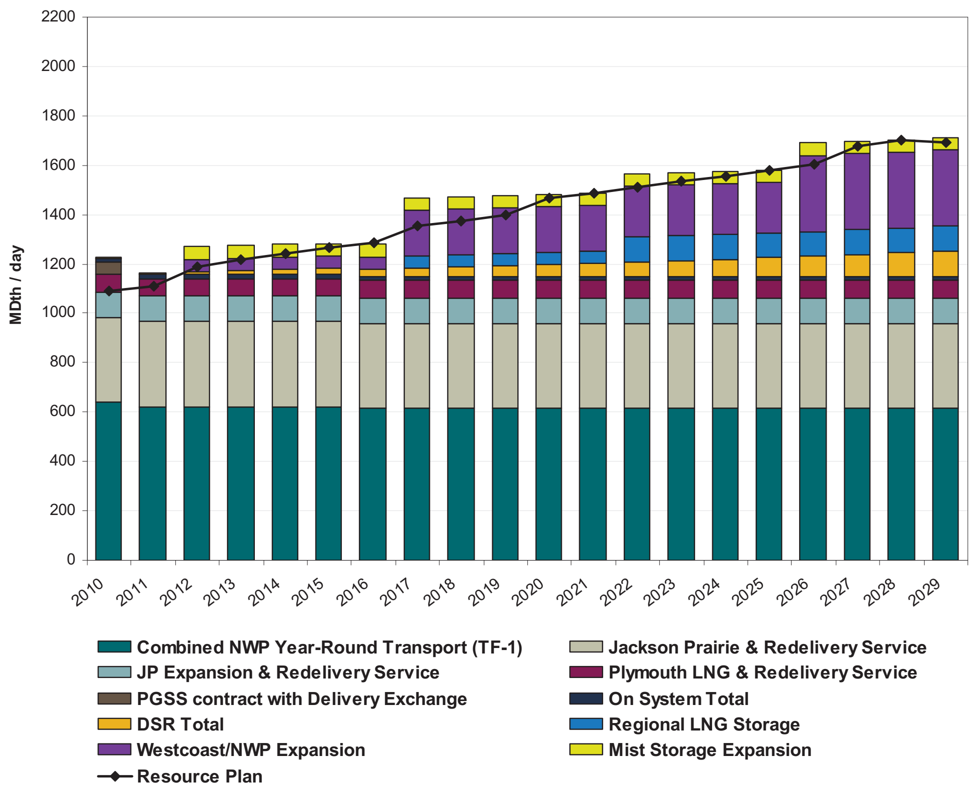


Figure 8-19
2009 Combined Gas Resource Plan

	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012		50	50	14
2017	50	129		26
2022	50	20		26
2026		111		20
2029		0		14
Total Additions	100	310	50	100

Figure 8-20, below, compares the resource additions included in the Gas Sales Resource Plan with those in the Combined Gas Resource Plan. Reflecting the growing reliance on natural gas to fuel electric generation, the combined plan expands capacity to Northern British Columbia sooner than the gas sales plan. It also adds capacity in larger amounts than the gas sales plan throughout the 20-year study period. Finally, it includes more Mist storage and related transportation than the gas sales plan. Regional LNG storage, a needle-peaking resource, is the same in both.

Figure 8-20
Comparison of Resource Additions
Gas Sales Resource Plan vs. Combined Gas Resource Plan

	Additions in MDth/day							
	Regional LNG Storage		Westcoast/NWP		Mist & Pipeline		DSR	
	Sales	Combined	Sales	Combined	Sales	Combined	Sales	Combined
2012				50		50	14	14
2017	50	50	30	129	16		26	26
2022	50	50		20			26	26
2026			62	111			20	20
2029				0			14	14
Total Additions	**100**	**100**	**92**	**310**	**16**	**50**	**100**	**100**

Discussion of Gas Sales Resource Plan Decisions

The optimal portfolios produced by the SENDOUT analysis tool are theoretical portfolios based on specified inputs and need to be reviewed based on judgment and market conditions. In this case PSE made minor changes only to the SENDOUT demand-side resource acquisition schedule. In the years beyond 2020, the company reduced DSR to incorporate marketplace constraints in gas DSR acquisition, and increased Westcoast/Northwest pipeline capacity by corresponding amounts. Figure 8-21 compares the 2009 Trends SENDOUT results with the resource plan capacity additions.

Figure 8-21
Gas Sales Portfolio Resource Additions
2009 Trends vs. Resource Plan

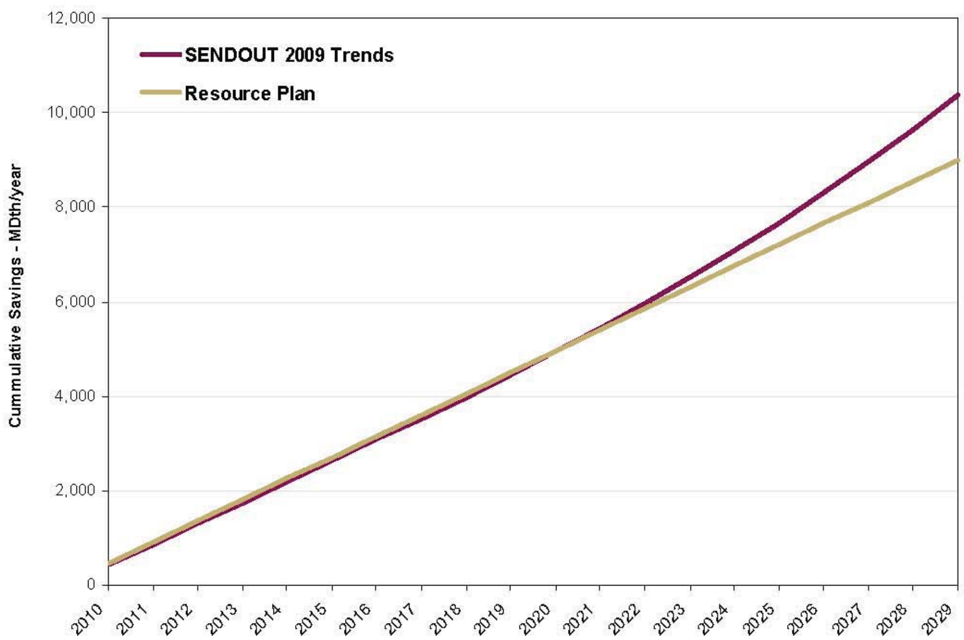
2009 Trends	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012				14
2017	50	30	16	26
2022	50			27
2026		47		26
2029				22
Total Additions	**100**	**77**	**16**	**115**

Resource Plan	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012				14
2017	50	30	16	26
2022	50			26
2026		62		20
2029				14
Total Additions	**100**	**92**	**16**	**100**

Demand-side Resource Additions

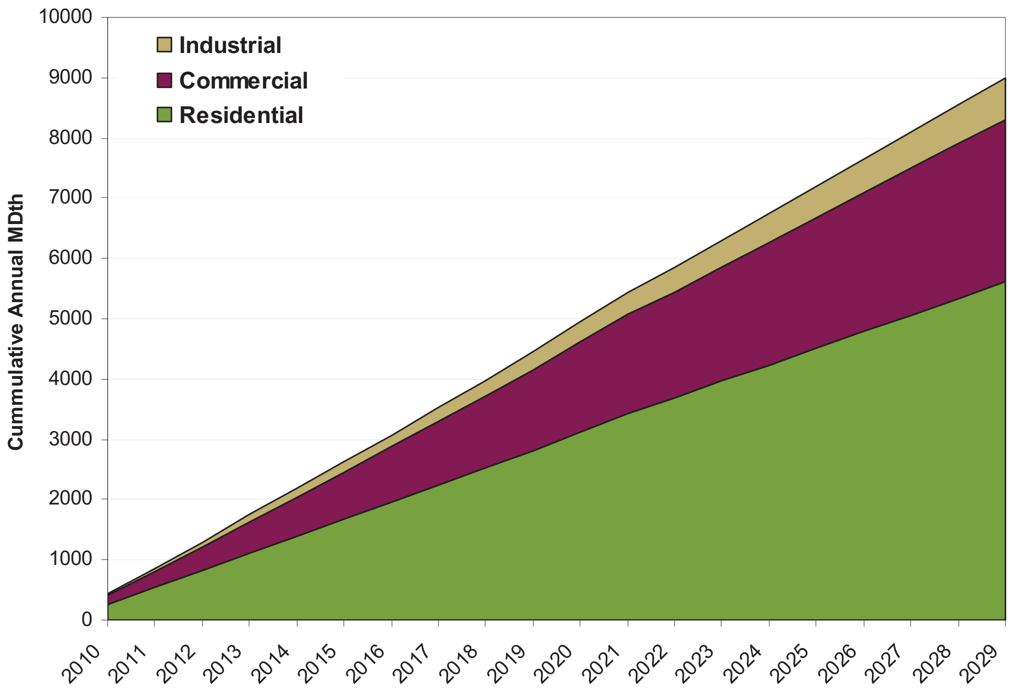
The 2009 Gas Sales Resource Plan includes about 3,600 MDth of demand-side resource savings by 2017 at an annual rate of 450 MDth per year, which translates to peak capacity savings of approximately 40 MDth per day. This is consistent with the level reflected in the SENDOUT optimization analysis for the 2009 Trends scenario up to the year 2020; after that the plan has a slightly lower acquisition rate. The 450 MDth annual rate represents a significant increase over PSE's current acquisition rate of approximately 350 MDth per year. We are not confident that PSE could achieve more on an annual basis, especially in the next few years, given current marketplace constraints. In the plan, DSR peak capacity additions were reduced consistent with the achievable annual volumes noted above, and Westcoast/Northwest Pipeline capacity was increased by corresponding amounts. Figure 8-22 below shows the difference in annual savings between the results modeled in SENDOUT and the resource plan.

Figure 8-22
Cumulative Energy Savings: SENDOUT vs. Gas Sales Resource Plan



The demand-side resources in the plan include contributions from every customer segment, as Figure 8-23 illustrates.

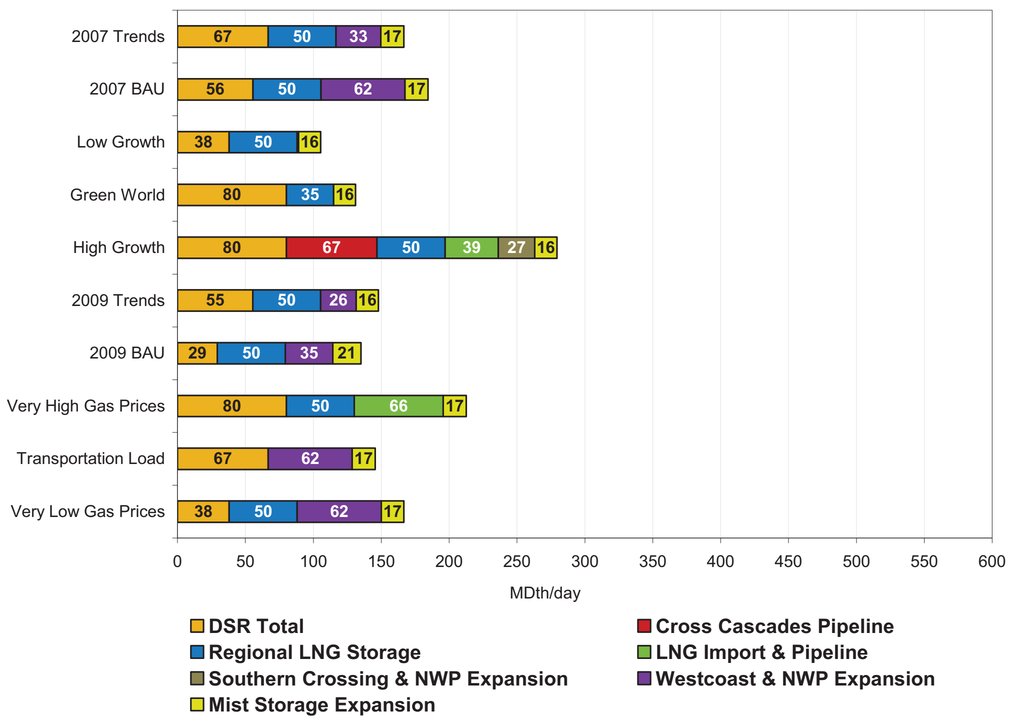
Figure 8-23
Customer Segment Contributions to DSR



Regional LNG Storage

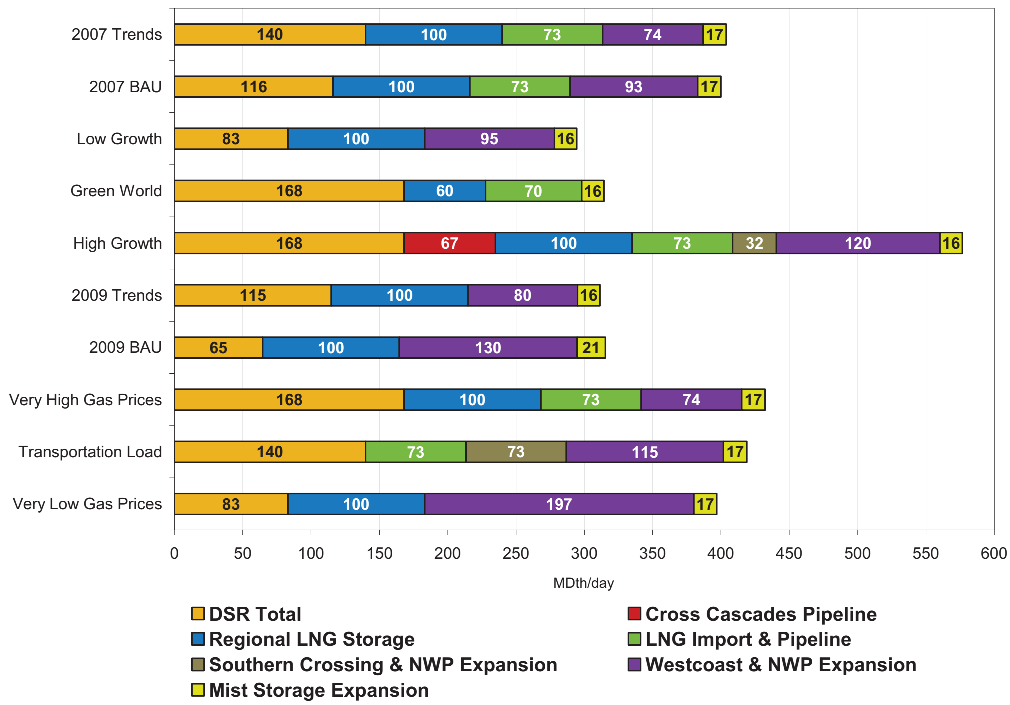
The gas sales plan includes 50 MDth per day of regional LNG storage capacity in 2017, and an additional 50 MDth per day of capacity appeared to be a least cost resource addition by 2022. (If a major Rockies pipeline expansion were developed, these resources would most likely not be required.) Addition of the first 50 MDth of LNG storage in 2017 is a robust decision across the analysis. Figure 8-24 illustrates that this alternative was selected as part of the least cost portfolio in nearly every planning scenario. The Monte Carlo analysis described in Chapter 6 also demonstrated that this alternative was part of the least cost portfolio in 90% of the cases tested.

Figure 8-24
Gas Sales Resource Additions in 2020



Further ahead in the planning horizon, an additional 50 MDth of LNG storage is included, for a total of 100 MDth by the end of the planning period. Again, this appears to be a robust least cost resource addition across the various planning scenarios, as Figure 8-25 illustrates.

Figure 8-25
Gas Sales Resource Additions in 2029



Westcoast and Northwest Pipeline Expansion: Northern B.C. Gas Supply

The gas sales plan calls for a 30 MDth per day expansion of Westcoast/Northwest pipeline capacity in 2017, and an additional expansion of 32 MDth per day around 2026. Smaller, incremental expansions along this route appear more feasible than expansion to the Rocky Mountain basin at this time. Figure 8-25, above, illustrates that the addition of 30 MDth per day of capacity is a robust decision across the various planning scenarios. Notice that several of the portfolios that do not include this alternative also model demand-side resources at significantly higher annual penetration rates than PSE believes it can count on achieving. Monte Carlo results for the 2009 Trends scenario indicate that this alternative is selected in about 53% of the draws by December 2017.

Mist Storage and Pipeline Capacity

A relatively small amount of Mist storage and Northwest Pipeline transportation capacity – 16 MDth per day – is included in the gas sales plan. Figure 8-25, above, illustrates that a small amount of Mist would be part of the least cost portfolio in every planning scenario.

Alternatives Not Included in Gas Sales Plan

Although not included in the plan, three resources were shown to be least cost in some planning scenarios. They include: the addition of Cross Cascades pipeline capacity that would increase access to supplies in the Rocky Mountain basin; imported LNG with related Northwest pipeline capacity; and the Southern Crossing and related Northwest pipeline capacity. The company chose to follow the least cost analysis guidance for the 2009 Trends scenario with regard to these resources. The following briefly explains why they were excluded:

Cross-Cascades/Rockies Expansion. Supply diversity is a concern; however, analysis in this IRP did not fully explore the value of expanded access to the Rockies basin. PSE will continue to quantify the costs and benefits associated with such diversity and may adapt resource strategies if the company is able to make the assessment that a major Rockies expansion would be lowest reasonable cost.

Import LNG and Northwest Pipeline Expansion. This alternative does appear to be least cost in several of the planning scenarios shown in Figures 8-24 and 8-25, but the timing of the addition is sufficiently distant that we can wait to see if an LNG import facility becomes commercially operational, and whether natural gas prices will make this a cost-effective resource. So far, pricing assumptions in 2009 updates do not support such a judgment. PSE will continue to monitor market developments.

Southern Crossing and Northwest Pipeline Expansion. Similar to the Rockies pipeline expansion, this resource was only selected in scenarios that assumed high growth rates and when assumptions about other resource expansions had been met. This alternative would not provide as much supply diversity benefit as expansion to the Rockies.

Discussion of Combined Gas Resource Plan Decisions

The rationale for the development of the combined gas resource plan is very similar to the rationale for the gas sales plan. Since both plans incorporate the same gas price forecasts, and since these prices largely determine the delivered cost of gas, the same optimal level of DSR was selected for both plans. As a result, the same reduction in DSR acquisitions and equivalent increase in Westcoast/NWP pipeline capacity (15 MDth per day) were made as in the gas sales portfolio.

For the combined plan, a second change was made to the optimal SENDOUT results based on the final electric resource plan. Total CCCT generating plant additions were reduced from 1,375 MW to 1,100 MW, as shown in Figure 8-26, which reduces the amount of peak day gas required by about 47 MDth per day. This change occurs after 2020, and reduces Westcoast/NWP capacity at the same time.

Figure 8-26
Combined Portfolio Resource Additions
2009 Trends vs. Resource Plan

2009 Trends	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012		50	50	14
2017	50	129		26
2022	50	19		27
2026		144		26
2029				22
Total Additions	**100**	**342**	**50**	**115**

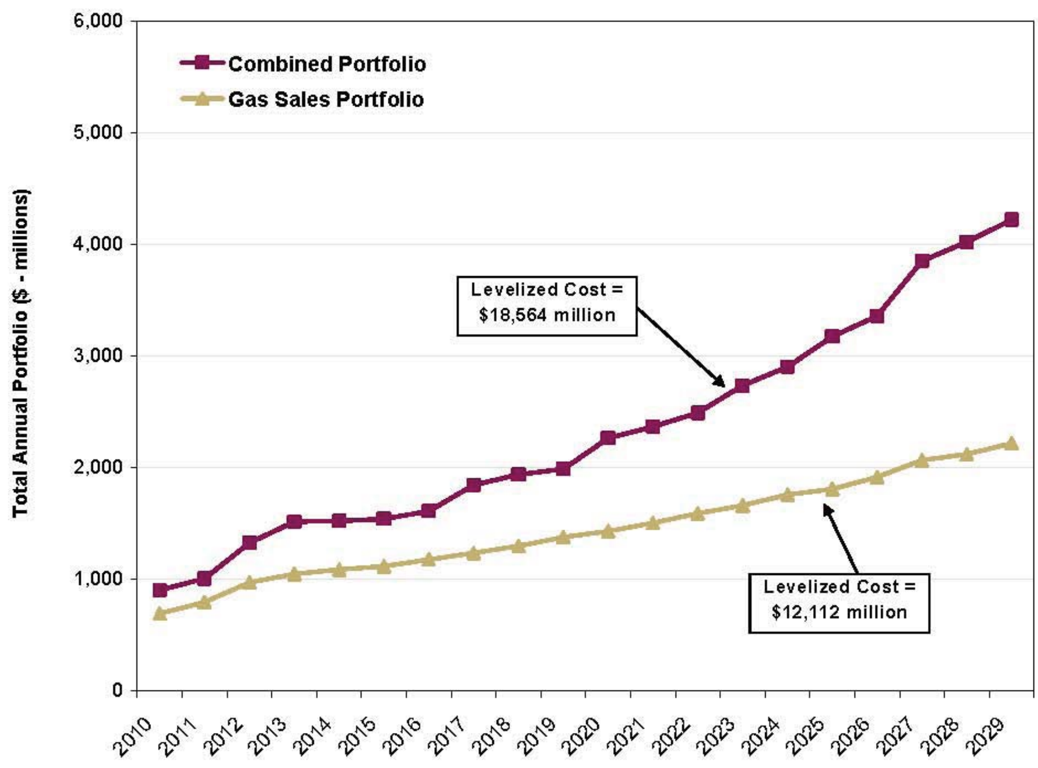
Resource Plan	Additions in MDth/day			
	Regional LNG Storage	Westcoast/NWP	Mist Storage & Pipeline	DSR
2012		50	50	14
2017	50	129		26
2022	50	20		26
2026		111		20
2029				14
Total Additions	**100**	**310**	**50**	**100**

As with the gas sales analyses, the regional LNG storage and Mist Storage alternatives were robustly selected in almost all scenarios for the combined gas plan.

Additional Considerations: Costs

Figure 8-27 illustrates the total annual costs and 20-year net present values (NPVs) of the portfolios in the 2009 Gas Sales and Combined Gas Resource Plans. Note that the costs for generation fuel are included in the electric resource plan as well.

Figure 8-27
Total Costs for 2009 Gas Sales and Combined Gas Portfolios



Action Plans

One of PSE's main objectives is to pursue acquisition of both demand- and supply-side resources that will accrue long-term benefits to our customers. The short-term, two-year electric and gas plans presented in sections I and II of this chapter outline specific actions for implementing the long-range integrated resource plans discussed in this 2009 IRP. Section III reports on the efforts PSE has made to address the Action Plan items developed in the 2007 IRP.

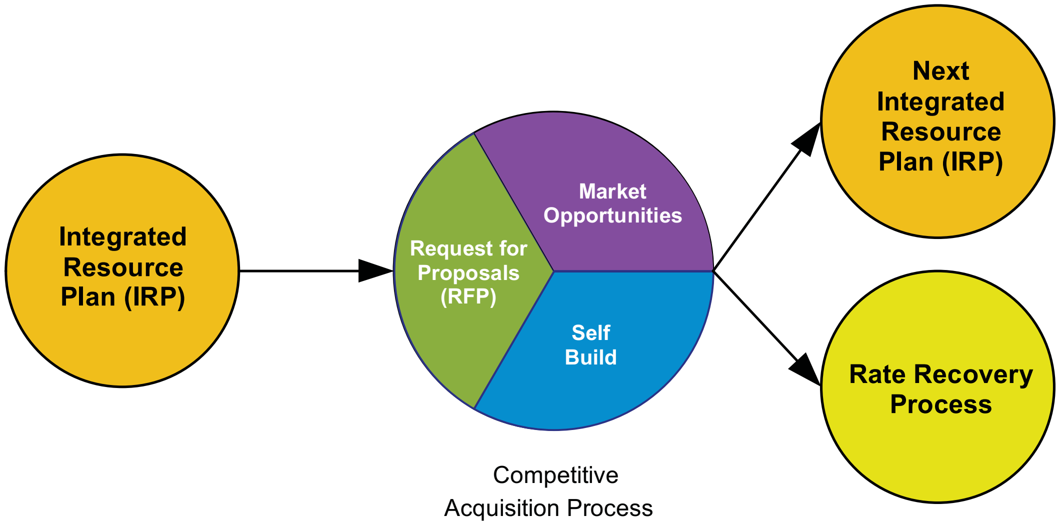
Developing the Integrated Resource Plan is an important process that gives PSE a structured opportunity to:

- *Think Broadly.* To consider different futures and understand implications those different futures might have on alternative resource strategies.
- *Consider Different Perspectives.* To obtain input from stakeholders that have a variety of experienced, informed perspectives about long-term energy markets, environmental issues, and other issues related to resource planning.
- *Make Reasoned Judgments.* To combine robust quantitative analysis and non-quantitative factors (reasoned qualitative analysis) into clear, well-supported conclusions that will help meet customer demands at the lowest reasonable cost.
- *Inform the Resource Acquisition Process.* To develop and refine analytical approaches and information that will assist the resource acquisition processes.
- *Communicate.* To describe the market conditions we face, and our thinking about the implications these conditions have for the resource decisions that must be made.

In some states, integrated resource planning is nearly synonymous with resource acquisition analysis. In Washington state, the IRP informs the acquisition processes rather than simply providing a shopping list of resources to acquire. Analysis in this IRP relies on generic resources to explore strategic issues, such as natural gas supply diversity. The resource acquisition process employs specific information about specific resources. The primary function of the IRP, beyond simply meeting regulatory requirements, is to inform our resource acquisition process.

Figure 9-1 illustrates the relationship between the IRP and activities related to resource acquisitions. Specifically, the chart shows how the IRP directly informs the formal RFP process. In Washington, the formal RFP process for demand-side and supply-side resources is just one source of information for making acquisition decisions. Market opportunities outside the RFP and self-build (or PSE demand-side resource programs) must also be considered when making prudent resource acquisition decisions. Figure 9-1 also illustrates how the resource acquisition process itself informs subsequent IRPs. As shown below, the IRP's primary purpose is to inform the acquisition process; it is not a substitute for the resource-specific analysis done to support specific acquisitions.

Figure 9-1
Relationship between the IRP and the Acquisition Process



I. 2009 Electric Resources Action Plan

The conclusions drawn from this IRP analysis support the following actions with regard to electric resources.

Assessment of Resource Needs

The 2009 IRP illustrates that PSE is relying on 1,200 MW of short-term market resources (less than three years in duration) to meet approximately 20% of our customers' resource needs. As the region becomes increasingly capacity constrained, physical liquidity of short-term market will become more of a concern. During the two-year action plan, we will focus efforts on assessing whether this level of reliance on short-term markets should be revised. Additionally—and in light of our reliance on short-term markets—we will continue to refine the resource need assessment pertaining to the 5% loss of load probability and interaction of operating and planning reserve margins.

Demand-side Resources

PSE will plan and implement electric demand-side resource programs, mainly energy efficiency programs, consistent with the guidance provided in this plan. Electric energy efficiency targets and programs will also be established to comply with the requirements of the Washington Energy Independence Act, RCW 19.285. We will work with external stakeholders in the Conservation Resource Advisory Group (CRAG) process to develop program goals, targets, and tariff filings to implement this strategy. Such processes will rely on updated avoided cost inputs and more specific assessments of achievability based on specific programs that are designed.

Wind and Other Renewables

PSE will continue working toward meeting our obligations under Washington's renewable portfolio standard. We will continue to implement strategies of moving deeper into the development process for renewables. Additionally, we will continue to remain active in exploring cost-effective opportunities as they appear during the formal RFP process and other market opportunities that may present themselves.

Thermal Resources

PSE will look to fill the remaining resource needs with a combination of purchased power agreements and/or natural gas-fueled power plants: peakers and combined cycle combustion plants. Our goal will be to meet resource needs through the formal RFP process, seek opportunities to acquire resources through bilateral negotiations, and consider self-build natural gas alternatives. PSE will also actively monitor and participate in policy, regulatory, and technology developments affecting the viability of new resources.

II. 2009 Natural Gas Resources Action Plan

The conclusions drawn from this IRP analysis support the following actions with regard to natural gas resources:

Gas Demand-side Resources

PSE will plan and implement natural gas demand-side resource programs consistent with the guidance provided in this plan. We will work with external stakeholders in the CRAG process to develop program goals, targets, and tariff filings to acquire cost effective and achievable energy efficiency savings. Such processes will rely on updated avoided cost inputs and more specific assessments of achievability based on specific programs that are designed.

Diversity of Supply Considerations and Pipeline Expansions

PSE is currently exposed to a single supply basin for the majority of its natural gas supplies, a situation that places the company and its customers in a position of physical supply and price risk. A thorough investigation into the benefits of such a strategy needs to take place, so that PSE may evaluate the costs and benefits of increasing supply diversity in a comprehensive way.

Regional LNG Storage

PSE will continue working with others in the region to identify and more fully define regional LNG peaking opportunities. This will entail exploring whether the needs identified in the gas resource plan can be met by expansion of existing facilities in the region. PSE also will include initial activity to begin assessing development of self-build alternatives.

III. Report on 2007 Electric Resource Action Plan

This section reviews the efforts PSE has made to address the Action Plan items developed in our 2007 Electric IRP.

Demand-side Resources

PSE will work toward significantly increasing our electric demand-side resource programs, mainly energy efficiency programs. We will work with external stakeholders in the CRAG process to develop program goals, targets, and tariff filings to implement this strategy. Our processes will rely on updated avoided cost inputs and more specific assessments of achievability based on specific programs that are designed.

Report: Completed. The company hosted several CRAG meetings that helped develop goals, targets and regulatory filings. Consistent with the guidance provided in the 2007 IRP, PSE increased our energy efficiency savings targets in 2008-09 over the previous two year period. Electric energy efficiency targets increased 32%, from a total of 40 aMW for 2006 and 2007 to a total of 53 aMW for the 2008 and 2009 plan years. We expect to exceed the 2008-09 program targets. PSE had an incentive to increase our acquisition of demand-side resources through the Electricity Conservation Incentive Mechanism. The Washington Utilities and Transportation Commission (WUTC) approved this mechanism in Docket No. UE-060266, by replacing the penalty-only structure with a new penalty-and-reward mechanism. In addition to our energy efficiency programs, we also introduced a single-family residential electric-to-gas fuel conversion program and commercial and residential direct load control demand response pilots.

Wind and Other Renewables

PSE will continue working toward meeting obligations under Washington's renewable portfolio standard. We will develop and begin implementing strategies to move deeper into the development process for renewables. Additionally, we will continue to remain active in exploring cost-effective opportunities as they appear during the formal RFP process and to other market opportunities that may present themselves.

Report: Completed. The company executed a Joint Development Agreement with RES to build, construct, own and contract wind generation in Columbia and Garfield Counties, moving deeper into the development process. We entered into the Klondike 3 wind purchased power agreement through the 2007 RFP process, we completed the in-fill project at Hopkins Ridge, adding four turbines and increasing the nameplate capacity of the facility by 7 MW, and we initiated the Wild Horse expansion project which will add 22 turbines and increase the nameplate capacity of the facility by 44 MW.

Base Load/Thermal Resources

PSE will take an opportunistic approach to filling the remaining resource needs with a combination of purchased power agreements and/or natural gas-fueled power plants. We will look to meet resource needs through the formal RFP process, seek opportunities to acquire resources through bilateral negotiations, and consider self-build natural gas alternatives. PSE will also actively monitor and participate in policy, regulatory, and technology developments affecting the viability of new coal resources.

Report: Completed. PSE has acquired, or extended contracts to retain, or is proceeding with the acquisition of, additional resources. These include: (i) short-term and long-term purchased power agreements (PPA), including a four-year winter PPA agreement with Barclays Bank PLC, a four-year and three-month PPA with Credit Suisse to replace a PPA executed with the now bankrupt Lehman Brothers PPA, a five-year PPA extension with Puget Sound Hydro LLC, and a four-year winter on-peak PPA with Powerex; (ii) the acquisition of the Mint Farm Generating Station from Wayzata Investment Partners; (iii) the acquisition of the Fredonia Generating Units No. 3 and No. 4, which PSE currently leases; (iv) the lease buyout of Whitehorn units 2 and 3; and (v) the acquisition of the Sumas Cogeneration Facility.

IV. Report on 2007 Gas Resource Action Plan

This section reviews the efforts PSE has made to address the Action Plan items included in the our 2007 Natural Gas IRP.

Gas Demand-side Resources

PSE is looking for opportunities to increase our gas programs where it is feasible. We will work with external stakeholders in the CRAG process to develop program goals, targets, and tariff filings to acquire cost effective and achievable energy efficiency savings. Such processes will rely on updated avoided cost inputs and more specific assessments of achievability based on specific programs that are designed.

Report: Completed. PSE hosted several CRAG meetings that helped develop goals, targets and regulatory filings. Consistent with the guidance provided in the 2007 IRP, PSE increased our energy efficiency savings targets in 2008-09 over the previous two year period. Gas energy efficiency targets rose 26%, from 4.2 million therms for 2006-07 to 5.3 million therms for 2008-09. The company expects to exceed the 2008-09 program targets.

Capacity Alternatives

PSE will continue working with others in the region to identify and more fully define regional LNG peaking opportunities. We will also continue to monitor transportation capacity alternatives that are tied to potential regional LNG import facilities. Additionally, we will monitor potential pipeline alternatives that could increase supply diversity.

Report: Completed. The company engaged in dialogue with others in the region regarding several specific potential capacity alternatives. As demonstrated by analysis in this 2009 IRP, a considerable effort has been made to identify and analyze commercially viable alternatives to balance the portfolio's access to Rockies gas supply.

Supply Alternatives: Imported LNG

PSE will work with other regional market participants to help determine if an LNG import facility in the region would be commercially viable, cost effective, and otherwise desirable for the market. If so, we will take reasonable actions to help encourage and/or participate in such development to benefit our customers.

Report: Completed. The company continued participating in regional dialogue with regard to potential LNG import facilities to assess the availability of long-term gas supply contracts with potential suppliers, if an import terminal is developed in the Northwest. Such market opportunities have not been available.

Generation Fuel Planning

Increasing reliance on natural gas-fired generation creates issues, some of which may be quite different than concerns for meeting needs of gas sales customers. PSE will define and prioritize these issues, develop plans for investigating potential solutions, and commence implementation of such solutions as appropriate. We will discuss such activity with our IRPAG members and other stakeholders to the extent that such discussions do not compromise our ability to achieve commercial benefits for our customers.

Report: Completed. PSE acquired two natural gas capacity resources to support generation fuel. We purchased the equivalent of 25,500 decatherms (Dth) per day of Westcoast Energy T-South pipeline capacity commencing November 1, 2009 through October 31 2018, with renewal rights, to serve a portion of its gas-fired generation fleet. PSE purchased Northwest Pipeline (NWP) transportation capacity to serve Mint Farm. Generation fuel planning was integrated more closely in this planning cycle than in the past. Diversity of supply analysis presented in Chapter 6, and discussed with the IRP Advisory Group, highlighted the potential timing issues of joint planning and capacity acquisitions.

Key Definitions and Acronyms

Abbreviation	Meaning
ACQ	annual contract quantities
AECO	gas hub in Alberta, Canada
AFUDC	allowance for funds used during construction
AIM	Area Investment Model, used to calculate financial performance indicators for projects
AMR	Automated Meter Reading
aMW	The average number of megawatt-hours (MWh) over a specified time period; for example, 295,650 MWh generated over the course of one year equals 810 aMW (295,650/8,760 hours).
ANOPR	advance notice of proposed rulemaking
ATC	available transmission capacity
AURORA	One of the two models PSE uses for integrated resource planning, which uses the western power market to produce hourly electricity price forecasts of potential future market conditions
BA	Balancing Authority, the area operator that matches generation with load
BACT	best available control technology (required of new power plants and those with major modifications)
BcF	billion cubic feet
BEF	Bonneville Environmental Foundation
BPA	Bonneville Power Administration
CAISO	California Independent System Operator
CAMR	clean air mercury rule (requires that coal plants reduce at least 30% of their mercury emissions by 2010, and at least 70% by 2018)
CCCT	combined cycle combustion turbines (see Appendix D)
CCS	carbon capture and sequestration
CCX	Chicago Climate Exchange
CDD	Contract Daily Demand
CDEAC	Clean and Diversified Energy Advisory Committee formed by the WGA to identify incentive-based, non-mandatory recommendations that would facilitate 30,000 megawatts of new clean and diverse energy by 2015, a 20% increase in energy efficiency by 2020 and adequate transmission for the region)
CFB	circulating fluidized bed (see FB)
CHP	combined heat and power plant (a more efficient use of non-renewable generation units because the CHP unit captures waste heat and uses it)
C/I	commercial/industrial
CLX	PSE's customer service information system
COE	U.S. Army Corps of Engineers

Abbreviation	Meaning
CNG	compressed natural gas
CPUC	California Public Utility Commission
CRAG	Conservation Resource Advisory Group
C&RD	BPA's conservation and renewables discount
CRO	contingency reserve obligation
CTED	Washington State Department of Community, Trade & Economic Development
CVR	conservation voltage reduction
DER	distributed energy resources
DETM	Duke Energy Trading and Marketing
DG	distributed generation. Small modular, decentralized, grid-connected or off-grid energy systems located near where energy is used
DIMP	Distribution integrity management program implemented by the Pipeline and Hazardous Materials Safety Administration
DOE	Department of Energy
DP	distributed power
DR	demand response (see Appendix D)
DR	district regulators
DSM	Demand Side Management
EA	environmental assessment
EFP	exchange for physical
EIA	U.S. Energy Information Agency
EITF	Emerging Issues Task Force (see Appendix F, section B)
EO	Executive Order (of Governor Christine Gregoire outlining goals for addressing climate change)
EPA	Energy Policy Act
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ERO	Electric Reliability Organization
ESP	electrostatic precipitator
EV	expected value (see Appendix J, section B)
FASB	Financial Accounting Standards Boards (see Appendix F, section B)
FB	fluidized bed (technology that mixes coal and an inert bed material such as sand in a combustor or boiler)
FEED	Front End Engineering Design (a study to develop the design envelope for IGCC; see IGCC section in Appendix D)
FEIR	Final Environmental Impact Report (filed by Cape Wind offshore wind farm)
FERC	Federal Energy Regulatory Commission
FF	fabric filter
GCM	general circulation models
GDP	gross domestic product
GHG	greenhouse gas
GP	Georgia Pacific
GTG	gas turbine generator (see CCTC section of Appendix D)
GTN	Gas Transmission Northwest
HAP	hazardous air pollutants

Abbreviation	Meaning
HC	Hadley Centre (model used to calculate hydro availability change)
HDD	heating degree days
HELM	Hourly electric load model (used to develop a 2002 demand profile, which was replaced by PSE's hourly load profile of electric demand). See Appendix H, section 3.
HP	high-pressure
HRSG	heat recovery steam generator (see CCCT section of Appendix D)
HVAC	heating, ventilation and air conditioning
I-937	Washington state's renewable portfolio standard (RPS), a citizen-based initiative codified as RCW 19.285, aka. the Energy Independence Act
ICNU	Industrial Customers of Northwest Utilities
iDOT	Investment Optimization Tool to identify a set of projects that will create maximum value
IEEE	Institute of Electric and Electronic Engineers
IGCC	integrated gasification combined cycle (generally refers to a model in which syngas from a gasifier fuels a combustion turbine to produce electricity, while the combustion turbine compressor compresses air for use in the production of oxygen for the gasifier)
IP	intermediate pressure
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent power producers
IRP	Integrated Resource Plan
IRPAG	Integrated Resource Plan Advisory Group
ISO	independent system operator
JISAO	Joint Institute for the Study of Atmosphere & Ocean
JP	Jackson Prairie
KWh	kilowatt hours
LCP	least cost plan (IRP)
LCPAG	Least Cost Plan Advisory Group (IRPAG)
LDC	local distribution company
LFG	landfill gas
LNP	liquefied natural gas
LOLP	loss of load probability
LP	linear program (see Appendix J, section A)
LP-Air	vaporized propane air
L/R Bal	load/resource balance (demand/availability)
MCFC	molten carbonate fuel cells
MDQ	maximum daily quantity
MEPA	Massachusetts Environmental Policy Act
MPI	Max Plank Institute Model
MSW	municipal solid waste
MUST	Managing & Utilizing System Transmission
MW	megawatt
MWh	megawatt hours
NAAQS	National Ambient Air Quality Standards (set by the EPA, which

Abbreviation	Meaning
	enforces the Clean Air Act, for six criteria pollutants: sulfur oxides, nitrogen dioxide, particulate matter, ozone, carbon monoxide and lead)
NARUC	National Association of Regulatory Utility Commissions
NAS	National Academy of Sciences
NCEP	National Commission on Energy Policy
NEEA	Northwest Energy Efficiency Alliance
NERC	North American Electric Reliability Council
NGCC	natural gas combined cycle
NOS	Network Open Season, a BPA transmission planning process
NPCC	Northwest Power and Conservation Council
NPP	nuclear power plant (a thermal power station in which the heat source is one or more nuclear reactors)
NRDC	National Resources Defense Council
NREL	National Renewables Energy Laboratories
NSPS	new source performance standards (new plants and those with major modifications must meet these EPA standards before receiving permit to begin construction)
NTAC	Northwest Transmission Assessment Committee (established in 2003 to approach transmission issues from a perspective influenced by both commercial and reliability needs)
NUG	nonutility generator
NWIGU	Northwest Industrial Gas Users
NWP	Northwest Pipeline (only pipeline directly to west WA)
NWPCC	Northwest Power Planning & Conservation Council
NWPP	Northwest Power Pool
NWS	BPA's None-wire Solutions Roundtable
NYMEX	New York Mercantile Exchange
OASIS	Open Access Same-Time Information System
OPS	Office of Pipeline Safety
OSU	Oregon State University
P	probability
PAFC	phosphoric acid fuel cells
PBA	power bridging agreement (designates PPAs that bridge the period until long-lead resources or transmission can be developed)
PC	pulverized coal (technology that grounds coal into fine powder that is mixed with air and blown into the boiler furnace to be burned)
PCA	power cost adjustment (electric)
PCORC	power cost only rate case
PEM	proton exchange membrane fuel cells
PFBC	pressurized fluid bed combustion (the boiler uses FB technology at elevated operating pressures to produce heat for steam production and pressurized gas to drive a gas turbine)
PGA	purchased gas adjustment
PG&E	Pacific Gas & Electric
PGE	Portland Gas Electric
PGSS	peak gas supply service

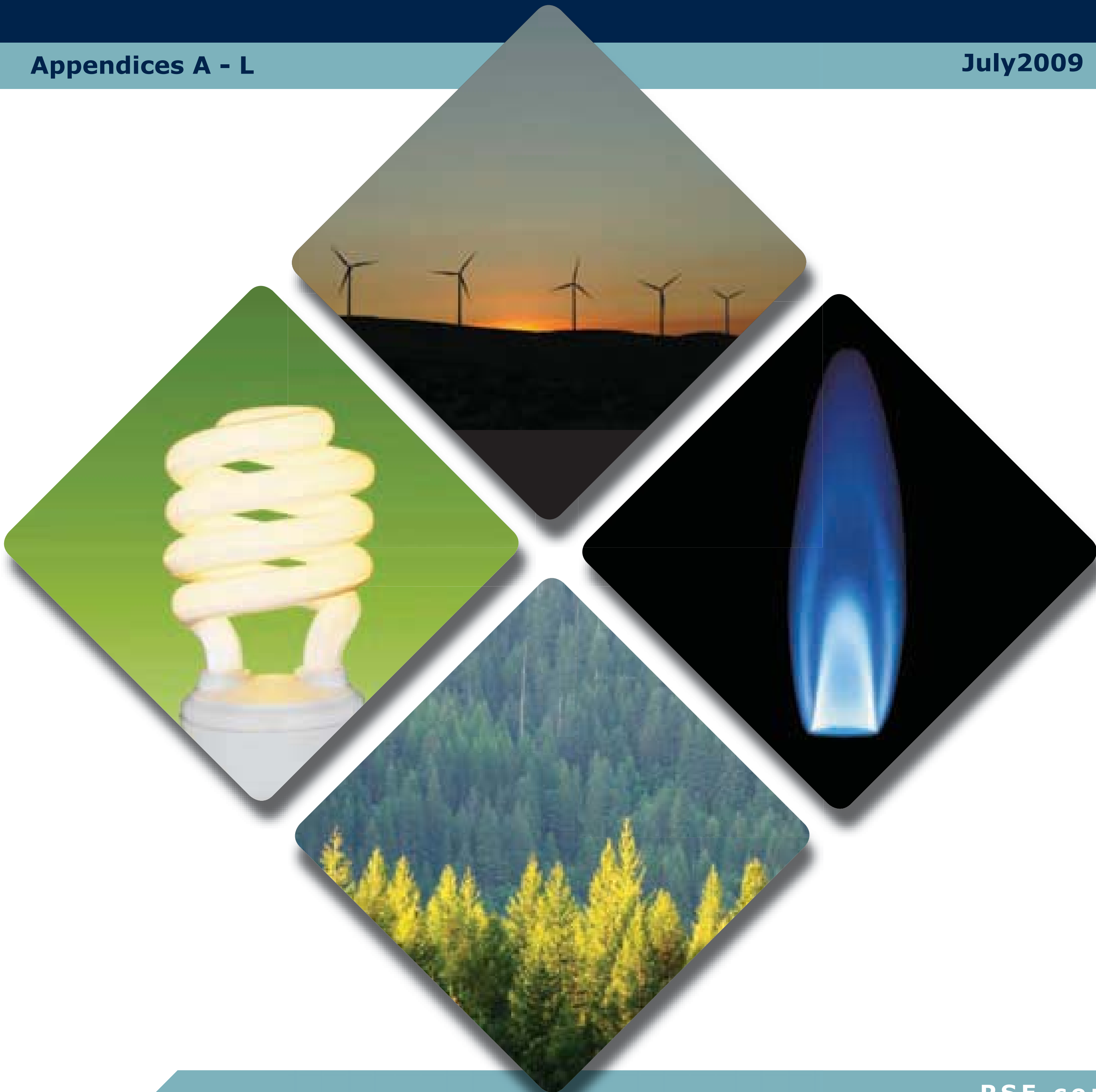
Abbreviation	Meaning
PHMSA	Pipeline & Hazardous Materials Safety Administration
PM	particulate matter
portfolio	specific mix of generic power resources
PPA	purchased power agreement (a bilateral wholesale or retail power short term or long term contract, wherein power is sold at either a fixed or variable price and delivered to an agreed-upon point).
PPM	parts per million
PSE	Puget Sound Energy
PSIA	Pipeline Safety Improvement Act
PSIG	pounds per square inch gauge
PSM	portfolio screening model (one of the two models PSE uses for integrated resource planning, which tests electric supply and demand portfolios to evaluate PSE's long-term revenue requirements for incremental portfolio)
PTC	production tax credit
PTI	Power Technologies, Inc.
PUD	public utility district
PV	photovoltaic
RCW 19.285	Washington state's renewable portfolio standard (RPS), aka. the Energy Independence Act
REAP	Renewable Energy Advantage Program
REC	renewable energy credit
RFP	request for proposal
RGGI	Regional Greenhouse Gas Initiative; a cooperative effort between northeast states mandating electric utility emissions reductions
RMATS	Rocky Mountain Area Transmission Study (see Appendix E)
RPS	renewable portfolio standard (mandates 3% renewables by 2012, 9% by 2016 and 15% by 2020))
RTO	regional transmission organization
SCADA	supervisory control and data acquisition
SCCT	Simple cycle combustion turbine (see Appendix D, section C)
scenario	consistent set of data assumptions to define a specific future; takes holistic approach to uncertainty analysis
SCGT	simple cycle gas turbines
SCPC	super critical pulverized coal (see PC)
SENDOUT	PSE's model used to help identify the long-term least cost combination of gas resources to meet stated loads.
SOFC	solid oxide fuel cells
STG	steam turbine generator (see Appendix D)
TCPL-Alberta	TransCanada's Alberta System
TCPL-British Columbia	TransCanada's British Columbia System
TCWG	Transmission Coordination Work Group, a WECC committee of project sponsors whose purpose is to coordinate planning studies and project communications
T&D	transmission and distribution
TIG	Transmission Issues Group

Abbreviation	Meaning
TRC	total resource cost
UCPC	ultra critical pulverized coal (see PC)
UPC	use per customer
USEIA	U.S. Energy Information Agency
VectorGas	facilitates the ability to model price and load uncertainty
WCSB	Western Canadian Sedimentary Basin
WECC	Western Electric Coordinating Council
WGA	Western Governors' Association (see Appendix E)
WOMR	West of McNary Reinforcement, a proposed transmission project
WUTC	Washington Utilities and Transportation Commission

Integrated Resource Plan

Appendices A - L

July2009



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Appendices

2009 Integrated Resource Plan

Public Participation

PSE is committed to public involvement in the planning process. Stakeholder meetings have generated valuable constructive feedback, and the suggestions and practical information we received from both organizations and individuals has helped to guide the development of this 2009 IRP. We wish to thank all who participated.

At the time this plan was filed with the Washington Utilities and Transportation Commission (WUTC), the following meetings had taken place: nine formal Integrated Resource Plan Advisory Group (IRPAG) meetings, ten Conservation Resource Advisory Group (CRAG) meetings, and dozens of informal meetings and communications. Stakeholders who actively participated in one or more meetings include WUTC staff, Public Counsel, Northwest Industrial Gas Users, Northwest Pipeline, conservation and renewable resource advocates, the Northwest Power and Conservation Council, project developers, other utilities, and the Washington State Department of Community, Trade and Economic Development (CTED).

This appendix briefly describes the purpose of the IRPAG and CRAG, and summarizes the formal meetings held to date. We especially want to thank those who attended these meetings, for both the time and energy they invested, and we encourage their continued participation. The IRPAG covers all elements of the IRP, while the CRAG focuses on energy efficiency and demand-side resources. While these two groups meet separately, they have many members in common.

I. Integrated Resource Planning Advisory Group (IRPAG)

PSE works with external stakeholders through an informal group called the IRPAG. The IRPAG is the primary means of satisfying the requirements of WAC 480-100/90-238 for public involvement. During the development of the 2009 IRP, PSE engaged the IRPAG in two ways: through a series of structured IRPAG meetings, and in individual discussions with various IRPAG members.

As part of the formal IRPAG meetings, we presented and discussed each building block in developing the IRP, often stepping through significant levels of detailed analysis. Other PSE departments were also invited to talk about topics of interest, such as the

2008 Request for Proposals (RFP) process and the Wild Horse Wind and Solar Facility. IRPAG meetings are open to all comers, including individual customers and other utilities.

In addition to the more structured IRPAG meetings, PSE spoke one-on-one with individual IRPAG members. These conversations were very productive, allowing a freer flow of ideas that would have been difficult to achieve in group settings. The combination of one-on-one discussions and group meetings was particularly helpful in generating feedback.

Discussions with IRPAG members provide new avenues for broadening the scope of information available to us in our planning process. Additionally, these interactions enhance our thinking by bringing a variety of perspectives to the process. We've found the IRPAG process to be valuable, and will continue to work toward improving upon this success.

II. Conservation Resources Advisory Group (CRAG)

The CRAG was formally established as part of the settlement of PSE's 2001 General Rate Case, which the WUTC approved in Docket No. UE-11570 and UG-011571. The group specifically works with PSE on development of energy efficiency plans, targets and budgets. The CRAG consists of ratepayer representatives, regulators, and energy efficiency policy organizations, including the following stakeholder groups:

- WUTC staff
- Public Counsel, Attorney General's Office
- Industrial Customers of Northwest Utilities (ICNU)
- Northwest Industrial Gas Users (NWIGU)
- NW Energy Coalition and Natural Resources Defense Council
- Energy Project (representing Low Income Agencies)
- Washington State Department of Community, Trade and Economic Development
- Customer representatives from commercial, industrial and institutional sectors (Microsoft, Kemper Development, King County)

The CRAG participated in the development of the 2009 IRP and energy efficiency program review through formal meetings in which it reviewed and offered feedback on the assessment of all demand-side resources (energy efficiency, fuel conversion, and demand response). The CRAG is also instrumental in reviewing IRP guidance to develop PSE's biennial energy efficiency targets and programs, as well as to review our progress toward achieving those targets. Many members participated in other aspects of the IRP advisory process as well.

No significant concerns about the 2009 IRP demand-side potential results have been expressed. Issues with the highest level of interest included avoided costs and the rationale and assumptions used to estimate achievable resource potential. Looking ahead, the CRAG will likely focus on how 2009 IRP results are factored into demand-side savings targets, and programs and budgets for 2010–2011, particularly with respect to compliance with I-937, the Washington Energy Independence Act (RCW 19.285).

III. Summary of IRPAG and CRAG Meetings

A. CRAG Meeting, May 9, 2007

This meeting primarily involved a discussion of the 2008 to 2009 program planning cycle. Topics included the planning and tariff filing process schedule, key issues (such as the IRP) and other considerations identified by the CRAG.

B. CRAG Meeting, June 29, 2007

This meeting involved a more comprehensive discussion of 2007 IRP guidance on energy efficiency and other demand-side resource potentials. Additionally, the CRAG considered ways to realistically translate this IRP guidance into programs.

C. CRAG Meeting, July 31, 2007

A discussion of the 2008 to 2009 biennial savings target and specific programs to achieve the target resulted in consensus agreement.

D. CRAG Meeting, September 19, 2007

The CRAG reviewed the detailed 2008 to 2009 program savings and budgets, and set a 2008 annual baseline target for the electric performance incentive.

E. CRAG Meeting, March 13, 2008

Topics for this meeting included a recap of 2006 to 2007 accomplishments, the derivation of program energy savings, and results for the 2007 electric performance incentive.

F. IRPAG Kick-off Meeting, April 3, 2008

The goals for this meeting were to re-introduce new and returning members of the IRPAG to the integrated resource planning process, share information about PSE's resource needs and alternatives, discuss WUTC staff feedback to the 2007 IRP, and describe changes to our planning tools and processes since the 2007 IRP. Updates included an overview of changes to our draft scenarios since the last plan and a description of the role of new modeling tools in the overall planning process.

G. IRPAG Meeting, June 19, 2008

This meeting began with a quick overview of PSE's resource needs and planning process, before moving into a discussion of PSE's draft planning scenarios, sensitivities, forecasted gas prices and carbon assumptions. Additional segments included an update from PSE's Acquisition team on the status of the 2008 RFPs, a discussion of PSE's planning standard, and an update on regional and federal efforts related to climate change legislation.

H. IRPAG Meeting, August 19, 2008

This meeting was held at the Wild Horse Wind and Solar Facility. The presentation included a discussion of Aurora assumptions and forecasts, and transmission updates related to the ten Northwest projects collectively known as the "Big Tent" projects and

BPA's Network Open Season. This was followed by a brief presentation about Wild Horse and a tour of the facility.

I. CRAG Meeting, September 2, 2008

Agenda items included updates related to the 2009 IRP, mid-year reports on programs and major projects, and a discussion of a proposed fuel conversion program.

J. IRPAG Meeting, October 2, 2008

PSE presented revisions to our electric planning scenarios, Aurora inputs and results, and a snapshot of various sensitivities to be tested in a "base case" scenario. The meeting concluded with a look at PSE's draft timeline for developing and filing the IRP.

K. IRPAG Meeting, November 20, 2008

This meeting began with a presentation of natural gas resources, beginning with an overview of pipeline, storage and LNG alternatives. PSE then presented a comparison of forecasted AECO, Henry Hub and world LNG levelized gas prices. The second half of the meeting was dedicated to a discussion of demand side resources (DSR). PSE presented a snapshot of the DSR analysis process, electric and gas energy efficiency supply curves, a summary of the DSR potential assessment performed by CADMUS, and a description of how PSE incorporates the product of this assessment into the overall resource planning process.

L. CRAG Meeting, November 20, 2008

The CRAG reviewed end-of-year projections for 2008 programs and the gas fuel conversion program tariff filing.

M. IRPAG Meeting, January 22, 2009

PSE began with an overview of the resource planning analysis process, and updates related to the electric and gas portfolio analyses. On the electric side, PSE shared key components of our electric planning scenarios, and presented sensitivities related to the

Green World, Business as Usual and Current Trends scenarios. PSE also discussed capacity and renewable needs, and presented snapshots of the resource builds for the eleven optimal portfolios identified by the Strategist optimization model.

On the gas side, PSE presented both our gas sales capacity need, and the combined gas sales and gas for generation capacity need. Additionally, a summary of the gas scenarios, an overview of gas resource alternatives and a comparison of gas capacity expansions by resource portfolio were presented.

N. CRAG Meeting, January 22, 2009

Topics included 2008 year-end program results, 2009 programs and proposed targets, evaluation of the 2007 to 2009 electric performance incentive mechanism, plans for extending the electric performance incentive beyond 2009 and adding a gas performance mechanism.

O. CRAG Meeting, February 24, 2009

PSE hosted a conference call to reach consensus on the final 2009 baseline electric efficiency target.

P. IRPAG Meeting, March 17, 2009

This meeting began with a discussion of PSE's intention to request a two-month filing extension with the WUTC. Primary drivers for this request were changes to gas prices and the economy since inputs were selected, load forecasts were run and modeling began. PSE presented a proposed revised timeline. Additional meeting topics included a presentation of updated load and gas price forecasts, as well as a progress report on our electric and gas analyses.

Q. IRPAG Meeting, April 23, 2009

This meeting was held at the Snoqualmie Operations Center. PSE provided a review of our planning assumptions and portfolios, and then launched a discussion of results and insights drawn from the planning process. Additionally PSE presented its recommended electric and gas plans. After the meeting, PSE provided a tour of the Snoqualmie Falls Hydroelectric Project.

R. IRPAG Meeting, June 25, 2009

Meeting topics included a discussion of the electric and gas resource plans, as well as updates to the plans and analysis since the release of the Draft IRP. The latter portion of the meeting was reserved for an open dialogue designed to solicit feedback from stakeholders.

S. CRAG Meeting, June 25, 2009

This meeting focused on reporting requirements related to 2008 savings (to obtain remaining 25% incentive), 2009 programs (to set up 2010-2011 planning) and major issues for 2010-2011 planning. Meetings to discuss 2010-2011 planning with two-year target setting, budget projections and program implementation details have been scheduled for July, August and September 2009.

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Legal Requirements

PSE is submitting this IRP pursuant to state regulations contained in WAC 480-100-238 regarding electric resource planning, and WAC 480-90-238 regarding natural gas resource planning. Tables B-1 and B-2 delineate the regulatory requirements for electric and natural gas integrated resource plans, and identify the chapters of this plan that address each requirement. Table B-3 addresses recommendations made by the Washington Utilities and Transportation Commission (WUTC) staff in a letter accepting PSE's 2007 IRP.

This IRP is the product of robust analysis that considered a wide range of future risks and uncertainties. PSE believes this plan meets applicable statutory requirements, and seeks a letter from the WUTC accepting this filing.

Figure B-1
Electric Integrated Resource Plan Regulatory Requirements

Statutory/Regulatory Requirement	Chapter
WAC 480-100-238 (3) (a) A range of forecasts of future demand using methods that examine the effect of economic forces on the consumption of electricity and that address changes in the number, type and efficiency of electrical end-uses.	• Chapter 4, Demand Forecasts
WAC 480-100-238 (3) (b) An assessment of commercially available conservation, including load management, as well as an assessment of currently employed and new policies and programs needed to obtain the conservation improvements.	• Chapter 5, Electric Resources • Appendix L, Demand-Side Resources Analysis
WAC 480-100-238 (3) (c) An assessment of a wide range of conventional and commercially available nonconventional generating technologies.	• Chapter 5, Electric Resources • Appendix F, Electric Resource Alternatives
WAC 480-100-238 (3) (d) An assessment of transmission system capability and reliability, to the extent such information can be provided consistent with applicable laws.	• Chapter 7, Delivery System Planning • Appendix G, Regional Transmission Resources

Statutory/Regulatory Requirement	Chapter
WAC 480-100-238 (3) (e) A comparative evaluation of energy supply resources (including transmission and distribution) and improvements in conservation using the criteria specified in WAC 480-100-238 (2) (b), Lowest reasonable cost.	• Chapter 5, Electric Resources • Chapter 8, Choosing a Resource Plan • Appendix G, Regional Transmission • Appendix I, Electric Analysis
WAC 480-100-238 (3) (f) Integration of the demand forecasts and resource evaluations into a long-range (e.g., at least ten years; longer if appropriate to the life of the resources considered) integrated resource plan describing the mix of resources that is designated to meet current and projected future needs at the lowest reasonable cost to the utility and its ratepayers.	• Chapter 5, Electric Resources • Chapter 8, Choosing a Resource Plan
WAC 480-100-238 (3) (g) A short-term plan outlining the specific actions to be taken by the utility in implementing the long-range integrated resource plan during the two years following submission.	• Chapter 9, Action Plans
WAC 480-100-238 (3) (h) A report on the utility's progress towards implementing the recommendations contained in its previously filed plan.	• Chapter 9, Action Plans
WAC 480-100-238 (4) Timing. Unless otherwise ordered by the commission, each electric utility must submit a plan within two years after the date on which the previous plan was filed with the commission. Not later than twelve months prior to the due date of a plan, the utility must provide a work plan for informal commission review. The work plan must outline the content of the integrated resource plan to be developed by the utility and the method for assessing potential resources.	• 2009 Integrated Resource Plan Work Plan filed with the WUTC in May 2008 • Chapter 9, Action Plans

Statutory/Regulatory Requirement	Chapter
WAC 480-100-238 (5) Public participation. Consultations with commission staff and public participation are essential to the development of an effective plan. The work plan must outline the timing and extent of public participation. In addition, the commission will hear comment on the plan at a public hearing scheduled after the utility submits its plan for commission review.	• Appendix A, Public Participation

Figure B-2
Gas Integrated Resource Plan Regulatory Requirements

Statutory/Regulatory Requirement	Chapter
WAC 480-90-238 (3) (a) A range of forecasts of future natural gas demand in firm and interruptible markets for each customer class that examine the effect of economic forces on the consumption of natural gas and that address changes in the number, type and efficiency of natural gas end-uses.	• Chapter 4, Demand Forecasts
WAC 480-90-238 (3) (b) An assessment of commercially available conservation, including load management, as well as an assessment of currently employed and new policies and programs needed to obtain the conservation improvements.	• Chapter 6, Natural Gas Resources • Appendix L, Demand-Side Resources Analysis
WAC 480-90-238 (3) (c) An assessment of conventional and commercially available nonconventional gas supplies.	• Chapter 6, Natural Gas Resources • Appendix K, Gas Market Overview
WAC 480-90-238 (3) (d) An assessment of opportunities for using company-owned or contracted storage.	• Chapter 6, Natural Gas Resources
WAC 480-90-238 (3) (e) An assessment of pipeline transmission capability and reliability and opportunities for additional pipeline transmission resources.	• Chapter 6, Natural Gas Resources • Chapter 8, Choosing a Resource Plan • Appendix J, Gas Analysis
WAC 480-90-238 (3) (f) A comparative evaluation of the cost of natural gas purchasing strategies, storage options, delivery resources, and improvements in conservation using a consistent method to calculate cost-effectiveness.	• Chapter 6, Natural Gas Resources

Statutory/Regulatory Requirement	Chapter
WAC 480-90-238 (3) (g) The integration of the demand forecasts and resource evaluations into a long-range (e.g., at least ten years; longer if appropriate to the life of the resources considered) integrated resource plan describing the mix of resources that is designated to meet current and future needs at the lowest reasonable cost to the utility and its ratepayers.	• Chapter 6, Natural Gas Resources • Chapter 8, Choosing a Resource Plan
WAC 480-90-238 (3) (h) A short-term plan outlining the specific actions to be taken by the utility in implementing the long-range integrated resource plan during the two years following submission.	• Chapter 9, Action Plans
WAC 480-90-238 (3) (i) A report on the utility's progress towards implementing the recommendations contained in its previously filed plan.	• Chapter 9, Action Plans
WAC 480-90-238 (4) Timing. Unless otherwise ordered by the commission, each natural gas utility must submit a plan within two years after the date on which the previous plan was filed with the commission. Not later than twelve months prior to the due date of a plan, the utility must provide a work plan for informal commission review. The work plan must outline the content of the integrated resource plan to be developed by the utility and the method for assessing potential resources.	• 2009 Integrated Resource Plan Work Plan filed with the WUTC in May 2008 • Chapter 9, Action Plans
WAC 480-90-238 (5) Public participation. Consultations with commission staff and public participation are essential to the development of an effective plan. The work plan must outline the timing and extent of public participation. In addition, the commission will hear comment on the plan at a public hearing scheduled after the utility submits its plan for commission review.	• Appendix A, Public Participation

Figure B-3
WUTC Staff Recommendations from 2007 IRP Acceptance Letter

WUTC Staff Recommendations	Chapter
Electric Portfolio Design	
In our letter acknowledging PSE's 2004 Least Cost Plan, the Commission recommended that the company "work toward a mathematically driven method of portfolio construction"…the Commission expects a more thorough discussion of the rational underlying each portfolio considered than was provided in this IRP.	PSE acquired the optimization program "Strategist" to directly address this recommendation. • Chapter 5, Electric Resources, sections IV and V. • Appendix I, Electric Analysis Results.
Basis for Resource Strategy Decisions	
In its next plan, PSE should weight the various scenarios according to its judgment of their relative probabilities. Alternatively, the company could detail why it based the final determination of the preferred resource portfolio on a subset of the scenarios developed.	• Chapter 1, Executive Summary • Chapter 8, Choosing a Resource Plan
DSM Related Issues	
I-937 Changes On November 7, 2006, Washington voters approved Initiative Measure No. I-937, now codified as RCW 19.285. … We expect that the Company's next IRP will describe what changes, if any, PSE has made to comply with this new mandate.	• Chapter 5, Electric Resources • Appendix I, Electric Analysis Results • Appendix L, Demand-side Resource Analysis
Peak Shaving …the Quantec report indicates that a curtailable load program and a critical peak pricing program both offer substantial technical potential but relatively low achievable potential. The company should investigate whether the achievable potential of these two programs could be improved at a reasonable cost.	• Appendix L, Demand-side Resource Analysis
Avoided Costs In its next plan, PSE should include a section specifically discussing its energy and capacity avoided costs over both short- and long-term time frames. This section should include a discussion regarding how PSE derived these avoided cost numbers.	• Appendix I, Electric Resource Analysis

<table>
<tr><td>Fuel Conversion

In addition, we would like the next plan to discuss the potential of fuel switching, i.e., the conversion from electricity to natural gas for water heaters, appliances and other applications, as a strategy to conserve energy and reduce emissions.</td><td>• Appendix L, Demand-side Resource Analysis</td></tr>
<tr><td colspan="2">Integrating Electric and Gas</td></tr>
<tr><td>Integrating Strategic Analysis

Work to develop synergies between natural gas and electricity strategic analysis techniques.</td><td rowspan="3">• Chapter 3, Framework and Key Assumptions
• Chapter 6, Gas Resources</td></tr>
<tr><td>Integrating Analysis

The Commission expects much more effort directed towards integrating the electric and natural gas plans in PSE’s next IRP.</td></tr>
<tr><td>Use Common Forecasts

The use of a common gas commodity price forecast and shared gas purchasing would allow PSE to reduce the resources devoted to demand forecasting and, in turn, the Commission’s effort in overseeing these forecasts.</td></tr>
<tr><td colspan="2">Responding to Feedback</td></tr>
<tr><td>…the Commission expects that PSE will include as a separate section a listing of how the company complied with all of the Commission recommendations, or the rationale for not acting in accordance with them.</td><td>• Appendix B, Legal Requirements, Figure B-3</td></tr>
</table>

Financial Considerations

PSE requires continuous access to capital markets on reasonable terms, available credit to operate the business, and the ability to execute risk management strategies in order to fulfill our responsibilities. This means financial considerations are central to the resource planning and acquisition process. The econometric model for load growth, discount rate, and inflation assumptions in this IRP are examples. The current financial market crisis and economic slowdown will impact PSE resource strategies and acquisitions in a number of ways. The financial crisis may reduce the number of credit-worthy counter-parties in many markets, making it more difficult for PSE to enter into transactions. Customer demand may also slow due to the economic downturn. However, there could be benefits from the 2009 American Recovery and Reinvestment Act and other federal stimulus measures. Many financial and economic issues are not directly modeled in this IRP analysis, but will need to be considered when making real-world acquisition decisions.

Impact on Demand

Regional economic and demographic conditions have a significant effect on use-per-customer and customer growth, and the recent downturn in economic conditions will impact PSE loads for at least the next few years. Accurately forecasting the long-term effect of the downturn on customer growth and energy use is difficult at this early stage, since utility load forecasting models and equations have not been developed or previously tested in conditions like these. PSE will work to update forecasting models as additional macroeconomic and demographic data becomes available.

Demand-side Resources

Deteriorating economic conditions may impact PSE's ability to acquire demand-side resources. Lower growth and lower use per customer means less demand-side potential, and lower incomes may reduce the willingness of customers to invest in energy efficiency resources. This could mean that PSE may have to pay significantly higher incentives to achieve energy efficiency goals. Typically, on aggregate, PSE has paid approximately 50% of measure costs. Figure C-1 compares recent energy efficiency costs with the total resource cost estimated through 2015 in this IRP. While PSE does not anticipate having to pay 100% of total resource costs to achieve higher efficiency targets, Figure C-1 illustrates there is considerable potential for increased levels of incentive. While the increase in energy savings may reduce costs over the long run, customers will continue to face increased rate pressure combined with the worsening economy in the short run.

Figure C-1
Comparison of Energy Efficiency Expenditures

Elec	Utility Cost	Customer Cost	Other Contri-butions	Total
2007	$ 35,998,202	$ 28,503,495	$ 57,654	$ 64,559,351
2008	$ 52,147,523	$ 71,318,638	$ 56,879	$ 123,523,040
2009	$ 64,248,000	$ 35,370,493	$ 56,879	$ 99,675,372
2010 (Bundle D)	$ 161,372,716			$ 161,372,716
2011 (Bundle D)	$ 164,734,859			$ 164,734,859
2012 (Bundle D)	$ 168,073,472			$ 168,073,472
2013 (Bundle D)	$ 158,997,764			$ 158,997,764
2014 (Bundle D)	$ 161,417,354			$ 161,417,354
2015 (Bundle D)	$ 166,368,236			$ 166,368,236

Impact on Ability to Finance

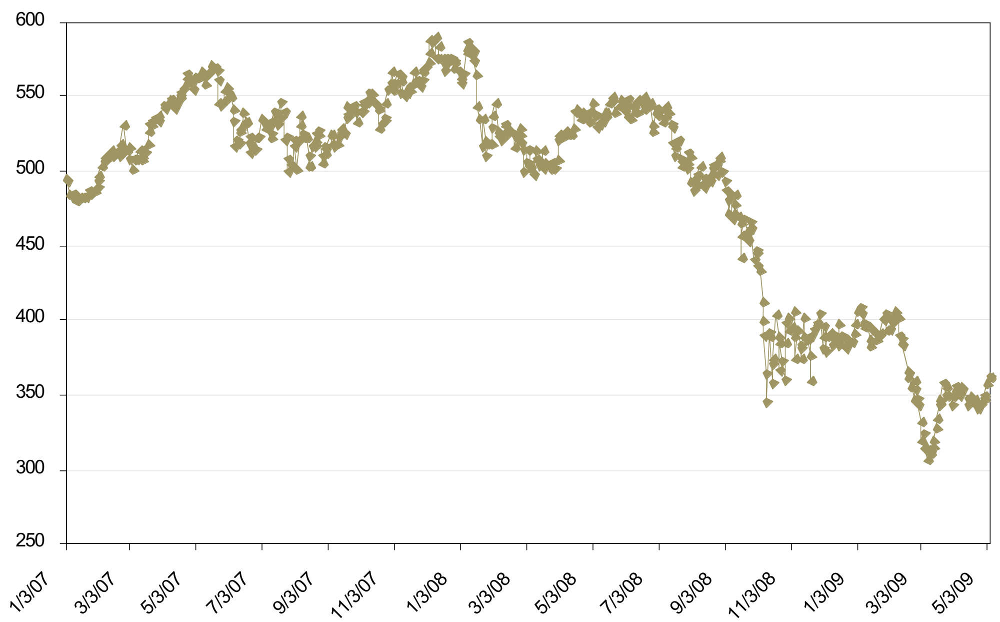
Access to Capital

Financing is a particularly significant topic given the turmoil experienced in capital markets since the latter part of 2008. Long-term and short-term credit markets have endured considerable disruptions. Major banks and financial institutions have been seriously weakened, and many prominent financial institutions – among them Washington Mutual, Bear Stearns, Merrill Lynch, Citibank, Lehman Brothers, and Wachovia – have either failed, shed portions of their business, or been acquired. Such dire conditions have curtailed lending and led to unprecedented government intervention aimed at restoring stability to the banking sector and promoting lending throughout the economic system. While the actions of the federal government appear to have helped stabilize credit markets, major uncertainties remain as to when capital markets will recover and to what degree.

Equity

PSE's ability to raise equity capital in such difficult markets has been greatly aided by its recent transaction with the Macquarie consortium. The settlement agreement approved by the Washington Utilities and Transportation Commission (WUTC) included a commitment to invest at least $5 billion in capital in the next five years. Absent this transaction, the company's stock price would likely have declined dramatically with the rest of the utility industry, making equity financing much more expensive for customers. Figure C-2 illustrates the performance of utility stocks since January 2007.

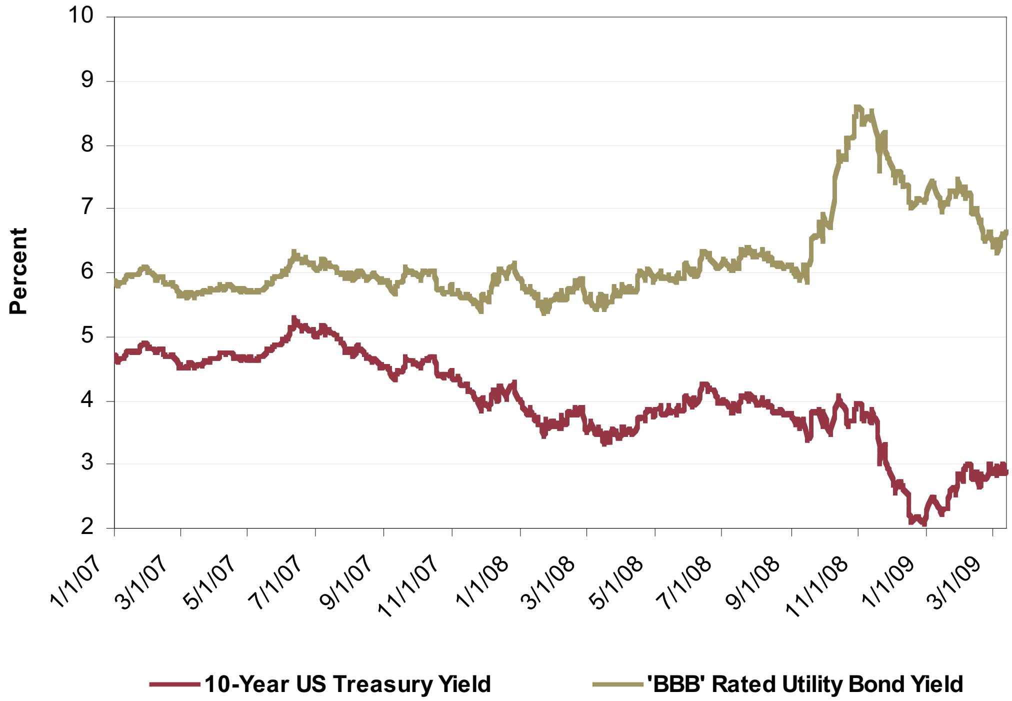
Figure C-2
Utility Stock Price Index Since January 2007



Debt

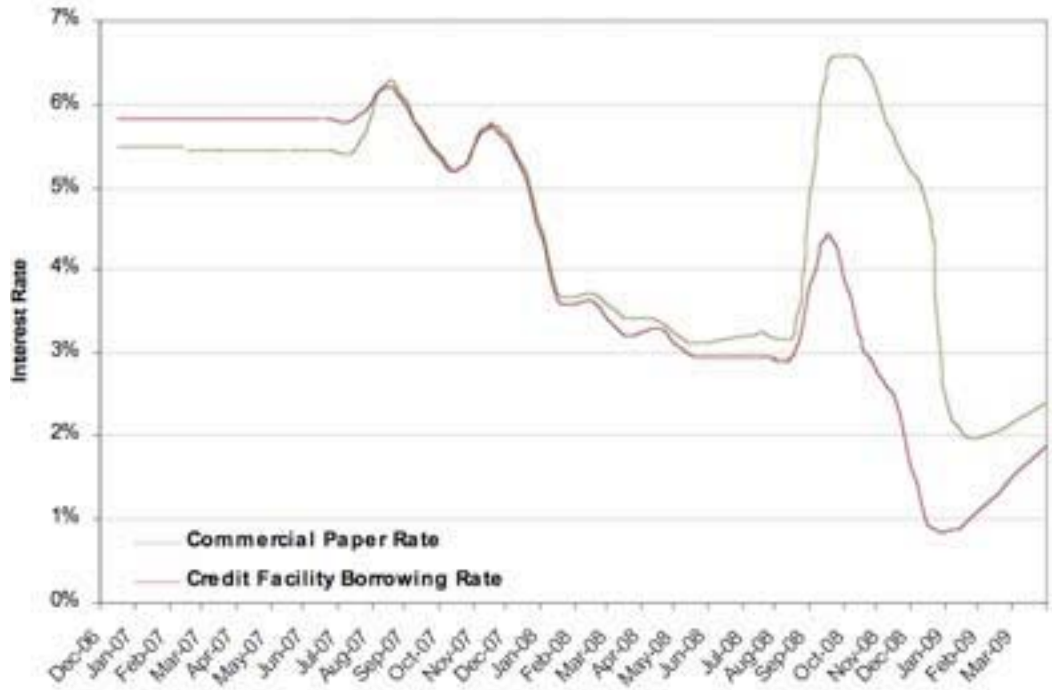
Traditionally, utilities have had fairly ready access to capital at reasonable costs; but market difficulties have increased risk premiums and made raising capital of any kind very difficult. Strong credit ratings are more important than ever, since bond spreads have widened dramatically for companies with lower ratings. Companies have also needed to wait for windows of opportunity to enter the capital markets to raise debt. The re-pricing of risk is evident in Figure C-3, which compares 10-year BBB utility bond rates with 10-year U.S. Treasury yields. During 2007, the credit risk premium (or "spread") averaged about 125 basis points. From mid-September 2008 through March 2009, the spread averaged over 400 basis points (the spread is the difference between the utility bond rate and the yield on the comparable U.S. Treasury securities).

Figure C-3
Re-pricing Risk: BBB-rated Utility Bonds Compared to U.S. Treasuries



Short-term markets also have experienced severe disruptions. Investors have moved toward extremely safe investments like U.S. Treasuries, and abandoned riskier options such as corporate commercial paper, a market in which PSE typically engages on a regular basis. Government assurance and other programs have brought some stability back into short-term markets, but risk premiums for lower-rated commercial paper programs, such as PSE's split rated tier 2/3 paper, have increased significantly from historical levels, as illustrated in Figure C-4. Market disruptions also were evident in inter-bank lending rates; these rose sharply before falling rapidly.

Figure C-4
Commercial Paper versus Credit Facility from January 2007 – March 2009



PSE has relied on its committed credit facilities to raise cash during the credit crisis. While the failure of bankrupt Lehman Brothers to fund their commitments effectively reduced PSE's total amount of committed credit, the company's several pre-negotiated facilities have provided the liquidity needed to fund operations.

Cost of Capital

Overall, the credit market turmoil has placed upward pressure on the cost of new capital, and created uncertainty in capital markets in general. The company has some insulation from these market dynamics due to our committed credit facilities and access to equity capital, both resulting from the merger in February 2009**.** The company will continue to need to access debt capital markets at various times to fund capital requirements and refinance maturing long-term debt. To do so at reasonable rates, it will be important to maintain an investment-grade credit rating and to seek out good opportunities to access capital markets.

Impact on Energy Trading and Hedging

The financial crisis and subsequent economic downturn may decrease energy market liquidity, increase credit risk, and tighten credit markets, potentially leading to material credit risk, financial liquidity, and energy hedging challenges. The steep decline in northwestern energy prices may exacerbate some of these challenges and partially mitigate others. The tightening of financial markets is increasing the risk of over-reliance on energy markets and putting increased pressure on portfolio hedging.

Decreased Energy Market Liquidity

The financial crisis may decrease energy market liquidity in the Northwest. Some market participants have ceased operations, and others have reduced their activity. Decreased liquidity could complicate execution of the company's energy hedging strategies and may lead to increased credit risk concentration and costs.

Increased Credit Default Risk

The relatively poor economic and financial environment may increase the likelihood that one or more of the PSE's energy suppliers may default on their obligations to the company. A counterparty's failure to perform under the terms of an energy supply or service agreement could require PSE to replace the lost product at a higher price. In this way, a decrease in the creditworthiness of counterparties could lead to higher costs for the company.

Tighter Credit Markets

The financial crisis may prompt some market participants to decrease the size of the unsecured credit lines they extend to other participants. Reductions in the unsecured credit lines granted to PSE may require that the company post additional collateral to support hedging activities, thereby increasing financial liquidity needs and cost. Obtaining additional financial liquidity may be difficult and expensive given current conditions, and an absence of sufficient financial liquidity could diminish the company's ability to hedge.

Decreased Energy Prices

Wholesale natural gas and power prices in the Northwest have declined substantially since July 2008. This drop in prices allows PSE to obtain additional energy supplies at more favorable prices. However, many energy suppliers now have increased credit exposure with the company because some previously executed hedges are at higher prices than the current market. This increased credit exposure may exacerbate the adverse impact that tighter credit markets have on the company. On the other hand, the decrease in prices also has reduced PSE's credit risk exposure to other energy suppliers, partially mitigating the aforementioned increase in credit default risk.

Impact on Resource Development

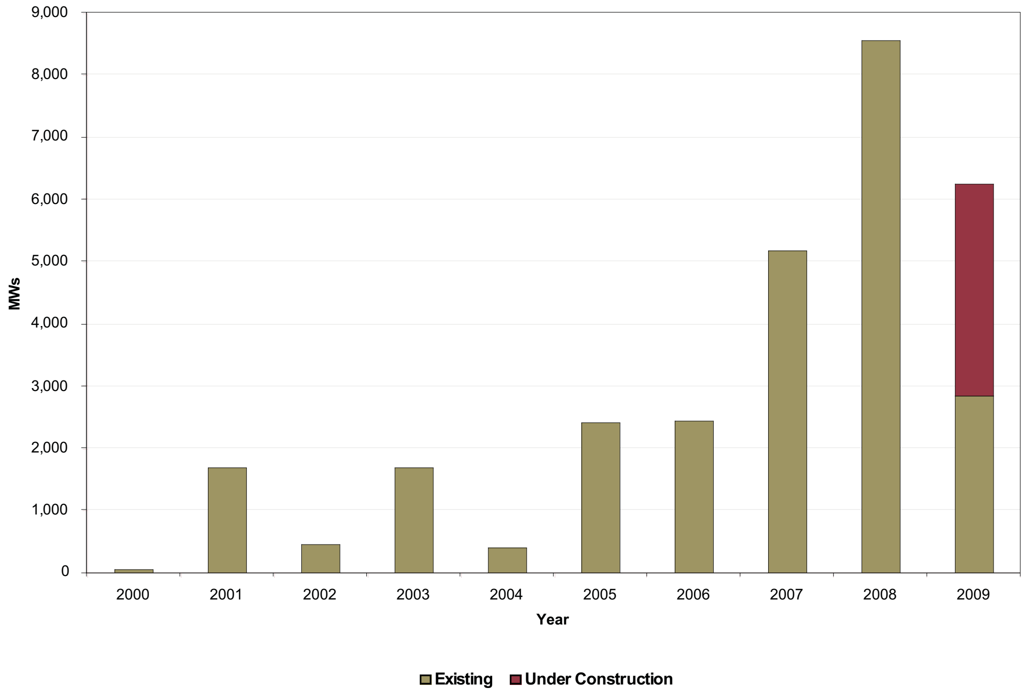
The current economic climate is also weakening the resource market. Increases in the cost of capital, decreases in demand for commodities, and declining power prices may reduce resource costs in the short term, creating attractive opportunities to address long-term needs at favorable prices.

Energy Supply Resources

Generally, the market for new generating projects has softened. Global economic conditions have destroyed asset valuations in nearly all classes, but particularly hard hit are fossil fuel prices; these have dropped nearly 66% from 2008 highs. Lower spot prices for power have followed the trend of lower fuel prices. Renewable projects such as solar PV or wind generation must now compete against low-cost wholesale market power, forcing potential customers to pay a premium compared to cheaper, fossil fuel-generated power. In addition, the number of renewable energy tax equity investors, and the amount of capital they have to invest, has dropped substantially in the last 12 months, because profitability is a prerequisite.

Constrained capital has led to increased return requirements, and ultimately slowed the development of new projects. Figure C-5 compares national wind additions. Note that 2009 additions will be well short of 2008 additions. The pace of independent renewable development is likely to slow to the minimum required to meet state renewable portfolio standards, absent legislation that increases the value of renewable power attributes and expands the tax credits market.

Figure C-5
U.S. Installed Wind Capacity (source: AWEA)



Weighted Average Cost of Capital (WACC) and Project Economics

The diminished supply of tax equity has led to a 100 to 200 basis point increase in required return rates for tax equity investors; this has at least two potential impacts on project economics. First, assuming no change to the WACC of utilities such as PSE, utility ownership of renewable projects should start looking more beneficial to customers than purchased power structures. The historically low debt and equity requirements of the last several years allowed independent power producers (IPPs) to access capital at lower rates than utilities. Now that risk has re-priced and capital has become more expensive for IPPs, a consolidation should occur in which utilities and IPPs with strong balance sheets consume weaker development companies. A second change involves diminished returns among project developers and equipment manufacturers. By and large, compensating for an increasing WACC via pass-through of higher power prices will be challenging in the current climate, which means that the shortfall will need to be made up by lower development fees and/or decreased equipment prices, though predicting the magnitude and split is difficult.

Demand for Renewable Resources

While renewable resource supply has generally increased, demand has increased as well. California's aggressive renewable portfolio standard, established in 2002 and accelerated in 2006, mandates that 33% of retail sales be derived from renewables. These ambitious goals have caused California utilities to look beyond the state's borders for resources. The near term goal – 20% by 2010 – will likely establish a price floor on renewable generation projects. In 2009, Washington state also considered increasing RPS requirements, but Senate Bill 5840 was defeated. Most states are grappling with climate change and renewable portfolio standards, and a national RPS is possible. If all utilities are required to meet the same goals in the same timeframe, demand for resources could change drastically.

Transmission

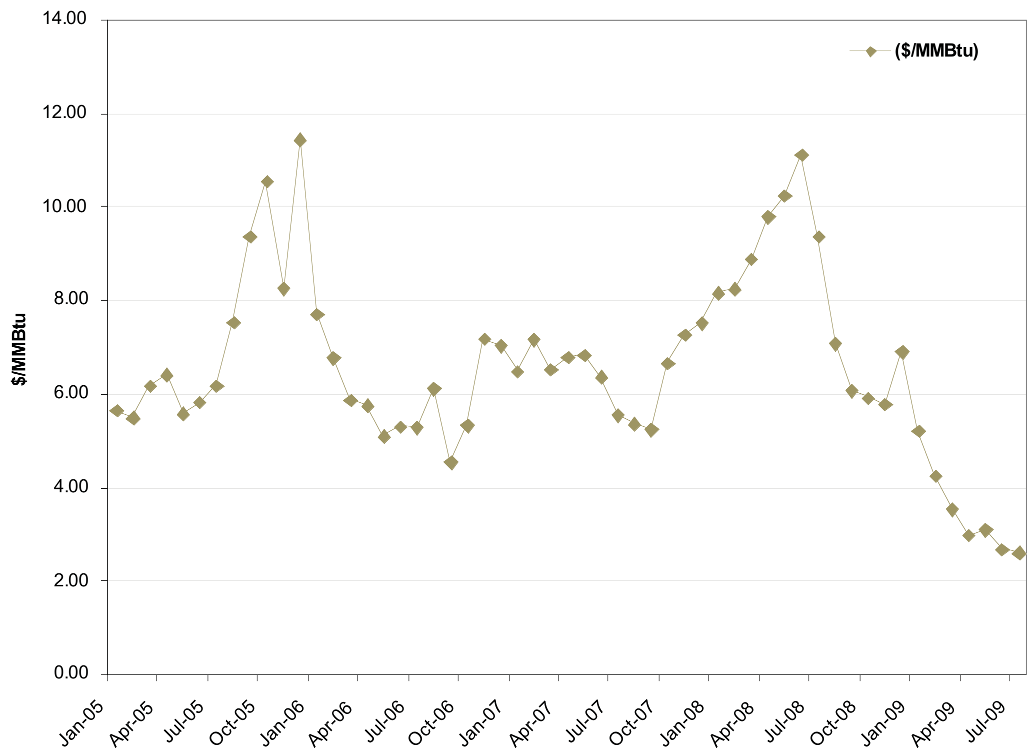
Transmission planning is influenced primarily by reliability criteria and the commercial environment surrounding energy markets. The downturn in the economy has not changed reliability criteria, and in fact, some improvements are being accelerated to take advantage of lower material and labor costs. However, many commercially driven transmission projects are suffering slowdowns. Major projects are experiencing significant delays or accelerations as stimulus capital finds its way to the highest-valued proposals. Utilities continue to respond to RPS requirements and treat transmission projects that support renewable acquisitions on par with reliability based projects. As the economy recovers, slowdowns in discretionary projects should reverse.

Natural Gas Pipelines and Supply

Despite the tremendous potential for unconventional natural gas supply exploration and development that came to light in 2008, primarily in shale formations across North America, the outlook for continued supply growth has become murky. Successful production increases in the U.S. Rockies and Texas, coupled with lower demand, has caused prices to spiral downward across North America. Figure C-6 illustrates the run-up and subsequent crash of natural gas prices that took place between 2005 and January 2008, and shows forward prices for Henry Hub, Sumas, and Rockies through 2012. Current forward prices are not likely to stimulate significant exploration and development activity in British Columbia – which purportedly requires $6 to $7 per dekatherm (Dth) pricing – and they will also probably curtail capital drilling programs severely in the United

States. Further complicating the situation, especially for U.S. development in the Rockies, is export pipeline capacity constraints. These have pushed Rockies forward prices below $4 per Dth for the next two years. Finally, even necessary pipeline expansions are struggling to obtain economically viable financing, and producers are reexamining long-term pipeline commitments given capital and cash flow constraints.

Figure C-6
Historical Sumas Gas Prices
(Jan 2005 - Jul 2009)



Potential Impact of Stimulus Bill

In February, the U.S. Congress adopted the American Recovery and Reinvestment Act of 2009 (ARRA). This legislation provided billions of dollars of new funding for investments in energy efficiency, renewable energy, emerging energy technologies, and a "smart" electrical grid. Many of these new and expanded funding programs will be administered through competitive matching grant programs. Some, like the smart grid program, are designed specifically for utilities. Others, including energy efficiency and renewables programs, will be administered by the states. PSE is currently evaluating opportunities to apply for ARRA funds either directly or through partnerships with other utilities and governmental agencies that could help fund investments in new energy infrastructure and energy efficiency.

Other Financial Considerations

Imputed Debt Methodologies

Utilities have used PPAs in the past as an alternative to the risk and expense of new plant development, construction, and operation. However, entering into long-term PPAs creates fixed obligations that can increase a utility's financial risks.

Both Moody's Investors Service and Standard & Poor's (S&P) use a quantitative methodology to calculate the risk of PPAs and the impact of that risk on the creditworthiness of electric utilities. The methodologies, while different from one another, were designed to make a fair comparison between electric utilities that own and generate power vs. utilities that contract for power.

In general, imputed debt is described in the 1994 update of S&P 1992 Corporate Finance Criteria:

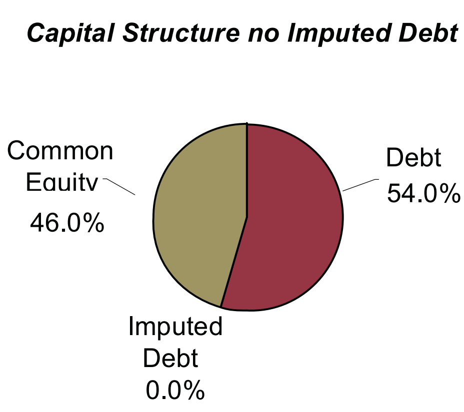
> To analyze the financial impact of purchased power, S&P employs the following financial methodology. The net present value of future annual capacity payments (discounted at 10%), multiplied by a "risk factor" (which in PSE's case is 30%) represents a potential debt equivalent—the off-balance sheet obligation that a utility incurs when it enters into a long-term purchase power contract.

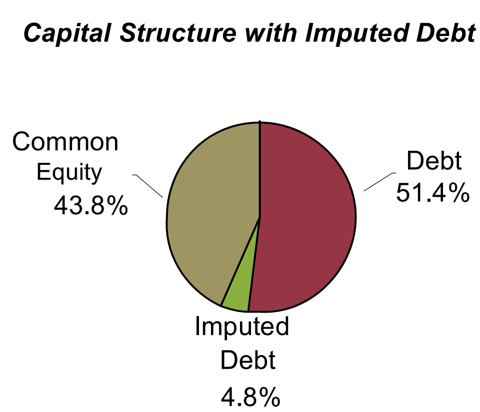
PSE's IRP, and our screening of potential resource acquisitions, includes a cost of equity to neutralize the reduction in credit quality from imputed debt for all PPAs. As described previously, the debt rating agencies consider long-term take-or-pay and take-and-pay contracts equivalent to long-term debt; hence there is a cost associated with issuing equity to rebalance the company's debt/equity ratio. Imputed debt in the IRP is calculated using a similar methodology to that applied by S&P. The calculation begins with the determination of the fixed obligations that are equal to the actual demand payments, if so defined in the contract, or 50% of the expected total contract payments. This yearly fixed obligation is then multiplied by a risk factor. PSE's current contracts have a risk factor of 30%, a change that occurred in May 2004. Prior to this change, PSE contracts had risk factors between 15% and 40%. Imputed debt is the sum of the present value, using a 7.7% discount rate (the company's current average cost of long-term debt), and a mid-year cash flow convention of this risk-adjusted fixed obligation. The cost of imputed debt is the return on the amount of equity that would be acquired to offset the level of imputed debt to maintain the company's capital and interest coverage ratios.

Imputed Debt's Effect on Capital Structure

Figure C-7 shows that the financial ratios with imputed debt are eroding PSE's financial strength as measured by the credit rating agencies. Total capitalization is approximately equal to year-end 2006, but the percentage mix of debt and equity is as allowed in the January 2007 General Rate Case order from the WUTC.

Figure C-7





Environmental Matters

This appendix contains a wide range of information that relates to the environmental concerns PSE faces and seeks to address.

1. PSE Greenhouse Gas Policy

Many scientists and policymakers believe climate change may prove to be the most important business issue of the 21st century. Business leaders once asked if the climate is changing. And if so, if humans are causing the change. But many now ask how profound the impacts will be, and if solutions to those impacts will be feasible and economically viable.

In just a few years, the possibility of climate change regulation has gone from almost “unthinkable” to a “strong possibility”. As the issue has gained momentum, federal efforts to address climate change have increased significantly, and a growing number of U.S. companies have abandoned their earlier view that it required more research before warranting emissions reduction.

In late 2006, the utility commissioners of California, Oregon, Washington, and New Mexico agreed to collaborate on strategies to fight climate change. Specifically, they said their "regulatory oversight ensures that the utilities operate in a manner that protects the environment and human health and safety, and protects ratepayers from economic risks of failure to plan for future regulation of emissions that cause climate change.”

PSE understands the importance of assuming leadership in devising new strategies to address climate change, even before such measures are mandated. As a first step, the company developed a climate change policy statement (see next page). The policy provides a guiding sense of the challenges PSE faces, its obligation as a utility, and the solutions we see are feasible. A discussion of the local implications of global climate change can be found in the 2007 IRP.

Greenhouse Gas Policy Statement

Puget Sound Energy (PSE) concurs with the growing concern that increased atmospheric concentrations of greenhouse gases will adversely impact the climate in a way that will do adverse economic and social harm. Presently, most of the world still relies heavily on fossil fuels for its electric power and heating needs. Therefore, climate change policies must balance a number of competing short-term and long-term interests to moderate the growth in greenhouse gas emissions while encouraging responsible growth of the economy.

Climate change is a very important issue which requires effective, efficient and equitable collective responses from policy makers. To that end, PSE advocates a national strategy that achieves both short-term measures designed to lessen the growth of greenhouse gas emissions and long-term strategies that will ultimately manage greenhouse gas emissions to appropriate levels in a scientifically sound, and responsible fashion. In furtherance of the strategy that reduces near-term growth of greenhouse gases, PSE's policy is to take cost-effective measures to reduce greenhouse gas emissions from our energy activities while maintaining a dependable and diverse energy portfolio mix that will sustain our customers' needs now and into the future.

The specific near-term strategies PSE will continue to explore and implement include the following:

1. Ongoing development and investment in our customer energy efficiency program;
2. Pursuit of a diverse energy portfolio mix of resources including renewable generation that will result in lowering of our greenhouse gas emissions consistent with least cost planning principles;
3. Customer based generation of renewable energy;
4. Opportunities to reduce greenhouse gas emissions with our partners in the utility industry, our local communities, and state and national government;
5. Ongoing development and investment in our green fleet and low emission vehicle programs;
6. Transparency with our greenhouse gas emissions footprint reporting; and

7. Coordination with our customers to help them minimize their greenhouse gas emissions footprint.

Furthermore, PSE believes the U.S. government must take a strong leadership role on this global issue by regulating the sectors that consume fossil fuels and setting corresponding policies, including the following:

1. Institute a tax policy that provides clear, long-term price signals so that affected firms can invest intelligently.
2. If a cap-and-trade system is established, a cost containment mechanism which establishes a price ceiling should be created so all firms can reliably estimate and manage compliance costs.
3. Formulate active strategies to promote the development and demonstration of new large-scale, low-emissions technologies and energy systems. Additionally, any tax and/or trading system should be leveraged to accelerate the adoption of new no and low-emission technologies through R&D incentives and appropriate price signaling.
4. Remove barriers, and disincentives for the advancement of renewable resources and smart grid technologies.
5. Sustainable energy is an essential component of sustainable development, and PSE will continue to take steps to meet the goal of providing reliable energy while decreasing the resulting impact on climate change.

A. PSE's Emissions

During 2007, PSE's total electric retail load of 23,195,000 MWhs was served from a supply portfolio of owned and purchased resources. Since 2002, the company has undertaken a voluntary inventory of the greenhouse gas (GHG) emissions associated with PSE's portfolio. This inventory follows the protocol established by the World Resource Institute GHG Protocol (GHG Protocol). The most recent data indicate that PSE's total 2007 GHG emissions -- both direct and indirect -- from its electric supply portfolio were 12,744,899 tons (CO_2e). Figure D-1 shows PSE's historic emissions from 2002 to 2007.

Figure D-1
Historic PSE Emissions

Year	Emissions (Total = Direct & Indirect)
2002	13,688,501 tons
2003	14,742,960 tons
2004	12,613,681 tons
2005	12,999,051 tons
2006	13,527,794 tons
2007	13,099,834 tons

B. Comparison of Life Cycle Greenhouse Gasses Emissions from Conventional and Alternative Generation Sources

The transition to a "low carbon" economy is underway, with wind, solar, and nuclear as some of the most promising options for "carbon-free" generation technologies. But are these technologies truly "carbon free," as many claim? Though these generation sources don't *directly* emit GHG's, emissions do result from the manufacturing processes behind these technologies. PSE has been and will continue to aggressively develop wind power. Each typical turbine in PSE's existing fleet is composed of three 7-ton composite blades, a hub, generator, and nacelle weighing over 90 tons that sits upon a 100-ton steel tower. The whole turbine rests on a 25' to 35' deep concrete footer reinforced with steel rebar.

The shipping and assembly also require consumption of fossil fuels and other resources. Of course, building a new natural gas or nuclear power plant would also require a vast amount of materials, but the central question is: How do the total emissions compare for conventional and alternative generation technologies when viewed from this perspective?

Life Cycle Assessment

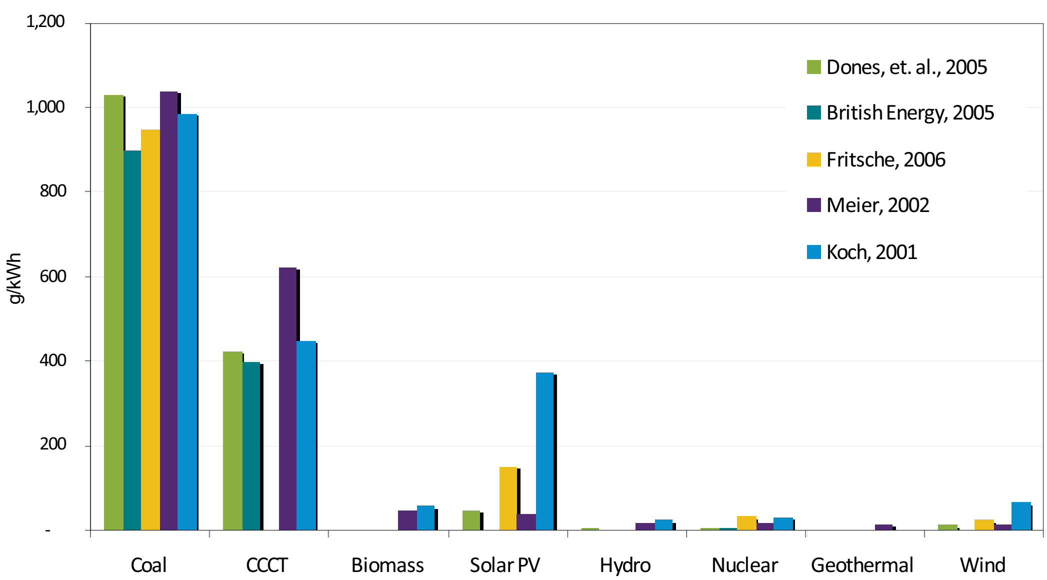
This question forms the basis for a field of study called Life Cycle Assessment (LCA). A similar form of analysis is "energy input-output", but this approach only measures the total energy required to produce and operate the system versus its life-cycle output. Such analysis is useful, but it does not analyze the relative emissions and the resulting impacts from the energy and materials inputs. LCA analyzes all components of a system or service, beginning with the gathering of raw materials to create the product and ending at the point when all materials are either recycled or returned to the earth. For example, an LCA for a nuclear plant would assess the emissions from plant construction and all embodied materials, uranium mining and processing, plant operation, and also end of life considerations such as plant decommissioning and spent fuel disposal and/or reprocessing. Many such analyses go beyond simply estimating emissions and attempt to quantify the type and magnitude of multiple environmental and social impacts. This next step is considerably more complicated and rests on many assumptions. The ultimate goal, however, is to avoid decisions that solve one environmental/social problem but end up creating another.

The LCA approach is becoming increasingly common and even standardized under the International Organization for Standardization (ISO 14040:2006 and ISO 14044:2006). Several databases provide the backbone for this type of analysis and are continuously refined and updated. The down side to this analytical approach is the massive amount of data that must be collected and analyzed, and the substantial number of assumptions and estimations that must frequently be made. Despite these limitations, the results can reveal important trends. The electric power industry would be wise to avoid the debacle of the ethanol industry, where the net environmental benefits of that fuel remain controversial. Relating this issue to PSE, we ask how the life-cycle emissions from wind power compare to existing and alternative generation technologies.

Results

While a comprehensive LCA was not performed on PSE's wind fleet, the company did conduct a preliminary literature review on the topic. Five studies were reviewed, and the results compared side-by-side. Not all studies analyzed all generation sources, but the results between studies for coal, natural gas combined-cycle combustion turbines (CCCT), hydropower, nuclear, and wind are largely consistent with one another (see figure D-2). The results also suggest that solar, hydropower, nuclear, and wind offer significantly lower life-cycle GHG emissions than natural gas and coal. More research is needed on biomass and geothermal, but the results from these studies look promising for these technologies as well.

Figure D-2
Life Cycle Greenhouse Gas Emissions (CO_2e) by Generation Source



Discussion

Discrepancies in methodology do exist between the studies, which partially explain the variability. For example, the British Energy study analyzed CO_2 emissions only (not CO_2-e) and thus likely understates the total GHG emissions. Other studies, such as Fritsche and Dones et. al., divided wind generation into land-based and offshore, which were averaged for the purposes of this review. Other assumptions such as the average wind capacity factor used will significantly affect the results.

The greatest variability exists in the results for solar photovoltaics (PV), mostly likely due to the nascent stage of the industry at the time of the Koch study (2001), and substantial discrepancies in assumptions for the type and size of the solar system analyzed and the energy mix assumed to be used to manufacture the cells and modules. For example, a solar cell composed of silicon manufactured in Moses Lake, WA, would have very low embodied GHG emissions because the electricity mix consists primarily of hydropower. A similar cell made of silicon manufactured in China would with coal-based electricity would have substantially greater life-cycle emissions.

One particularly interesting result, considering PSE's substantial and growing reliance on natural gas fired generation, is that life-cycle GHG emissions can be substantially higher than direct emissions. According to the Meier study, a 48% efficient CCCT will directly emit 382 grams of CO_2-equivalent per kWh from operations, but when the emissions related to natural gas production are included, CO_2-e emissions increase by 23% to 469 g/kWh, mainly due to methane releases during gas extraction and transport. Methane is over 20 times more powerful as a heat trapping gas than CO_2, and thus increases the GHG emission rate sharply. If future legislation imposes caps or taxes on this type of emission, this generation source would find itself at a competitive disadvantage.

Conclusions

Despite the discrepancies and uncertainties, the results of this literature review reveal that solar, nuclear, hydropower, biomass, and wind all have substantially lower life-cycle emissions of greenhouse gasses than that of natural gas or coal fired generation. Our conclusion from this is that PSE's focus on wind power is a sound choice to reduce GHG emissions. As efforts intensify to reduce such emissions, life cycle assessment will likely be an important tool to ensure that wise long-term decisions are made.

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2. Regulatory and Policy Activity

Limits on emissions of GHG in the United States have gained significant political momentum in just the past few months. The federal government hasn't successfully addressed the issue yet, but states, local governments and corporations are taking action, resulting in a patchwork of GHG policies and regulations that are adding significant challenges to long-term resource planning. This section outlines regulations and policies that may impact PSE's operations.

I. Federal Policies

<u>Obama Administration</u>

The election of President Obama and stronger Democrat majorities in Congress have greatly increased the likelihood that the federal government will adopt climate change legislation within the next two or three years. In stark contrast to President Bush, President Obama has indicated that he supports the creation of a federal cap and trade program to reduce the emission of GHG. Like a growing number of political leaders, he supports the setting of a cap to reach an 80% reduction of GHG emissions by 2050.

He further demonstrated his priority on energy and environmental matters by appointing former Clinton Environmental Protection Agency (EPA) Administrator Carol Browner as his new Special Assistant for Energy and Climate Change. In this role, Browner is expected to work closely with the Council on Environmental Quality, as well as the Department of Energy and the EPA to develop aggressive renewable energy and climate change policies.

<u>U.S. House of Representatives</u>

Newly elected House Energy and Commerce Committee Chairman Henry Waxman (D-Calif.) has moved rapidly in this new Congress to tackle energy and climate change matters. In appointing his new Energy and Environment Subcommittee chairman, Waxman asked his long-time colleague Rep. Ed Markey (D-Maine) to lead the committee's work to develop new climate and energy legislation. Markey is also the Chair of the House Select Committee on Global Warming, which he led during the last Congress as well. Markey has been a vocal advocate for developing strong national climate legislation.

Waxman has already set an aggressive timeline for developing new energy and climate legislation this year. In June, 2009 the U. S. House of Representatives passed the American Clean Energy and Security Act (ACES), which supports a cap and trade system for CO2 emissions.

U.S. Senate

This year, the U.S. Senate will be reviewing the ACES 2009 bill that passed the House of Representatives in June 2009.

II. State and Local Polices

A. In Washington State

Washington state is taking an aggressive approach to GHG emissions, making reduction a priority issue for state government. During 2008, the Legislature passed House Bill 2815, which 1) established GHG emission reduction levels to an ultimate goal of returning to 1990 levels by 2020, 2) created a mandatory reporting program for greenhouse gases to begin in 2010, and 3) established a "green jobs" program. The measure also directed the Department of Ecology (DOE) to negotiate on behalf of the state in the Western Climate Initiative (WCI) process to develop a regional cap-and-trade program. Additionally, Governor Christine Gregoire reconvened a citizen's group, the Climate Action Team, to explore and present possible complimentary measures for the reduction of GHG emission through areas such as energy efficiency codes, land use permitting, waste reduction, and transportation planning.

DOE will implement the Washington GHG mandatory reporting requirement for GHG emitters in 2010. All stationary sources that emit at least 10,000 metric tones per year of CO2 equivalent, or on road motor vehicle fleets that emit at least 2,500 metric tones of CO2 per year will be subject to reporting requirements. PSE will comply with all reporting requirements.

In 2008, the DOE, the Washington Utilities and Transportation Commission (WUTC), and the Washington Energy Facility Site Evaluation Council adopted rules to implement an emissions performance standard for utilities. The rules outline the emission profile of resources utilities must meet on resource acquisitions, currently equal to or less than 1,100 pounds of GHG emissions per megawatt hour. PSE is aggressively seeking out renewable resources to meet customer load while at the same time being a good environmental steward.

State efforts to reduce GHG emissions in 2009 shifted to energy use applications rather than generation sources. The Legislature passed measures to cut GHG emissions through increased energy efficiency application, building code upgrades, and the development of electric vehicle infrastructure. PSE will be required to assist government, companies, and individuals in the work to minimize greenhouse gases.

B. Local

Local governments and non-governmental organizations (NGO) in the Pacific Northwest continue to develop their own climate change and sustainability ordinances and policies, many of which require PSE compliance. Following the creation of the U.S. Mayors Climate Protection Agreement in 2005 (launched by Seattle Mayor Greg Nickels), more than 500 mayors nationwide, including 28 mayors representing communities within PSE's service territory, agreed to commit to the following actions:

1. Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies, to urban forest restoration projects, to public information campaigns;

2. Urge their state governments and the federal government to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol;

3. Achieve a 7% emissions reduction from 1990 levels by 2012; and

4. Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system.

In addition to these activities, five local communities have established "Green Ribbon Commissions on Climate Protection" through a stakeholder group developed to create additional local emissions reduction policies. PSE developed a handbook for climate change, which provides municipal and business customers with a guide of PSE resources to help evaluate how their energy use is related to their impact on the climate.

The City of Seattle formed a Mayor's Green Building Task Force to focus on improving efficiencies in new and existing buildings, and PSE assisted with efforts to develop a plan to achieve the mayor's request of a 20% increase in the energy efficiency of Seattle's buildings.

PSE is actively working to foster more efficient direct use of natural gas through local programs to reduce overall carbon emissions in our region. We are doing so by 1) reducing electric demand by converting electrically heated homes to gas, where appropriate; 2) encouraging the conversion of oil heated homes to natural gas, resulting in 41% less carbon emissions; and 3) offering incentives to install high efficient gas equipment.

Lastly, NGOs and other quasi-judicial organizations continue to seek PSE's input on a variety of local climate change projects including the provision of emission inventory tools for local governments, green fleet initiatives, data repositories, local reports and guidance. PSE's local government and community relations departments work with municipal customers to explain how the company calculates our carbon footprint, as well as to connect customers with PSE services to help them manage their own energy use and emissions.

III. Regional Polices

Renewable Portfolio Standards (RPS) are important in the effort to reduce GHGs across the West Coast, with Washington, Oregon and California among 32 states with RPS laws in effect. The standards require electric utilities and retail providers to supply a specified minimum amount of customer load with electricity from eligible renewable energy sources. California's efforts to increase its RPS standard to 33%, along with potential federal renewable standards, will affect energy markets across the country.

In a coordinated effort through the Western Climate Initiative (WCI), seven western states and four Canadian provinces are designing a cap and trade system, targeting implementation in 2012. The goal is to reduce each state's GHG emissions levels by 15% below the levels of 2005, by the year 2020.

The group released a draft design in late 2008 outlining principles and general framework for a system to allocate and allow buying, trading and selling of GHG emission allowances. Each WCI member must evaluate the design and choose to implement the program in its jurisdiction. So far, only California has provided the necessary legal requirements to implement the WCI plan.

Other options to affect GHG emissions releases are being explored by government entities in the West, including the carbon tax on fossil fuels in British Columbia. The British Columbia carbon tax, which began in 2008 and will ramp up the rate until 2012, applies to gasoline, diesel, natural gas, coal, propane, and home heating fuel. To offset the carbon tax cost to consumers, corporate and personal income tax rates will drop, and lower-income residents of British Columbia will receive an annual climate action credit of $100 per adult and $30 per child.

Whatever policy governments make, it is clear PSE and other utilities will face an ever increasing move toward greater GHG reductions. The company's resource plans must include these possible factors.

3. Challenges/Issues of Climate Change Policy

With ongoing development of state and federal initiatives intended to address climate change, the challenge to develop strategic solutions is more complicated than ever. However, PSE believes that now is the time to act. Consequently, the company will work with lawmakers to achieve the objectives of the Greenhouse Gas Policy Statement, and address what we feel are some of the major challenges and obstacles associated with climate change policy.

A. Energy Efficiency

Chapter 5 and Appendix L of the IRP discuss PSE's ongoing energy efficiency efforts. PSE is committed to continuing its leadership in energy efficiency. However, some challenges need to be addressed. Appendix L shows the historic potential of demand-side resources (DSR), but does not identify infrastructure constraints that go beyond the modeling. Moving beyond the 30 aMW achieved in 2007, and toward the levels identified in the appendix will require infrastructure investments to develop greater DSR.

B. Transportation Efficiency

PSE recognizes that approximately 50% of the GHG emissions in the Puget Sound region, and almost 28%[1] nationally are caused by transportation. PSE believes that any efforts to address climate change must improve transportation use and efficiency. To that end, the company has implemented several internal programs to improve efficiency in its own operations.

The company's Green Fleet Program has expanded the use of hybrid vehicles within its fleet in order to reduce fuel use. Currently, PSE has 45 hybrid cars and light truck vehicles in fleet service, and has added a hybrid line truck to its fleet for testing.
PSE also has an active commuter trip reduction program to help employees reduce the emissions associated with their daily travels. To help minimize work related travel, PSE has a network of teleconference facilities across our operations, as well as a fully networked system that allows for mobile employees.

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[1] U.S. transportation sector GHG emission data is for 2007. Source: U.S. Energy Information Administration, *Emissions of Greenhouse Gases Report (DOE/EIA-0573 [2007])*, released December 3, 2008

PSE's fleet is also piloting the use of two electric plug-in vehicles, and the utility is an active participant in regional discussions about the use of alternative fueled vehicles, including electric and natural gas vehicles.

C. Renewable Energy

One of the biggest challenges facing renewable energy is how to integrate renewable resources. Appendix H discusses wind integration. Currently, the most readily available renewable source of energy is wind generation. While PSE plans to meet the RPS requirements, it is important for the utility, and the region, to begin exploring the adequacy of the hydroelectricity, transmission, and gas systems to integrate intermittent renewable resources such as wind.

D. Carbon Sequestration

PSE is tracking and using technologies such as integrated gasification combined cycle plants, which use coal and other fuels, yet are capable of capturing and sequestering carbon. PSE participates in the Big Sky Carbon Sequestration Partnership based in Bozeman, Mont., which is investigating numerous sequestration technologies for effectiveness and cost.

Carbon sequestration can be terrestrial or geologic. Terrestrial carbon sequestration uses natural methods for returning carbon to the soil and plants at the surface level. Soil contains CO2 sequestered by plants, but overgrazing reduces the ability of plants to perform this function; improved pasture management can increase soil CO2. Crops also sequester carbon in the soil, but the tilling process releases it back into the atmosphere. Agricultural practices that reduce tilling have led to an increased level of carbon in the soil. Afforestation projects—growing trees to capture and hold carbon until the wood decomposes or is combusted—require long-term management to ensure that the carbon stays sequestered. Overall, while agriculture is responsible for a small portion of America’s contribution to climate change, it can also be part of the solution.

Geologic sequestration involves pumping CO2 deep into the ground, where it reacts with rocks to form an inert compound. There are numerous opportunities for carbon capture and sequestration (CCS). For example, oil companies have practiced “enhanced oil recovery” for 30 years—pumping CO2 produced by the refining process into their wells to improve oil recovery. Companies in the Northwest are currently testing wells drilled deep into the saline aquifer. Pumped CO_2, in an aqueous state, reacts with basalt to form inert calcite. Costs for this type of geologic sequestration have not yet been determined; however, large-scale CCS will require significant infrastructure investments.

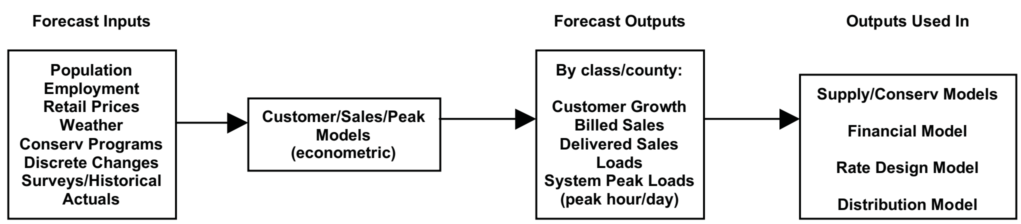
The Big Sky CO_2 Partnership is currently operating several test injections of CO_2. The basalt injection site in eastern Washington involves the test injection of CO_2 into a basalt formation that was extensively characterized by the Department of Energy. The Labarge Platform site in Wyoming involves injecting up to one million tons of CO_2 per year into a sandstone formation that is present in significant portions of the West.

Load Forecasting Models

This appendix provides a more detailed technical description of the four econometric methodologies used to forecast (a) billed energy sales, (b) customer counts, (c) system peak loads for electricity and natural gas, and (d) hourly distribution of electric loads.

For the 2007 load forecast used in the 2009 IRP, we updated our key forecast driver assumptions and re-estimated the main equations. The diagram below shows the overall structure of the analysis.

Figure E-1
Econometric Model for Forecasts
of Energy Sales, Customer Counts, and Peak Loads



I. Electric and Gas Billed Sales and Customer Counts

PSE estimated the following use-per-customer (UPC) and customer count equations using varied sample dates from within a historical monthly data series from January 1989 to September 2007, depending on sector or class and fuel type. The billed sales forecast is based on the estimated equations, normal weather assumptions, rate forecasts, and forecast of various economic and demographic inputs. The variable “t” denotes a month within the sample, and is therefore unique. However, when we restrict a given month to be 1, 2,…,12 it is to be understood that we are talking about which monthly equivalence class it belongs to.

The UPC and customer count equations are defined as follows:

$$UPC_{c,t} = f(UPC_{c,t(k)}, RR_{c,t(k)}, W_{c,t}, ED_{c,t(k)}, MD_m)$$
$$CC_{c,t} = f(CC_{c,t(k)}, ED_{c,t(k)}, MD_m)$$
$$MD_i = \begin{cases} 1, Month = i \\ 0, Month \neq i \end{cases} \quad i \in \{1, 2, \ldots 12\}$$

$UPC_{c,t}$ = use (billed sales) per customer for class "c", month "t"

$CC_{c,t}$ = customer counts for class "c", month "t"

$\_\__{t(k)}$ = the subscript $t(k)$ denotes either a lag of "k" periods from "t" or a polynomial distributed lag form in "k" periods from month "t"

$RR_{c,t(k)}$ = effective real retail rates for class "c"

$W_{c,t}$ = class-appropriate weather variable; cycle-adjusted HDD/CDD using base temperatures of 65, 60, 45, 35 for HDD and 65 and 75 for CDD; cycle-adjusted HDDs/CDDs are created to fit consumption period implied by the class billing cycles

$ED_{c,t(k)}$ = class-appropriate economic and demographic variables; variables include income, household size, population, employment levels or growth, and building permits

MD_i = monthly dummy variable that is 1 when the month is equal to "i", and zero otherwise for "i" from 1 to 12

UPC is forecast at a class level using several explanatory variables including: weather; retail rates; monthly effects; and various economic and demographic variables such as income, household size, and employment levels. Some of the variables, such as retail rates and economic variables, are added to the equation in a lagged, or polynomial lagged form to account for both short-term and long-term effects of changes in these variables on energy consumption. Finally, we use a lagged form of the dependent variable in many of the UPC equations. This lagged form could be as simple as a one month lag, or could be a more sophisticated time-series model, such as an ARIMA(p,q) model. This imposes a realistic covariant structure to the forecast equation.

Similar to UPC, PSE forecasts the customer count equations on a class level using several explanatory variables such as household population, total employment, manufacturing employment, or the retail rate. Some of the variables are also implemented in a lagged or polynomial distributed lag form to allow the impact of the variable to vary with time. Many of the customer equations use monthly growth as the dependent variable, rather than totals, to more accurately measure the impact of economic and demographic variables on growth, and to allow the forecast to grow from the last recorded actual value.

We generate customer forecasts by county by estimating an equation relating customer counts by class and county to population or employment levels in that county. Once the customer counts for each county are estimated, adjustments are made proportionally so that the total of all customer counts is scaled to the original service area forecast.

The billed sales forecast for each customer class is the product of the class UPC forecast and the forecasted number of customers in that class, as defined below.

$$Billed\ Sales_{c,t} = UPC_{c,t} \times CC_{c,t}$$

The billed sales and customer forecast is adjusted for discrete additions and subtractions not accounted for in the forecast equations, such as major changes in energy usage by large customers. These adjustments may also include fuel and schedule switching by large customers. Total billed sales in a given month are calculated as the sum of the billed sales across all customer classes:

$$Total\ Billed\ Sales_{t} = \sum_{c} Billed\ Sales_{c,t}$$

PSE estimates total system delivered loads by distributing monthly billed sales into each billing cycle for the month, then allocating the billing cycle sales into the appropriate calendar months using degree days as weights, and adjusting each delivered sales for losses from transmission and distribution. This approach also enables computation of the unbilled sales each month.

II. Peak Load Forecasting

A. Electric Peak-hour Load Forecast

Based on the forecast delivered loads, we use hourly regressions to estimate a set of monthly peak loads for both residential and nonresidential sectors based on 3 specific design temperatures: “Normal”, “Power Supply Operations” (PSO) and “Extreme”. The “Normal” peak is based on the average temperature at the monthly peak during the historical time period, currently the past 27 years. The winter peaks are set at the highest Normal peak which is currently the December peak of 23° F. We estimated the PSO peak design temperatures to be a 1-in-20 year probability of exceedance. These temperatures were established by examining the minimum temperatures of each winter month. A function relating the monthly minimum temperature and the return probability was established. The analysis revealed the following design temperatures: 15°F for January and February, 17°F for November and 13°F for December. Finally, the "Extreme" peak design temperatures are estimated at 13°F for all winter months.

Weather dependent loads are accounted for by the major peak load forecast explanatory variable, the difference between actual peak hour temperature and the average monthly temperature multiplied by residential loads and commercial loads. The equations allow the impact of peak design temperature on peak loads to vary by month. This permits the weather-dependent effects of residential and nonresidential delivered loads on peak demand to vary by season. The sample period for this forecast utilized monthly data from January 1991 to December 2004.

In addition to the effect of temperature, the peak load is estimated by accounting for the effects of several other variables. A variable is used to account for the portion of monthly residential and nonresidential delivered loads which are non-weather dependent and affect the peak load. The peak forecast also depends on a number of other variables such as a dummy variable accounting for large customer changes, a day of the week variable, and a cold snap variable to account for when the peak day occurs following several cold days. The functional form of the electric peak-hour equation is

$$PkMW_t = \vec{\alpha}_{1,m} R_t + \vec{\alpha}_{2,m} NR_t + \vec{\alpha}_{3,m} \chi_1 \cdot \Delta T \cdot Ws + \vec{\alpha}_{4,m} \chi_2 \cdot \Delta T \cdot C + \alpha_{5,m} S48 + \vec{\beta}_d \cdot DD_d + \alpha_{6,m} CSnp$$

where:

$$\chi_1 = \begin{cases} 1, & Month \neq 7,8 \\ 0, & Month = 7,8 \end{cases}$$

$$\chi_2 = \begin{cases} 1, & Month = 7,8 \\ 0, & Month \neq 7,8 \end{cases}$$

$PkMW_t$ = monthly system peak-hour load in MW

R_t = residential delivered loads in the month in aMW

NR_t = commercial plus industrial delivered loads in the month in aMW

ΔT = deviation of actual peak-hour temperature from monthly normal temperature

Ws = residential plus a % of commercial delivered loads

C **=** monthly delivered loads for the commercial class.

$S48$ = dummy variable for when customers in schedule 48 switched to transportation customers

DD_d = day of the week dummy

$CSnp$ = 1 if the minimum temperature the day before peak day is less than 32 degrees

χ_1, χ_2 = dummy variables used to put special emphasis on summer months to reflect growing summer peaks.

To clarify the equation above, when forecasting we allow the coefficients for loads to vary by month to reflect the seasonal pattern of usage. However, in order to conserve space, we have employed vector notation. The Greek letters α_m and β_d are used to denote coefficient vectors; α_m denotes a monthly coefficient vector (12 coefficients) and β_d denotes a coefficient for the day of the week (7 coefficients). The difference between α_m and $\dot{\alpha}_m$ is that all values in α_m are constant, whereas $\dot{\alpha}_m$ can have unique values by month. That is to say, all "January" months will have the same coefficient. There are also two indicator variables that use a weather-sensitive combination of residential and some commercial loads for all months except for July and August, which use only commercial loads, to reflect the growing summer usage caused by increased saturation of air conditioning.

B. Gas Peak-day Load Forecast

Similar to the electric peaks, the gas peak day is assumed to be a function of weather-sensitive delivered sales, the deviation of actual peak-day average temperature from monthly normal average temperature, and other weather events. The following equation used monthly data from October 1993 to June 2006 to represent peak day firm requirements:

$$PkDThm_t = \dot{\alpha}_{1,m} Fr_t + \dot{\alpha}_{2,m} \Delta T_g \cdot Fr_t + \alpha_{3,m} EN + \alpha_{4,m} Win + \alpha_{5,m} Smr + \alpha_{6,m} Csnp$$

where:

$$Win = \begin{cases} 1, & Month = 1,2,11,12 \\ 0, & Month \neq 1,2,11,12 \end{cases}$$

$$Smr = \begin{cases} 1, & Month = 6,7,8,9 \\ 0, & Month \neq 6,7,8,9 \end{cases}$$

$PkDThm_t$ = monthly system gas peak day load in dekatherms

Fr_t = monthly delivered loads by firm customers
ΔT_g = deviation of actual gas peak-day average daily temperature from monthly normal temperature
EN = dummy for when El Nino is present during the winter
Win, Sum = winter or summer dummy variable to account for seasonal effects
$CSnp$ = indicator variable for when the peak occurred within a cold snap period lasting more than one day, multiplied by the minimum temperatures for the day

As before, the Greek letters are coefficient vectors as defined in the Electric Peak section above.

This formula uses forecasted billed sales as an explanatory variable, and the estimated model weighs this variable heavily in terms of significance. Therefore, the peak day equation will follow a similar trend as that of the billed sales forecast with minor deviations based on the impact of other explanatory variables. An advantage of this process is the ability to account for the effects of conservation on peak loads by using billed sales with conservation included as the forecast variable. It also helps estimate the contribution of distinct customer classes to peak loads.

The design peak day used in the gas peak-day forecast is a 52 heating degree day (13°F average temperature for the day), based on the costs and benefits of meeting a higher or lower design day temperature. In the 2003 Least Cost Plan (LCP), PSE changed the gas supply peak-day planning standard from 55 heating degree days (HDD), which is equivalent to 10°F degrees or a coldest day on record standard, to 51 HDD, which is equivalent to 14°F degrees or a coldest day in 20 years standard. The Washington Utilities and Transportation Commission (WUTC) responded to the 2003 plan with an acceptance letter directing PSE to “analyze” the benefits and costs of this change and to “defend” the new planning standard in the 2005 LCP.

As discussed in our 2005 LCP, Appendix I, PSE completed a detailed, stochastic cost-benefit analysis that considered both the value customers place on reliability of service and the incremental costs of the resources necessary to provide that reliability at various temperatures. This analysis determined that it would be appropriate to increase our planning standard from 51 HDD (14°F) to 52 HDD (13°F). PSE’s gas planning standard relies on the value our natural gas customers attribute to reliability and covers 98% of historical peak events. As such, it is unique to our customer base, our service territory, and the chosen form of energy. Thus, we use projected delivered loads by class and this design temperature to estimate gas peak-day load.

III. Hourly Electric Demand Profile

Because temporarily storing large amounts of electricity is costly, the minute-by-minute interaction between electricity production and consumption is very important. For this reason, and for purposes of analyzing the effectiveness of different electric generating resources, an hourly profile of PSE electric demand is required.

We use our hourly (8,760 hours) load profile of electric demand for the IRP, for our power cost calculation, and for other AURORA analyses. The estimated hourly distribution is built using statistical models relating actual observed temperatures, recent load data, and the latest customer counts.

A. Data

We developed a representative distribution of hourly temperatures based on data from January 1, 1950 to December 31, 2003. Actual hourly delivered electric loads between January 1, 1994 and December 16, 2004 were used to develop the statistical relationship between temperatures and loads for estimating hourly electric demand based on a representative distribution of hourly temperatures.

B. Methodology for Distribution of Hourly Temperatures

The above temperature data were sorted and ranked to provide two separate data sets:

- For each year, a ranking of hourly temperatures by month, coldest to warmest, over 54 years was used to calculate average monthly temperature.
- A ranking of the times when these temperatures occurred by month, coldest to warmest; these rankings were averaged to provide an expected time of occurrence.

Next we found the hours most likely to have the coldest temperatures (based on observed averages of coldest-to-warmest hour times) and matched them with average coldest-to-warmest temperatures by month. Sorting this information into a traditional time series then provides a representative hourly profile of temperature.

C. Methodology for Hourly Distribution of Load

For the time period January 1, 1994 to December 31, 2003, we used the statistical hourly regression equation:

$$\hat{L}_h = \vec{\beta}_{1,d} \cdot DD_d + \alpha_1 L_{h-1} + \alpha_2 \left(\frac{L_{h-2} + L_{h-3} + L_{h-4}}{3} \right) + \left(\vec{\alpha}_{3,m} T_h + \vec{\alpha}_{4,m} T_h^2 \right) + \vec{\beta}_{2,d} Hol + \alpha_5 P^{(1)}(h)$$

for h from 1 to 24 to calculate load shape from the representative hourly temperature profile. This means that a separate equation is estimated for each hour of the day.

$\hat{L}_h =$ Estimated hourly load at hour "h"
L_h = Load at hour "h"
L_{h-k} = Load "k" hours before hour "h"
T_h = Temperature at time "h"
T_h^2 = Squared hourly temperature at time "h"
$P^{(1)}(h)$ = 1st degree polynomial
Hol = NERC holiday dummy variables

All Greek letters again denote coefficient vectors.

Electric Resource Alternatives

This section is designed to provide a brief overview of technology alternatives for electric power generation. It encompasses mature technologies but emphasis is placed on new methods of power generation with near- and mid-term commercial viability.

All data has been gathered from public sources except where noted, and in these instances is non-sensitive PSE data. It should be noted that many data sources are the manufacturers themselves, who may provide optimistic availability, cost, and production figures.

I. Demand-side Measures (DSM)

A. Energy Efficiency

Energy efficiency is defined as a technology that demonstrates the same performance for a given task as competing technologies, but requires less energy to accomplish the task.

Discretionary Measures

PSE refers to all energy efficiency improvements and upgrades to existing construction as “discretionary measures.” This may include bringing building components up to or beyond code levels, or the early replacement of existing technologies such as lighting or appliances. Similar measures exist for new construction, and are discussed below under Lost Opportunities.

Lost Opportunity

Lost opportunities refer to the moment when a customer is making a decision about acquiring new equipment. Once the purchasing decision is made, there will not be another opportunity to influence the decision towards an energy efficient technology. When new buildings are being built, the construction phase is the best time to install the most efficient measures. Also, when a customer needs to purchase new equipment, savings can be gained by purchasing high-efficiency models.

Codes and Standards

Any codes and standards with energy efficiency provisions that have been passed at the time of the 2009 IRP and slated to go into effect in the future are incorporated as non-programmatic energy efficiency savings. These are savings that impact the load growth at no cost to the company.

Lighting

Switching from highly inefficient incandescent lighting to fluorescent lighting can result in significant savings. Lighting measures for typical household applications are categorized by use: low (1 hour per day), medium (2.5 hours per day), and high (4 hours per day) represent frequency of use.

Heating, Ventilation, and Air-Conditioning (HVAC)

Measures associated with the HVAC system improve the overall heating and cooling loads on a building. They include measures such as a high efficiency DX cooling package and programmable thermostats.

Building Envelope

"Building envelope" measures improve the thermal performance of a building's walls, floor, ceiling or windows. The baseline technology and the energy efficiency upgrades are discussed below. Building envelope energy efficiency measures include insulation (ceiling/roof, wall, and floor) and windows.

Domestic Hot Water

In addition to a more efficient water heating system, any equipment measures that require less hot water are also included in the domestic hot water measures below.

Plug Load

ENERGY STAR® rated plug-in loads reduce the overall electric load of a household compared to standard equipment. This measure identifies the specific plug-in equipment. The following list includes both typical household entertainment equipment and home-office equipment. Office equipment such as computers, monitors, and printers can all be ENERGY STAR® classified, indicating lower energy use than conventional equipment. Savings is achieved, in part, because the machine is equipped with a standby mode.

B. Fuel Conversion

When customers switch from electricity to natural gas, particularly in the case of space and water heating, electrical savings are gained from the reduction in electrical energy use.

Fuel conversion measures, specifically water heaters, space heaters, zone heaters, ranges and dryers, fall under the Lost-Opportunity Equipment category, as described above.

C. Distributed Generation

Distributed generation refers to small-scale electricity generators located close to the source of the customer's load.

Non-renewable Distributed Generation

Combined Heat and Power. Combined heat and power (CHP) plants are a more energy-efficient use of non-renewable generation units. A CHP starts with a standard non-renewable generator, but improves the overall utility by capturing the waste heat produced by the generator. For example, a typical spark-ignition engine has an electrical efficiency of only about 35%. The "lost" energy is primarily waste heat. A CHP unit captures much of this waste heat and uses it for space heating or domestic hot water. Thus, there are cost savings for the water heating in addition to electricity generation. Three-engine generator technologies are considered for use with CHP: reciprocating engines, micro-turbines and fuel cells.

Renewable Distributed Generation

Renewable generation encompasses all generation that uses a renewable energy source for the fuel; in other words, a fossil fuel is not consumed. There are two main categories of renewable generation: biomass and clean energy.

Biomass. Sometimes referred to as "resource recovery," biomass is used as the fuel to drive a generator. The source of the biomass can vary, but can be broadly categorized into "industrial biomass" or "anaerobic digesters."

Clean Energy. Generation that is achieved without the consumption of a hydrocarbon fuel. The two main sources for clean energy are wind and solar photovoltaics (PV).

D. Demand Response

Demand-response (or demand-responsive) resources are comprised of flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. Development of Smart Grid in the future will enable the automation of demand response resources, thereby enhancing the value, benefits and flexibility of such resources. Acquisition of demand-response resources may be based on either reliability considerations or economic/market objectives. Objectives of demand response may be met through a broad range of price-based (e.g., time-varying rates and interruptible tariffs) or incentive-based (e.g., direct load control, demand buy-back, and dispatchable stand-by generation) strategies. In this assessment, we considered five demand-response options: Direct Load Control, Critical Peak Pricing, Curtailable Rates, Demand Buyback, and Distributed Standby Generation.

PSE issued two demand response Request for Proposals (RFP) in 2007 and 2008. The first was a commercial sector demand response pilot issued in August 2007. We received two proposals and awarded one contract. PSE issued a second demand response RFP for the residential sector in November 2008. We received nine proposals, and four have been shortlisted.

E. Distribution Efficiency

Distribution efficiency resources are comprised of phase balancing and conservation voltage reduction. Phase balancing eliminates total current flow losses, also known as I^2R losses, in the three phases of an unbalanced distribution system. Therefore, a concerted effort to balance phases can reduce energy loss. Conservation voltage reduction is the practice of reducing the voltage on distribution circuits to reduce energy consumption. At reduced voltages, many appliances and motors can perform properly while consuming less energy.

II. Solar Energy

Solar energy is the harnessing of the sun's energy to create electricity or heat. Solar energy is generated in two major ways: using photovoltaics to directly convert sunlight to electricity, and using solar thermal technologies to convert the sun's energy to heat. Solar technologies have been around for decades, but these technologies have grown rapidly over the past several years as demand for renewable energy sources increases, and improved technologies and manufacturing volumes have reduced costs. At this time, solar technologies can be cost competitive in some markets where subsidies are available.

PSE's Wild Horse solar project is a demonstration of the potential for solar power output in Washington state. Located at the Wild Horse Solar Facility in Kittitas County, it was completed in 2008 and produces an output of up to 500 kW at peak performance (full sun), which is enough to serve approximately 300 households. This facility uses fixed-angle, multicrystalline photovoltaic solar-panel technology, and has the ability to produce power under cloudy skies (roughly 50% to 70% with bright overcast, and 5% to 10% with dark overcast). This project is currently the largest solar facility in the Pacific Northwest.

All solar energy used for electric generation qualifies as renewable energy under Washington's renewable portfolio standard.

A. Photovoltaics

Description of Technology

Photovoltaic (PV) cells are semiconductors which convert sunlight into electricity and represent the overwhelming majority of solar installations to date. PV currently comes in two major types, crystalline silicon and thin-films.

Crystalline silicon solar cells are manufactured from ingots of silicon grown in specialized silicon plants, similar to computer chips. These ingots are sliced into wafers and contacts are added to create solar cells. Multiple solar cells are typically joined together and encapsulated in panels.

Thin-film PV panels are made of films of semiconductor material deposited onto a substrate. The common types of thin-film PV are non-crystalline amorphous silicon (a-Si), cadmium telluride (CdTe), and copper indium gallium diselenide (CIGS). Common substrates include glass and plastic. Because of the flexibility of some substrates, large panels are easier to make, and these thin-films can be incorporated into other products, such as building materials.

Organic photovoltaics are an emerging technology, manufactured from inexpensive organic materials. They are yet to be commercialized in large volumes, but are being developed both by private industry and in universities and government labs.

The different types of solar photovoltaics have different advantages. Crystalline silicon solar cells have the highest efficiencies, typically 15% to 20%. Thin-films have a lower efficiency than crystalline silicon cells, ranging from about 7% to 13%. However, with the lower efficiency comes a lower cost. Thin-film costs are approximately 50 cents to 70 cents per watt less than multi-crystalline[1]. Due to the lower efficiency, a greater area of thin film panels is required to create the same power output as crystalline silicon panels. Competing with thin films, a relative undersupply of silicon has kept silicon PV prices high recently, but a new wave of PV-specific silicon plants is expected to cause a price drop in the coming years.

Solar panels do have some degradation of their output over time, but all come with manufacturer warranties guaranteeing their power curve for 20 to 25 years. PV panels generate DC power and require an inverter to switch to AC power. Typically, the losses for wiring and inversion in a PV system give the system an overall 80% efficiency from DC output of the panel to AC power.

Opportunities in Puget Sound Region

In the Seattle area, average sunlight is around 3.7 kWh per m^2 per day (11% CF), contrasting with the eastern half of Washington, where sunlight is significantly better at around 4.8 kWh per m2 per day (15% CF).[2]

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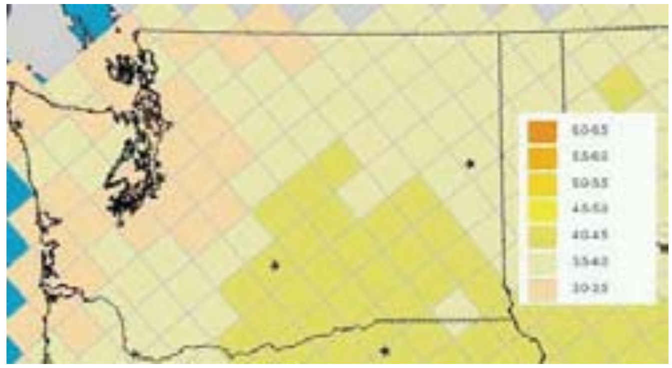
[1] Solarbuzz, retrieved 1/26/09.
[2] PV Watts, flat plate fixed at latitude for Seattle and Yakima and Frank Vignola, Univ. of Oregon

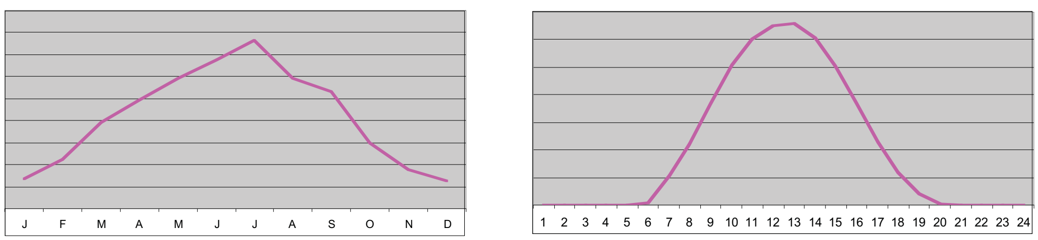
Figure F-1
Sunlight Averages for Washington State

Currently, solar projects are not eligible for Production Tax Credits, but are eligible for a 30% Investment Tax Credit. Recent changes extended this tax credit until 12/31/2016 and made it eligible to utilities and businesses. Washington state recently passed legislation that provides a solar production incentive ranging from $150 to $540 per MWh but that is capped at $2,000 per project. Solar projects receive five-year MACRS and are exempt from Washington sales tax.



Source: National Renewable Energy Laboratories (NREL)

Figure F-2
Washington State Solar Irradiance



Annual Energy Shape (% by month)

Daily Energy Shape (% by Hour)

Notable Companies

Crystalline silicon cell and panel manufacturers	Q-Cells, Sharp, Kyocera, Suntech, BP, QCell
Thin-film manufacturers	Uni-Solar, First Solar
Developers	SunPower, SunEdison

Figure F-3
Solar Photovoltaic Key Metrics

Capital Cost w/o subsidies ($/kW)	Levelized Cost w/o subsidy ($/MWh)	Typical Installation Size (kW)	Expected Life (years)
$3,500 – $10,000	$300 - 800	3 – 15,000	20 – 25+

Source: Public Press for Large Scale Installations, Contractor estimates, PSE experience

B. Thermal and Concentration Technologies

Technology Descriptions

Thermal and concentration technologies use mirrors or lenses to concentrate direct sunlight onto a receiver. Solar thermal technologies capture the heat of the sunlight, which is then used to create steam and drive a traditional steam turbine. Concentrating photovoltaics use a high-efficiency PV cell to directly convert the concentrated sunlight to electricity. All thermal and concentrating technologies share a common characteristic of only being able to utilize direct sunlight, unlike photovoltaics, which can use both direct and diffuse sunlight. This reduces the solar energy they can harness in Washington state by about 30%. All such systems track the sun on at least one axis. Generally, solar thermal technologies are best suited for commercial or utility scale installations, as they require large installations and complicated mechanical equipment. Concentrating PV is being developed at residential scale through utility scale.

To date, solar thermal trough technologies are the most developed, with over 300 MW in service since the 1990s. The other thermal and concentrating technologies have been limited to testing or pilot installations to date, some dating back decades. Many of these technologies have commercial installations proposed.

Figure F-4
Solar Thermal and Concentration Technologies

Solar Thermal Troughs

Parabolic mirrored troughs concentrate energy onto a receiver pipe to heat a carrier fluid to temperatures up to 500 degrees C. This heated carrier fluid is then used to create steam, which is run through a steam turbine to generate power. Approximately 300 MW of solar thermal troughs are installed in California in the SEGS I – IX facilities. These were built in the 1980s and are still in operation today. There was a lull in construction of the last SEGS facility until the last two years, when several small facilities and the 64 MW Nevada Solar One facility were brought online. Additional plants have been proposed in Nevada, Arizona, and California, including the 280 MW Solana plant in Arizona, and the 553 MW Mojave Solar Park Project in California. In addition, new troughs were recently added to the SEGS systems.

Internationally, the 50 MW Andasol 1 plant started commercial operation in later 2008, and two more Andasol plants in Spain are under construction.

Solar Thermal Trough systems have the promise of including energy storage as heat. The Andasol facility in Spain is including approximately seven hours of storage, and the Solana Plant planned for Arizona will incorporate thermal storage.

Compact Linear Fresnel Reflectors

Compact Linear Fresnel Reflectors (CLFR) function similarly to solar trough systems, but instead of using large parabolic curved mirrors, these systems use motors to adjust several flatter mirrors to focus sunlight onto the receiver pipes. Some of the current systems directly generate steam in the receiver pipes, instead of using an intermediary carrier fluid. A 5 MW facility was recently commissioned in California, and a 177 MW facility is planned there.

Hybrid Solar and Thermal Plants

Several hybrids incorporating a traditional thermal generating plant with solar collectors to provide additional heat have been proposed. These include combinations with gas turbines and with biomass. The Liddell Station Coal Plant in Australia incorporates a solar thermal system to increase output. The 75 MW Martin Next Generation Solar Energy Center in Florida is under construction.

Power Towers

Power towers use a field of mirrors to focus the sun's direct rays on a central receiver. The focused sun heats a carrier fluid, which is then used to heat water into steam that drives a steam turbine to generate power.

Solar One was the first installation. It was built by the Department of Energy in 1981 and operated from 1982 to 1986. This facility was renamed Solar Two in 1995, when it was rebuilt to include additional mirrors and thermal storage in molten salt. The facility was decommissioned in 1999.

Power towers have the ability to focus more sun on the heat collecting fluid than trough systems, increasing the temperature and thus raising the efficiency of the system. They also have a smaller circulating loop for the heated fluid, minimizing required piping and heat losses. Historically, some of the problems with power towers have been maintaining the fine focus of the mirrors on the receiver, keeping mirrors clean, and the high-temperature materials used for the receiver and associated equipment.

Recently, power towers have seen renewed interest, with over 600 MW proposed in California.

Dish Engine Systems Dish engine systems are comprised of a dish of mirrors that concentrate sunlight onto a heat-driven Stirling engine. This engine technology has been proven in space programs for many years, but is yet to be rolled out in large scale manufacturing. Several manufacturers are testing their facilities in the United States, notably at Sandia National Labs and in Washington state. Several California utilities signed large PPA agreements in 2005, but it is unclear if the facilities will ultimately be built.	
Concentrating Photovoltaics Concentrating photovoltaics use a plastic lens or mirror to focus solar energy on a small high-efficiency PV cell, thus reducing the number of PV cells needed. The added heat has reduced the efficiency of the cells in some applications. The system pictured here is a 25 kW Amonix concentrating system built in 2006 in Nevada. A significant number of startup companies are focusing on commercializing concentrating photovoltaics for applications ranging from utility scale installations to individual rooftops.	

Notable Companies

Solar Thermal Trough	Acciona, Solel, Abengoa
Compact Linear Fresnel Reflectors	Ausra, Skyfuel
Power Tower	eSolar, Brightsource
Dish-Engine	Sterling Energy Systems, Infinia
Concentrating PV	Amonix, SolFocus, Sol3G, Greenvolts

Note, the limited number of installations in the market limit the accuracy of cost estimates.

Figure F-5
Solar Trough Key Metrics

Technology	Capital Cost ($/kW)	Levelized Cost ($/MWh)	Typical Installation Size (kW)	Expected Life (years)
Solar Thermal Trough[3]	$4,950	$220	25-50,000	20
Compact Linear Fresnel Reflectors	Unavailable	Unavailable	Unavailable	Unavailable
Power Tower	Unavailable	Unavailable	Unavailable	Unavailable
Dish-Engine	Unavailable	Unavailable	Unavailable	Unavailable
Concentrating PV	Unavailable	Unavailable	Unavailable	Unavailable

Source: 3

[3] Based on Nevada Solar One and Solar Tres announced capital costs

III. Biomass

The term biomass generally applies to a fuel source (or feedstock) rather than a specific generation technology. Biomass fuels are organic materials that can vary dramatically in form. Biomass fuels, biomass fuel sources, and the generation technologies used for biomass are widely diverse. Biomass fuels include but are not limited to wood residues, spent pulping liquor, agricultural field residues, municipal solid waste, animal manure, and landfill and wastewater treatment plant gas. Biomass fuel resources and power generation technologies are listed in Figures F-6 and F-7, respectively.

Of the biomass fuel resources listed in Figure F-6, all would qualify as renewable energy under Washington's renewable portfolio standard, with the exception of municipal solid waste, pulping chemical recovery (pulping liquor), and crops grown on land cleared from old growth or first growth forests after December 7, 2006. Modifications are being considered in Washington's legislature that may alter some of these provisions, but have not yet been finalized. All of the power generation technologies listed in Figure F-7 are eligible as renewable energy under Washington's renewable portfolio standard.

Figure F-6
Biomass Fuel Resources

General Classification Biomass Type	Brief Description
Forest Products:	
- Forest Residue - Mill Residue - Pulping Chemical Recovery	- Logging slash and forest thinning - Wood chips, shavings, sander dust and other large bulk wood waste - Spent pulping liquor used in chemical pulping of wood
Agricultural Resources:	
- Crop Residues - Energy Crops - Animal Waste	- Residues obtained after each harvesting cycle of commodity crops - Crops grown specifically for use as feedstocks in energy generation processes, includes hybrid poplar, hybrid willow, and switchgrass - Combustible gas obtained by anaerobic decomposition of animal manure

Urban Resources:	
- Municipal Solid Waste - Landfill Gas / Wastewater Treatment	- Organic component of municipal solid waste - Combustible gas obtained by anaerobic decomposition of organic matter in landfills and wastewater treatment plants

Figure F-7
Biomass Conversion Technology Types[4]

Technology	Conversion Process Type	Major Biomass Feedstock	Energy or Fuel Produced
Direct Combustion	Thermochemical	wood agricultural waste municipal solid waste residential fuels	heat steam electricity
Gasification	Thermochemical	wood agricultural waste municipal solid waste	low or medium-Btu producer gas
Pyrolysis	Thermochemical	wood agricultural waste municipal solid waste	synthetic fuel oil (biocrude) charcoal
Anaerobic Digestion	Biochemical (anaerobic)	animal manure agricultural waste landfills wastewater	medium Btu gas (methane)
Ethanol Production	Biochemical (aerobic)	sugar or starch crops wood waste pulp sludge grass straw	ethanol
Biodiesel Production	Chemical	rapeseed soy beans waste vegetable oil animal fats	biodiesel
Methanol Production	Thermochemical	wood agricultural waste municipal solid waste	methanol

[4] http://egov.oregon.gov/ENERGY/RENEW/Biomass/BiomassHome.shtml

There is a wide array of technologies for converting biomass into power, fuel or heat. New and existing technology for using wood fuel effectively to produce power generation can be generally classified as direct combustion, co-firing, and gasification.

Direct combustion is the oldest and most proven technology. Most of today's biomass power plants are direct-fired systems, similar to most fossil fuel-fired power plants. The biomass fuel is burned in a boiler to produce high-pressure steam. This steam is then introduced into a steam turbine generator. Biomass power boilers are typically in the 20 MW to 50 MW range. While steam generation technology is very dependable and proven, its efficiency is limited. The small capacity plants tend to be lower in efficiency because of economic trade-offs and the variability and moisture contents of fuel sources limit the efficiency of the fuel. Typical plant efficiencies are in the low 20% range.

Co-firing involves substituting biomass for a portion of coal in an existing power plant furnace. It is the most economic near-term option for introducing new biomass power generation. Because much of the existing power plant equipment can be used without major modifications, co-firing is far less expensive than building a new biomass power plant. Compared to the coal it replaces, biomass reduces sulfur dioxide, nitrogen oxides, and other air emissions, though tuning and pollution controls may still be required.[5] After "tuning" the boiler for peak performance, there is little or no loss in efficiency from adding biomass. This allows the energy in biomass to be converted to electricity with the high efficiency (in the 33% to 37% range) of a modern coal-fired power plant. Most co-firing plants operate with small amounts of biomass input to limit ash generation and slagging.

Gasification is the process of heating organic materials in an oxygen-starved environment until volatile pyrolysis gases (carbon monoxide and hydrogen) are released from the wood. Depending on the final use of the typically low-energy wood gas, the gases can be mixed with air or pure oxygen for complete combustion and the heat that is produced can be transferred to a boiler for energy distribution. Otherwise, the gases can be cooled, filtered, and purified to remove tars and particulates and used as fuel for internal combustion engines, micro turbines, and gas turbines. The use of pure biomass gas in a combustion turbine is in early research. Biomass Integrated Gasification Combined Cycle (BIGCC) technologies have been experimented with, but they are not yet commercially viable. Demonstration projects include the McNeil Power Plant in Burlington, Vt.

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[5] http://www.eia.doe.gov/oiaf/analysispaper/biomass/

Pyrolysis is the process of heating solid materials in an oxygen-starved environment until volatile gases are released and the solid material starts to break down and volatilize. This creates a synthetic gas that can be condensed for refining into liquid fuels, as well as charcoal that can be further burned in another process. Depending on the temperature and length of the heating, the degree to which the material is volatilized is affected. Pyrolysis is being used somewhat for production of liquid fuels.

Anaerobic Digestion uses naturally occurring bacteria and other microorganisms to quickly degrade organic slurries, often animal manures or activated sludges in wastewater treatment plants. This degradation is done in an environment with limited oxygen, which causes the bacteria to release methane and other gases as a byproduct of decomposition. These gases typically have a heat content of about 500 to 600 btu per cubic foot, about half of the heat content of natural gas. The gases can be filtered and combusted in a boiler or internal combustion engine. These gases have been used to generate power and fuel vehicles.

Figure F-8
Biomass Power Technology Types[6]

Biomass Type	Technology	Size
Solid Fuels (agricultural, municipal solid waste, forest residue, mill residue)	Direct fired / steam turbine or Direct co-fire with coal	5, 10, 25, 50, 100 (MW) 7.5, 15, 30 (MW)
Biogas/Manure	IC-engine	65, 130, 650, 750 (kW)
Biogas/Landfill	IC-engine	1, 5 (MW)

As shown in Figure F-8 above, biomass generation can range from very small scale to utility scale power production. The diverse biomass fuel types and technology choices make biomass a complex resource to analyze for an electrical generation resource. There are many factors and determinates to consider before choosing biomass generation. Providing cost estimates for wood energy systems requires flexibility and a technical understanding that costs fluctuate widely depending on the site requirements and present site capabilities.

[6] http://www.westgov.org/wga/initiatives/cdeac/Biomass-full.pdf, PSE Experience

Like most combustion technologies, biomass generation's high energy cost is largely driven by the cost of the fuel itself. The technology also has a high capital cost, and is only half as efficient as a combined cycle gas turbine of similar size.

Biomass is a widely distributed resource. Fuel competition and transportation costs typically preclude the construction of power plants with capacities greater than 50 MW. Many existing biomass plants in the Northwest function as cogeneration facilities sited adjacent to a forest products plant. Most pulp and paper mills, and some sawmills, use waste biomass from their processes to fire boilers. The high-grade steam from these boilers is used to generate power, and then the lower-grade steam is reused for process heat. Most future power plants fueled by dry biomass resources are likely to be in the range of 15 MW to 30 MW. The local market for available supply of wood may limit the benefits of burning wood fuel. Hauling wood biomass from outside a 50-mile radius is usually not economical.

Many existing biomass plants source their biomass from waste forest products, and the availability and pricing of hog fuel used for many existing biomass facilities fluctuates with the productivity of the forest products industry. A rigorous life-cycle analysis is necessary to fully understand the fuel supply chain and options to diversify fuel supply. Initial costs of wood biomass generation facilities are typically 50% greater than those of a fossil fuel generation system due to the fuel handling and storage system requirements, and ongoing labor costs are higher as there are additional fuel handling systems to be maintained.

Biomass power is reliable base load electric power, but cannot easily perform load-following. Further, because many biomass facilities in the northwest are configured as cogeneration facilities, these may not be routinely dispatched due to process needs of the steam host and the inherent limitations of a combustion/steam-cycle power plant.

Obvious benefits may be gained by burning wood residues to reduce a manufacturer's fuel oil and electricity bill. These benefits may be offset by high capital costs, low plant efficiency, and increased maintenance levels. Of course, the economics of wood waste energy generation becomes more attractive as traditional fuel prices increase and as reliable biomass sources are available at competitive prices.

There are 45 potential sources of biomass in Washington state, according to a December 2005[7], report, "Biomass Inventory and Bioenergy Assessment: An Evaluation of Organic Material Resources for Bioenergy Production in Washington State." Categories included field residues, animal manures, forestry residues, food packing/processing waste, and municipal wastes. The report states that Washington has an annual production of over 16.9 million tons of underutilized dry equivalent biomass, which is capable of producing, via assumed combustion and anaerobic digestion, approximately 1,769 MW of electrical power. Looking to just forestry resources (mostly mill residues and pulping recovery), the totals are approximately 945 MW. This study does not consider economic or commercial issues. Therefore, these results seem to be extremely aggressive and the report is based on the absolute potential, not viable or economic potential.

Several new biomass power projects have been developed or proposed in the Northwest recently. Sierra Pacific Resources installed a 23 MW cogeneration facility in Burlington, and plants are planned for Lakeview, Ore., and Warm Springs, Ore.

In addition to traditional biomass power projects, many anaerobic digesters are being built in the Northwest. These typically have capacities ranging from 500 kW to 2 MW. In Washington state, digesters are operating in Lynden, Sunnyside, and Monroe, and an additional digester is under construction in Mount Vernon.

During PSE's 2004 and 2006 RFP cycles, we received and evaluated three proposals for biomass cogeneration totaling 100 MW. We received no proposals for biomass facilities during the 2008 RFP cycle. Considering the impact of the Washington state Renewable Portfolio Standards (RPS), and the potential demand for diverse renewable resources, biomass may look more economically attractive as the demand grows, though it is expected to continue to be tied to the forest products industry in the near term.

Additional References:

- http://www.fpl.fs.fed.us/tmu/wood_for_energy/wood_for_energy.html
- http://www.nwcouncil.org/energy/powerplan/5/Default.htm
- http://www1.eere.energy.gov/biomass/
- http://www.nrel.gov/biomass/
- http://www.eia.doe.gov/oiaf/analysispaper/biomass/
- http://www.calbiomass.org/
- http://www.energytrust.org/bio/
- http://www.pacificbiomass.org/

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[7] http://www.pacificbiomass.org/documents/WA_BioenergyInventoryAndAssessment_200512.pdf

IV. Fuel Cells

Fuel cells have been touted for their potential as an alternative to the internal combustion engine, but are examined here predominantly for their application in stationary power generation. The United States is a dominant fuel cell developer. The market for large fuel cell generation (>10 kW) is dominated by four types of cells: phosphoric acid, solid oxide, proton membrane exchange, and molten carbonate. Prices remain uncompetitive at around $4,500 per kW, although a new unit marketed at $2,500 per kW is expected to come on the market in 2009, and the Department of Energy (DOE) has set a target of $400 per kW by 2010.[8] [9]

Most fuel cells today operate using natural gas or hydrogen. Because of the fuel source, these would not be considered renewable energy sources under Washington's renewable portfolio standard. However, if a renewable fuel source such as anaerobic digester gas from a wastewater treatment plant was used as a fuel, the energy would count as renewable in Washington state.

A. Phosphoric Acid Fuel Cells (PAFC)

PAFC technology was the first to market and remains the most common. PAFC cells are limited to stationary applications as they are large, heavy, expensive, and slow to start. Their advantages in maturity and lifespan, however, have given PAFC the largest market share in stationary applications. PAFC fuel cells are predominantly manufactured by United Technologies and Fuji.

B. Proton Exchange Membrane Fuel Cells (PEMFC)

PEM fuel cells are generally thought to be the technology of choice for mobile applications, but have more limited roles in stationary situations. PEM fuel cells operate at much lower temperatures and have a long lifespan, but require an expensive platinum catalyst. PEM cells are very sensitive to fuel impurities and require pure hydrogen. Ballard Power Systems of Vancouver, B.C. is a world leader in PEM fuel cell development, although many auto manufacturers also conduct their own PEM research.

[8] Fuel Cell Today, http://www.fuelcelltoday.com/media/pdf/surveys/2008-LS-Free.pdf
[9] DOE, http://www.fossil.energy.gov/programs/powersystems/fuelcells/

Ballard markets a stand-alone 1 kW unit for sale in Japan that includes a natural gas reformer and co-generates hot water and power.

A type of PEM cell, the direct methanol cell, is being tested for small portable applications, such as laptop computers. By using methanol, or another liquid fuel, energy density is increased and compression requirements decreased over PEMs fueled directly with hydrogen. Larger PEM cells have typically not used liquid fuels due to the availability of hydrogen and the added expense and maintenance associated with reforming other fuels into hydrogen for use in the PEM cell.

C. Molten Carbonate Fuel Cells (MCFC)

MC fuel cells operate at much higher temperatures, but also much higher efficiencies than phosphoric acid fuel cells. The higher temperature of molten-carbonate fuel cells functions as an internal reformer and allows it to internally reform a variety of gasses, but also lengthens start-up and shut-down. Among the world's largest MCFCs is a 1 MW demonstration plant in Renton, Wash. at the South Wastewater Treatment Plant which operated from 2004 to 2006[10]. This demonstration used both gas from anaerobic digesters at the plant, and natural gas from PSE. The Environmental Protection Agency provided approximately $12.5 million of the $22 million project cost. The largest challenge with MCFC is to lengthen the lifespan of the fuel cell stack, which has lower durabilities (8,000 hours) due to the high temperature of operation.

D. Solid Oxide Fuel Cells (SOFC)

SO fuel cells operate at higher temperatures than MCFCs, and accept an even wider variety of fuels.[11] In addition, the high temperature precludes the need for noble metal catalysts, reducing costs.[12] SOFC technology is still in early stages of development but is expected to have an increasingly important role in stationary applications. Figure D-9 shows the number of new large scale fuel cell projects by technology type and the rise of SOFC starting in 2003. Cogeneration systems are particularly attractive with solid oxide cells, due to the high operating temperature. See Figure F-9.

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[10] King Country, http://www.kingcounty.gov/environment/wastewater/EnergyRecovery/FuelCellDemonstration/Library.aspx
[11] E-sources, http://www.e-sources.com/fuelcell/fuelcell-intro.htm
[12] CEA, http://www.cea.fr/var/cea/storage/static/gb/library/Clefs50/pdf/087a091giraud-gb.pdf

Figure F-9
Fuel Cell Operating Temperatures and Efficiencies

Fuel Cell Type	Development Stage	Projected Efficiency (w/heat recovery)	Operating Temp. (°C)	Lifespan (hrs)	Fuels
Phosphoric Acid	Commercial	40% (85%)	150-200	40,000 - 60,000	Hydrogen Natural Gas
Proton Exchange Membrane (PEMFC)	Demonstration	25-35% (70-90%)	50-100	40,000	Hydrogen Methanol
Molten Carbonate (MCFC)	Demonstration	45% (80%)	600-700	5,000-20,000	Hydrogen Methane Natural Gas
Solid Oxide (SOFC)	R&D	40% (90%)	600-1000	20,000	Hydrogen Methane Natural Gas

Sources: 13, 14, 15

[13] DOE, http://www.eere.energy.gov/hydrogenandfuelcells/fuelcells/pdfs/ fc_comparison_chart.pdf
[14] Siemens, http://www.powergeneration.siemens.com/products-solutions-services/products-packages/fuel-cells/
[15] Dr. Karl Kordesch, http://www.electricauto.com/fc_compare.html

V. Water Based Generation

Water based generation can be broken into four distinct categories: hydroelectricity, wave energy, tidal or in-stream energy, and ocean thermal conversion.

A. Hydroelectricity

Large scale impoundment and diversion hydroelectricity is the backbone of power generation in the Pacific Northwest. However, large-scale projects are now difficult to build because of their large capital costs, regulatory burdens and environmental concerns.

Smaller scale hydroelectricity, on the other hand, has received attention due to its somewhat smaller implementation barriers. The DOE defines “small” hydropower as generation capacity less than 30 MW, while “micro” hydropower refers to anything less than 100 kW.[16] In one example, Crown Hill Farm in Oregon successfully installed 25 kW of micro-hydro capacity. To do so, they invested $100,000 and dealt with 12 government bureaus over the course of 18 months.[17] PSE currently has 4 customers that have installed micro-hydro systems connected to PSE. In addition, we hold long-term contracts with 8 small hydro systems in our service area.

Under Washington’s existing renewable portfolio standards, only efficiency upgrades to existing hydroelectric plants count as renewable energy. These efficiency upgrades must be completed after March 31, 1999 and cannot result in new impoundment of water.

B. Tidal and In-Stream Energy

For the purpose of this brief, river in-stream energy and tidal energy are viewed as equivalent, as the equipment and siting processes are expected to be similar. The roots of tidal energy are related to the development of wind energy resources. Both technologies rely upon a multi-blade rotor to supply rotational energy to a generator. As with wind turbines, a speed increaser is required due to the physical limitations of the generator size and rotor diameters.

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[16] DOE, http://www1.eere.energy.gov/windandhydro/hydro_plant_types.html
[17] Oregen DOE, http://egov.oregon.gov/ENERGY/CONS/BUS/docs/CrownHill.pdf

Most tidal energy development appears to be centered on the conventional "open" turbine that is very similar to contemporary wind turbines: a "ducted" turbine where the turbine blades are enclosed within a venturi shape, or a hybrid Gorlov design with its characteristic spiral shaped turbine blades.

Figure F-10
Examples of Tidal Turbine Designs

When compared with wind turbines, tidal energy has two unique advantages: its predictable nature; and the possibility of using smaller rotor diameters for the same power output (owing to the mass flow density differences between air and water). Tidal currents are also bi-directional, which requires some of these turbine designs to pivot 180º to generate energy when the tidal current reverses its direction on the following tide cycle, while others have been designed to capture the tidal flows from both directions from a fixed position. While tidal generation is anticipated to be very predictable, it is not expected to have a significantly greater capacity credit than wind since its output over time may not correlate with high load hours.

Tidal power continues to face significant technical, environmental, and legal challenges. Generation equipment remains in testing phases, and the industry has not consolidated to a common design, as the wind industry has. Project permits in the United States are spread between federal, state, and local agencies, and a formal process has not yet been designed. Finally, subsidy and development programs vary considerably from state to state and country to country.

Tidal energy would count as renewable energy under Washington's renewable portfolio standard.

Globally, testing of tidal generation equipment is underway at several locations; notably the Strangford Lough in Ireland, the Roosevelt Island Site in New York, the European Marine Energy Center in Scotland, the Western Passage in Maine, the Hastings Dam in Minnesota, and Vancouver Island, B.C. Several developers are calling their sites "commercial." To date, however, none of these sites has been built out to its planned scale.

Nationally, the Federal Energy Regulatory Commission (FERC) has granted 29 preliminary permits for tidal energy projects, and another 115 preliminary permits for in-river projects as of early 2009.

In the Puget Sound region, preliminary permits for development of tidal energy are held by Snohomish County PUD for seven sites, shown in the table and maps below. Snohomish County PUD is working on feasibility studies for these sites, and is planning a test installation at one of the sites, likely Admiralty Inlet, by about 2015. Tacoma Power holds a preliminary permit for the Tacoma Narrows. After completing several feasibility studies, Tacoma Power has decided not to move forward with further activities in the narrows.

Figure F-11
FERC Preliminary Permits for Tidal Energy Locations within Puget Sound

FERC ID#	Location	Developer	Estimated Annual Output[18]	Equivalent Wind Farm (30% CF)
12687	Deception Pass	Snohomish Co. PUD	20,700 MWh	7.9 MW
12688	Rich Passage	Snohomish Co. PUD	8,560 MWh	3.3 MW
12689	Spieden Channel	Snohomish Co. PUD	32,470 MWh	12.4 MW
12690	Admiralty Inlet	Snohomish Co. PUD	146,200 or 75,600 MWh[19]	55.6 MW
12691	Agate Passage	Snohomish Co. PUD	340 kW[20]	0.3 MW
12692	San Juan Channel	Snohomish Co. PUD	33,270 MWh	12.7 MW

[18] The estimated annual outputs are as reported in the preliminary permit applications submitted to FERC.
[19] The estimated annual output by Snohomish County PUD for the Admiralty Inlet location depends on the transect where the turbines are installed within Admiralty Inlet. The Point Wilson to Admiralty Head transect was estimated at 146,200 MWh and the Bush Point to Nodule Point transect was estimated at 75,600 MWh.
[20] Snohomish County PUD did not report an estimated annual output for the Agate Passage location.

FERC ID#	Location	Developer	Estimated Annual Output[18]	Equivalent Wind Farm (30% CF)
12698	Guemes Channel	Snohomish Co. PUD	28,500 MWh	10.8 MW
12612	Tacoma Narrows	Tacoma Power	120,000 MWh	45.7 MW

Figures F-12 and F-13 map of the various Puget Sound locations.

Figure F-12
Puget Sound Tidal Energy Locations with FERC Preliminary Permits
North Sound Map

Source: www.pstidalenergy.org, March 2007

Map Key:

1. Admiralty Inlet
2. Deception Pass
3. Guernes Channel
4. San Juan Channel
5. Spieden Channel

Figure F-13
Puget Sound Tidal Energy Locations with FERC Preliminary Permits
Central Sound Map

Source: www.pstidalenergy.org, March 2007

Map Key:

6. Agate Passage
7. Rich Pass
8. Tacoma Narrows

Also in Puget Sound, but not under FERC jurisdiction, is a small, ducted tidal energy device developed by Clean Current Turbines and deployed at an ecological preserve located at the southeastern corner of Vancouver Island in British Columbia. The majority of the funding for this project was provided by EnCana™, a natural gas and oil provider with locations in both Canada and the United States. This project is ongoing, with additional work planned in 2009.

Pearson College provided the host site for the project, and both the government and parks departments of British Columbia provided the necessary permits. The project was originally installed in 2006, and a new turbine was just installed in late 2008. The output of the project is used to power a lighthouse and research facilities on the island.

The Electric Power Research Institute's (EPRI) estimated summary of the economics for a full installation at the Tacoma Narrows is provided in Figure F-14. It is important to note that no commercial installations exist and these estimates are highly theoretical.

Figure F-14
Tacoma Narrows Tidal Plant Cost Estimates

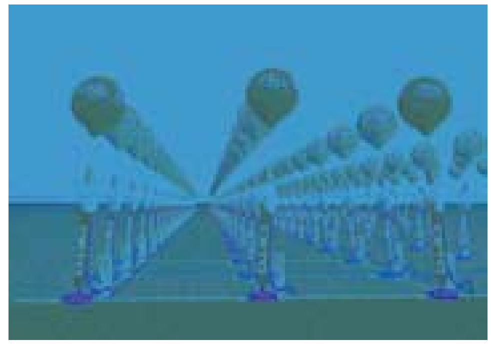
Project	Capital Cost ($/kW)	Levelized Cost ($/MWh)	Commercial Installation Size (kW)	Expected Life (years)	Typical Capacity Factor
Tacoma Narrow Tidal Plant Cost Estimates	$2,300 / kW	$112	16,000	20	35 %

Source: Electric Power Research Institute, EPRI

C. Wave Energy

Wave energy devices are early in development, but have potential for considerable power in the future, as many locations globally have significant wave energies. The major technology types, shown in Figure F-15, are floating point collectors, such as the AquaBuOY and the OSU Permanent Linear Generator, the submerged point collector, such as the CETO, floating linear collectors such the Pelamis Wave Energy Converter, and Oscillating Water Column Generators, such as the Limpet and Oceanlinx.

Figure F-15
Examples of Wave Energy Conversion Devices

Floating Point Collector The AquaBuOY by FINAVERA Renewables 	**Submerged Point Collectors** CETO by Renewable Energy Holdings 
Floating Linear Attenuator The Pelamis Wave Energy Converter by Ocean Power Delivery LTD 	**Oscillating Water Column** The Land Installed Marine Power Energy Transmitter (LIMPET) by Wavegen® 

Floating point collectors use the difference in motion between rising and falling waves and the tethered device to either pressurize a hydraulic system, such as the AquaBuOY, or to move a linear generator, such as the OSU Permanent Linear Magnet Generator Buoy. As an example, the AquaBuOY makes use of two hose pumps that alternately produce streams of water that drive a small Pelton wheel, which in turn drives a generator.

Submerged point collectors such as the Archimedes Wave Swing or the CETO, use a similar principle to a floating point collector using a hydraulic system. The differential motion between the fixed bottom of the collector and the top of the collector, which moves in the waves, drives a hydraulic system that turns a generator. This generator may be located underwater with the device, or on-shore.

Floating Linear Collectors, notably the Pelamis, are the most sophisticated and commercially mature wave energy equipment. These devices use the differential motion of floating buoys to pressurize a hydraulic system. Electrical energy is produced as the flow of oil through the hydraulic system rotates hydraulic motors attached to electrical generators. The key features of the Pelamis design are large cylindrical floats that attach directly to the hydraulic rams within a power module. Each power module is located between a pair of floats and the positions of the hydraulic rams within the power module allow the Pelamis device to convert both the vertical and horizontal movement of the floats into electrical energy. A 2.25 MW commercial facility using Pelamis equipment started operation off the north coast of Portugal in September 2008. Another project is planned off of the coast of Scotland, with a potential commercial operation date in 2009.

Oscilllating Water Column Devices, notably the LIMPET and a device from Oceanlinx, rely upon wave action to initiate airflow through a turbine attached to an engineered structure located at either an on-shore or off-shore location with substantial wave activity. This structure consists of a series of inclined, open chambers with one end submerged in the sea. The wave action results in oscillating water columns inside the structure, which expel air as the wave impinges upon the structure and create a vacuum as the water columns drop during the subsequent trough before the next wave arrives. This, in turn, necessitates a bi-directional air driven power turbine to capture the energy of the air as it is both expelled and drawn back into the engineered structure. The LIMPET, which has a capacity of 500 kW, has been operating along the coast of Scotland since 2000, and a larger installation is planned for an island off Scotland.[21] The Oceanlinx device has a prototype installation operating in Australia, and additional projects planned in Australia, the Cornwall Wave Hub in the UK, Namibia, Hawaii, and Mexico.

Several wave power sites have been proposed for the West Coast of the United States. Gray's Harbor Ocean Energy has applied for a permit for two combination wave and wind generating platforms near Ocean Shores, Wash. In Oregon, Ocean Power Technologies has proposed two projects, one in Reedsport, and the other in Coos County. Douglas County, Ore. is also working on developing a project with Wavegen.Several proposed developments have also recently been abandoned.

[21] http://www.wavegen.co.uk/news-npower-siadar-planningok%20jan%2009.htm

Wave energy does qualify as renewable energy under Washington's renewable portfolio standard.

Wave energy is derived from wind blowing across the sea, which creates waves. As such, wave energy is affected by weather, and is subject to some inherent unpredictability over the longer term. Wave heights and intensities can be predicted several days out, so short-term predictions are possible with reasonable accuracy.

While wave energy technology is perceived to have less potential impact on marine life than its tidal energy counterpart, it still faces similar challenges. As with tidal energy plants, commercial scale wave energy plants will have multiple units, with sophisticated anchoring and power transmission systems. This means each plant will have its own potential impact to the local aquatic environment. Underwater construction challenges, permitting processes with both local and federal agencies, and access to grid interconnection points must also be resolved at each potential wave energy location before the wave energy plant can proceed to commercial scale and become a viable renewable energy resource.

EPRI's estimated summary of the economics for a full commercial installation off the Oregon Coast using a Pelamis machine is provided in Figure F-16. It is important to note that no commercial installations exist, and these estimates are highly theoretical. For instance, the recent Pelamis installation in Portugal had capital costs closer to $6,000 per kW, and the UK Carbon Trust estimates that future installations will have capital costs ranging from $3,375 per kW to $6,747 per kW.

Figure F-16
Wave Energy Plant Cost Estimates

Capital Cost ($/kW)	Levelized Cost ($/MWh)	Commercial Installation Size (kW)	Expected Life (years)	Typical Capacity Factor
$3,375 – 6,747/ kW	$150-240/MWh	90,000	20	40 %

Sources: UK Carbon Trust, EPRI

VI. Waste to Energy Technologies

Waste to energy technology refers to methods of generating heat and power from energy that would otherwise be lost. This includes the collection and use of landfill gas, the incineration of solid waste, and the capture of energy lost in industrial processes. All forms of waste to energy technology are considered green, albeit to varying degrees.

Under Washington's renewable portfolio standard, landfill gas does qualify as a renewable energy resource, but municipal solid waste does not. Under revisions to Washington's renewable portfolio standard, the definitions of wastes and biomass would be clarified to allow some new wastes, such as food wastes, to qualify as renewable energy sources.

A. Landfill Gas (LFG)

The EPA requires the collection of landfill gas (LFG) at nearly all U.S. landfills. They can sell the LFG, or use it to generate electricity. There are approximately 2,400 landfills in the United States. Of these, 658 have landfill gas use projects in operation or under construction. Of these projects, approximately 72% convert the gas to electricity, with a total capacity of 1,600 MW. The actual energy produced from these projects will vary over time, as the gas production of each landfill varies. Washington state has five landfills generating electricity from landfill gas, totaling 15 MW of capacity. The largest of these is the Roosevelt Regional Landfill in Klickitat County. The EPA estimates that King County has nearly 33 million tons of unused waste in candidate landfills, enough for approximately 26 MW of generation.[22]

LFG is comprised of approximately 50% methane, and 50% CO_2, with trace amounts of other gasses. Although combustion of this gas does result in a net increase of greenhouse gasses, it is considered a renewable energy and qualifies for many renewable portfolio standards.

[22] EPA Landfill Methane Outreach Program ("LMOP") Database, http://www.epa.gov/landfill/proj/xls/mopdata.xls

B. Incineration of Municipal Solid Waste (MSW)

Only 14.7% of U.S. municipal solid waste (i.e. common trash) is directly incinerated, from which about 2,500 MW are generated nationwide. The primary reason for incineration is the reduction (up to 90% by volume) of the waste to be landfilled.[23] In nations with limited space or strong mandates, incineration is more common. For example, Singapore incinerates 90% of its municipal solid waste, and Germany banned landfilling of wastes in 2005.[24]

Figure F-17. Emissions Control Improvements

	1992 % of Waste Total		1999 % of Waste Total
Cadmium	35.9%		0.8%
Mercury	17.5%		1.3%
Arsenic	1.2%		1.0%
Chrmomium	9.3%		0.2%
Nickel	1.8%		0.3%
Lead	5.5%		0.1%
Particulates	0.3%		<.1%
Nitrogen Oxides	0.2%		0.2%
Sulphur Dioxide	0.1%		<.1%
Dioxins and Furans [a]	57.3%		4%[b]

[a] I-TEG : International Toxic Equivalent. This is derived as the sum of the Toxic Equivalent Factor (TEF) of all the dioxins and furans present in a mixture. The TEF for each compound is its relative toxicity in relation to the most toxic dioxin 2,3,7,8 - tetrachlorodibenzo-p-dioxin (TCDD)

[b] 1998 Data

Source: UK emissions in detail 1999, National Atmospheric Emissions Inventory

Historically, the public has opposed incineration, predominantly because of environmental concerns. For example, efforts to build a Seattle-area incineration facility were halted in the late 1980s. Although emissions controls have improved significantly since the 1980s (see Figure F-17), public opposition to waste incineration remains. Further, the economic benefits of waste incineration can be limited when landfill fees are low.

C. Other Waste to Energy (WTE) Processes

1. Pyrolosis

Pyrolosis is a thermochemical process that involves heating waste to between 750 and 1,600 degrees Fahrenheit in an oxygen and water-free environment, which separates the hydrocarbons. Products of the pyrolysis of municipal solid waste (MSW) are a syngas made up of hydrogen, CO, inert gases, tars and oils, and solid char materials. There

[23] EPA, http://www.epa.gov/cleanenergy/muni.htm
[24] UN Environment Program, http://www.unep.or.jp/ietc/estdir/pub/msw/sp/sp5/sp5_1.asp

were several experimental facilities for pyrolysis of MSW operated in the United States in the 1970s and 1980s, but none remain today. A facility in Germany has been in operation since 1983.

2. Gasification

Gasificiation is a thermochemical process that involves partially combusting organic materials at high temperatures (typically 1,600 to 2,200 degrees Fahrenheit) in an environment with controlled amounts of oxygen. This partial combustion creates a synthetic gas of moderate btu content composed mainly of carbon monoxide, hydrogen, and inert gases. The resulting synthetic gas can be purified and combusted in boilers or internal combustion engines. Gasification has also been used for woody biomass and coal. Gasification can accept many feedstock types, but requires a much more uniform feedstock than waste incineration.

Several experimental plants operated in the United States in the 1970s and 1980s, but all were shutdown or converted to other uses. Operating plants remain in Europe and Japan, and there has been some renewed interest in the United States to avoid landfilling, notably in California.

3. Plasma Gasification

Plasma Gasification is an adaption of a plasma-enhanced melting process developed for treatment of hazardous and radioactive wastes. Waste is heated in an insulated chamber by a plasma (electrically conducting gas) with a high voltage current. This heat volatilizes the organic components of the waste, which are then reacted with steam to make a hydrogen-rich synthesis gas. This hydrogen-rich gas can be combusted to make electricity. Metals and minerals released from the plasma process are captured for recycling. InEnTec, a company in Richland, Wash., has commercialized this process and has seven operating facilities globally, with additional facilities under construction.

4. Reverse Polymerization

Reverse Polymerization is a process by which microwaves bombard solid waste in a low-oxygen environment and generate hydro-carbons. The hydro-carbons can then either be used to generate electricity, or refined for industrial uses. This process can be applied to plastics, but is most commonly discussed in relation to tire disposal. Tires have a higher heat content than coal and generally have a negative fuel cost.[25]

The key advantage of reverse polymerization over incineration is the ability to recover the tire's carbon black and steel. This allows for 100% recycling of the tire. The results of this are similar to tire pyrolysis, although pyrolysis is not currently commercially viable. Reverse polymerization is in early development, and is also not yet commercial.

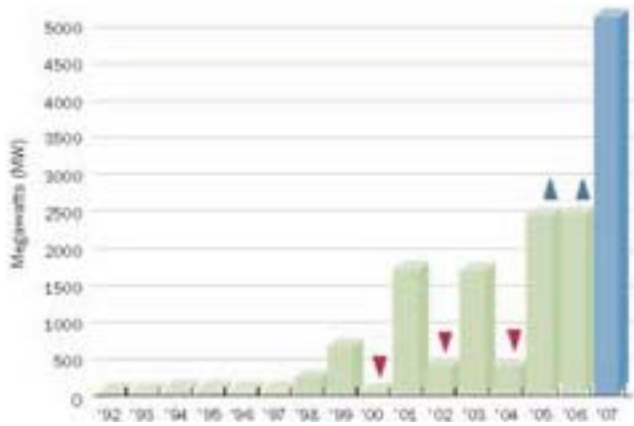
D. Waste Heat Recovery

Waste heat recovery projects typically harness exhaust heat to generate power. Recovery projects tend to be small in scope (less than 10 MW), as facilities with significant volumes of waste heat generally incorporate heat recovery into the original design. Specifics such as heat rates, availability and costs are highly project specific, depending on the volume and method of heat recovery. Many of these projects focus on high compression equipment, cement plants, or industrial processes.

[25] EPA, http://www.epa.gov/epaoswer/non-hw/muncpl/tires/faq.htm

VII. Wind Energy

Figure F-18. U.S. Wind Capacity Growth



Source: AWEA, "Wind Power 2008"

Wind energy is the lowest cost alternative energy technology in the United States, and capacity is growing rapidly, as shown in Figure F-18. In 2008, U.S. wind capacity increased by 8,358 MW[26], accounting for about 42% of the entire new power-producing capacity added in the United States last year. Total installed wind energy capacity in the United States now exceeds 25,000 MW[27]. The recent extension of the Production Tax Credit (PTC), and addition of alternative tax credits in the new economic stimulus bill, should continue this trend. With the completion and reliable commercial operation of our Hopkins Ridge and Wild Horse wind farms, PSE has a strong familiarity with wind energy. This section addresses onshore wind technology as well as the potential for offshore wind farms.

A. *Onshore Wind Power Trends*

A wind turbine transforms the kinetic energy of the wind into electrical energy for transmission and use at a utility customer's home or business. Utility-scale wind turbines for land-based wind farms are available in several rotor diameters and nameplate capacities. Rotor (blade) diameters typically range from 75 meters to 100 meters, with towers of roughly the same size. A 90-meter diameter turbine with a 90-meter tower would have a total height from the tower base to the tip of the rotor of approximately 135 meters (442 feet).

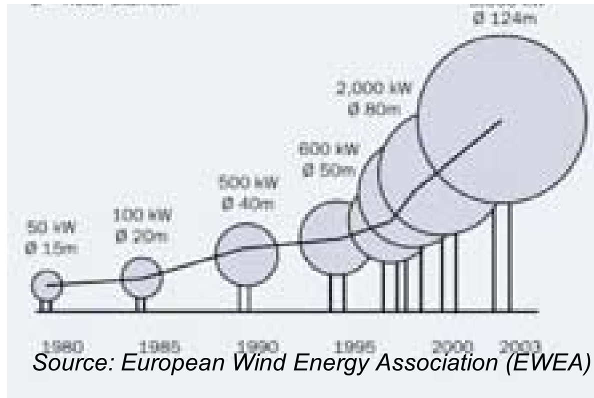
The Danish Wind Industry notes three trends in grid connected turbines:

- Growth in size, height and capacity of turbines
- Increases in efficiency
- Decreased investment costs

[26] According to 2008 data from the American Wind Energy Association ("AWEA")
[27] According to 2008 data from the Global Wind Energy Council

Although the cost of turbines has risen in the last few years (a short-term spike driven by robust demand and limitations on manufacturing and supply logistics), all three of these design trends have held true long term. The cost spike may abate due to the current recessionary economic outlook and relative illiquidity of capital, but is expected to return to a robust growth cycle as stimulus package funding begins to enter the economy.

Figure F-19
Growth in Wind Turbine Capacity



Source: European Wind Energy Association (EWEA)

Wind turbines, towers, and blades are all growing in size, driven by relatively fixed O&M costs, a desire to reduce incremental construction cost, and the presence of stronger and more stable winds at higher rotor hub heights. Better designs, materials, and manufacturing are improving efficiency and reliability.

In the state of Washington, 13 wind projects are operational with a total electrical capacity of 1,375 MW. Washington ranks fifth in the nation for installed wind capacity, while Texas ranks number one, with 7,116 MW.

Figure F-20
Washington State Wind Capacity

Name	Location	Power Capacity (MW)	Units	Turbine Mfr.	Developer	Owner	Power Purchaser	Year Online
Windy Point	Klickitat County	8	4	REPower	Cannon	Cannon	Puget Sound Energy	2008
Hopkins Ridge II	Columbia County	7.2	4	Vestas	RES America	Puget Sound Energy	Puget Sound Energy	2008
Marengo II	Columbia County	70.2	39	Vestas	RES America	PacifiCorp	PacifiCorp	2008
Goodnoe Hills	Klickitat County	94	47	REPower	enXco/Power Holdings	enXco/Power Holdings	PacifiCorp	2008
Nine Canyon III	Benton County	32.2	14	Siemens	Energy Northwest/ RES Americas	Energy Northwest	Energy Northwest	2008
White Creek Wind Power Project	Klickitat County	204.7	89	Siemens	Last Mile Electric Cooperative	Last Mile Electric Cooperative	Last Mile Electric Cooperative	2007
Marengo	Columbia	140.4	78	Vestas	RES America	PacifiCorp	PacifiCorp	2007

Name	Location	Power Capacity (MW)	Units	Turbine Mfr.	Developer	Owner	Power Purchaser	Year Online
Wind Farm	County							
Big Horn Wind Power Project	Klickitat County	199.5	133	GE Energy	PPM Energy	Iberdrola Renewables	Modesto-Santa Clara-Redding Public Power Agency	2006
Wild Horse Wind Power Project	Kittitas County	228.6	127	Vestas	Horizon Wind Energy	Puget Sound Energy	Puget Sound Energy	2006
Hopkins Ridge Wind Farm	Columbia County	149.4	83	Vestas	RES America	Puget Sound Energy	Puget Sound Energy	2005
Nine Canyon Wind Farm, phase II	Benton County	15.6	12	Bonus	Energy Northwest	Energy Northwest	Energy Northwest	2003
Nine Canyon Wind Farm	Benton County	48.1	37	Bonus	Energy Northwest	Energy Northwest	Energy Northwest	2002
Stateline Wind Energy Project	Walla Walla County	176.88	268	Vestas	FPL Energy	FPL Energy	PPM Energy	2001

Electricity generated by a wind farm is fed into the electric power transmission network. Individual turbines are interconnected with a medium voltage (usually 34.5 kV) power collection system and communications network. At the project substation, this medium-voltage electrical current is increased in voltage with a transformer for connection to the high voltage transmission system.

B. Offshore Wind Generation

Five countries have wind turbines installed offshore, providing clean, renewable electricity: Denmark, Sweden, the United Kingdom, the Netherlands, and Ireland. Germany has approved 22 new offshore projects. The world’s first offshore wind project was built in Denmark in 1991, north of the island of Lolland. The 4.9 MW project has performed well. Now more than 25 offshore projects are in operation, with others under construction or in the planning stage.

The world's largest operating offshore wind project, Horns Reef, was completed in 2003, with 80 Vestas 2.0 MW turbines totaling 160 MW of capacity.[28] A still larger offshore project, Thanet Offshore Wind project in the UK, is expected to enter service in 2009 with over 300 MW of electrical capacity.

Cape Wind, a hotly debated project near Cape Cod in Nantucket Sound, is still moving forward and could be the first U.S. offshore wind farm in operation. Still pending are approvals from state, local, and federal organizations including the Coast Guard, Department of the Interior and the Federal Aviation Administration. However, two projects planned off Long Island (Bluewater and LIPA Offshore) are close behind. NREL's goal is to lower costs to $50 per MWh by 2012, at which time it expects to utilize new 5 MW to 7 MW turbines installed in shallow water (less than 15 meters).

Offshore wind farms benefit from stronger, more stable winds, but have higher capital and operating costs. Offshore turbines may also have higher capacities than their onshore cousins due to modified gearboxes with higher rotation rates and greater sound levels than would be allowed on shore. Currently, there is no land lease fee for building wind turbines in federal waters, where all turbines for the Cape Wind project are located. The U.S. Army Corps of Engineers, the final authority for permitting, issued a largely positive Draft Environmental Impact Study for Cape Wind in 2004.[29] It reported minimal impacts on marine and bird life, as well as minimal water and noise pollution. Cape Wind filed its Final Environmental Impact Report (FEIR) in February 2007 with the Massachusetts Environmental Policy Act (MEPA) office.

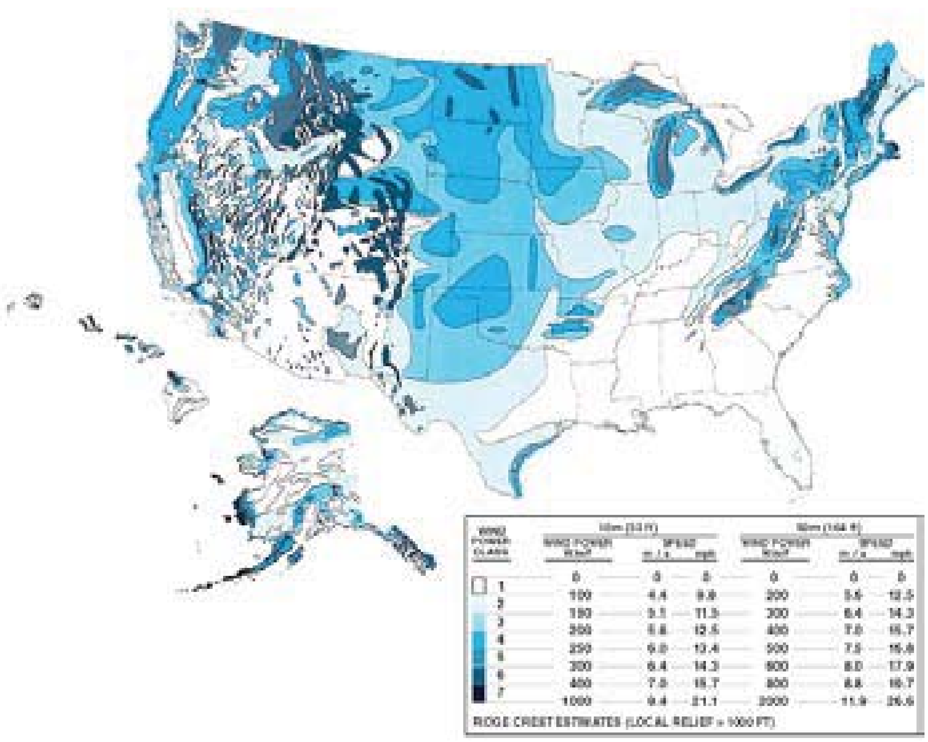
In general, offshore wind power is hoped to have less community resistance, although The Alliance to Protect Nantucket Sound, an energized opposition group comprised of prominent politicians, has formed in response to Cape Wind. Greenpeace and many other environmental groups have endorsed offshore wind energy, particularly Cape Wind.[30] It is unclear what kind of impact offshore farms will have on real estate values. Onshore studies in the United Kingdom have indicated that there is an initial negative impact to residential property values near wind farms, although this impact largely disappeared two years into operations.[31] European experience suggests that a decrease in property values may be offset, at least in part, by an increased tourism industry.

[28] Danish Wind Industry Association, 2003
[29] Army Corp of Engineers, 2004, http://www.nae.usace.army.mil/projects/ma/ccwf/ deis.htm
[30] Cape Wind, 2005, http://www.capewind.org/article47.htm
[31] Royal Institute of Surveyors, UK, 2003, http://www.rics.org/NR/rdonlyres/66225A93-840F-49F2-8820-0EBCCC29E8A4/0/Windfarmsfinalreport.pdf

An alternative with potentially fewer citizen objections is deep water wind farms. The European Commission is funding a pilot project in which two 5 MW REPower wind turbines were installed in the Scottish region of the North Sea at the Talisman Beatrice project in 2006.[32]

As indicated in Figure F-21 the coast of Washington state has strong winds, which may make it a potential site for offshore wind power projects. However, it remains to be determined whether such technology will become commercially viable and acceptable to the community.

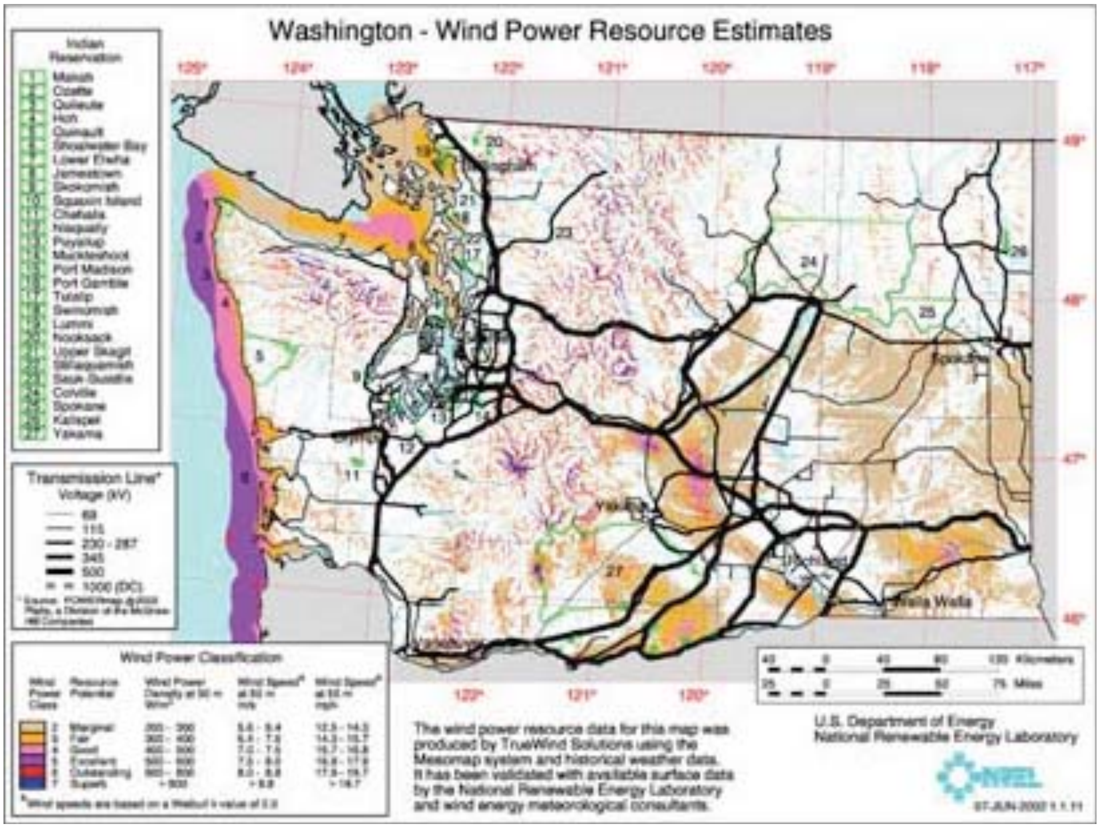
Figure F-21. Available US Wind Energy



Source: National Renewable Energy Laboratory (NREL)

[32] Royal Institute of Technology in Stockholm, http://www.kth.se/forskning/pocket/project.asp?id=22466

Figure F-22
Available Washington State Wind Energy



Source: National Renewable Energy Laboratory (NREL)

VIII. Geothermal

Worldwide geothermal generation capacity is over 9,000 MW, of which the United States has the largest national share at over 2,900 MW.[33,34] Some countries such as Iceland (over 300 MW) and the Philippines (over 1,900 MW) generate large portions of their power from geothermal sources[35], but to date the technology is inherently limited by geology. Development of geothermal power in the United States is concentrated in California, with the remaining capacity in Nevada, Hawaii and Utah. Small geothermal plants also exist in Idaho, Alaska, and New Mexico.

Geothermal energy qualifies as renewable energy under Washington's renewable portfolio standard.

Geothermal power production captures heat from inside the earth using one of four methods:

- Dry Steam Plants utilize hydrothermal steam from the earth directly in turbines. This was the first type of geothermal power generation technology, but is limited by the number of sites that offer very hot (greater than 235°C) hydrothermal fluids that are predominantly steam.[36]
- Flash Steam Plants operate similarly to dry steam plants but use low pressure tanks to vaporize hydrothermal liquids into steam. Like dry steam plants, this technology is best suited to high temperature geothermal sources (greater than 182°C).[37]
- Binary Cycle Power Plants can use lower temperature (107°C to 182°C) hydrothermal fluids to transfer energy through a heat exchanger to a fluid with a lower boiling point. This system is completely closed-loop, without even steam emissions. The majority of new geothermal installations are likely to be binary cycle systems due to emissions and the greater number of potential sites.[38]

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[33] International Geothermal Energy Association, http://iga.igg.cnr.it/geoworld/ geoworld.php?sub=elgen
[34] Geothermal Energy Association, http://www.geo-energy.org/publications/reports/ Geothermal_Update_August_7_2008_FINAL.pdf
[35] IGA 2000, http://iga.igg.cnr.it/geoworld/geoworld.php?sub=elgen
[36] Renewable Energy Policy Project, http://repp.org/geothermal/geothermal_brief_power_ technologyandgeneration.html
[37] EERE, http://www1.eere.energy.gov/geothermal/geothermal_basics.html
[38] Ibid

- The United States, Japan, England, France, Germany and Belgium are testing Enhanced Geothermal or "hot dry rock" technologies.[39] These systems involve the drilling of deep wells into hot dry or nearly dry rock formations and injecting water to develop the hydrothermal working fluid. The heated water is then extracted and used for generation. There are small operating facilities in Germany and France. Several commercial facilities are under development in Australia, and the US Department of Energy has funded a test project in the United States.

Several factors affecting geothermal resource development are longevity and quality, plant siting, land availability and proximity to transmission lines, and equipment lead times.

Geothermal resources in the United States underwent significant exploration drilling in the 1970s, but many exploration programs were slowed or halted after the 1970s energy crisis ended. Because of the difficulty in assessing subsurface conditions without drilling, the majority of recent development has involved known resources where risks are lower.

Geothermal depletion is a concern that leads many to question whether geothermal power is truly a renewable resource. Continued aggressive use of a geothermal well can lead to temperature and pressure reductions. The Geysers complex of geothermal installations in northern California decreased in output from over 1,800 MW in the late 1980s to around 1,000 MW in 2001. Economic modeling of 20 to 30 years of production is standard.[40] In addition to resource longevity, there is the question of resource quality. Some geothermal fluids are corrosive and may contain scaling elements. Research is ongoing with heat exchanger linings and acid resistant cements. In addition, there are efforts to extract commercial products such as zinc or high purity silica from geothermal fluids to offset costs.[41] Further, although SO_x and CO_2 emissions are very low, they are both present in both dry and flash steam plants as part of the geothermal fluid.

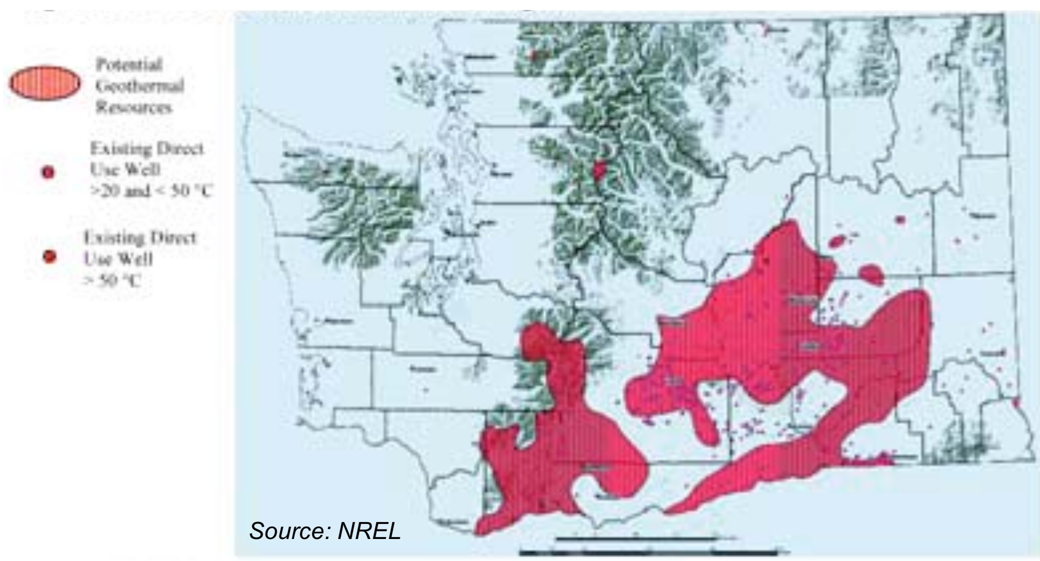
Siting geothermal plants can be difficult, as many geothermal resources in the western United States are not located close to existing transmission. Further, the majority of lands in the western United States are managed by the U.S. government, requiring a process

[39] Geothermal Education Office, 2000, http://geothermal.marin.org/pwrheat.html
[40] Geothermal.org, 2002, http://www.geothermal.org/articles/California.pdf
[41] Lawrence Livermoore National Labs, 2004, http://www.geothermal.org/DOE_presentations/BRUTON_L.PPT

for land leasing, permitting, and development. The Energy Policy Act of 2005 created a new competitive leasing process for geothermal lands, which has increased the number of leases awarded each year.

Development of geothermal resources takes 2 to 3 years, and drilling equipment availability significantly affects development timelines. There are a limited number of drill rigs capable of geothermal development in the United States, and they are in demand. Further, there is competition with the oil industry for labor, which can drive up costs.[42]

Figure F-23
Geothermal Potential in Washington

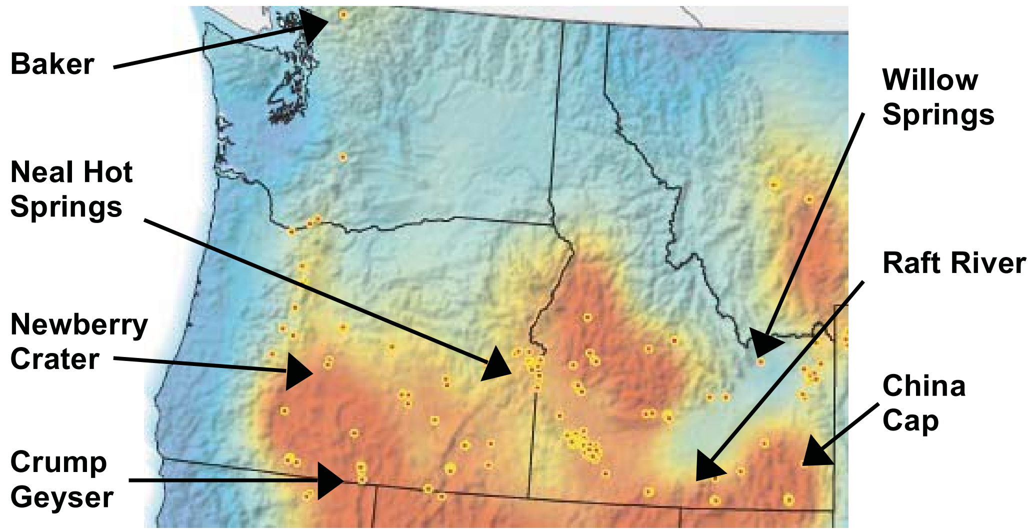


Source: NREL

There are no active geothermal projects in Washington state, though there has been recent interest. Vulcan Power has applied for a lease in the North Cascades, and several private and public entities have been working on development assessments. Several geothermal plants are under development in Oregon, and the Raft River Plant in Idaho became operational in 2007. The plants proposed or under development in the Northwest are shown in Figure F-24.

[42] Glitnir Bank, http://docs.glitnir.is/media/files/Glitnir_USGeothermalReport.pdf

Figure F-24
Proposed or Active NW Geothermal Developments



IX. Coal

There are three principal technologies available for utilizing coal, and other solid fuels, in the production of electricity. Two of these technologies, pulverized fuel boilers and fluidized bed boilers, combust fuel to produce heat. The heat boils water to produce steam, which in turn drives a steam turbine-generator to produce electricity. When fueled with coal, these are referred to as “conventional coal” technologies. The third technology, gasification, converts any carbon-containing material into a synthesis gas (syngas) composed primarily of carbon monoxide and hydrogen. This syngas can be used to fuel the generation of electricity or steam production or as a chemical feedstock.

A. Pulverized Coal

With pulverized coal (PC) technology, the coal is ground into a fine powder that is mixed with air and blown into the boiler furnace to be burned. The resulting heat is then used to produce steam. Fuel efficiency can be improved by increasing the temperature and pressure of the steam generated in the boiler. Current designs utilize steam pressures of 2,500 psi and greater.

Supercritical boilers produce steam in excess of 3,200 psi. Such boilers were introduced in the United States in the 1970s, but were plagued by metallurgical problems due to high operating temperatures and pressures. More recently, supercritical PC units (SCPC) have been operated successfully in Europe and Japan and are re-emerging in North America. To further improve efficiency, ultra-supercritical PC units (UCPC), operating at even higher pressures, are now available.

Most coal-fired boilers operating in the United States today use PC technology. Similar boilers are also used to burn petroleum coke and other solid fuels. Boiler designs are available in a range of sizes from units producing less than 100 MW to those exceeding 1,000 MW, powered by a single PC boiler. In addition to increasing boiler efficiency with SCPC and UCPC units, equipment suppliers are improving combustion and post-combustion pollution control equipment to meet increasingly stringent emission reduction requirements.

B. Fluidized Bed

Fluidized bed (FB) technologies mix coal and an inert bed material, such as sand, in a combustor or boiler. The mixture of particles is suspended by an upward flow of air and burns producing heat to generate steam. Increasing the air flow affects the fluid-like flow of the particles, resulting in a fixed, bubbling or circulating bed condition. Limestone may be added to the bed material to help capture sulfurous gases that are released as the coal is burned. High heat transfer in the boiler occurs with lower combustion temperatures, resulting in lower levels of NOx formation than in PC boilers. Post-combustion technologies are also used to further lower air emissions.

FB boilers can burn a wide variety of solid fuels in addition to coal and petroleum coke. Single FB boilers are available in sizes up to 600 MWe and the first super-critical FB boiler (460 MWe) just began operation in Poland. In 2001, the Northside Repowering Project of the Jacksonville (FL) Electric Authority replaced two boilers fueled by oil or gas with two circulating fluidized bed (CFB) boilers fueled by coal. At approximately 300 MW each, these are the two largest CFB boilers in the United States.

The pressurized fluidized bed combustion (PFBC) boiler utilizes fluidized bed technology at elevated operating pressures to produce heat for steam production and hot pressurized exhaust gases that may be used to drive a combustion turbine. In the early 1990s, Ohio Edison built a demonstration PFBC plant to power a 55 MW steam turbine[43] and a 15 MW combustion turbine. Although the PFBC offers the promise of higher energy production efficiency, there has been no further commercial development of PFBC technology in the United States.

C. Gasification

Coal and other solid or waste fuels have been gasified to create liquid or gaseous fuels for more than 100 years. In the 1800s, crude coal gasification provided gas for lighting streets and homes. During World War II, Germany gasified coal to produce fuel for airplanes and tanks. South Africa has gasified its indigenous coal supply to create liquid and gas fuels since the 1950s, and these plants continue to operate today.

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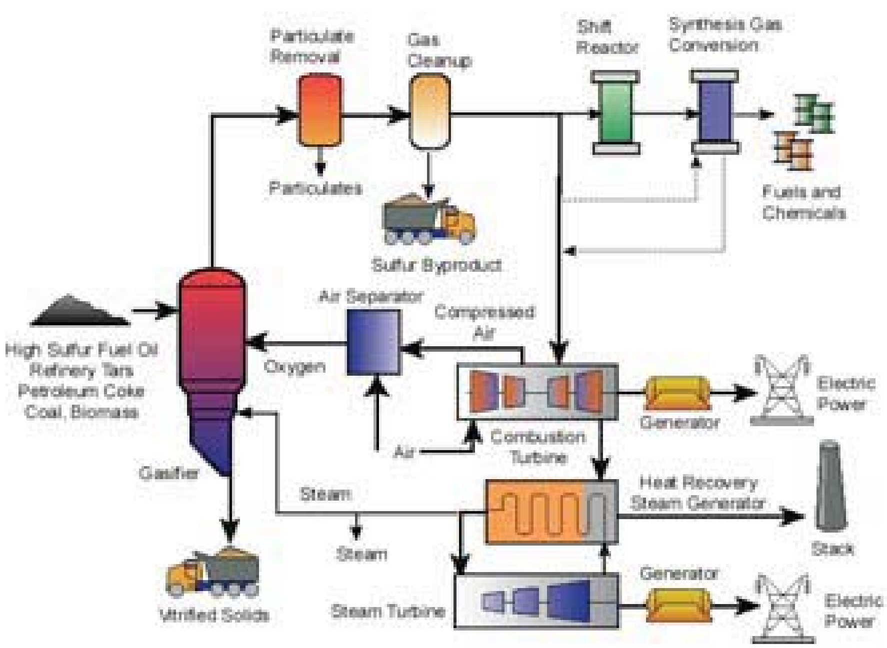
[43] The US DOE funded 35% of the cost of this project.

Coal gasification uses a partial oxidation process to produce a low to medium Btu (100 to 450 Btu per SCF) syngas, which can be fired in a boiler to produce steam to drive a steam turbine generator or may be substituted for natural gas in combustion turbines. In the partial oxidation reaction, there is insufficient oxygen present to convert all of the carbon in the fuel to carbon dioxide. When available oxygen is reduced, less heat is released from the coal, and gaseous products appear. These products include hydrogen, carbon monoxide, and methane (CH4), all of which contain potential chemical energy.

Integrated Gasification Combined Cycle (IGCC)

The integrated gasification combined cycle process teams a gasifier with combined cycle equipment. While the extent of integration may vary, depending upon the gasification and combustion turbine equipment selected, IGCC generally refers to a model in which syngas from the gasifier fuels a combustion turbine to produce electricity, while the combustion turbine compressor compresses air for use in the production of oxygen for the gasifier. Additionally, heat from the gasifier is coupled with exhaust from the combustion turbine to generate steam, which is used to drive a steam turbine-generator to produce additional electricity. This design has been widely used with natural gas and distillate fuels since the 1980s.

Figure F-25
The Coal Gasification Process



Source: Gasification Technologies Council (www.gasification.org)

The combination of coal gasification and combustion turbine technologies was first successfully demonstrated in the United States for electric power production on a commercial scale at the 100 MW Cool Water Demonstration Project in Daggett, Calif. This plant was operated successfully by Texaco, Bechtel, General Electric, and EPRI from 1984 to 1989 and was then decommissioned. A number of additional demonstration projects were developed in the 1980s and 1990s.

Commercial Availability

To date, the application of gasification for electric power production using IGCC has been limited to demonstration projects. While there are a number of vendors and technologies for gasification, the experience with coal is limited. The table below identifies the existing gasification plants in the United States, the products produced, and the fuel utilized.

Figure F-26
Existing Gasification Plants in the U.S.

Plant Name	Location	Year of Initial Operation	Main Product Produced	Fuel Utilized
Houston Oxochemicals Plant	Houston, TX	1977	Chemicals	Gas
Baton Rouge Oxochemicals Plant	Baton Rouge, LA	1978	Chemicals	Petroleum
LaPorte Syngas Plant	Deer Park, TX	1979	Chemicals	Gas
Hoechst Oxochemicals Plant	Bay City, TX	1979	Chemicals	Petroleum
68Kingsport Integrated Coal Gasification Facility	Kingsport, TN	1983	Chemicals	Coal
Sunoco Oxochemicals Plant	Texas	1983	Chemicals	Gas
Texas City Dow Syngas Plant	Texas City, TX	1983	Chemicals	
Great Plains Synfuels	Bismarck, ND	1984	Gaseous fuels	Coal

Plant Name	Location	Year of Initial Operation	Main Product Produced	Fuel Utilized
Plant				
Convent H2 Plant	Convent, LA	1984	Chemicals	Petroleum
Wabash River Energy Ltd.	West Terre Haute, IN	1995	Power	Petcoke
Taft Syngas Plant	Taft, LA	1995	Chemicals	Gas
LaPorte Syngas Plant	LaPorte, TX	1996	Chemicals	Gas
Texas City Praxair Syngas Plant	Texas City, TX	1996	Chemicals	Gas
Polk County IGCC Project	Mulberry, FL	1996	Power	Coal
Oxochemicals Plant	Texas	1998	Chemicals	Gas
Coffeyville Syngas Plant	Coffeyville, KS	2000	Chemicals	Petcoke
Baytown Syngas Plant	Baytown, TX	2000	Gaseous fuels	Petroleum
Delaware Clean Energy Cogeneration Project	Delaware City, DE	2002	Steam & Power	Petcoke
Longview Gasification Plant	Longview, TX	2002	Chemicals	Gas

Source: World Gasification Database; Gasification Technologies Council

To encourage commercialization of IGCC, major technology licensors have formed "alliances" with engineering and construction firms to provide design and construction on a turnkey basis. These alliances may provide limited guarantees of cost and schedule and initial operating performance. To begin development, a buyer must select a design type and provide detailed fuel specifications and proceed with a Front End Engineering Design (FEED) study to develop the design envelope. Each alliance requires a specific

FEED study before negotiating the contract and guarantees. FEED studies are currently estimated to cost more than $20 million for each fuel specification and do not ensure the technology will be economic.

There are currently two operating, commercial-size, coal-based IGCC power plants in the United States. The 262 MWe[44] Wabash River IGCC repowering project in Indiana commenced operation in 1995[45]. Tampa Electric's 250 MWe Polk Power Station IGCC project in Florida commenced operation in 1996[46]. Additionally, there are two operating, commercial-sized IGCC power plants in Europe, and three gasification projects utilizing coal or petcoke in the United States which produce feedstocks for chemical production.

The increase in cost and price volatility of natural gas in the mid-2000s generated a renewed interest in IGCC for electric power production. More recently, this interest has waned, as it has with other coal-based power projects, due to the rapid increase in the cost of construction materials and uncertainty over greenhouse gas control regulations.

D. Estimated Cost of Current Coal Technologies[47]

There is uncertainty within the electric power industry regarding the costs and reliability of IGCC technology versus "conventional coal combustion" technologies. The installed cost of a power island using a pulverized coal (PC) boiler ranges between $2,600 per KW to $3,200 per KW in current dollars. Circulating fluidized bed (CFB) plants are in the same range; however, larger plants (over 250 MW) must be built in modules due to the size limits of available CFB boilers. IGCC plants are estimated to cost 15% to 25% more to construct than PC units of equal size.

Further, the gasification train of IGCC projects is less reliable than the power generation equipment of PC and atmospheric FB boilers. Without a spare gasifier, the equivalent availability of an IGCC unit is projected to be 85%, while new PC units commonly attain

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[44] MWe is the abbreviation for megawatt electric. In this case MWe is used to indicate that the gasified coal is used to fuel a gas turbine, thus producing electric power.

[45] The Wabash River IGCC project uses the E-Gas gasification technology, which was acquired by ConocoPhillips in 2003.

[46] The Polk Power Station uses the Texaco gasification technology, which was acquired by GE Energy in 2004.

[47] This discussion is based on costs related to permitting, planning, design, construction and commissioning of the "power island" which begins at the point of receipt of the coal fuel at the plant site and ends with the generator step-up transformers before connection of the plant to a substation and the high voltage transmission system. The cost of interest during construction, or AFUDC, is not included.

over 90% equivalent availability. The reliability of the electricity-producing combined cycle plant can be increased to over 90% if the facility is designed to use both syngas and natural gas.

IGCC vendors are under pressure to reduce both the cost and down-time of their products. In time, it is expected that IGCC unit costs will become similar to PC unit costs as more plants are built. IGCC plants can also be modular, in units of 250 MW to 300 MW, to take advantage of existing combustion turbine technology. Because of the equipment redundancy of modular CFB or IGCC plants, their reliability may be higher than that of a single boiler, single turbine PC unit.

The cost of a new coal plant is highly affected by siting factors: availability of electric transmission interconnection, availability of water and rail, and other infrastructure. Such costs may eliminate the cost differences between technologies. The cost of development, permitting and preliminary design can range from $20 million to over $50 million without assurance that the plant can be built.

E. Environmental Climate

Major electric generating plants are subject to federal and state permitting laws and regulations covering air and water emissions, water use, waste management and pollution prevention. Additionally, state and local land use and zoning laws may govern site selection, and may also affect other plant siting issues, economic impacts or operating requirements. In the Pacific Northwest, the states of Washington, Oregon and Montana have created special regulation to manage the process of permitting major electric generating plants.

The Federal Clean Air Act applies to any electric generating facility and covers six Criteria Pollutants and more than 180 Hazardous Air Pollutants (HAPs). Of the HAPs, it is usually only Mercury and nickel[48] that affect plant permitting and require specific control devices as part of the plant design, though many others must be analyzed during the permitting process. The EPA enforces the Clean Air Act and has set National Ambient Air Quality Standards (NAAQS) for six Criteria Pollutants: Sulfur Oxides, Nitrogen Dioxide, Particulate Matter, Ozone, Carbon Monoxide and Lead.

[48] Mercury and nickel are the subjects of ongoing EPA rulemaking. A number of individual states have enacted limits on mercury emissions.

The federal Clean Air Mercury Rule (CAMR), which required that existing and new coal plants reduce at least 30% of their mercury emissions by 2010, and at least 70% by 2018, has been vacated by a Federal District Court. This rule was designed to permanently cap and reduce mercury emissions from coal-fired power plants. To date, several states, including Washington and Montana, have enacted mercury control rules.

Additionally, while the federal government has not addressed the issue of greenhouse gases (GHGs), states and local governments have been taking action. Washington state is a member of the Western Climate Initiative, which was launched in February 2007. The Western Climate Initiative is a collaboration of seven U.S. governors and four Canadian premiers.

Carbon dioxide (CO_2) emissions from power generators are not currently regulated at the federal level. Washington has adopted a limit on carbon dioxide emissions from new, baseload power plants and requires mitigation of CO_2 emissions. See the Regulatory and Policy Activity chapter of the Environmental Concerns appendix for more information about possible future legislation.

New power plants (and major modifications to existing power plants) must employ Best Available Control Technology (BACT) and meet the New Source Performance Standards (NSPS) established by the EPA before receiving a permit to begin construction. What constitutes BACT is a function of the equipment and fuel to be utilized and the local and regional air quality. BACT is determined on a case-by-case basis, taking into account energy, environmental and economic impacts, and costs. Competition among equipment vendors, combined with pressure from plant owners and regulators, have caused the BACT process to result in significant reductions in permitted emission levels. At present, the rate of change in BACT for gasification is far more rapid than for PC and FB units. Current EPA regulations and policy do not require that IGCC be included when performing BACT analyses for new PC and FB units; however, the permitting processes in many states do require such comparison. In February 2006, EPA revised its regulations to clarify that combustion turbines and combined cycle plants that receive 75% or more of their heat input from synthetic coal gas are subject to the same rules as utility steam boilers (40 CFR 60, Subpart Da) rather than the rules (Subpart KKKK) covering combustion turbines.

For more information about local and federal environmental regulations and related environmental issues, see Chapter 2, Planning Environment, and the Environmental Concerns Appendix, where PSE's Greenhouse Gas Policy can be found.

F. Emission Control Technologies

A significant difference between PC, FB and IGCC technologies is how, where in the process cycle, and how effectively Criteria Pollutants and HAPs are controlled. Conventional coal plants built recently include specialized, highly efficient pollution control equipment to reduce the emissions of sulfur dioxide (SO_2), nitrogen oxides (NOx), mercury, and particulates. Many older plants have also added advanced pollution control devices and further federal legislation and EPA action is expected to significantly increase the number of existing plants with retrofitted pollution control equipment.

IGCC vendors claim greater capture rates for sulfur dioxide, nitrogen oxides and particulates because pollutant removal is performed prior to the introduction of the syngas fuel into the combustion turbine. In PC and FB boilers, these pollutants are captured during or after coal combustion. Vendors of conventional boilers have responded to these claims by continuing to offer equipment designs with lower emission rates.

The following discussion focuses on the typical pollutants and HAPs that must be considered in converting coal to electricity. Because of the wide variety of proprietary gasification system designs, the process flow and equipment described may vary somewhat in configuration; however, all use the same basic steps.

Particulate Matter

Particulate matter refers to inorganic impurities in the coal in the form of fine ash.

Figure F-27
Particulate Matter Controls

PC and FB units	Particulate matter is captured using an electro-static precipitator (ESP) or a fabric filter (FF), also called a bag-house, to clean flue gases after they exit the boilers. ESPs were the first control devices applied to existing PC boilers. ESPs or FFs are used in the construction of all new PC and FB designs. Current performance requirements for ESPs and FFs are 0.02 lbs per MMBtu of heat input (about 0.2 lbs per MWh) or less in flue gases released to the atmosphere.
IGCC	Particulates are separated by gravity from the raw syngas in the gasifier. They exit the gasifier as slag or other similar solids. Additional removal of fine particulates takes place in candle filters in the raw syngas clean-up equipment between the gasifier and the combustion turbine. Current performance requirements are less than 0.01 Lbs per MMBtu or 0.1 Lbs. per MWh.

Sulfur Dioxide (SO_2)

All coal contains sulfur. It ranges from less than 1% by weight in some western U.S. coals to more than 6% in some mid-western coals. Petroleum coke, the waste product from the refining process, contains most of the sulfur from the original crude oil supply, which may be 4% by weight or more.

Figure F-28
Sulfur Dioxide Controls

PC units	Scrubbers are employed downstream of the boiler to mix an alkaline material, such as lime, with boiler exhaust gases to capture sulfur compounds. Some older scrubber designs also capture particulate matter (fly ash), eliminating the need for a separate ESP or FF. Scrubber designs fall into two broad categories: dry and wet. Dry scrubbers: Flue gas heat evaporates water media used to supply the alkaline material, leaving a dry alkali-sulfur compound. Particulate control equipment, normally placed after the scrubber, captures this dry product. Wet scrubbers: Particulate control occurs ahead of the scrubber. In such case, the alkali-sulfur product is a slurry with a chemical composition similar to natural gypsum. If transportation cost can be minimized, the scrubber product can be dried and sold for wall board manufacture.
FB units	Most FB units use an alkaline material as part of the bed. Before leaving the boiler, the alkali captures the sulfurous gas released during combustion and is then captured by the particulate control equipment, normally an FF. A polishing scrubber, similar to the main scrubbers on a PC unit, can be added to further reduce the amount of sulfur that leaves the stack in flue gases.
IGCC	The raw syngas that leaves the gasifier contains carbonyl sulfide (COS), which is converted to hydrogen sulfide (H2S) through electrolysis. Acid gas clean-up equipment then removes the H2S. Between the gasifier and the sulfur removal, the syngas is cooled in heat exchangers that use recovered heat to generate additional steam for the steam turbine. A sulfur recovery system may be added after the acid gas clean-up to recover sulfur as a salable by-product, either as elemental sulfur or as sulfuric acid.

Current SO_2 performance requirements for both PC and FB units require removal of more than 99% of the sulfur in the coal, yielding an emission level of 0.1 lbs per MMBtu (about 1 lbs per MWh) or less in the flue gases released into the atmosphere.

Current SO_2 performance requirements for gasification systems require removal of 99.5% of the sulfur in the coal, yielding an emission level as low as 0.03 lbs per MMBtu (less than 0.3 lbs per MWh) or less in the flue gases released into the atmosphere. In order to effectively capture mercury, the SO_2 emission level must be below 0.01 lbs per MMBtu before reaching the mercury absorber equipment. This requires use of a proprietary acid gas clean-up process, such as Selexol.

Nitrogen Oxides

Figure F-29
Nitrogen Oxide Controls

PC units	Nitrogen oxides (NOx) can be reduced in the PC boiler during combustion of the coal using Low NOx Burners, which reduce combustion temperatures, thereby affecting the amount of NOx produced. Over-fire air is used with Low NOx Burners to further cool the fireball in the furnace and reduce NOx production. Ammonia (NH3) can be injected into the PC boiler flue gas as it leaves the boiler to reduce NOx. A catalyst can be employed to aid in the chemical reaction between NH3 and NOx, that results in formation of water (H2O) and elemental nitrogen (N2). When a catalyst is used, this is called Selective Catalytic Reduction (SCR). Without a catalyst, it is known as Selective Non-Catalytic Reduction (SNCR).
FB units	In FB boilers, NOx is reduced in the combustor by keeping the combustion temperatures lower and may be further reduced by the addition of SCR or SNCR technology in the flue gas stream after the boiler.
IGCC	There is no NOx produced in the oxygen blown gasification process. The only NOx production occurs during the syngas combustion in the combustion turbine. NOx emission levels below 0.03 Lbs per MMBtu can be obtained with normal combustion practices using water and N2 (from the air separation plant) injection into the combustors of the combustion turbine with the syngas. Even lower levels, down to 0.01 Lbs per MMBtu or lower may be obtained by addition of SCR equipment to the combustion turbine exhaust. This requires extremely low levels of SO2 in the syngas stream to the combustion turbine.

Current NOx performance requirements for both PC and FB units is an emission level of 0.07 Lbs per MMBtu (about 0.7 Lbs per MWh) or less in the flue gases released to the atmosphere.

IGCC projects currently being permitted are being asked to review whether use of SCR equipment is BACT.

Mercury

As previously discussed, the regulations in Washington, Montana and a number of other states require that all coal-burning power plants reduce their mercury emissions. The past five years have seen much research and demonstration of sorbent injection and other techniques to remove mercury from PC and FB unit flue gasses, but no single technology has been confirmed to provide long-term mercury removal for all types of coal and all boiler designs.

The Tennessee Eastman coal gasification facility has demonstrated success in removing mercury to non-detectable levels using sorbent beds during its syngas clean-up processes. The plant has been in operation generating chemical feedstocks since 1984.

This sorbent bed technology should facilitate mercury removal at levels high enough to meet existing state requirements.

Carbon Dioxide

Although carbon dioxide (CO_2) is not currently regulated as an air pollutant, there is keen interest in developing technologies to economically remove it from flue gases. Washington requires mitigation of carbon dioxide emissions from new power plants and limits the emission of CO2 from new, base-load power plants. The technology for carbon dioxide capture in the gas clean-up portion of the IGCC is clearly more developed than is post-combustion capture of carbon dioxide from either a PC or FB boiler. However, effective methods of permanent sequestration, other than injection for enhanced oil recovery in specific locations, is not commercially developed and readily accessible. A July 2006 study for the EPA found that adding carbon capture technology to various IGCC designs increased the cost of electricity by 25% to 40%. The cost of energy from a supercritical PC unit was estimated to increase by as much as 65%. Not only does carbon capture entail the large capital and operating costs of additional equipment, it also significantly increases parasitic plant energy use. This and other studies caution that IGCC design and cost information is more sensitive to both the specifics of the site and the type of coal to be used than a PC unit. The limited development of carbon dioxide sequestration technologies and sites, however, limits the current ability of both IGCC and conventional coal technologies to “solve” the GHG problem.

Carbon capture

Amine-based CO2 capture systems have been demonstrated on a limited basis in flue gas slipstreams of PC and FB systems. Research is also underway to produce more cost-effective systems using ammonia-based or other processes, but no systems are currently available for full-scale CO2 removal from PC or FB units. Furthermore, preliminary estimates indicate these systems could increase the cost of electricity by 60% or more.

The use of “oxy-fuel” combustion practices, which use an air separation plant to deliver O_2 rather than air for the combustion process, is being developed for PC units. This could be used in new designs or retro-fit to existing PC units. Using oxy-fuel techniques yields a flue gas stream of nearly pure CO_2, which eliminates the need to separate the CO_2 from the other gases, primarily nitrogen, in the flue gas stream. Other than pilot projects, this technology has yet to be demonstrated, and no solid cost estimates are available.

Separation of CO_2 in the gasification process has been demonstrated using the water shift reaction to convert carbon monoxide (CO) and water into CO_2 and elemental hydrogen (H_2) as the fuel gas. However, manufacturers are researching and developing combustion turbines that can utilize H_2, though these are not yet commercially available.

Carbon Sequestration

Terrestrial carbon sequestration utilizes natural methods for returning carbon to the soil and plants at the surface level. Soil contains CO_2, which is sequestered by the plants. But overgrazing reduces the plants' ability to perform their function. Improved pasture management can increase the amount of CO_2 in the soil. Crops also sequester carbon in the soil, but the tilling process releases it back into the atmosphere. Agriculture practices that reduce tilling have been shown to increase the level of carbon in the soil. Afforestation is the growing of trees that will capture carbon and hold it until the wood decomposes or is combusted. Hence, long term management of afforestation projects is necessary to insure that the carbon stays sequestered. Overall, while agriculture is responsible for a small portion of America's contribution to climate change, it can still be part of the solution.

Geologic sequestration involves pumping CO_2 deep into the ground, where it reacts with the rocks to form an inert compound. There are numerous opportunities for carbon capture and sequestration (CCS). For example, for 30 years oil companies have practiced "enhanced oil recovery," whereby CO_2 is injected into the wells to improve the recovery of oil. In the Northwest, testing is currently underway with wells drilled deep into rock formations. The pumped CO_2, in an supercritical state, reacts with the mafic rock (basalt) to form the inert calcite. The economic cost of the geologic sequestration has not been determined at this time; however, significant infrastructure investments are necessary in order to accomplish CCS on a large scale.

PSE participates in the Big Sky Carbon Sequestration Partnership based in Bozeman, Mont., which is investigating numerous sequestration technologies for effectiveness and cost[49] and is following research and sequestration demonstrations activities of the Pacific Northwest National Laboratory operated by Battelle.

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[49] Big Sky Carbon Partnership, Montana State University, Bozeman, MT; http://www.bigskyco2.org/

Water Use

Because IGCC units utilize both gas turbines and steam turbines for electricity production, consumptive water use is typically about one-third less than that of similarly-sized PC or FB units. IGCC units use smaller steam turbines, requiring less condenser cooling water.

Solid Wastes

PC, FB and IGCC units all produce solid waste products that can be marketed or disposed of as solid waste. The types of products produced vary by technology and design. The ability to market these products is largely a function of plant location and bulk material transportation costs.

X. Natural Gas

A. Combined-cycle Combustion Turbines

A combined-cycle combustion turbine (CCCT) power plant consists of one or more gas turbine generators (GTG) equipped with heat recovery steam generators (HRSG) to capture heat from the gas turbine exhaust. Steam produced in the HRSG powers a steam turbine generator (STG) to produce additional electric power. Use of the otherwise wasted heat in the turbine exhaust gas results in high thermal efficiency compared to other combustion based technologies. CCCT plants currently entering service can convert about 50% of the chemical energy of natural gas into electricity.

A single-train CCCT plant consists of one GTG, HRSG, and STG (or 1x1 configuration). Using “F-class” combustion turbines - the most common technology in use for large CCCT plants - this configuration can produce about 270 MW of capacity. Plants can also be configured using two or even three GTGs and a HRSG feeding a single, proportionally larger STG. Larger plant sizes result in economies of scale for construction and operation, and designs using multiple GTGs provide improved part-load efficiency. A 2x1 configuration using F-class technology will produce about 540 MW of capacity. Other plant components include a switchyard for electrical interconnection, cooling towers for cooling the STG condenser, a water treatment facility, and control and maintenance facilities.

Additional generating capacity can be obtained by use of various power augmentation features, including inlet air chilling and duct firing (direct combustion of natural gas in the HRSG). For example, an additional 20 MW to 50 MW can be gained from a single-train plant by use of duct firing. Though the incremental thermal efficiency of duct firing is lower than that of the base CCCT plant, the incremental cost is low and the additional electrical output can be valuable during peak load periods.

GTGs can operate on either gaseous or liquid fuels. Pipeline natural gas is the fuel of choice because of historically low and relatively stable prices, deliverability, and low air emissions. Distillate fuel oil can be used as a backup fuel.

Because of high thermal efficiency, low initial cost, high reliability, relatively low gas prices, and low air emissions, CCCTs have been the new resource of choice for bulk power generation for well over a decade. Other attractive features include significant operational flexibility, the availability of relatively inexpensive power augmentation for peak period operation, and relatively low carbon dioxide production.

Proximity to natural gas mainlines and high voltage transmission is the key factor affecting the siting of new CCCT plants. Secondary factors include water availability, ambient air quality, and elevation.

Carbon dioxide, a greenhouse gas, is an unavoidable product of combustion of any power generation technology using fossil fuel. The carbon dioxide production of a CCCT plant on a unit output basis is much lower than that of other fossil fuel technologies.

B. Peaking Power Plants[50]

Peaking power plants, also known as peaker plants, are power plants that generally run only when there is a high demand, known as peak demand, for electricity or a requirement to maintain system operating reserves. In contrast, base load power plants operate continuously, stopping only for maintenance or unexpected outages. Intermediate plants operate between these extremes, curtailing their output in periods of low demand, such as during the night. Base load and intermediate plants are used preferentially to meet electrical demand because the lower efficiencies of peaker plants make them more expensive to operate.

Peaker plants can operate many hours a day, or as little as a few hours per year, depending on the loading condition of the region's electrical grid. It is expensive to build an efficient power plant, so if a peaker plant is only going to be run for a short and variable time, it does not make economic sense to make it as efficient as a base load power plant. In addition, the equipment and fuels used in base load plants are often unsuitable for use in peaker plants because the fluctuating conditions would severely

[50] References for peaking power plant information
http://www.simplecyclepowerplants.com/
http://en.wikipedia.org/wiki/Gas_turbine
http://www.energysolutionscenter.org/DistGen/Tutorial/TutorialFrameSet.htm
http://www.gepower.com/prod_serv/products/tech_docs/en/downloads/ger4222a.pdf
http://www.energysolutionscenter.org/DistGen/Tutorial/TutorialFrameSet.htm
http://en.wikipedia.org/wiki/Reciprocating_engine
http://www.energy.ca.gov/distgen/equipment/reciprocating_engines/reciprocating_engines.html
http://www.cat.com/cda/layout?m=37508&x=7
http://www.eere.energy.gov/de/gas_fired/
http://www.wartsila.com/,en,solutions,applicationdetail,application,F00F72F1-9579-47E6-B6BD-60A0E42943A4,B0B76B09-FEAF-497D-9D59-BA2EC30AFB1E,,.htm

strain the equipment. For these reasons, nuclear, geothermal, waste-to-energy, coal and biomass plants are rarely, if ever, operated as peaker plants.

Peaker plants are generally gas turbines that burn natural gas. A few of them burn distillate fuel, but their use is limited since distillate fuel is usually more expensive than natural gas. However, many peaker plants are able to use distillate fuel as a backup. The thermodynamic efficiency of gas turbine peaker power plants ranges from 20% to 40%, with about 30% to 35% being average for a new plant. The most efficient gas turbine plants are generally used for load cycling, cogeneration projects, or are intended to be operated for longer periods than usual. Reciprocating engines are sometimes used for smaller peaker plants.

C. Simple Cycle Combustion Turbines (SCCT)

Simple cycle combustion turbines in the power industry require smaller capital investment than coal, nuclear or even combined cycle natural gas plants and can be designed to generate both small and large amounts of power. Also, the actual construction process can take as little as several weeks to a few months, compared to years for base load power plants. Their other main advantage is the ability to be turned on and off within minutes, supplying power during peak demand. Since they are less efficient than combined cycle plants, they are usually used as peaking power plants, which operate anywhere from several hours per day to a couple dozen hours per year, depending on the electricity demand and the generating capacity of the region. In areas with a shortage of base load and load following power plant capacity, a gas turbine power plant may regularly operate during most hours of the day and even into the evening. A typical large simple cycle combustion turbine may produce 75 MW to 180 MW of power and have 35% to 40% thermal efficiency. The most efficient turbines have reached 46% efficiency.

The modern power combustion turbine is a high-technology package that is comprised of a compressor, combustor, power turbine, and generator. In a combustion turbine, a large volume of air is compressed to high pressure in a multistage compressor. Fuel is then added to the high-pressure air and combusted. The combustion gases from the combustion chambers power an axial turbine that drives the compressor and the generator. In this way, the combustion gases in a combustion turbine power the turbine directly, rather than requiring heat transfer to a water/steam cycle to power a steam turbine, as in the steam plant. The latest combustion turbine designs use a turbine inlet temperature of 1,500°C (2,730°F) and compression ratios as high as 30:1 (for aeroderivatives) giving thermal efficiencies of 35% or more for a simple-cycle combustion turbine.

D. Reciprocating Engine Systems

Reciprocating engines are piston-driven electrical power generation systems ranging from a few kilowatts to over 15 MW. Reciprocating engine technology has improved dramatically over the past three decades because of economic and environmental pressures for power density improvements (more output per unit of engine displacement), increased fuel efficiency, and reduced emissions.

The reciprocating, or piston-driven, engine is a widespread and well-known technology. Also called internal combustion engines, reciprocating engines require fuel, air, compression, and a combustion source to function. Depending on the ignition source, they generally fall into two categories: (1) spark-ignited engines, typically fueled by gasoline or natural gas, and (2) compression-ignited engines, typically fueled by diesel oil fuel.

Almost all engines used for power generation are four-stroke and operate in four cycles (or stokes). The four-stroke, spark-ignited reciprocating engine has intake, compression, power, and exhaust cycles. In the intake phase, as the piston moves down in its cylinder, the intake valve opens, and the upper portion of the cylinder fills with fuel and air. When the piston returns upward in the compression cycle, the spark plug emits a spark to ignite the fuel-air mixture. This controlled reaction, or "burn," forces the piston down, thereby turning the crank shaft and producing power. In the exhaust phase, the piston moves back up to its original position, and the spent mixture is expelled through the open exhaust valve.

The compression-ignition engine operates in the same manner, except the introduction of diesel fuel at an exact instant ignites in an area of highly compressed air-fuel mixture at the top of the piston. In diesel units, the air and fuel are introduced separately with fuel injected after the air is compressed by the piston in the engine. As the piston nears the top of its movement, a spark is produced that ignites the mixture (in most diesel engines, the mixture is ignited by the compression alone).

Dual fuel engines use a small amount of diesel pilot fuel in lieu of a spark to initiate combustion of the primarily natural gas fuel. The pressure of the hot, combusted gases drives the piston down the cylinder. Energy in the moving piston is translated to rotational energy by a crankshaft. As the piston reaches the bottom of its stroke, the exhaust valve opens and the exhaust is expelled from the cylinder by the rising piston.

Commercially available reciprocating engines for power generation range from 0.5 kW to 16.5 MW. Reciprocating engines can be used in a variety of applications because of their small size, low unit cost, and useful thermal output. They offer moderate capital cost, easy start-up, proven reliability, good load-following characteristics, and heat recovery potential. Possible applications for reciprocating engines include continuous or prime power generation, peak shaving, backup power, premium power, remote power, standby power, and mechanical drive use. When properly treated, the engines can run on fuel generated by waste treatment (methane) and other biofuels.

XI. Nuclear

A nuclear power plant (NPP) is a thermal power station in which the heat source is one or more nuclear reactors. Nuclear power is the controlled use of the nuclear fission reaction to release energy for work including propulsion, heat, and the generation of electricity. Nuclear energy is produced when a fissile material, such as uranium-235 (U^{235}), is concentrated such that nuclear fission takes place in a controlled chain reaction and creates heat—which is used to boil water, produce steam, and drive a steam turbine to generate electricity[51].

Nuclear fuel production for light water reactors begins with concentrating the U^{235} fraction of natural uranium to the desired enrichment. The enriched uranium is reacted with oxygen to produce uranium oxide. This is fabricated into pellets, which are then stacked and sealed into zirconium tubes to form a fuel rod. Fuel rods are assembled into fuel assemblies - bundles of rods arranged to accommodate neutron absorbing control rods and to facilitate removal of the heat produced by the fission process. Nuclear fuel is a highly concentrated and readily transportable form of energy, freeing nuclear power plants from fuel-related geographic constraints[52].

Operating nuclear units in the United States are based on light water reactor technology developed in the 1950s. Future nuclear plants are expected to use advanced designs employing passively operated safety systems and factory-assembled standardized modular components. These features are expected to result in improved safety, reduced cost and greater reliability. Though preliminary engineering is complete, construction and operation of a demonstration project is required before the technology can be considered commercial. Electricity industry interest in participating in one or more commercial-scale demonstrations of advanced technology is increasing. But even if demonstration plant development moves ahead in the next several years, lead times are such that advanced technology is unlikely to be fully commercial until about 2015. This suggests the earliest operation of fully commercial advanced plants would be around 2020. Also needed for public acceptance of new nuclear development is a fully operational spent nuclear fuel disposal system. Though spent fuel disposal technology is available and the Yucca Mountain site is under development, the timing of commercial operation remains uncertain.

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[51] http://en.wikipedia.org/wiki/Nuclear_power
[52] Northwest Power Planning Council

Nuclear plants could be attractive under conditions of sustained high natural gas prices and aggressive greenhouse gas control. Other factors favoring nuclear generation would be failure to develop economic means of reducing or sequestering the CO2 production of coal based generation, and difficulty expanding transmission to access new wind or coal resources.

Nuclear energy uses an abundant, widely distributed fuel, and mitigates the greenhouse effect if used to replace fossil-fuel-derived electricity. Lately, there has been renewed interest in nuclear energy from national governments due to economic and environmental concerns. Other reasons for interest include increased oil prices, new passively safe designs of plants, and the low emission rate of greenhouse gas.

Nuclear power plants are base load stations, which work best when the power output is constant (although boiling water reactors can come down to half power at night). Their units range in power from about 40 MW to over 1,200 MW. New units under construction in 2005 are typically in the range 600 MW to 1,200 MW. As of 2006, new nuclear power plants are under construction in several Asian countries, as well as in Argentina, Russia, Finland, Bulgaria, Ukraine, and Romania.

Nuclear power is highly controversial, enough so that the building of new commercial nuclear power plants in the United States has ceased - at least temporarily. Under recent legislation intended to jump-start development, Congress is offering more than $8 billion in subsidies and loan guarantees for the first few new plants that get built. Constellation Energy Inc. has publicly identified two sites for development. A consortium of utilities called NuStart Energy Development LLC is in the application and development process for two new plants. Also, Dominion Resources Inc. and Southern Company are each considering new plants.[53]

Almost all the advantages and disadvantages of commercial nuclear power are disputed in some degree by the advocates for and against nuclear power. The use of nuclear power is controversial because of the problem of storing radioactive waste for indefinite periods, the potential for possibly severe radioactive contamination by accident or sabotage, and the possibility that its use in some countries could lead to the proliferation of nuclear weapons. Proponents believe that these risks are small and can be further reduced by the technology in the new reactors. Disposal of spent fuel and other nuclear waste is claimed by some as an advantage of nuclear power, claiming that the waste is

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[53] "Power Producers Rush to Secure Nuclear Sites: First to Develop Plans Could Tap $8 Billion In Federal Subsidies" WSJ 1/29/2007

small in quantity compared to that generated by competing technologies, and the cost of disposal small compared to the value of the power produced. Others list it as a disadvantage, claiming that the environment cannot be adequately protected from the risk of future leakages from long-term storage.

The cost benefits of nuclear power are also in dispute. It is generally agreed that the capital costs of nuclear power are high and the cost of the necessary fuel is low compared to other fuel sources. Proponents claim that nuclear power has low running costs, and opponents claim that the numerous safety systems required significantly increase operating costs.

At the end of 2008, 438 reactors in 30 countries were in operation, and another 44 reactors were under construction. Even so, the prospects for growth and expansion of nuclear power depend on several challenges being met[54], including:

- Continued diligence in achieving safety and reliability;
- Improving economic competitiveness;
- Achieving and retaining public confidence in nuclear power;
- Retaining and developing the necessary workforce competences;
- Continuing successful management of spent fuel and radioactive waste;
- Demonstrating the successful ultimate disposal of spent fuel and high-level waste;
- Management and acceptance of the transport of nuclear fuel;
- Maintaining confidence in nuclear non-proliferation and nuclear security;
- Establishing acceptable infrastructure in countries introducing nuclear power;
- Achieving proven reactor designs appropriate to specific countries;
- Achieving, for the long term, effective and sustainable use of resources.

New Plant Costs[55]

There has been little hard evidence of recent U.S. nuclear developments from which reasonable cost estimates can be made. However, the table below contains current information from the Northwest Power and Conservation Council and International Atomic Energy Agency that can shed some light on international nuclear developments. Please

[54] International Status and Prospects of Nuclear Power, IAEA, 2008
[55] The information provided in this section has been adapted from a Northwest Power and Conservation Council presentation titled "Costs and Prospects for New Nuclear Reactors", which was developed and presented by Jim Harding in February 2007.

note that these figures reflect "overnight" costs as opposed to "all-in" costs, meaning that they assume the plant could be acquired overnight and thus, no interest or related development cost risks are assessed for the seven to ten year development period.

Figure F-30
Nuclear Plant Capital Costs

Plant Name	Location	COD	"Overnight" Cost (in 2002 dollars)
Genkai 3	Japan	1994	$2818/kW
Genkai 4	Japan	1997	$2218/kW
Onagawa	Japan	2002	$2409/kW
KK6	Japan	1996	$2020/kW
KK7	Japan	1997	$1790/kW
Yonggwang 5&6	Korea	2004/5	$1800/kW
Olkiluoto 3	Finland	2010-2011	$2500-3000/kW

Plant Name	Location	COD	"Overnight" Cost (in 2007 dollars)
Turkey Point	USA-Florida	Proposed	$3,108 - $4,540/kW
Levy	USA-Florida	Proposed	$4,260/kW
Connecticut IRP	USA-Connecticut	Study Estimate	$4,038/kW

Source: Northwest Power and Conservation Council

As Figure F-30 illustrates, the average "overnight" cost of the seven recently-built units is $2,130 per kW in 2002 dollars, and two proposed units in 2007 dollars. These figures do not reflect the impact of escalation to 2009 dollars. Further, they do not reflect the impact of nuclear fuel cost increases, which have risen significantly since 2002.

Florida Power & Light filed a Petition for Determination of Need with the Florida Public Service Commission (PSC) in October 2007 for two new nuclear units at its Turkey Point site. FP&L provided a nonbinding estimate for overnight capital costs of between $3,108 per kWe and $4,540 per kWe (2007 dollars), depending on the cost of materials escalation, owner's scope and cost, and transmission integration required. FP&L based its estimate on an earlier study done by the Tennessee Valley Authority (TVA) for its Bellefonte site, adjusted for site-specific factors and elements not included in the TVA study.

Progress Energy Florida filed a Petition for Determination of Need with the Florida PSC in March 2008 for its proposed Levy nuclear power plant. Progress' non-binding overnight cost estimate for its two-unit greenfield site is $4,260 per kWe (2007 dollars). This initial estimate does not include the cost of transmission system upgrades, which will be necessary to accommodate the new units.

Connecticut Integrated Resource Plan (IRP). In January 2008, the Brattle Group, under contract to Connecticut Light and Power and United Illuminating, published an IRP for the state of Connecticut. The IRP assumed an overnight capital cost for new nuclear of $4,038 per kWe (2008 dollars) and an operating cost of $83.40 per MWh.

In October 2007, Moody's delivered a rather negative analysis of the U.S. nuclear sector [56], saying it did "…not believe the sector will bring more than one or two new nuclear plants online by 2015." Moody's further stated that it believed many of the current expectations for nuclear were "overly ambitious." Moody's June Global Credit Research paper concluded, "The cost and complexity of building a new nuclear power plant could weaken the credit metrics of an electric utility and potentially pressure its credit ratings several years into the project." Moreover, the Nuclear Energy Institute, the industry's trade organization, has stated, "There is considerable uncertainty about the capital cost of new nuclear generating capacity."

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[56] Moody's Corporate Finance, "New Nuclear Generation in the United States: Keeping Options Open vs. Addressing An Inevitable Necessity", Special Comment, October 2007

Regional Transmission Resources

PSE transports power from its origination point to our service area over the regional transmission grid through contracts with various transmission providers. Expanded capacity and new transmission routes are needed to meet growing demand, but the number of parties and jurisdictions involved make this a complicated challenge. Recently, there have been signs that new processes and collaborations may help address some longstanding problems.

I. Introduction

The Pacific Northwest's regional transmission situation is marked by an increasing frequency and duration of transmission constraints. The ability to build new transmission has been hindered by:

- Limited coordination between generation and transmission development,
- The absence of a single regional transmission planning body,
- Limited access to significant amounts of capital, and
- No central permitting and siting authority.

There are signs that some of these problems are being addressed:

- Bonneville Power Administration (BPA) has instituted a Network Open Season process to facilitate its ability to plan and construct new transmission lines.
- Other regional utilities are planning large transmission projects to interconnect generation, particularly wind, from outside the Pacific Northwest.
- The Federal Energy Regulatory Commission (FERC) Order 890 requires transmission companies to establish a coordinated, open and transparent planning process. The region is responding to this requirement by using ColumbiaGrid to perform the regional transmission planning function.

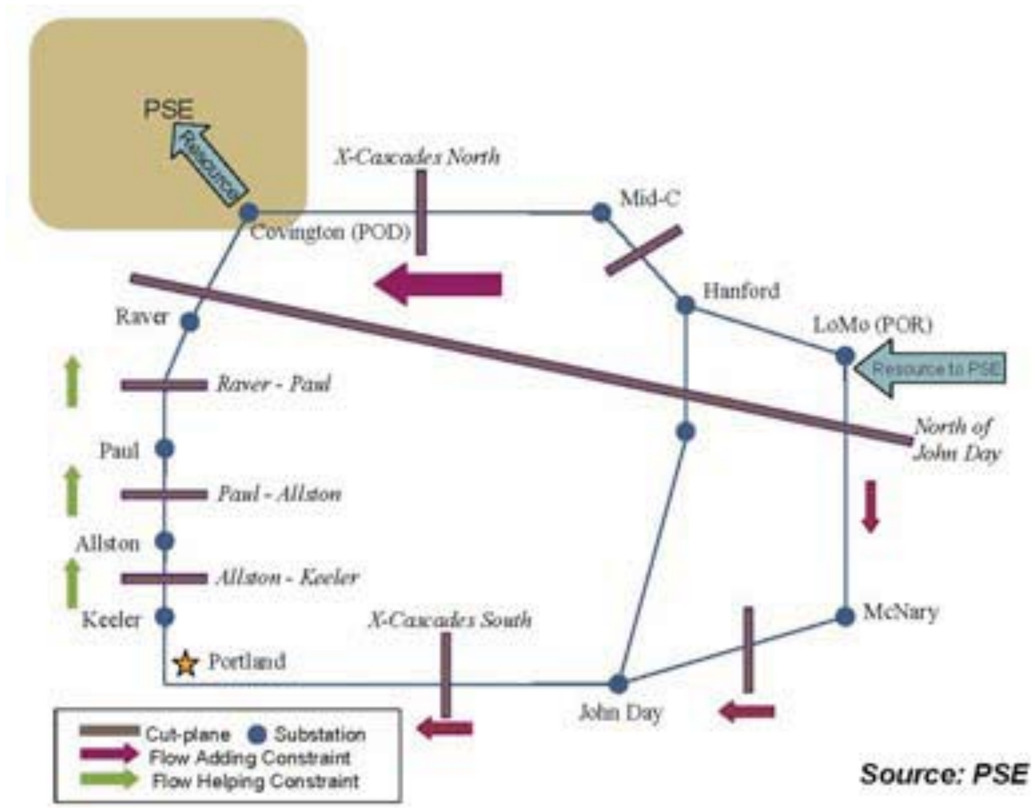
This section describes PSE's current transmission situation, and discusses the efforts to improve the Northwest's regional transmission situation.

II. The State of PSE's Current Transmission System

Historically, PSE and other regional utilities have relied on BPA's transmission system to transport energy and capacity resources. However, as PSE and the region's resource portfolios have grown in conjunction with increasing loads, the Pacific Northwest's transmission system has not kept pace with these demands in recent years. As a result, the region is experiencing significant transmission constraints during various times of the year. This situation is a growing challenge for PSE, in particular as we move energy and capacity resources to the west from eastern Washington (east of the Cascades) and to the north and south through the I-5 corridor.

Figure 1 below illustrates how power is transmitted from a resource located east of the Cascades, and then west to PSE's service area. The flow of power is indicated by the arrow symbol and typically follows on two paths: Cross-Cascades North, and Cross-Cascades South. The portion of power flowing in the southward direction is also traversing the constrained cutplanes of West of McNary, West of John Day, and the I-5 corridor. Note that the arrow sizes are proportional to the relative amount of power flowing. The red arrows illustrate flows in the same direction of the constrained path, while those in blue signify flows in the opposite direction. In order for incremental power to flow through an already congested transmission cutplane, it will require new transmission lines and/or some additional or improved reliability protection schemes.

Figure G-1
PSE Transmission Need to Deliver East-side Resources



PSE is investigating the following options to relieve congestion on the paths illustrated above:

(a) Rely on BPA to build and/or improve the congested paths through its normal Open Access Same-time Information System (OASIS) requests, and if necessary through its Network Open Season process.

(b) Join other transmission project sponsors in joint development efforts.

(c) Develop transmission projects that meet the projected resource additions

PSE's need for additional transmission is driven primarily by increasing loads and the necessity for new generating resources. This requirement for additional resources results from a combination of continued load growth, loss of contracted generation, potentially the retirement of existing resources and compliance with the state's renewable portfolio standards (RPS). Our 2007 IRP identified wind and gas-fired generating resources as PSE's primary options for additional energy and capacity. These two resource types are typically located in different parts of the state; gas-fired generation is traditionally built west of the Cascades near the actual load centers, while wind resources are built east of the Cascades where the topography and wind conditions are more favorable. Each of these generating resources requires a different transmission solution.

Those on the west side are close to PSE's load center and therefore require simpler and less expensive transmission solutions. However, anything east of the Cascades typically relies on the transmission capacity from or through the Mid-Columbia area, which involves a complex solution and is more costly to build and upgrade. The required level of transmission capacity varies depending on the actual size and location of the future resources.

The BPA Option - Role of BPA in PSE's Future Resources

One option for acquiring additional transmission is to work through BPA. While this involved submitting an OASIS request to BPA in the past, just recently BPA completed its first Network Open Season (NOS), designed to obtain commitments from utilities to purchase transmission from BPA. It is expected that the NOS will assist BPA's transmission customers in acquiring incremental transmission to serve customer needs. NOS enables BPA to more efficiently augment its transmission system through better planning. Instead of responding to one request at a time, BPA plans and accelerates the process by performing a "Cluster Study" which combines all financially committed NOS participants into a single group. The Cluster Study identifies key areas of reinforcement on the BPA network that would address all of the requests. From its initial NOS, BPA has proposed five transmission projects and announced its near-term plans to move forward with the construction of the West of McNary projects. In order to accommodate PSE's new wind projects in eastern Washington, BPA must also upgrade the Little Goose transmission line, which will increase capacity and reliability. Lastly, BPA's I-5 transmission project, also intended to increase capacity and reliability, is important to integrate any future west-side generating resources.

Wind power will play a major role in both meeting the region's future energy needs and satisfying RPS requirements. In fact, approximately 10,000 MW of renewable generation (predominantly wind power) will be necessary to fulfill the combined RPS requirements of Washington and Oregon. To meet this increase, BPA must continue to build transmission lines and substations to deliver electricity from the new wind projects in remote locations. Integrating this amount of wind energy into the region's electrical grid poses many challenges, and BPA's role will certainly require innovative and cooperative approaches to effectively manage the variability of wind power to meet consumer and legislative demands.

PSE's future resources – especially wind – will most likely face tough economic and technical challenges, along with business uncertainties. Continuing to rely on BPA to integrate our wind resources has a limit, which means we must continue to look for alternatives to integrate wind either directly into our Balancing Authority (BA), or seek other innovative lower-cost approaches (BA refers to the area operator that matches generation with load). We can pursue these approaches concurrently with BPA's NOS.

The Joint Development Option

A second transmission option is for PSE to continue to investigate partnership opportunities with other entities currently working to address their own transmission needs in the same region. PSE has performed a preliminary investigation of these projects to determine how they might address our integration needs, and identified three possibilities:

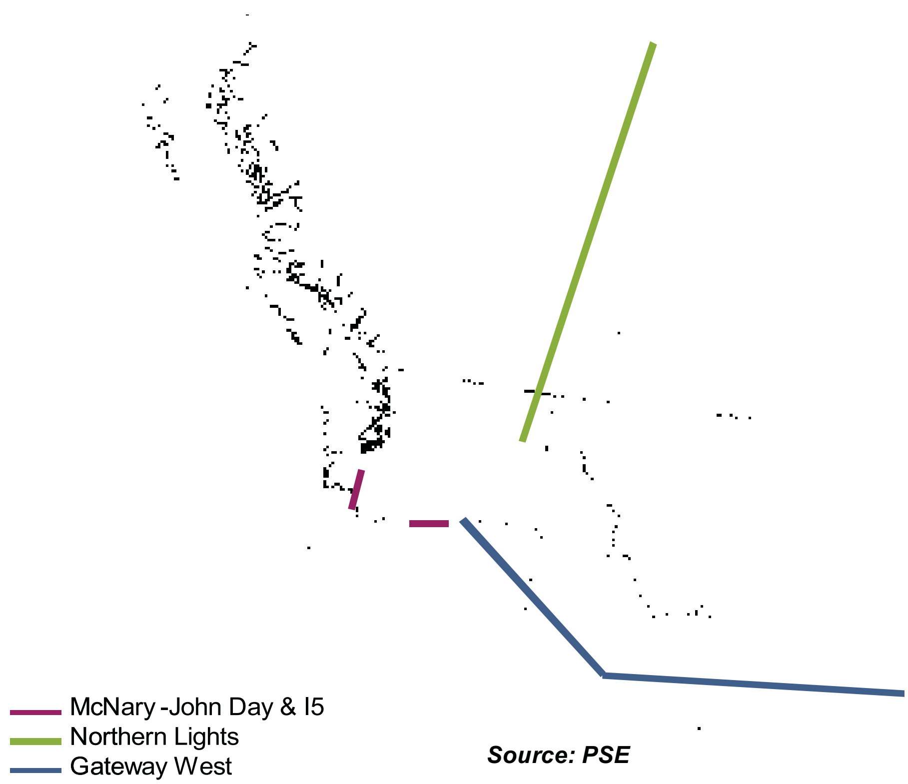
- The BPA NOS projects for West of McNary Reinforcement, which involves BPA building a new 79-mile 500 kV transmission line that runs along the Columbia River, and a new 500 kV substation;
- The BPA NOS I-5 Corridor Reinforcement, which involves the construction of a new 70-mile 500 kV line from the Troutdale substation to a new substation located approximately 12 miles north of the Allston substation, near Longview; and
- Two non-BPA options to integrate additional wind generation from outside of the Pacific Northwest:

    Northern Lights: This project is planned for a new DC line from the Edmonton, Washington/Oregon border. It will provide access to Alberta's renewable resources and to the Alberta market.

    Gateway West: This project is intended to connect renewable and other resources from Wyoming to southeastern Idaho and to the Mid-Columbia area.

These two projects are relevant candidates for PSE. They would provide access to renewable resources from Alberta, Wyoming, and southeastern Idaho. For additional market flexibility, the Northern Lights project also gives PSE access to the Alberta market.

Figure G-3
Top Three Transmission Project Candidates



Source: PSE

The Self Build Option

PSE may need to design, permit and build transmission to accommodate the development or acquisition of new resources, in the event that other options do not meet the need.

III. Regionally-Based Transmission Efforts

In response to the Pacific Northwest's significant transmission constraints, various organizations have undertaken many efforts to address long-term regional transmission planning and expansion issues. The following summarizes some of these efforts:

ColumbiaGrid

ColumbiaGrid is a non-profit membership corporation formed in 2006 to improve the operational efficiency, reliability, and planned expansion of the Pacific Northwest's transmission grid. While the corporation itself does not own transmission, PSE, other members, and additional parties to ColumbiaGrid's agreements do own and operate an extensive network of transmission facilities. ColubmiaGrid's members are PSE, Avista, BPA, Chelan County PUD, Grant County PUD, Seattle City Light, and Tacoma Power.

ColumbiaGrid has substantive responsibilities for transmission planning, reliability, Open-Access Same-Time Information System (OASIS), and other development services. These tasks are defined and funded through a series of "Functional Agreements" with members and other participants. Development of these agreements is carried out in a public process with broad participation. ColumbiaGrid's transparent processes encourage broad participation and interaction with stakeholders, including customers, transmission providers, states, and tribes. It also provides a non-discriminatory forum for interested parties to receive and present pertinent information concerning the regional interconnected transmission system.

Planning and Expansion

ColumbiaGrid's Planning and Expansion Program is intended to promote single-utility planning and expansion of the regional grid. The Planning and Expansion Functional Agreement (PEFA), which has been signed by all of ColumbiaGrid's members and two non-member participant (Snohomish County PUD and Cowlitz County PUD), defines the obligations under this program.

In short, the agreement charges ColumbiaGrid with answering three key questions concerning the transmission network: what should be built, who should build it, and who should pay for it. ColumbiaGrid will provide a number of services in this planning program, including performing annual transmission adequacy assessments, producing a

Biennial Transmission Plan, and identifying transmission needs. ColumbiaGrid also will facilitate a coordinated planning process for the development of multi-transmission system projects.

In February 2009, ColumbiaGrid completed its first cycle of planning and produced the final draft of the 2009 Biennial Transmission Expansion Plan. In support of the Biennial Plan, there are five Study Teams active within ColumbiaGrid addressing specific regions. These study teams include: Puget Sound Area Study Team (PSAST), Northern Mid-Columbia Area Study Team, Olympic Peninsula Study Team, West of McNary Area Reinforcement Project Study Team and the I-5 Corridor Reinforcement Study Team. PSE has actively participated in all five teams and is studying several expansion projects in the PSAST including the following:

- North King County Transformer Capacity Project (Novelty substation)
- South King County Capacity Increase Project (Covington-Berrydale 230kV line)
- Pierce County Transformer Capacity Project (Alderton substation)
- Thurston County Transformer Capacity Project (St Clair substation)
- South of Sedro Capacity Increase (Sedro Woolley – Horseranch #2 230kV line)
- North Cross Cascades Capacity Increase Project (115kV IP line upgrade to 230kV)

Columbia Grid OASIS

Beginning in 2009, ColumbiaGrid will provide program participants with a common Open-Access Same-time Information System (OASIS) portal, which is a single OASIS interface website, to facilitate transmission service requests within and across member and qualified non-member systems.

Initially, this common portal will display information common to those participants that have their own OASIS and provide links to those OASIS systems for the actual transmission requests. Additionally, the OASIS portal will allow posting of available transmission by participating utilities that do not have their own OASIS site.

The initial efforts are focused on developing methodologies for determining common Available Transmission Capacity (ATC) and common queuing of requests for transmission service and interconnection. As a common methodology becomes accepted and implemented, the ColumbiaGrid OASIS will provide common ATCs calculated using that methodology.

ColumbiaGrid will also participate in efforts to identify and develop business practices, products, and tariff provisions common among the participants, and will post these on the ColumbiaGrid OASIS.

Joint Initiatives

In mid-2008, representatives from three West Coast sub-regional planning groups (Northern Tier Transmission Group, ColumbiaGrid and WestConnect) joined forces to pursue a number of projects that would benefit from a broader reach of expertise and geography. Each group had begun work in areas that captured the interest of its peers, and a mutual Joint Initiative program was conceived and begun.

As part of the Joint Initiative, two "Strike Teams" are addressing technical exploration of individual projects using resources from entities that see value in participation. One team works on Products & Services concerns, while the other focuses on the issues related to System Infrastructure. A broad stakeholder "Think Tank" group acts as a steering committee that provides a place for information sharing. Those parties that decide to move forward with implementation of the projects developed by the Strike Teams will do so pursuant to an Implementation Agreement among. The teams are exploring the following initiatives:

- Within-Hour Transmission Purchase and Sale Business Practices - facilitate more efficient use of the transmission system.
- Intra-hour Transaction Accelerator Platform – an automated information exchange to facilitate intra-hour transmission products such as Balancing, Redispatch, etc.
- Dynamic Scheduling System – provides mechanism to facilitate dynamically scheduled products such as regulation and load following between participating BAs.

The Big Tent Projects

In late 2007, Northwest utility sponsors of significant new high voltage transmission projects informed the Western Electricity Coordinating Council (WECC) of their plans to build about 2,200 miles of transmission lines. Pacific Gas & Electric (PG&E), Portland Gas Electric (PGE), BPA, Idaho Power, PacifiCorp and Avista made the initial announcement, and TransCanada and Sea Breeze joined later. The group's projects are referred to as the "Big Tent" transmission line projects, not just because of their significance, but also because the parties do not jointly participate in any one organization. The Big Tent projects will be critical in developing a reliable and integrated West Coast transmission grid for the 21st century.

WECC is coordinating transmission studies for the proposed Big Tent projects since the projects fall within the Council's footprint. The utility sponsors anticipate many benefits through coordination. They proposed the creation of a common base case for all technical studies, and anticipated conducting those studies using consistent assumptions and outages, in addition to sending study results through the same committee for review. By using a common platform and a consistent approach, all of the technical studies during the different phases of the WECC Rating Process (described later) can be presented and approved in a cohesive fashion. Coordination will enable each project sponsor to regionally create project plans of service and meaningful line ratings for the individual segments.

As of January 2009, the group has proposed 11 Big Tent projects. WECC encourages the associated project sponsors to follow its regional policies and procedures, especially when their projects might create additional congestion on the existing rated paths. What follows is an overview and updates for 9 of these projects that could seriously impact PSE's ability to deliver various generation resources to its generation portfolio. A description of the WECC Three Phase Rating process is provided first for the purpose of following the Big Tent project updates.

WECC Regional Planning Process

Generally, to fulfill the requirements of the WECC Three Phase Rating process, project sponsors submit comprehensive reports during the planning of a project. This is in compliance with FERC Order 890, and follows nine principles: Coordination, Openness, Transparency, Information Exchange, Comparability, Dispute Resolution, Regional Participation, Congestion Study, and Cost allocation.

The purpose of the WECC rating process is primarily threefold: 1) to foster development of a broad regional planning perspective, 2) to promote the most efficient use and development of the region's existing and future facilities, and 3) to assure that all relevant regional planning issues are considered. The process is divided into three different phases (1-3), with an additional phase 0 initially required to jumpstart the process:

- **Phase 0** -- Regional planning dialog -- a feasibility analysis is required. Coordination takes place between the regulators and stakeholders. Corridor options, proposed schedule, and a high-level cost estimate are identified.

- **Phase 1** -- Project definition -- a comprehensive progress report documenting results and describing project study details including a preliminary plan of service (i.e., proposed rating, flow scenarios, anticipated service date, etc.) is submitted and reviewed by the Technical Studies Subcommittee (TSS) members within WECC. Informal reports are presented at various TSS meetings. A letter requesting Phase 2 status is submitted at the conclusion of this phase. The acceptance of the Comprehensive Progress Report by WECC TSS and Planning Coordinating Committee (PCC) demonstrating how the project will meet the NERC/WECC Planning Standards signals the completion of Phase 1, at which time the project is granted a Planned Rating and Phase 2 can begin.

- **Phase 2** -- Facility rating -- non-simultaneous and simultaneous transfer capability for project is identified – meaning the project capacity will be studied and demonstrated independently and concurrently with other facilities. The mitigation of adverse impacts to existing facilities is addressed. This might also include the mitigation issues involved with permitting and/or land acquisition.

- **Phase 3** -- Confirmation -- Definitive agreements are achieved for projects to be placed in service.

The whole process from start to finish could take up to three years to complete.

Major Projects in the WECC process

As mentioned before, there are 11 projects proposed for the Pacific Northwest. These projects may impact each other as well as the existing WECC paths. All project sponsors are required to proceed in an open and transparent planning process. For that reason, the Transmission Coordination Work Group (TCWG) was formed to aid the project sponsors with coordinating the planning studies and project communications.

In several meetings since early 2008, the TCWG has focused primarily on development of a common power flow data base, presentation of study results, and review of WECC Phase 1 Comprehensive Progress Reports. The results of studies detailing information such as path flowability, resource and load assumptions, and seasonal flow patterns are expected. Each project sponsor is also expected to conduct sufficient studies including any known effects and relationships with the existing paths. Most of the Big Tent projects are currently in the process of completing the WECC Phase 1 process and may enter Phase 2 in early 2009, provided that WECC accepts their Comprehensive Progress Reports and grants the Phase 2 project rating status.

Project sponsors, during the Phase 2 process, will form and lead a Project Review Group (PRG). This PRG would usually be comprised of interested WECC member representatives and other relevant stakeholders. TCWG may be called to be the PRG for each of these projects. Since the beginning of the WECC Phase 1 process, TCGW has actively helped in determining the power flow base cases, generation resources, and load requirements.

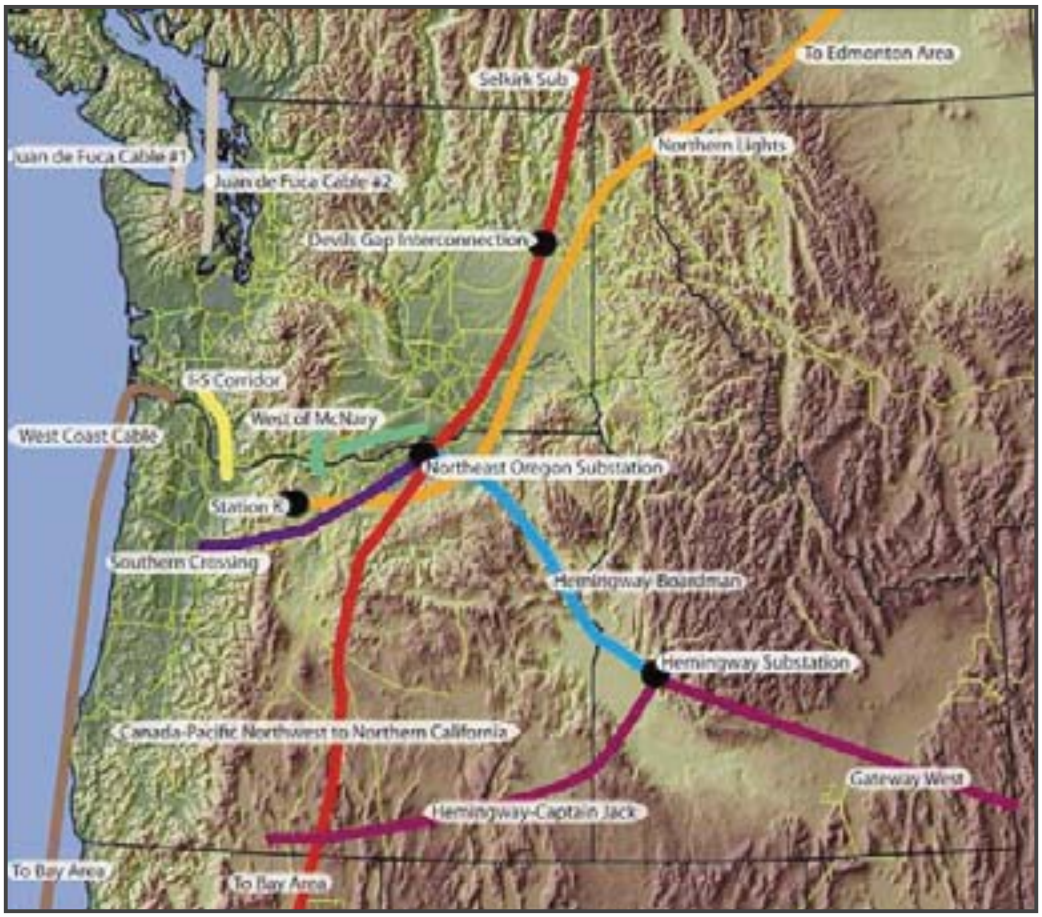
Nine major regional projects with project sponsor, name, estimated cost, and timeframe are listed below. These projects are shown in Figure G-4.

1. PacifiCorp’s Gateway West: ~ $2.7 billion, 2014
2. TransCanada’s Northern Lights: ~ $2 billion, 2014
3. Idaho Power’s Boardman to Hemmingway: ~ $600 million, 2013
4. PG&E’s Canada-Pacific Northwest to Northern California: ~ $billions, 2015

5. PGE's Southern Crossing: ~ $100's million, 2013
6. See Breeze's Cable Projects, Costs unknown, timeframes unknown
7. PacifiCorp's Hemmingway to Captain Jack: ~ $750 million, 2014
8. BPA's West of McNary: ~ $362 million, 2012
9. BPA's I-5 Corridor Reinforcement, ~ $342 million, 2015

Figure G-4

Regional Proposed Big-Tent Transmission Projects



Source: "2009 Biennial Transmission Expansion Plan," Columbia Grid

The main benefits these projects bring to the region are: 1) the access to significant incremental renewable resources in Canada and in the northwestern states, 2) the improvement in regional transmission reliability, and 3) the market opportunities in dealing with participants outside of the region. For PSE in particular, the BPA projects would allow the utility to integrate wind resources east of the Cascades and the gas resources on the west side. Having access to the Alberta market also has a benefit of getting wind and other renewable resources from that area. The flexibility of buying and trading energy north of the border would also increase. As such, the Northern Lights transmission line may become a beneficial candidate for PSE to partner with. Another project that may be beneficial to PSE is the Gateway West transmission line, paired with the Idaho Power Company Hemmingway - Boardman line. In addition to accessing the rich wind resource in Wyoming, PSE would also be able to transfer energy out of and into Idaho. Additional attributes on these projects are provided in the "Joint Development Option" section below.

BPA Network Open Season

BPA Network Open Season (NOS) is a process to determine future regional transmission needs by aligning resource development plans with projected load forecasts. The NOS process utilizes cluster studies to analyze impacts and new facility requirements on an aggregated basis for the long term transmission requests. Commencing in 2008 and in accordance with FERC approval, BPA initiated a NOS process under its Open Access Transmission Tariff (OATT). A multi-step process was implemented beginning with transmission customers submitting Transmission Service Requests (TSR) for desired transmission. BPA responded with an offer of a corresponding Precedent Transmission Service Agreement (PTSA), requiring a security deposit in an amount equal to the charge for 12 months of transmission service at the tariff rate. The PTSA obligates the customer to take service for its TSR if BPA satisfies the following precedent: (1) BPA determines that it can reasonably provide service for the TSRs in the cluster at embedded cost rates, and (2) if facilities must be built to provide the service, BPA decides, after completion of a BPA-funded NEPA study, to build the facilities.

As a result of the 2008 NOS, BPA proposed that transmission service enabled by the following new facilities be provided at embedded (rolled-in) rates:

1. West of McNary Reinforcement (WOMR)
    a. McNary – John Day
    b. Big Eddy – Station Z (line and substation)
2. Little Goose Area Reinforcement
3. West of Garrison Remedial Action Scheme (no new construction)
4. I-5 Corridor Reinforcement

The total direct cost for the above projects totals $806 million, and enables 3,699 MW in addition to the 1,782 MW already authorized in the queue restack. This totals 5,481 MW enabled at a cost of $147,000 per MW. The 20-year average rate impact is projected to be 2.02% per year.

Rationale for the above projects includes an estimated $8 million to $10 million annually in thermal production variable cost savings, reduced congestion on BPA's network flowgates, supporting multi-state RPS requirements, geographic diversity of new renewable generation, and reduced curtailment events impacting the loss of service associated with non-firm service.

PSE requested transmission service for the following projects in BPA's 2008 NOS:

1. Hopkins Ridge Infill – 7 MW
2. Cross Cascades – 150 MW
3. Goldendale Duct Firing – 27 MW
4. RES Joint Development – 600 MW

BPA has awarded PSE the Hopkins Ridge Infill, Cross Cascades, and Goldendale transmission. 250 MW of the 600 MW for the RES Joint Development begins in the requested month of December 2011, and the additional 350 MW is contingent upon the completion of BPA's proposed Little Goose and West of McNary Reinforcement projects.

IV. Outlook

Recommended options

With projected load growth, I-937 RPS requirements, and expiring resource contracts, PSE continues to have significant resource needs. Our current resource strategy includes aggressive demand side resource acquisition, as well as aggressive acquisition of renewables and natural gas generating resources. Additional transmission capacity will be required to transmit electricity from these new resources to PSE's load center.

PSE can pursue the following options:

1. Continue to participate in BPA's Annual Network Open Season for additional transmission capacity to transmit wind and other resources. We have already committed to the transmission offered in BPA 2008 NOS #1 process. We may continue to make transmission requests with BPA through the OASIS and/or take part in the future NOS processes, as the need arises.
2. Partner with other transmission developers
3. Consider self-build options of transmission lines to increase transfer capability and system reliability.

Remaining Regional Transmission Issues

1. Lack of coordinated regional planning

Requesting transmission is a cumbersome process, involving multiple steps and the possible requirement of completing one or more planning studies. This process can take anywhere from a few months to several years. If a project requires service from multiple transmission providers, the applicant utility must make requests with each provider. Since the timing of review processes may not match (e.g. one provider can offer immediate service while the other requires facility upgrades), the transmission applicant may face the decision to sign up for one section of the transmission before securing rights for the entire route.

ColumbiaGrid has established a process for its members to jointly plan the transmission systems of its members systems. The Northern Tier Transmission Group accomplishes this task for its members. Jointly the two groups cover most if not all of the Northwest utilities.

These two groups do not currently coordinate transmission requests. Per FERC rules, transmission providers must sell long-term firm transmission rights through their OASIS. Resource developers, therefore, must identify and apply to the individual transmission providers necessary to transmit electricity from the point of receipt (the generator) to the point of delivery (load center).

2. Lack of centralized transmission siting

Transmission siting issues and development risks are commensurate with those for resource development. To construct new transmission, resource developers must be prepared to work with multiple jurisdictions observing differing processes for each jurisdiction.

Early assessment of environmental issues associated with resource development will determine the level of permitting necessary to gain regulatory approval. Common regulatory permits at the federal and state levels include SEPA/NEPA, Endangered Species (biological assessments), Army Corps of Engineers section 404 and 10 permits, Department of Fish/Wildlife HPA and the Department of Ecology (NPDES). At the city or county level, common permitting needs are conditional use permits for shorelines, clearing and grading, critical area review, and right-of-way use.

Public involvement is incorporated throughout the planning and development phases of transmission projects. This involves engaging stakeholders in many of the necessary decisions.

Routing of transmission lines can require the use of corridors other than those available via municipal, county or state rights-of-way. In these instances, easements from individual property owners are required. Because negotiation of these rights can become contentious and ultimately result in condemnation, careful consideration is critical.

APPENDIX 1 - Transmission Modeling Assumptions

The use of resources located in the Pacific Northwest assumes that PSE acquires transmission through BPA's NOS at embedded rates requiring zero dollars for transmission upgrades. Equity participation in any transmission expansion in the Pacific Northwest for a generation project is assumed to be at or near the cost of BPA's transmission tariff. The exception to this assumption is the Long Haul Wind resource.

Long Haul Wind includes potential wind outside of the Pacific Northwest including eastern Montana, Wyoming, British Columbia, and Alberta. In order to secure transmission for wind resources in these areas, PSE must participate in a regional transmission expansion project. With the current transmission system, there is limited capacity to bring energy from these remote resources home. The following costs were used in the IRP modeling assumptions:

Figure G-5
Long Haul Wind Cost Estimate

Area	Alberta	BC	Montana	Wyoming	Average
Transmission Expansion Capital Cost ($/kw)	$850.00	$1,666.67	$1,000.00	$921.67	**$1,109.58**
Fixed Transmission Tariff Charges ($/kw-yr)	$62.45	$67.25	$77.67	$65.51	**$68.22**
Variable Transmission Tariff Charges ($/MWh)	$13.96	$17.80	$13.57	$19.06	**$16.10**

Additional Long Haul Wind Assumptions:

- Montana Wind is east of the continental divide.
- Wind integration service charges are assumed to be BPZ's estimated $3 kw-mo.
- Losses assumed to be 5% on new transmission lines.
- Fixed and variable transmission tariff charges reflect rates as of 10/31/2008.
- Commercial operation date of wind projects is 2010.
- All costs are in 2008 dollars.
- No O&M charges are included for the transmission expansion projects, only fixed capital.
- Interconnection facilities assumed to be included in capital development costs.

APPENDIX 2

McNary – John Day

Status: Progressing through BPA's Network Open Season

- Facilities Study completed
- WECC regional planning done
- Finishing BPA cluster studies

Next Step:

- Building approval to proceed

Timeframe: 2009 – 2013

Review:

- ColumbiaGrid's planning process
- Big Tent planning process
- BPA planning process

Capacity: 1500 MW

Risk Assessment:

- Permitting delay and schedule uncertainty
- BPA flow-gate assessment change
- Wind projects associated with transmission requests not proceeding
- Cost of material inflation

Benefit Discussion:

- Congestion relief for east-west flows
- Connection of southeastern wind generation to Puget load
- Higher local jobs are created because this line will allow for near-by Mid-C resources to be delivered to our native loads

- Funded through BPA Open Season

Alternatives:

- Relying on Northern Lights and Gateway West projects to get to other renewable sources
- BPA Conditional Firm products
- Building more generation projects on the west side

I5 Corridor

Status: On hold

- WECC regional planning process completed
- WECC phase 1 rating process pending

Next Step:

- Call for interested parties to submit transmission and connection requests to BPA when review process is completed

Timeframe: 2009 – 2015

Review:

- ColumbiaGrid's planning process
- Big Tent planning process
- BPA planning process

Capacity: 1300 MW

Risk Assessment:

- Permitting delay and schedule uncertainty
- BPA flow-gate assessment change
- Wind projects associated with transmission requests not proceeding
- Cost of material inflation

Benefit Discussion:

- Congestion relief between Portland and Seattle on BPA system
- Access to N. Oregon and S. Washington wind
- Improved system reliability
- Funded through BPA Open Season

Alternatives:

- Relying on Northern Lights and Gateway West projects to get to other renewable sources
- BPA Conditional Firm products
- Building more generation projects on the west side

Gateway West

Status: Project scoping

- WECC regional planning process ongoing

Next Step:

- Call for interested parties to submit transmission and connection requests to BPA when review process is completed

Timeframe: 2010 – 2014

Review:

- Big Tent planning process
- WECC regional planning process
- WECC three-phase rating process

Capacity: 3000 MW

Risk Assessment:

- Permitting delay and schedule uncertainty
- Lack of participation
- Cost of material inflation

Benefit Discussion:

- Access to renewable resources outside the Pacific Northwest assuming Amendment of I-937 is in place
- Significantly expands transmission to the east
- Access to Wyoming wind
- Access to S. Idaho geothermal

Alternatives:

- Relying on Northern Lights project and BPA's NOS to get to other renewable resources
- BPA Conditional Firm products
- Building more generation projects on the west side

Northern Lights

Status: WECC Phase 1 rating process

- WECC regional planning process completed
- Phase 1 rating process in the verge of completion

Next Step:

- WECC Phase 2 rating process
- Call for interested parties to participate in the investment

Timeframe: 2010 – 2014

Review:

- Big Tent planning process
- WECC regional planning process
- WECC three-phase rating process

Capacity: 2000 MW

Risk Assessment:

- Permitting delay and schedule uncertainty
- Lack of participation
- Cost of material inflation

Benefit Discussion:

- Access to renewable resources in Alberta assuming Amendment of I-937 is in place
- Access to Alberta, Mid-C, and California trading markets
- Potential I-5 corridor relief

Alternatives:

- Relying on Gateway West project and BPA's NOS to get to other renewable resources
- BPA Conditional Firm products
- Building more generation projects on the west side

Wind Integration

I. Overview

A. Existing and Future Wind Development

As of December 2008, the installed wind capacity in the Pacific Northwest was almost 3,000 MW. Over 60% of this wind capacity is interconnected to Bonneville Power Administration's (BPA) Balancing Authority (BA), with the remainder interconnected to PacifiCorp West, PSE and NorthWestern Energy. "BA" refers to the area operator that matches generation with load. Over the next few years, there are several thousand megawatts planned for development in this region. The majority of existing and planned wind projects are located in the Lower Columbia region.

PSE's power portfolio benefits from 480 MW of wind capacity. We currently own two wind projects: Hopkins Ridge and Wild Horse. In addition, PSE has executed a 50 MW Purchased Power Agreement (PPA) for a portion of the output of the Klondike III facility, located in Oregon.

The Hopkins Ridge wind project is located in eastern Washington and has a capacity of 156.6 MW. Both the Hopkins Ridge and Klondike III wind projects are interconnected to BPA's BA. As a result, BPA provides integration services to manage the variable output of wind and delivers the hourly scheduled amount of wind generation to PSE's system. Because the Wild Horse wind project is located in central Washington and is interconnected to PSE's BA, our system must accommodate the variations in wind output. We plan to expand the Wild Horse wind project by an additional 44 MW by 2010.

B. Managing Variable Output

Wind generation is an intermittent and non-dispatchable generation resource. Like PSE's load, its variability can be managed, though the unpredictable nature of wind creates uncertainty. There can be large differences between a short-term wind generation forecast for hour- or-day-ahead time frames compared to the actual power produced. Short-term, unanticipated ramping events present some of our greatest challenges as we work to ensure that our electric system meets industry reliability standards.

If actual real-time generation output diverges from the hourly scheduled wind output, the operator must rebalance the system by increasing or decreasing generation from Mid-Columbia and other generating assets within our system. The instantaneous fluctuations are generally mitigated by Mid-Columbia hydroelectric generation, which is on automatic generation control (AGC) and can respond instantaneously. Regulation is the ability to meet moment-to-moment fluctuations in loads and wind generation to correct for unintended fluctuations. Regulation is met with generation that is online, spinning, and AGC equipped. Large, unanticipated ramping events must be managed within the hour with a combination of AGC and dispatcher actions. Wind generation following corrects for wind generation differences over longer time increments of 10 to 50 minutes between hourly scheduling adjustments. “Following” is the use of other generating facilities to compensate for un-forecasted decreases and increases in wind facility output.

II. Wind Integration Costs in IRP Modeling

For this IRP, PSE was able to estimate BPA wind integration costs, ascertained during workshops with BPA officials. As of October 2008, the best estimate of these rates was $3 a KW-Month. This rate estimate was escalated and a nominal cost was used. Other wind integration costs, such as imbalance charges, are consistent with PSE's experience in integrating the Wild Horse and Hopkins Ridge projects, and are described in more detail below.

III. Short Term Outlook Case Study

A. Integration of Hopkins Ridge Wind Project

PSE’s 156.6 MW Hopkins Ridge wind project is interconnected to BPA’s BA and integrated into BPA’s system. The hourly scheduled amount of power is delivered to our system. Wind is scheduled 30 minutes prior to the start of the hour and the schedule is automatically sent to BPA. The wind schedule is developed every hour using the most up-to-date information from a combination of actual real-time observations and vendor-provided forecast models. The forecast model employs publicly available weather forecasts, advanced statistical algorithms, numerical weather prediction models and a self-learning artificial intelligence logic.

BPA's integration services are two-fold: One service -- generation imbalance -- captures the after-the-fact difference between the hourly average generation that was scheduled, versus what was actually produced. The second service -- wind integration -- manages the second-to-second, minute-to-minute variability in wind generation by providing regulation and wind generation following. In October 2008, BPA implemented a wind integration rate of $0.68 per KW per month, or $3.11 per MWh assuming a 30% capacity factor, which was settled in the 2009 BPA Wind Integration Rate Case. This rate resulted in a fixed monthly charge of $106,488 which translates to approximately $4 to $6 per MWh depending on the amount of monthly generation produced. This megawatt-hour cost increases if less monthly wind generation is produced.

Customer workshops leading up to the 2010 - 2011 BPA Power and Transmission Rate Cases, which will set a new wind integration rate effective Oct. 1, 2009, suggest that the rate will increase to $2.73 per KW per month, or $12.47 per MWh assuming a 30% capacity factor. This rate is more than four times higher than the rate set in BPA's 2009 Wind Integration Rate Case and does not include the Generation Imbalance, Unauthorized Increase Charge or Failure to Comply penalties that BPA may also assess.

BPA's anticipated wind integration rate of $2.73 per KW per month is based on a wind scheduling accuracy assumption of a 2-hour persistence forecast. A 2-hour persistence forecast assumes that the hourly average wind generation observed two hours ago is the forecast or schedule for the next hour. If BPA assumes a higher wind scheduling accuracy (less forecast error) such as a 60-minute or a 30-minute persistence forecast, then the rate could decrease to $1.37 per KW per month, or $6.26 per MWh assuming a 30% capacity factor, according to the details released by BPA in January 2009. At this time, BPA is still using the 2-hour scheduling accuracy and has not committed to using a higher wind scheduling accuracy to reduce the wind integration cost.

B. Integration of Wild Horse Wind Project

For most of the calendar year, PSE's 1,100 MW share of Mid-Columbia hydroelectric generation is sufficient to manage the instantaneous Wild Horse wind and load variability and deviations from its schedule. Wild Horse wind output is scheduled at 30 minutes prior to the start of the hour using similar tools described for Hopkins Ridge.

During the spring runoff period when the Columbia River flows are high, the Mid-Columbia hydroelectric system has to be managed to stay within the legal Total

Dissolved Gas (TDG) limits by minimizing spill. Mid-Columbia flexibility is limited between available capacity and the minimum generation limit that does not violate the TDG limits. To stay below the TDG limits, spill must be avoided completely or minimized by operating close to turbine capacity. This type of operation results in limited upward and downward generation flexibility. If wind output is less than scheduled, the system must respond by increasing generation elsewhere. However, the Mid-Columbia cannot respond because it is already operating at capacity. During off-peak hours, the Mid-Columbia hydroelectric generation and most of PSE's other resources are operating at or close to their minimum project generation. As a result, the system has limited downward flexibility to respond if the wind output is greater than scheduled.

When the Mid-Columbia system does not provide the necessary flexibility to manage the Wild Horse wind project, PSE uses its thermal resources and market transactions to balance the system. During spring 2008, PSE experienced insufficient Mid-Columbia flexibility and had to mitigate some of the wind output using our thermal resources. The thermal units were dispatched and operated at minimum, mid-point and maximum to provide the flexibility to either increase or decrease generation.

As PSE's Mid-Columbia contracts expire and undergo renegotiation, our share of Mid-Columbia hydroelectric generation will decrease over time. In addition, more restrictive protection of anadromous fish could also limit PSE's Mid-Columbia flexibility. Our current 1,100 MW share of Mid-Columbia could be less than 500 MW by 2020. As the Mid-Columbia capability decreases, PSE will have to rely more on other resources within our portfolio, as well as increased market transactions to address our system balancing needs.

1. Use of market resources to provide wind integration services

Short term market transactions, which smooth out the forecast error between forecast time horizons, are an important component of wind integration within PSE's current portfolio. As PSE's wind portfolio expands, they will continue to be a critical component into the future. Day-ahead markets allow us to balance positions given the forecast error which occurs between long-term models and day-ahead wind forecasts. Real time markets allow us to rebalance hourly positions for the forecast error that occurs between day-ahead scheduling and hour-ahead forecasts.

From time to time, PSE purchases ancillary energy in the short term and forward markets. Aside from energy itself, both "spinning" and "non-spinning" reserve energy can often be found in the market. Spinning reserve is defined as unused capacity that can be activated by the operator and is procured through devices that are synchronized to the network and able to affect the active power. Non-spinning reserve is defined as offline generating capacity that is capable of being brought online within 10 minutes. PSE generally has surplus non-spinning reserves, but at times can be deficit on spinning reserve as required by the Northwest Power Pool (NWPP). As a member of the NWPP Reserve Sharing Group, PSE is required to hold generation in reserve in order to meet our Contingency Reserve Obligation (CRO). Under the current calculation, PSE holds in standby as a contingency 5% of all hydropower and wind generation, plus 7% of all thermal generation online and loaded within the PSE BA. Of that total, at least 50% is obligated to be spinning and the remaining 50% can be non-spinning. Leaning on the short term markets to meet our CRO is sometimes useful and more economical than dispatching a thermal unit, but transmission and liquidity can challenge this reserves market. For transactions to meet the BA's CRO, there must be a firm transmission path from source BA to sink BA. Because firm transmission is often unavailable in real time, a real time ancillary market is very hard to find.

PSE has had some limited success procuring ancillary products in the forward market. For a spring 2008 delivery, we secured 50 MW of spinning reserve capacity for a six-week period during the peak of the spring runoff. Long term capacity products help balance the PSE portfolio and should be considered as a viable option for wind integration.

2. Cost of integrating wind in PSE's balancing authority

PSE's Wind Integration Team is evaluating historical regulation and generation following requirements for both Wild Horse and Hopkins Ridge. In order to meet Washington state's Renewable Portfolio Standards, PSE may add up to an additional 1,000 MW of wind to our current portfolio, yet we have not yet determined the interconnections of the new wind projects. To ensure that PSE is well positioned to manage the additional wind, all integration options are being evaluated to determine the least cost options. The cost associated with integrating wind in PSE's BA can be divided into two categories: 1) within-hour balancing reserves (regulation and generation following) and 2) the opportunity cost of reshaping the Mid-Columbia hydroelectric generation and dispatching the thermal units.

If our internal study determines that PSE's existing portfolio does not provide the necessary flexibility to adhere to regulation, generation following and forecast error, then PSE may be required to improve the existing thermal fleet by adding AGC and coordinating controls. As a final option, we may also need to add new, flexible resources to our portfolio. We continue to study wind integration and look for opportunities to minimize such costs.

C. Integration of Klondike III Wind Project

The Klondike III project is interconnected to BPA's BA and receives the same wind integration services as Hopkins Ridge. PSE receives the forecasted wind output for both the day-ahead and next-hour time horizon from the project's owner/operator. The forecasted wind output is then scheduled with BPA, and PSE receives the hourly scheduled wind output for the next-hour. PSE has to mitigate the forecast error between the two time horizons, hour ahead and day ahead. However, the instantaneous wind variability and unanticipated wind ramps are managed by BPA's BA.

As negotiated in the PPA, PSE is not responsible for the cost of generation imbalance, but is required to pay for half of BPA's wind integration cost of $0.68 per KW per month, or $3.11 per MWh assuming a 30% capacity factor. As discussed above, the cost of wind integration will change when BPA's 2010 - 2011 Power and Transmission Rate Case concludes.

IV. Regional Challenges and Solutions

Wind development poses some new challenges for the region as well as opportunities for growth and system improvements. In the last few years, the region has gained a lot of knowledge and has developed new tools to help overcome some of the challenges. Several regional efforts focusing on issues related to wind integration are discussed below.

A. Wind Diversity

Most wind development has occurred in the same general geographical area, the Lower Columbia region. Wind projects that are developed and located within the same general geographical region lack diversity and may result in large, simultaneous and unscheduled swings in wind generation. Sufficient reserves must be held so that the system can respond to these swings. More geographically diverse, negatively correlated wind projects naturally smooth out the wind output. Geographic diversity between wind projects may provide real benefits and reduce the amount of reserves needed to manage the variability. Access to transmission lines is a key factor affecting wind diversity. New transmission lines are expensive, and access to existing lines is limited.

B. Flexibility on the Hydro System

To date, the Pacific Northwest's hydroelectric system has adequately accommodated the integration needs associated with wind power. However, recent dramatic growth in wind generation means that at times there is no longer sufficient system flexibility. This is evidenced by BPA announcing a temporary moratorium on accepting new Large Generator Interconnect Agreements until a more optimal integration solution can be found. Currently, there are already times of the year when the hydro system is not available to manage wind and BAs rely on thermal generation and market transactions. In the future, the region may observe shifts in the way the system is operated as new, creative and cost-effective solutions are developed.

C. Wind Forecasting

The science of wind generation forecasting is relatively new and there is limited wind speed data available for study purposes and to calibrate forecasting models. However, the accuracy of wind generation forecasts does continue to improve. Most operators closely monitor actual, real-time wind output and use a vendor-produced forecast to help predict wind output for the next hour and next day time horizons. Modeling techniques have a level of built-in probability or uncertainty that can be adjusted, and over time forecasts may improve. However, accuracy of less than a 30-minute persistence forecast appears to be an ongoing challenge.

Regionally, BPA has reported a large difference between actual wind generation and wind farm forecasts, which results in large generation imbalance needs. In September

2008, when BPA first shared its observation, the forecast level accuracy was at the 2-hour persistence forecast. By year end, however, improvements put the forecast accuracy closer to the 1-hour persistence forecast. This is an indication that even without sophisticated forecasting tools, noticeable system improvements are possible.

Operational benefits may be realized with either a single entity forecasting wind generation for an entire region, or a BA since these would allow for complete data sharing. However, we have no indication that the region would be willing to move to this type of forecasting, nor of how many other benefits could be gained from such a process.

D. Predicting Wind Ramps

One of the main challenges with wind forecasting is the ability to predict wind ramps. Wind ramps are large changes in the output of a wind farm over a short time frame, usually less than 30 minutes. BPA's Technology Innovation Group, in partnership with the California ISO, is funding a Wind Ramp Forecasting R&D proposal to forecast wind ramps in BPA BA. Wind ramps will be forecasted 36 hours ahead and tracked to real time. In the first year, vendors will use historical data to forecast 2006 and 2007 energy output at select wind plants. The vendors with the smallest errors will then have the opportunity to forecast all wind plants in BPA BA in 2010. The success of this project could significantly impact the PNW.

E. Thermal Generation on AGC

While some thermal units in PSE's portfolio can respond quickly, they cannot be used to respond instantaneously, like the Mid-Columbia hydroelectric generation, because they are not equipped with AGC. Those units that *are* considered to have fast response and appropriate operating characteristics are being evaluated to determine if installing AGC is the most economical option to gain the additional flexibility necessary to maintain system reliability. Operating thermal units on AGC will likely increase O&M costs for these generators as variable generation requirements increase.

F. Automatic Control of Wind

In order to successfully integrate wind generation, firming resources must have the capability to provide both up regulation and down regulation. From a system management perspective, each hourly position must be set to allow the wind generation to move up and down freely. While shedding generation is acceptable, shedding load is not. For the simple fact that generators can be curtailed, over generation is not considered to be a system reliability event as defined by both WECC and NERC. Conversely, not having enough generation is a major concern and addressed clearly by both organizations.

G. Market and Scheduling Practices

Currently there are two active forums exploring the potential for alleviating intra-hour scheduling challenges associated with integrating variable generation wind resources: One is the Northwest Wind Integration Action Plan (Action Plan), co-sponsored by BPA and the Northwest Power and Conservation Council, and comprised of representatives from Northwest utility, regulatory, consumer and environmental organizations. The other forum is the Joint Initiative Work Group (Joint Initiative), made up of ColumbiaGrid participants, Northern Tier Transmission Group, and WestConnect.

The Action Plan created 16 recommendations that would help with the integration of wind generation. Action Item 13 of the Action Plan found that reducing barriers to market system flexibility would help with integrating wind, and stated that *"it is critical to develop mechanisms for better utilizing the flexibility of the region's thermal resources as well as developing new products, services and business practices for exchanging energy and capacity on a sub-hourly basis"*. As a result, WSPP drafted an intra-hour capacity product, and created of the Joint Initiative. The goal of the Joint Initiative is to identify the business process changes required to enable sub-hourly energy and transmission scheduling. Definitive timelines for achieving the objectives and goals in these two forums are being developed.

Intra-hour schedules will reduce the length of uncertainty around wind generation. A shorter scheduling period provides more opportunities to adjust wind schedules more closely to what the actual output is and thus rely less on balancing resources to make up the difference. The down side of this is that more schedules require more administration, including creating, approving, and modifying schedules and e-tags. Large scale regional participation is not required to make this approach beneficial, although wide-spread participation would create more market liquidity and options available to BAs that are managing wind.

H. Dynamic Scheduling

Dynamic scheduling provides mechanisms to schedule resources from a source BA to a sink BA. Currently, BAs are capable of dynamically scheduling from across another BA, as long as the source and sink BAs are the same. However, the appropriate hardware is not yet in place to allow two BAs, and therefore two AGC systems, to communicate and dynamically transfer resources. Once the capability to dynamically schedule is in place, a wind facility interconnected to a BA will be able to use flexible resources from another BA to manage the variable output. This system will provide additional flexibility to the region and provide more market liquidity.

I. Wind Pooling and Wind Only Balancing Authority

A small group of Northwest utilities that manage wind power is discussing the possibility of creating a wind-only BA. The fundamental concept behind a wind-only BA is that it facilitates the integration of wind resources by combining signals from “diverse” wind-plants and optimizes this diversity. The BA would accept bids from flexible resources which help firm, shape, and balance the output generation products. The BA would receive the variable wind generation and deliver a fixed schedule to each participant in the BA based on the schedule provided by that participant. The system reliability would then be based on the summation of all the wind input data. With this arrangement, wind diversity helps greatly reduce the variation of the system, thereby decreasing the total wind integration cost.

There are many challenges and constraints to overcome, both technically and economically, to bring the wind-only BA to fruition. To be commercially viable, a wind-only BA would require a broad participation of wind resources with negatively correlated generation profiles. It also requires significant amounts of balancing resources to maintain system reliability and adequate assurance that resources will be available if needed. Determination and allocation of benefits and costs amongst BA participants could be insurmountable in forming the BA. Implementation and on-going costs to operate and mange the BA could be significant. However, a wind-only BA could provide the integration certainty wind developers need to construct plants.

J. ACE Diversity Interchange

Area control error (ACE) diversity interchange (ADI) offers a means of reducing the system control burden for any number of BAs within a group of BAs, without undue investment or sacrifice by any participant in a group. The method achieves a mutual reduction in regulation requirements and generator output adjustments (ramping). The impacts of wind integration on any one BA can be reduced by sharing flexible resources and operational constraints. Through ADI, BAs share ACE to reduce instantaneous generator movement by leveraging the diversity in their short-term load and resource balance. PSE became a member of the regional ADI program in 2008. While ADI helps distribute the response to the variability of wind, its impact is relatively small compared to the overall fluctuations in wind generation. ADI is minimal in cost to establish and maintain, and can be implemented in a matter of months. It requires broad participation to get meaningful effects.

K. Transmission

A significant cost to wind projects is the need to purchase transmission equal to the wind project nameplate rating. However, the actual capacity factor of a wind turbine, expressed as the ratio of average power output to its nameplate rating, is not as high. Many national targets assume an average capacity factor of around 30% for wind. Therefore, a typical wind generation project is not using its transmission line 70% of the time. As such, the unit cost of transmission for wind projects is much higher compared to a high capacity factor resource.

An option that allows a wind project to use a larger portion of its transmission rights is to locate wind and flexible resources in the same general area. The idea is that wind varies significantly and there is always room to schedule other flexible resources using the transmission that has already been assigned for the wind resource. Assigning 100% of transmission for a resource having the capacity in the 30% range is not the most optimum use of the transmission system.

Electric Analysis

This appendix presents details of the methods and models employed in PSE's electric resource analysis, and the data produced by that analysis.

1. Methods and Models

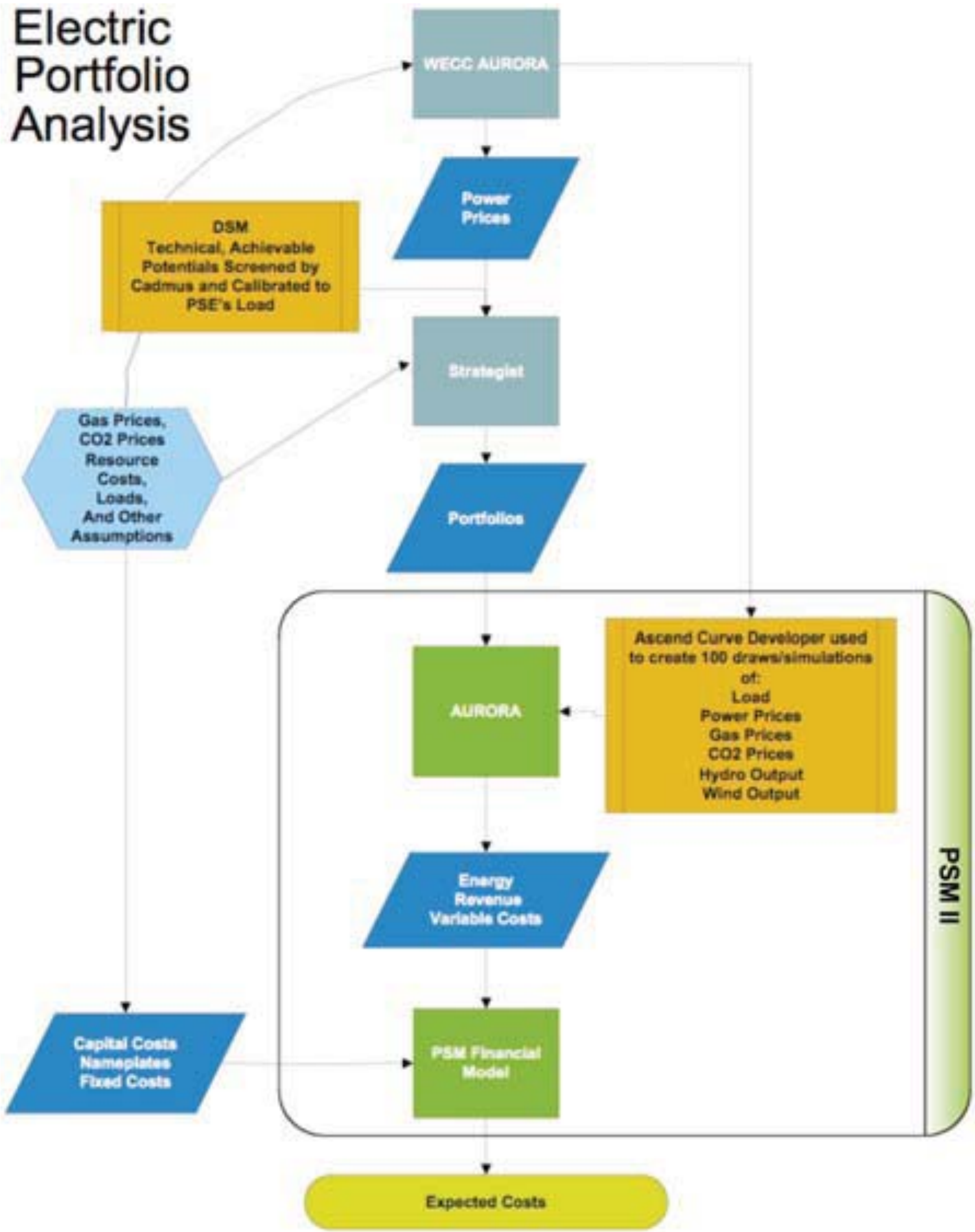
2. Data

1. Methods and Models

I. Methods

A. Diagram of Process for 2009 IRP

PSE uses three models for integrated resource planning: AURORAxmp, Strategist and the Portfolio Screening Model II (PSM II). AURORA analyzes the western power market to produce hourly electricity price forecasts of potential future market conditions, as described in Chapter 3. Strategist creates optimal long-term electric supply and demand portfolios for each of the potential futures also described in Chapter 3. PSM II tests these portfolios to evaluate PSE's long-term revenue requirements for the incremental portfolio and risk of each portfolio. The following diagram shows the methods used to quantitatively evaluate the lowest reasonable cost portfolio.


Electric Portfolio Analysis
WECC AURORA
Power Prices
DSM Technical, Achievable Potentials Screened by Cadmus and Calibrated to PSE's Load
Strategist
Gas Prices, CO2 Prices Resource Costs, Loads, And Other Assumptions
Portfolios
Ascend Curve Developer used to create 100 draws/simulations of: Load Power Prices Gas Prices CO2 Prices Hydro Output Wind Output
AURORA
Energy Revenue Variable Costs
Capital Costs Nameplates Fixed Costs
PSM Financial Model
PSM II
Expected Costs

B. Risk Analysis

i. Scenarios

A description of the nine scenarios can be found in Chapter 3, section 1, *Electric Analysis Components*. The monthly price output from these scenarios can be found in section 2 of this appendix.

ii. Portfolios

An optimal portfolio was found for each scenario and sensitivity described in Chapter 3 for a total of 16 portfolios. The optimal portfolio for each scenario is the lowest cost combination of supply and demand side resources that meets PSE's needs. More details on these portfolios can be found in section 2 of this appendix. Two additional portfolios were created as extreme situations, one all peaker and one all base load CCCT portfolios.

iii. Probabilistic Analysis of Risk Factors

In addition to using scenarios to assess risk, this 2009 IRP continues to assess portfolio uncertainty through probabilistic Monte Carlo modeling in AURORAxmp. It relies on Monte Carlo simulations of six uncertainty factors: market prices for natural gas, market prices for power, CO2 prices, weather variability for load, wind generation variability, and hydroelectric generation availability. The simulations are based on assumptions about correlations and volatilities between the risk variables and also across time, based on the Ascend Analytics Curve Developer model. This model and its assumptions are further described later in this appendix.

iv. Risk Measures

The results of the Monte Carlo simulation allow PSE to calculate portfolio risk. Risk is calculated as the average value of the worst 10% of outcomes (called TailVar90). This risk measure is the same as the risk measure used by NWPCC in its Fifth Power Plan. Additionally, PSE looked at annual volatility by measuring year to year changes in revenue requirements. Then the company calculated the standard deviation of those year to year changes. The final measure of volatility is the average of the standard deviation across the simulations. It is important to recognize that this does not reflect actual expected rate volatility. The revenue requirement used for portfolio analysis does not include rate base and fixed cost recovery for existing assets.

II. Models

A. The AURORA Dispatch Model

i. Overview

PSE uses the AURORA model to estimate the market price of power used to serve its core customer load. The model is described below in general terms to explain how it operates, with further discussion of significant inputs and assumptions.

The following text was provided by EPIS, Inc. and edited by PSE.

> AURORA is a fundamentals-based program, meaning that it relies on factors such as the performance characteristics of supply resources, regional demand for power, and transmission, which drive the electric energy market. AURORA models the competitive electric market, using the following modeling logic and approach to simulate the markets: prices are determined from the clearing price of marginal resources. Marginal resources are determined by "dispatching" all of the resources in the system to meet loads in a least cost manner subject to transmission constraints. This process occurs for each hour that resources are dispatched. Resulting monthly or annual hourly prices are derived from that hourly dispatch.
>
> AURORA uses information to build an economic dispatch of generating resources for the market. Units are dispatched according to variable cost, subject to non-cycling and minimum-run constraints until hourly demand is met in each area. Transmission constraints, losses, wheeling costs and unit start-up costs are reflected in the dispatch. The market-clearing price is then determined by observing the cost of meeting an incremental increase in demand in each area. All operating units in an area receive the hourly market-clearing price for the power they generate.

ii. Long Run Optimization

AURORA also has the capability to simulate the addition of new generation resources and the economic retirement of existing units through its long-term optimization studies. This optimization process simulates what happens in a competitive marketplace and produces a set of future resources that have the most value in the marketplace. New units are chosen from a set of available supply alternatives with technology and cost characteristics that can be specified through time. New resources are built only when the combination of hourly prices and frequency of operation for a resource generate enough revenue to make construction profitable, unless reserve margin targets are selected; that is, when investors can recover fixed and variable costs with an acceptable return on investment. AURORA uses an iterative technique in these long-term planning studies to solve the interdependencies between prices and changes in resource schedules.

iii. Use of Reserve Margin Targets

During the summer of 2006, EPIS, Inc. released a new version of AURORAxmp, along with an input database that included the necessary inputs to perform long-term studies using planning reserve margin targets. The model builds resources to meet target reserve margins and estimates the "capacity price payments necessary to support the marginal entrants supplying capacity to the system."[1]

PSE uses reserve margin targets at the pool level, which consists of the Northwest Power Pool territory. The overall pool reserve margin target is 15%. PSE tested capacity pool reserve margins at 0%, 5%, and 15%. A pool reserve margin of 15% best mitigated summer price spreads without increasing average prices unreasonably. Many U.S. regions plan for at least a 15% reserve margin.

Existing units that cannot generate enough revenue to cover their variable and fixed operating costs over time are identified and become candidates for economic retirement. To reflect the timing of transition to competition across all areas, the rate at which existing units can be retired for economic reasons is constrained in these studies for a number of years.

[1] EPIS, Inc., "Long-Term Studies Using Reserve Margins," from AURORAxmp electronic documentation, December 2005.

B. Strategist

The following text was provided by Ventyx:

i. Overview

Strategist, a computer software system developed by Ventyx, supports electric utility decision analysis and corporate strategic planning. The system combines quality planning software, a proven track record, Ventyx's commitment to ongoing maintenance and support, comprehensive user documentation (online help), and fast response to client needs. Strategist is available as a demand-side management analysis system, as a least cost resource optimization system, as a comprehensive planning tool for quick evaluation of hundreds of alternatives, as a finance and rates planning system and as selected application modules that complement planning capabilities already in place. Strategist consists of the following application modules:

- Load Forecast Adjustment (LFA)
- Generation and Fuel (GAF)
- PROVIEW (PRV)
- Capital Expenditure and Recovery (CER)
- Differential Cost Effectiveness COST (DCE)
- Dynamic Marketing Program Design (DPD)
- Financial Reporting and Analysis (FIR)
- Class Revenue (CRM)
- Holding Company (HCM)

ii. General Description

Strategist's advantage as an integrated planning system is its strength in all functional areas of utility planning. Strategist allows analysts to address all aspects of an integrated planning study at the depth and accuracy level required for informed decisions. Hourly chronological load patterns are recognized. Production cost simulations are comprehensive, yet fast. Financial analyses are accurate and thorough. Rate-level determinations reflect each utility's customer class definition and cost-of-service allocation factors. The system employs dynamic programming to develop optimal portfolios of resources. Sophisticated screening methodologies are available to develop and refine strategic marketing initiatives, identify market potential, and build portfolios of initiatives. In Strategist, integrated resource screening and optimization is accomplished within a single system that handles strategic marketing programs, production costing, environmental reporting, capital budgeting and financial, tax, and revenue forecasts on a rate class basis. Using a single, integrated software system for demand- and supply-side analysis of all resource types makes these studies much more manageable, ensures consistency in data assumptions, and provides credible, auditable results. With Strategist, utility management can examine many more options in a shorter period of time. The system has been designed to streamline the many steps in a comprehensive integrated planning effort and to handle the mechanics. This minimizes human error, inconsistencies, and repetitive data entry. For instance, if a combustion turbine's in-service date is delayed in the optimization program, the new in-service date is automatically specified to the production costing module as well as the capital budgeting and financial modules. The module also performs year-by-year "round robin" processing in order to appropriately address price elasticity. Strategist provides a wide variety of standard reports ranging from unit by unit generating statistics to construction project accounting reports to comprehensive pro forma financial results. The system includes full input summaries and detailed diagnostics.

C. Portfolio Screening Model II – Risk Analysis Model

i. Overview

The new risk model used for this IRP combines the strengths of the short term risk model (Ascend Analytic's Curve Developer) in generating the Monte Carlo draws for the risk variables with the dispatch algorithm in AuroraXMP, plus the financial modeling detail of the portfolio screening model. Given each draw from the Curve Developer, Aurora model generates the variable costs of dispatched generation from a given PSE portfolio that includes existing/new resources and market purchases/sales. These outputs are then used as inputs into the Portfolio Screening Model which combines other data to generate the revenue requirements. Below is a description of the various models.

ii. Development of Monte Carlo Draws for the Risk Variables

PSE utilized Ascend Analytic's Curve Developer to develop the draws for the risk variables. The heart of the simulation engine is a Monte Carlo simulation of physical elements and market prices. This engine produces Monte Carlo simulations of weather, load, market prices, and hydropower and wind generation through a state-space modeling approach.

State-space modeling in its simplest form is regression analysis with uncertainty. The uncertainty associated with regression analysis can be used to explain how weather relates to load, or yesterday's forward price relates to today's forward price. Simple regression analysis seeks to maximize the predictive capabilities of the explanatory variables on the dependent variable.

The regression line provides the best fit between the individual explanatory values and maximizes the predictive value of each explanatory variable to the dependent variable. However, there exist several components of uncertainty in a regression equation, including: i) uncertainty in the coefficient estimate, ii) uncertainty in the residual error term, and iii) the covariate relationship between the uncertainty in the coefficients and the residual error. State-space modeling captures these elements of uncertainty.

By preserving the covariate relationships between the coefficients and the residual error, PSE is able to maintain the relationship of the original data structure as we propagate results through time. For a system of equations, correlation effects between equations are captured through the residual error term.

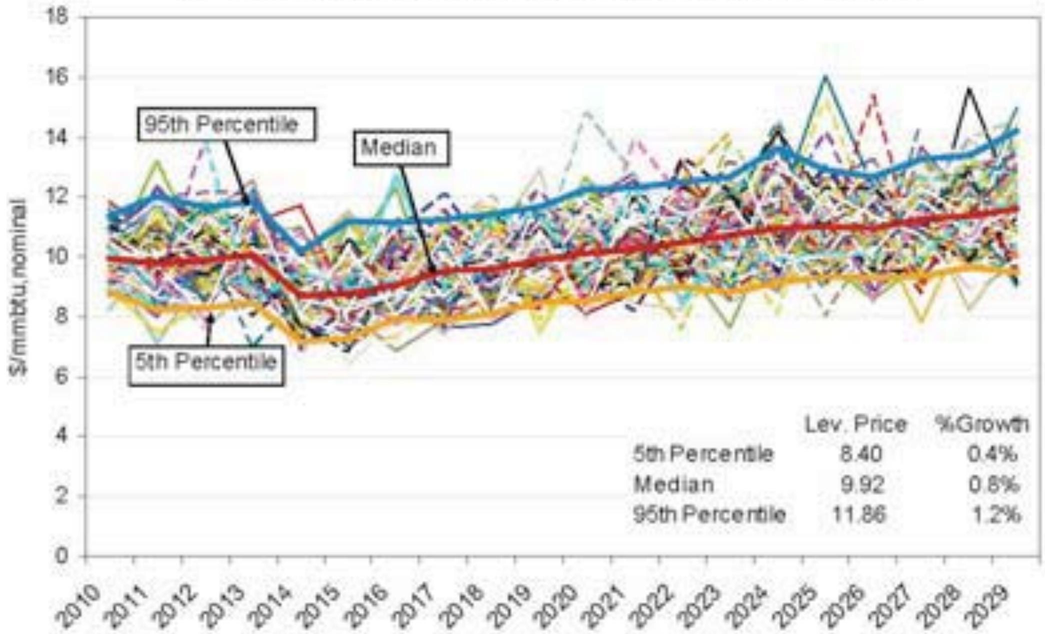
The logic of the linked physical and market relationships needs to be supported with solid benchmark results demonstrating the statistical match of the input values to the simulated data.

It is important to compare this approach with what was done in previous IRPs. Previous IRPs have only assumed a distribution of the risk variables with a given correlation between electric and gas prices. There were no linked relationships between weather and load or hydro/wind generation, for example. Draws were made independent of the links; hence, it was possible to obtain results which were less realistic.

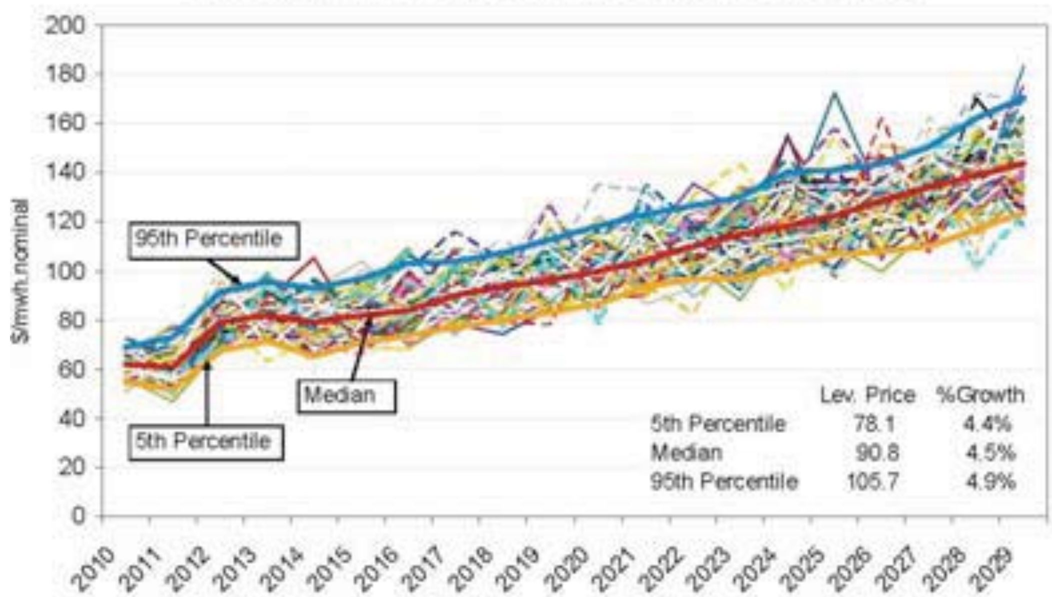
This approach is used to generate 100 simulations of the following risk variables: PSE's load forecasts which depend on temperatures, hydroelectric generation for Mid Columbia projects and PSE-owned hydroelectric projects in Western Washington, wind outputs from Wild Horse and Hopkins Ridge, Mid Columbia electric prices, Sumas gas prices, and CO2 emission prices. The correlation between electric and gas prices is assumed to be 0.85.

Examples of the simulation of Sumas gas prices and Mid Columbia electric prices for Current Trends scenario are shown in the two charts below. The chart shows the 100 draws, median, 5th and 95th percentiles over time, including a comparison of their levels and growth rates.

Current Trends Distribution of Sumas Gas Price Draws



Current Trends Distribution of Mid-C Electric Price Draws



iii. Aurora Risk Modeling of PSE Portfolios

The advanced modeling capabilities of Aurora are utilized to generate the variable costs of any given portfolio. The main advantage of using Aurora is its fast hourly dispatch algorithm for 20 years that is already well known by the majority of Northwest utilities. It also calculates market sales and purchases automatically, and produces other reports such as fuel usage and generation by plant for any time slice. Instead of defining the distributions of the risk variables, however, the set of 100 draws for all of the risk variables (power prices, gas prices, CO2 prices, PSE loads, hydroelectric generation and wind generation) are fed into the model. Given each of these input draws, Aurora then dispatches a given PSE portfolio to market price and computes the implied market sales and purchases each hour. The results of each draw are then saved and passed on to the portfolio screening model, where expected revenue requirements and risk metrics are computed. Expected costs and risk metrics can then be computed for each set of portfolio generated by Strategist.

iv. Portfolio Screening Model

The Portfolio Screening Model (PSM) is a Microsoft Excel-based revenue requirement model the company developed to evaluate incremental cost and risk for a wide variety of resource alternatives and portfolio strategies. The PSM calculates the incremental portfolio costs of resources required to serve load. Incremental cost includes: (i) the variable fuel cost and emissions for PSE's existing fleet, (ii) the variable cost of fuel emissions and operations and maintenance for new resources, (iii) the fixed depreciation and capital cost of investments in new resources, (iv) the book cost and offsetting market benefit remaining at the end of the 20-year model horizon, and (v) the market purchases or sales in hours when resources are deficient or surplus to PSE's need.

PSM is a modeling tool that can

(i) quickly evaluate and compare results for a wide range and large number of alternative resource strategies;

(ii) calculate variable costs for all resources, including existing and new resources, as well as fixed costs for new resources.

The primary input assumptions to the PSM are:

(i) PSE's existing portfolio,

(ii) variable cost, total energy and revenue from AURORAxmp,

(iii) costs of generic resources,

(iv) financial assumptions such as cost of capital and escalation rates, and

(v) a generic resource mix.

2. Data

I. Key Inputs and Assumptions

A. Aurora Inputs

Numerous assumptions are made to establish the parameters that define the optimization process. The first parameter is the geographic size of the market. In reality, the continental United States is divided into three regions, and electricity is not traded between these regions. The western-most region, called the Western Electricity Coordinating Council (WECC), includes the states of Washington, Oregon, California, Nevada, Arizona, Utah, Idaho, Wyoming, Colorado, and most of New Mexico and Montana. The WECC also includes British Columbia and Alberta, Canada, and the northern part of Baja California, Mexico. Electric energy is traded and transported to and from these foreign areas, but is not traded with Texas, for example.

For modeling purposes, the WECC is divided into 30 areas primarily by state and province, except for California which has eight areas, Nevada which has two areas, and Oregon, Washington, Idaho and Montana combined have 12 areas. These areas approximate the actual economic areas in terms of market activity and transmission. The databases are organized by these areas and the economics of each area is determined uniquely.

Load forecasts are created for each area. These forecasts include the base year load forecast and an annual average growth rate. Since the demand for electricity changes over the year and during the day, monthly load shape factors and hourly load shape factors are included as well. All of these inputs vary by area: for example, the monthly load shape would show that California has a summer peak demand and the Northwest has a winter peak. For the 2009 IRP, load forecasts for Oregon, Washington, Montana and Idaho were based on the Pacific Northwest Utilities Conference Committee's (PNUCC) 2007 Northwest Regional Forecasts. All generating resources are included in the resource database, along with characteristics of each resource, such as its area, capacity, fuel type, efficiency, and expected outages (both forced and unforced). The resource database assumptions are based on EPIS's 2008-1 version produced in February 2008.

Many states in the WECC have passed statutes requiring Renewable Portfolio Standards (RPS) to support the development of renewable resources. Typically an RPS states that a specific percentage of energy consumed must be from renewable resources by a certain date (e.g., 10% by 2015). While these states have demonstrated clear intent for policy to support renewable energy development, they also provide pathways to avoid such strict requirements. Further details of these assumptions are discussed in Section B below.

Coal prices were adopted from Global Insight's winter 2007-2008 US Energy Outlook price forecasts.

Water availability greatly influences the price of electric power in the Northwest. PSE assumes that hydropower generation is based on the average stream flows for the 50 historical years of 1929 to 1978. While there is also much hydropower produced in California and the Southwest (e.g., Hoover Dam), it does not drive the prices in those areas as it does in the Northwest. In those areas, the normal expected rainfall and hence, the average power production is assumed for the model. For sensitivity analysis, PSE can vary the hydropower availability, or combine a past year's water flow to a future year's needs.

Electric power is transported between areas on high voltage transmission lines. When the price in one area is higher than it is in another, electricity will flow from the low priced market to the high priced market (up to the maximum capacity of the transmission system), which will move the prices closer together. The model takes into account two important factors that contribute to the price: first, there is a cost to transport energy from one area to another, which limits how much energy is moved; and second, there are physical constraints on how much energy can be shipped between areas. The limited availability of high voltage transportation between areas allows prices to differ greatly between adjacent areas. EPIS updates the model to include known upgrades (e.g., Path 15 in California) but the model does not add new transmission "as needed."

B. Production Tax Credit and Renewable Portfolio Standard

i. Production Tax Credit Assumptions

The Production Tax Credit (PTC) is one of many federal subsidies related to production of nuclear, oil, gas and alternative energy. The present PTC amounts to approximately $21 (in 2010 dollars) per MWh for ten years of production, and is indexed for inflation. As of September 2008, the PTC was scheduled to expire at the end of 2009. The reference assumption is that PTCs remain at the current rate through 2013. PTCs are still assumed to be given to a project for 10 years after it is placed into service. As of 2014, this reference assumes no further PTCs are available to new resource development.

ii. Investment Tax Credit Assumptions

The Investment Tax Credit (ITC) is one of many federal subsidies related to production of renewable energy. The present ITC amounts to approximately 30% of the capital cost for solar resources and 10% of the capital cost for biomass and geothermal resources. Currently the ITC is scheduled to expire at the end of 2016. This scenario assumes ITCs remain at the current rate through 2016, then drop to 10% for solar and remain the same for biomass and geothermal for the remainder of the time horizon.

iii. Renewable Portfolio Standard

Renewable portfolio standards (RPSs) exist in 29 states and the District of Columbia, including most of the states in the WECC. Each state defines renewable energy sources differently, has different timetables for implementation, and has different requirements for the percentage of load that must be supplied by renewable resources. To model these varying laws, PSE first identified the load forecast for each state in the model. Then the company identified the benchmarks of each RPS (e.g. 3% in 2015, then 15% in 2020) and applied them to the load forecast for that state. No retirement of existing WECC renewable resources was provided for, which perhaps underestimates the number of new resources that need to be constructed. After existing and expected renewable energy resources were accounted for, new renewable energy resources were matched to the load to meet the RPS. With internal and external review for reasonableness, these resources are created in the AURORA database. The renewable energy technologies included wind, solar, biomass and geothermal. Estimates of potential production by states in the “Renewable Energy Atlas of the West” served to guide the creation of RPS resources by technology type. These vary considerably. For example, Arizona has little wind potential, but great solar potential. For this IRP, RPS targets were updated for Oregon, California, Colorado, New Mexico and British Columbia.

The Table below includes a brief overview of the RPS for each state in the WECC that has one. The "Standard" column offers a summary of the law, as provided by the Lawrence Berkeley National Laboratory (LBNL), and the "Notes for AURORA Modeling" column includes a description of the new renewable resources created to meet the law.

State	Standard (LBNL)	Notes for AURORA Modeling
Arizona	New Proposed RPS: 1.25% in 2006, increasing by 0.25% each year to 2% in 2009, then increasing by 0.5% a year to 5% in 2015, and increasing 1% a year to 14% in 2024, and 15% thereafter. Of that, 5% must come from distributed renewables in 2006, increasing by 5% each year to 30% by 2011 and thereafter. Half of distributed solar requirement must be from residential application; the other half from non-residential non-utility applications. No more than 10% can come from RECs, derived from non-utility generators that sell wholesale power to a utility.	Very little potential wind generation is available. Most of the requirement is met with central solar plants. The distributed solar (30%) is accounted for by assuming central renewable energy.
British Columbia	Clean renewable energy sources will continue to account for at least 90% of generation. 50% of new resource needs through 2020 will be met by conservation.	The assumption is that a majority of this need will be met by hydropower and wind.
California	IOUs must increase their renewable supplies by at least 1% per year starting January 1, 2003, until renewables make up 20% of their supply portfolios. The target now is to meet 20% level by 2010, with potential goal of 33% by 2020. IOUs do not need to make annual RPS purchases until they are creditworthy. CPUC can order transmission additions for meeting RPS under certain conditions.	The California Energy Commission created an outline of the necessary new resources by technology that could meet the 20% by 2010 goal. Technologies include wind, biomass, solar and geothermal in different areas of the state The renewable energy resources identified in the outline were incorporated into the model.
Colorado	HB 1281 -Expands the definition of "qualifying retail utility" to include providers of retail electric services, other than municipally owned utilities, that serve 40,000 customers or less. Raises the renewable energy standard for electrical generation by qualifying retail utilities other than cooperative electric associations and municipally owned utilities that serve more than 40,000 customers to 5% by 2008, 10% by 2011, 15% by 2015, and 20% by 2020. Establishes a renewable energy standard	The primary resource for Colorado is wind. The 4% solar requirement is modeled as central power only.

State	Standard (LBNL)	Notes for AURORA Modeling
Colorado	for cooperative electric associations and municipally owned utilities that serve more than 40,000 customers of 1% by 2008, 3% by 2011, 6% by 2015, and 10% by 2020. Defines "eligible energy resources" to include recycled energy and renewable energy resources.	
Montana	5% of sales (net of line losses) to retail customers in 2008 and 2009; 10% from 2010 to 2014; and 15% in 2015 and thereafter. At least 50 MW must come from community renewable energy projects during 2010 to 2014, increasing to 75 MW from 2015 onward. Utilities are to conduct RFPs for renewable energy or RECs and after contracts of at least 10 years in length, unless the utility can prove to the PSC the shorter-term contracts will provide lower RPS compliance costs over the long-term. Preference is to be given to projects that offer in-state employees or wages.	The primary source for Montana is wind. The community renewable resources are modeled as solar units of 50 MW then 25 MW.
Nevada	6% in 2005 and 2006 and increasing to 9% by 2007 and 2008, 12% by 2009 and 2010, 15% by 2011 and 2012, 18% by 2013 and 2012, ending at 20% in 2015 and thereafter. At least 5% of the RPS standard must be from solar (PV, solar thermal electric, or solar that offsets electricity, and perhaps even natural gas or propane) and not more than 25% of the required standard can be based on energy efficiency measures.	The Renewable Energy Atlas shows that considerable geothermal energy and solar energy potential exists. For modeling the resources are located in the northern and southern part of the state respectively, with the remainder made up with wind.
New Mexico	Senate Bill 418 was signed into law in March 2007 and added new requirements to the state's Renewable Portfolio Standard, which formerly required utilities to get 10% of their electricity needs by 2011 from renewables. Under the new law, regulated electric utilities must have renewables meet 15% of their electricity needs by 2015 and 20% by 2020. Rural electric cooperatives must have renewable energy for 5$ of their electricity needs by 2015, increasing to 10% by 2020. Renewable energy can come from new hydropower facilities, from fuel cells that are not fossil-fueled, and from biomass, solar, wind, and geothermal resources.	New Mexico has a relatively large amount of wind generation currently for its small population. New resources are not required until 2015, at which time they are brought in as wind generation.
Oregon	Large utility targets: 5% in 2011, 15% in 2015, 20% in 2020 and 25% in 2025. Large utility sales represented 73% of total sales in 2002. Medium utilities 10% by 2025 Small utilities 5% by 2025.	

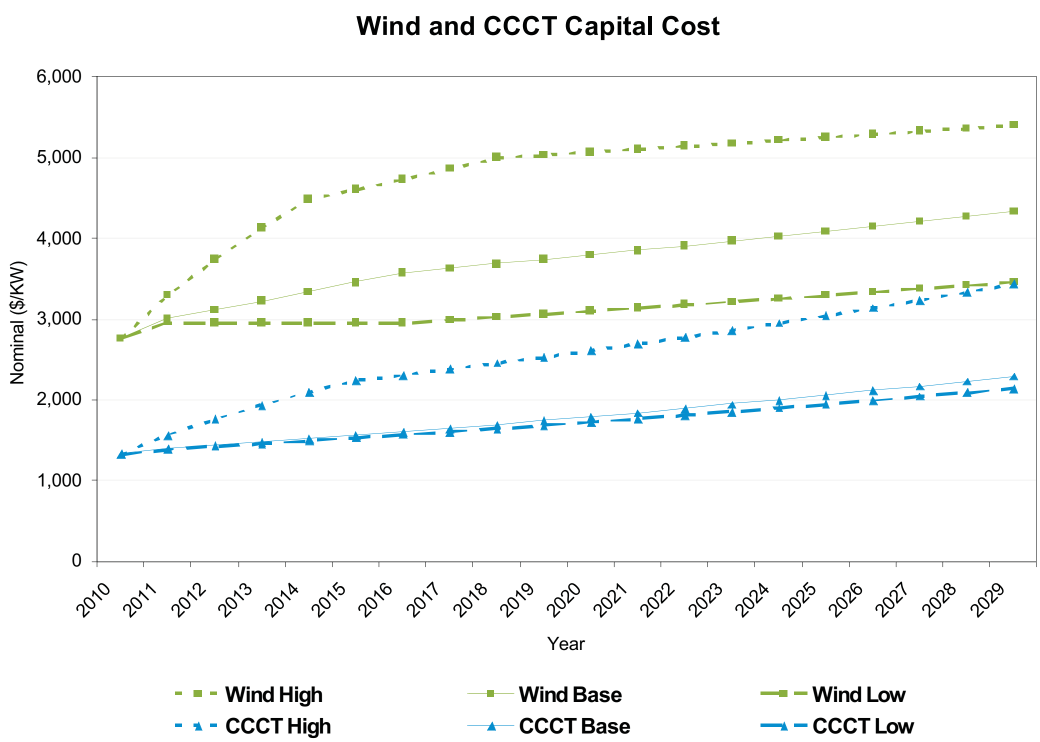
State	Standard (LBNL)	Notes for AURORA Modeling
Washington	Washington state RPS: 3% by 2012, 9% by 2016, 15% by 2020. Eligible resources include wind, solar, geothermal, biomass, tidal. Oregon officials have been discussing the need for an RPS, and the governor has proposed 25% by 2025.	

C. Generic Resource Costs and Characteristics

Generic Resource Costs (2008$)	Units	CCCT	CCCT w CCS	Peaker	Coal SCPC	IGCC	IGCC w CCS	Wind	Long Haul Wind	Solar CST	Biomass	Geothermal
Capacity	MW	275	250	160	250	250	250	100	100	50	20	25
Capital Cost	$/KW	$1,257	$2,470	$1,240	$4,079	$4,527	$5,960	$2,433	$3,753	$4,950	$2,704	$3,449
O&M - Fixed	$/kW-yr	$22.00	$35.07	$23.92	$48.52	$68.14	$80.19	$40.00	$40.00	$63.00	$80.00	$132.00
O&M - Variable	$/MWh	$3.00	$4.27	$1.40	$6.67	$4.24	$6.45	$2.00	$2.00	$0.00	$3.00	$1.80
Availability	%	95%	95%	98%	90%	85%	85%	30%	36%	28%	85%	95%
Capacity Credit	%	93%	93%	93%	93%	93%	93%	5%	5%	5%	93%	93%
Heat Rate - GT	Btu/kWh	7,038	8,424	8,600	8,998	8,573	10,544				14,000	
Heat Rate - Duct Firing	Btu/kWh	8,800										
Fixed Gas Transportation	$/Dth per day	$0.50	$0.50	$0.18								
Fixed Gas Transportation	$/kW-yr	$30.83	$36.90	$4.52								
Fuel Basis Differential	$/MWh	$4.32	$5.18	$5.28								
Electric Transmission - Fixed	$/kW-yr	$3.63	$3.63	$3.63	$86.48	$86.48	$86.48	$56.80	$125.23	$20.94	$3.63	$23.12
Electric Transmission - Variable	$/MWh	$0.00	$0.00	$0.00	$4.53	$4.53	$4.53	$8.32	$16.96	$2.02	$0.00	$2.23
Emissions:												
CO2	lbs/MMBtu	117	0	117	212.67	212.67	0					
SO2	lbs/MMBtu	0.01	0.01	0.01	0.07	0.07	0.06					
NOX	lbs/MMBtu	0	0	0	0.12	0.03	0.03					
Hg	lbs/MMBtu											
Location		PSE Control	PSE Control	PSE Control	MT/WY/Alberta	MT/WY/Alberta	MT/WY/Alberta	WA/OR	MT/WY/Alberta/BC	SE OR	PSE Control	OR/ID
First year Available		2010	2025	2012	2018	2020	2025	2010	2018	2014	2012	2018

D. Generic Resource Capital Costs Escalation Profiles

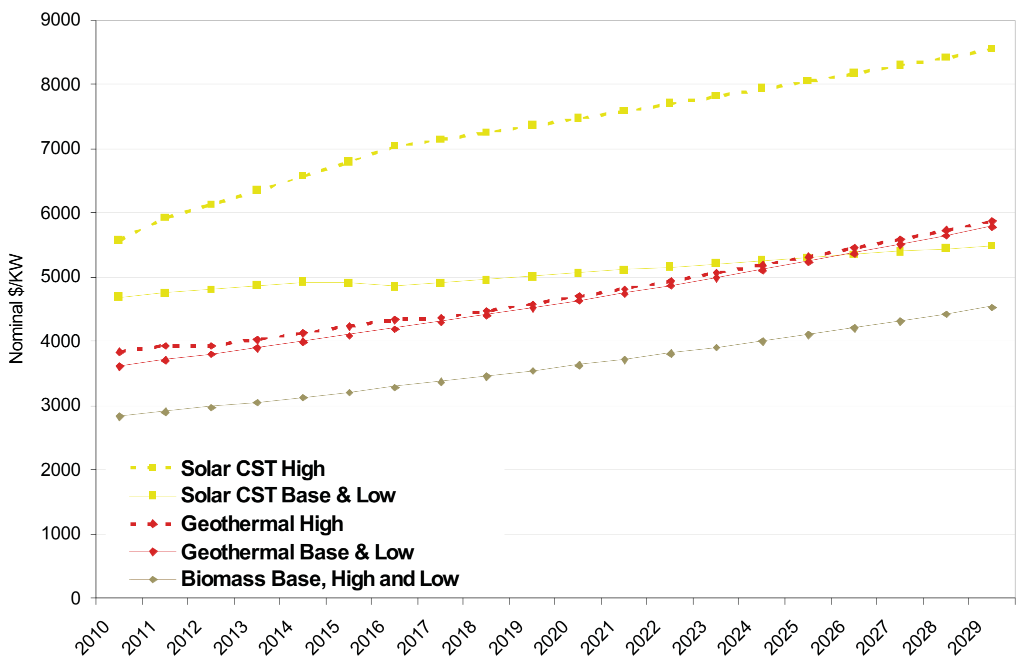
The estimated cost of generic resources is based on bids received in response to PSE's formal 2007 Request for Proposals (RFP), along with information obtained during 2008 as part of PSE's ongoing market activity. Bid prices received were not firm and were occasionally revised upward. The cost of each resource is escalated at varying rates over the 20-year time horizon. PSE hired ION Consulting to develop potential range-of-cost escalation rates for gas combined cycle plants and wind plants. The company used those studies as a starting point to develop the cost escalation rates, as shown below. PSE also used the Energy Information Administration's "Annual Energy Outlook 2008" escalation for solar capital costs. The conventional coal and IGCC escalation costs were based on the historical relationship between Producer's Price Index (PPI) and the cost of resources, and forecast of PPI from Global Insight. Biomass and Geothermal were kept constant in real terms; in other words, the nominal cost rises at the same rate as inflation (a 2.5% annual inflation rate was assumed in this analysis).



The larger range in cost escalations for wind vs. combined cycle plants is based on the relative importance of supply chain shortages in the wind development chain. For example, increased world-wide gear manufacturing for wind plants may reduce costs in the future, or lack of such increase could increase wind plant costs as demand for wind generators continues to grow. The ION studies illustrate cost uncertainty with combined cycle plant costs including things like turbines, but the gas combined cycle supply chain appears to have fewer such critical factors in short supply relative to the wind plant supply chain. The high resource cost assumptions for wind and CCCT were adjusted in the first five years. The capital cost assumptions were taken from the last three IRPs and then trended from 2010-2015. The same cost escalation of wind was applied to the Long Haul Wind resource and likewise, the same cost escalation of a CCCT was also applied to the Peaker and CCCTwCCS resources.

The chart below shows the capital cost escalation assumptions for Solar CST, Geothermal and Biomass.

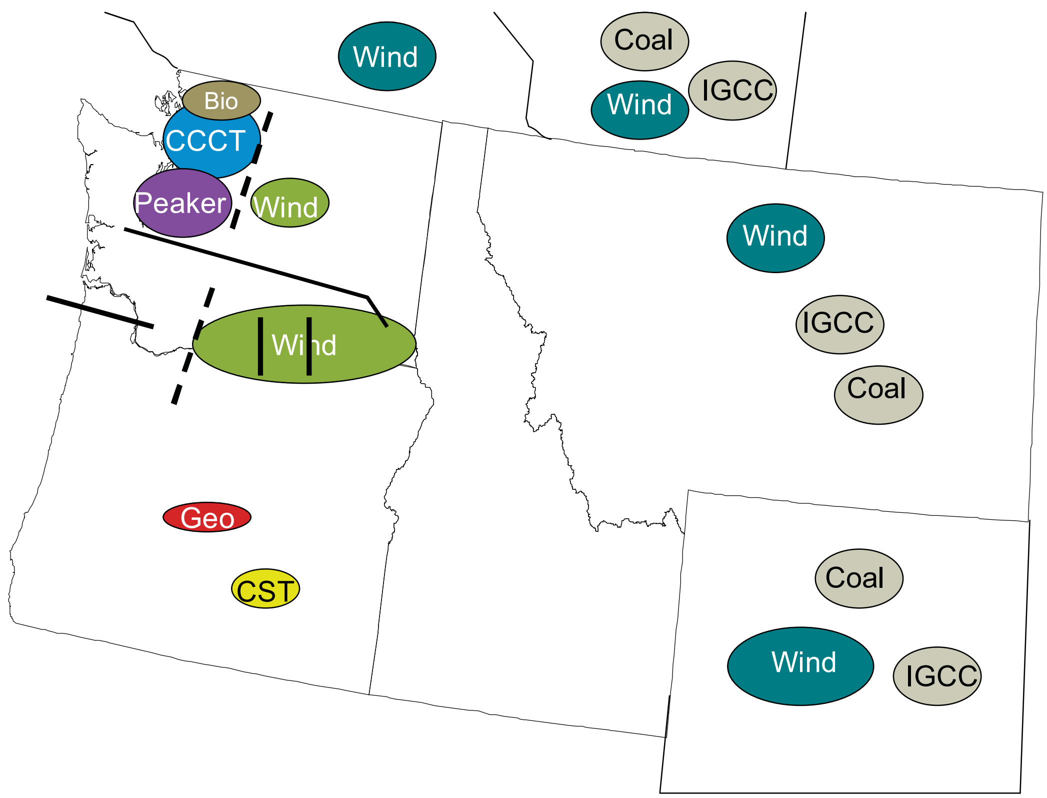
Other Renewable Capital Cost



E. Wind Capacity Credit

For the 2009 IRP, PSE is using 5% of plant nameplate capacity for wind capacity credit when evaluating wind resources. The company adopted the current recommendation that is being evaluated by the Pacific Northwest Resource Adequacy Forum, which was presented to the NWPCC.

F. Diagram of Resource Locations



G. Updated Planning Standard

The company has updated its planning standard to include a 15% planning reserve margin for capacity. The "B2 Energy Planning Standard" used for our last three resource plans represented a reasonable balance of cost and risk in 2003 when it was adopted, but much has changed since then (see Chapter 5). Resource alternatives are now quite different (coal was considered a low price-risk option in 2003 for instance), and regional approaches to assessing adequacy have developed substantive guidelines. In fact, PSE collaborated with the NW Regional Resource Adequacy Forum [2] on the adoption of a Loss of Load Probability approach to planning that is common in other parts of the country.

From 2003 through 2007, PSE used a planning standard that was based on meeting "energy" demand in the worst month of the year (December), in which a 13 ^{o} F one-hour peak load condition was used, unrelated to the loss of load probability. This approach could have resulted in lower planning reserve margins than is believed to be acceptable today.

The following summarizes how the company derived the 15% planning reserve margin standard:

The primary objective of PSE's capacity planning standard analysis was to determine the appropriate level of planning reserve margin for the utility. Planning reserve margin for capacity is, in general, defined as the appropriate level of generation resource capacity reserves required to provide for a minimum acceptable level of system generation reliability. This is one of the key constraints in any capacity expansion planning model, because it is important to maintain a uniform reliability standard throughout the planning period to obtain comparable capacity expansion plans. This planning reserve margin is measured as:

Reserve Margin = (Generation Capacity – Normal Peak Loads)/Normal Peak Loads

The appropriate level of planning reserve margin is typically identified in terms of its relationship with the loss of load probability (LOLP). LOLP is further defined as the probability of system loads greater than resource capability in any given hour, or

LOLP = Probability [-(Generation Capacity-Loads)>0].

Thus, as the reserve margin increases, one would expect that the loss of load probability also decreases. Because of uncertainties in loads due to extreme temperature events and resource capabilities due to outages and operating reserves, it is necessary to examine the probabilities using a Monte Carlo analysis.

[2] A description of the NW Regional Resource Adequacy Forum and the standards adopted can be found at: http://www.nwcouncil.org/energy/resource/Default.asp

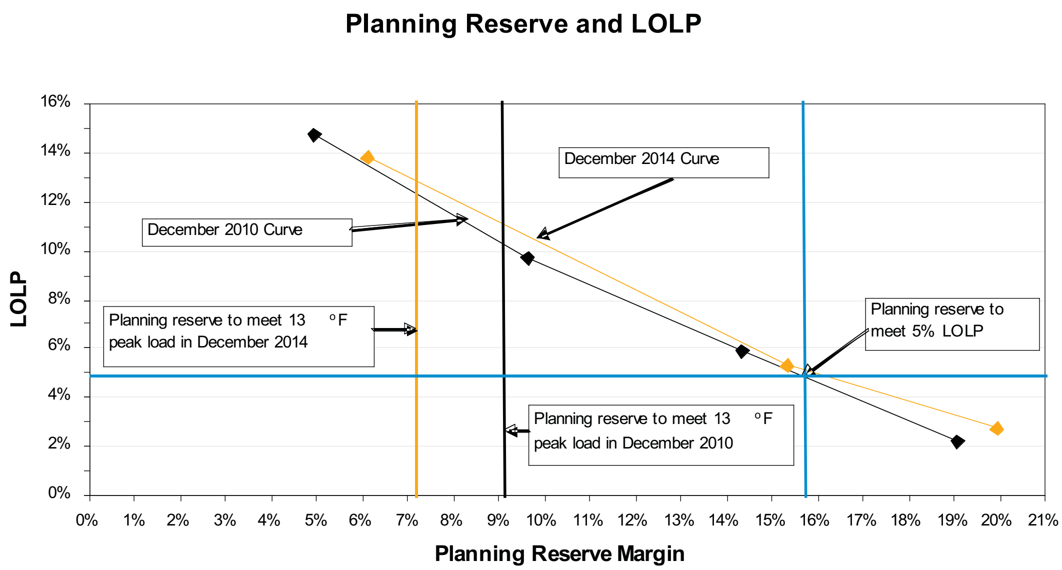
The starting point for the Monte Carlo simulation analysis is the short-term winter peaking analysis completed every summer for the subsequent winter. The analysis identifies various resources available to meet the 13 ^{o} F, one-hour, predicted peak load, given available transmission capability. Historical data tells us that December is when the peak load condition is typically experienced. The resources included are Colstrip, Mid Columbia and western Washington hydroelectric resources, several gas plants (simple- and combined-cycle units), purchased power contracts, and market purchases up to the available transmission capability. The following sources of variation were considered:

1. Forced Outage Rate for Thermal Units - modeled as a combination of an outage event and duration of an outage event (skewed beta distribution with fixed endpoints), subject to minimum up and down time conditions and total outage rate equal to GRC reported outage rate;
2. Hourly System Loads – modeled as an econometric function of hourly temperature for the month, and using the hourly temperature data in the last 100 years to preserve its chronological order;
3. Mid Columbia and Baker Hydropower – modeled as a binomial distribution with the critical hydro water year at 1/70th probability;
4. Market Purchases – modeled as 50% from hydropower with same variability as Mid Columbia resources; 50% from thermal with same variability as a combined cycle unit since it is difficult to determine the exact source of market purchases;
5. Load Forecast Error – modeled as a discrete distribution so that load error is +/- 1% for 60% of the trials, with a range of +/-3.5%.

As mentioned above, loss of load probability is defined as the number of trials where PSE observed a loss of load over the total number of trials. 3,000 trials were conducted. Such a large number was chosen because at this level the resulting loss of load frequency becomes very stable. The simulation is also done for all hours in 2010 and all hours in 2014. This allows the utility to capture the effects of increasing loads and the expiration of some Mid Columbia hydropower contracts, as well as non utility generator (NUG) contracts and other short-term purchase contracts.

The goal of the simulation analysis for any hour is to run the simulation for the existing resource and load conditions, which imply an existing reserve margin. Loss of load probability associated with this reserve margin is then computed based on the 3,000 Monte Carlo draws of the risk variables. Generating capacity is then incremented using a combined-cycle plant as the “typical” plant added which results in a higher reserve margin. Again, the loss of load probability associated with this higher reserve margin is computed based on the Monte Carlo simulation of the risk variables. The process is repeated until the loss of load probability is reduced to an industry standard level.

The results of these simulations are shown in Figure 5-3. The figure illustrates that the planning reserve margin implied by a 5% LOLP is around 15.8% for both years. The figure also demonstrates that the loss of load probability implied by meeting the 13° F peak loads from the B2 Energy Planning Standard is much higher (10% for December 2010 and 13% for December 2014) if no additional resources are added. The 5% LOLP is chosen to be consistent with the regionally adopted loss of load for resource adequacy standards. Similar LOLP analyses were performed for every month, primarily to reflect seasonal hydropower availability. PSE focused discussion on December because the company found that if we have resources adequate to meet the 5% LOLP in December, we will have resources sufficient to meet that reliability threshold during the rest of the year.



II. Output

A. Aurora Electric Prices and Avoided Costs

Below is a series of tables with the AURORA price forecasts for the different scenarios. Consistent with WAC 480-107-055, this schedule of estimated Mid Columbia power prices is intended to provide only general information to potential bidders about the avoided costs of power supply. It does not provide a guaranteed contract price for electricity.

Monthly Flat Mid-C Prices
(Nominal $/MWH)

2007 Trends

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	69.19	73.22	65.48	54.78	49.40	51.20	59.72	62.54	61.60	59.56	68.19	67.10	61.83
2011	66.28	69.85	62.48	52.48	49.81	51.84	60.74	63.25	62.32	59.99	67.67	66.05	61.06
2012	82.31	85.90	81.17	73.01	71.86	72.40	78.34	80.24	79.84	79.48	84.57	81.09	79.18
2013	84.60	88.53	84.11	76.36	74.05	75.02	81.26	83.48	83.19	81.97	86.53	85.06	82.01
2014	82.76	84.93	80.16	78.92	71.68	70.83	76.57	81.42	76.83	78.53	80.95	84.92	79.04
2015	85.98	87.81	83.13	81.74	75.75	75.79	80.59	84.84	80.22	81.82	84.50	89.25	82.62
2016	89.15	92.04	87.27	84.03	76.91	77.05	82.10	86.75	81.91	83.65	88.79	94.51	85.35
2017	95.70	97.68	92.86	89.07	81.44	81.08	86.88	90.87	85.58	87.92	92.99	98.54	90.05
2018	98.98	101.48	97.23	93.32	86.25	85.87	90.95	95.35	90.49	91.36	95.83	100.97	94.01
2019	101.74	104.10	100.13	97.32	91.08	90.24	94.98	98.82	94.95	95.14	99.15	104.37	97.67
2020	105.28	106.87	103.30	100.36	94.00	93.82	98.17	102.25	98.79	99.02	103.16	107.77	101.07
2021	109.97	111.54	108.38	105.21	97.61	97.55	101.40	106.42	102.78	103.39	107.94	111.74	105.33
2022	115.21	116.84	113.71	109.71	102.20	102.16	105.81	111.59	107.36	108.31	112.47	116.28	110.14
2023	119.42	120.49	116.82	113.24	106.70	106.64	110.31	116.29	111.91	113.10	117.14	120.35	114.37
2024	127.45	129.24	125.77	116.83	109.56	109.25	113.77	119.77	115.96	116.46	124.65	127.98	119.72
2025	130.42	132.82	128.43	120.26	113.18	112.49	117.76	123.04	120.53	121.07	127.50	130.62	123.18
2026	134.52	134.88	131.48	125.05	117.99	116.75	121.40	128.08	125.97	126.57	132.64	134.43	127.48
2027	139.32	140.92	137.21	129.95	123.00	121.64	126.53	132.87	131.36	132.13	140.39	140.43	132.98
2028	146.61	148.05	142.66	135.56	128.55	127.53	132.68	138.74	136.92	138.13	147.84	146.95	139.18
2029	153.46	154.67	149.20	141.82	133.09	131.09	137.93	144.26	142.81	142.55	152.90	154.25	144.84

2007 Business As Usual (BAU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	68.96	73.65	65.84	54.12	49.43	51.28	59.76	62.52	61.47	59.49	68.54	66.94	61.83
2011	66.82	69.87	62.13	52.68	49.54	51.41	60.16	63.00	61.79	59.78	67.24	65.82	60.85
2012	66.53	68.93	61.84	53.76	51.70	52.12	61.76	63.86	61.76	60.83	67.97	65.96	61.42
2013	67.82	70.90	63.72	55.39	52.58	52.47	63.23	66.01	64.44	62.52	68.65	69.40	63.09
2014	63.62	65.32	57.73	56.34	48.85	47.06	57.03	62.03	56.59	57.89	61.44	67.03	58.41
2015	64.65	65.70	58.44	57.70	49.94	48.97	57.95	63.31	57.68	59.04	63.42	69.45	59.69
2016	66.36	68.43	59.85	57.71	49.18	48.04	56.85	63.57	57.92	58.50	66.23	72.98	60.47
2017	70.49	71.57	62.43	59.27	51.18	49.79	59.04	65.70	59.61	61.15	68.15	74.54	62.74
2018	72.08	73.20	65.38	62.05	53.73	51.40	60.66	68.23	62.80	63.25	69.02	75.73	64.79
2019	73.38	74.42	66.16	63.88	55.84	53.46	62.67	70.09	65.19	65.06	70.72	77.10	66.50
2020	73.90	74.63	66.19	63.89	55.07	53.54	62.61	69.63	65.50	64.78	71.99	78.44	66.68
2021	76.45	77.76	68.97	66.21	57.04	55.72	64.38	71.76	67.15	66.84	74.51	80.55	68.95
2022	78.72	79.72	70.97	67.77	59.89	58.56	66.76	74.34	69.54	69.85	76.45	81.25	71.15
2023	79.94	80.26	71.41	68.70	61.89	60.23	68.66	76.67	71.17	72.06	78.00	81.97	72.58
2024	84.89	85.64	76.83	70.36	63.47	60.83	69.75	77.43	72.17	72.60	82.09	87.14	75.27
2025	85.72	86.11	77.37	71.13	63.69	61.43	70.04	77.38	72.67	73.29	82.21	86.67	75.64
2026	85.93	85.83	77.33	72.37	65.44	63.77	71.81	78.63	74.69	75.37	83.51	86.93	76.80
2027	86.75	87.16	79.34	74.07	67.26	65.67	72.91	79.89	75.88	76.88	86.12	89.28	78.43
2028	89.15	89.51	81.87	75.76	69.89	68.14	75.12	82.11	77.72	79.73	88.50	91.06	80.71
2029	91.26	91.81	85.08	78.75	71.73	68.98	76.76	83.78	79.26	81.13	89.21	92.98	82.56

Green World (GW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	81.41	84.31	78.38	69.66	61.89	60.23	73.92	78.83	77.75	72.22	88.28	89.54	76.37
2011	84.40	85.26	76.03	68.66	60.86	59.82	72.31	79.76	73.19	68.29	82.51	85.21	74.69
2012	105.87	109.53	104.54	97.41	91.27	89.66	97.53	102.52	97.46	96.16	104.19	104.14	100.02
2013	107.86	110.55	105.88	101.05	94.81	93.97	100.76	106.23	100.77	100.15	103.49	105.28	102.57
2014	114.39	118.26	114.15	111.28	105.40	104.80	111.08	115.93	109.99	110.24	113.48	116.22	112.10
2015	120.43	123.84	119.34	116.58	110.37	111.31	117.74	121.45	115.10	115.49	119.40	122.96	117.83
2016	128.35	133.77	128.88	124.21	116.53	117.55	124.82	128.92	122.48	122.59	128.68	132.43	125.77
2017	136.93	141.48	136.43	130.22	123.37	123.73	130.67	135.66	129.24	129.69	135.69	138.74	132.66
2018	148.21	151.41	147.72	141.23	134.10	133.01	140.00	146.53	141.91	140.32	147.03	150.00	143.45
2019	153.34	156.54	153.19	146.22	138.45	138.10	145.42	151.87	148.14	145.75	152.90	155.38	148.78
2020	152.37	156.07	153.22	145.51	137.49	136.82	146.22	152.57	148.45	146.37	153.49	156.49	148.76
2021	157.61	161.19	157.58	149.12	140.40	141.15	149.35	156.78	151.70	150.02	158.24	160.37	152.79
2022	161.91	165.54	161.76	152.67	146.23	145.85	154.14	161.72	155.89	154.92	162.17	163.60	157.20
2023	164.98	168.50	165.23	156.58	149.64	150.82	158.29	165.72	159.77	158.57	166.21	166.93	160.94
2024	169.43	174.25	169.23	156.92	149.56	148.84	159.04	166.48	159.96	157.55	169.13	170.82	162.60
2025	171.95	176.41	171.41	159.09	151.33	149.52	160.89	167.82	162.26	160.24	171.83	172.86	164.63
2026	175.54	178.35	173.97	161.68	153.79	153.27	163.56	170.09	165.93	163.52	175.56	176.08	167.61
2027	173.28	177.66	172.65	161.34	154.18	154.05	163.03	170.19	165.06	163.92	175.10	175.68	167.18
2028	178.20	182.14	177.45	164.36	158.15	158.76	167.50	174.59	168.05	168.27	179.94	179.92	171.44
2029	182.76	187.23	182.02	169.34	160.82	160.56	171.02	177.82	172.28	170.84	183.26	183.79	175.14

Low Growth (LG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	58.91	59.92	55.52	47.33	37.19	36.43	41.21	44.20	47.42	47.07	57.81	61.85	49.57
2011	60.39	60.32	53.02	47.04	36.33	35.69	39.96	44.61	43.28	44.13	52.45	57.97	47.93
2012	58.41	58.55	51.55	46.16	36.30	35.08	39.05	42.73	41.53	43.54	49.62	54.36	46.41
2013	54.35	52.91	46.28	44.68	36.08	34.62	39.54	43.98	41.75	43.83	45.81	50.89	44.56
2014	51.05	51.76	44.86	45.14	36.63	35.65	40.90	45.38	42.48	45.40	47.34	53.52	45.01
2015	51.86	51.91	45.85	46.47	38.01	37.51	42.39	46.70	43.76	46.90	48.99	55.87	46.35
2016	52.84	54.21	47.46	46.00	36.78	36.03	41.25	46.38	43.43	45.95	50.82	58.38	46.63
2017	56.90	56.76	49.64	47.51	37.94	37.14	42.37	47.80	44.75	47.91	52.50	59.99	48.44
2018	57.93	58.06	51.42	49.52	40.02	38.68	43.84	49.65	47.13	49.76	53.32	60.91	50.02
2019	58.68	58.55	52.21	50.90	41.69	40.06	44.76	50.45	48.82	50.91	54.14	61.36	51.04
2020	58.50	58.69	51.92	50.84	40.95	39.94	44.47	50.04	49.06	50.61	54.69	62.07	50.98
2021	60.16	60.69	53.97	52.27	42.51	41.54	45.60	51.39	50.27	52.19	56.43	63.43	52.54
2022	62.05	61.74	55.32	53.68	44.67	43.71	47.40	53.31	52.06	54.59	57.82	63.76	54.18
2023	62.61	61.63	55.09	54.22	46.14	44.65	48.58	54.93	53.20	56.22	58.62	64.00	54.99
2024	67.16	66.45	58.87	55.68	46.86	45.24	49.36	55.26	53.59	56.44	62.13	68.27	57.11
2025	67.27	66.14	59.01	56.40	47.77	46.26	50.01	55.93	54.64	57.23	62.15	67.83	57.55
2026	67.18	65.84	59.12	57.49	49.49	48.35	51.79	57.23	56.15	58.71	63.06	67.75	58.51
2027	67.37	66.49	60.30	58.41	50.74	49.58	52.46	58.16	57.17	59.78	64.81	69.33	59.55
2028	69.10	67.87	61.80	59.75	52.98	51.54	54.09	59.65	58.44	61.82	66.35	70.45	61.15
2029	70.55	69.41	63.75	61.98	54.33	52.18	54.90	60.93	59.76	63.10	67.03	72.24	62.51

High Growth (HG)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	83.23	85.64	79.77	71.10	63.79	61.25	75.26	79.96	78.73	74.06	89.33	90.87	77.75
2011	88.07	88.51	79.14	71.95	63.64	61.00	74.57	81.65	75.64	71.55	84.91	88.20	77.40
2012	100.42	102.98	96.40	89.48	83.03	80.81	90.70	95.70	89.20	88.09	96.61	97.35	92.57
2013	95.28	96.85	90.98	86.97	81.18	79.36	88.08	94.40	87.92	87.42	90.82	92.40	89.30
2014	94.18	97.27	91.98	89.17	84.00	82.52	91.81	97.78	90.93	90.75	94.47	97.31	91.85
2015	97.15	100.37	95.44	93.17	87.40	86.60	95.51	100.97	94.01	94.00	98.20	101.92	95.39
2016	101.17	104.95	99.94	95.41	89.38	88.45	97.44	103.47	95.81	96.19	102.62	107.15	98.50
2017	107.18	110.39	104.98	99.61	93.69	92.70	101.40	107.76	99.50	100.54	106.92	110.75	102.95
2018	111.59	114.62	110.43	104.67	98.79	96.95	105.85	112.74	105.00	104.64	110.51	114.58	107.53
2019	115.27	118.50	114.79	109.39	103.51	102.03	110.50	117.13	110.08	108.79	114.96	118.63	111.96
2020	119.04	121.93	118.06	112.66	106.66	105.94	114.24	120.40	113.48	112.53	118.93	123.06	115.58
2021	124.47	128.22	123.61	116.92	111.19	110.68	118.55	125.10	117.67	117.05	124.77	127.95	120.52
2022	129.81	133.18	128.70	121.77	117.19	116.75	124.17	130.35	123.13	122.56	129.90	132.15	125.81
2023	135.92	138.09	133.23	126.84	123.43	122.71	130.67	136.81	129.11	128.59	135.85	137.56	131.57
2024	144.12	147.84	143.52	133.42	129.21	128.14	136.39	141.88	134.20	132.70	143.83	146.26	138.46
2025	148.96	151.85	147.14	137.86	133.48	131.62	140.54	145.68	138.26	137.20	146.78	150.25	142.47
2026	154.08	156.20	152.01	143.18	137.62	137.25	145.19	151.21	143.59	142.89	152.81	154.61	147.55
2027	160.11	162.94	159.54	149.36	143.40	143.18	150.65	157.33	149.96	149.34	160.17	162.29	154.02
2028	167.04	170.99	166.56	154.88	150.06	150.09	157.32	163.36	155.98	155.66	168.23	168.93	160.76
2029	174.28	179.83	174.64	162.32	156.16	155.16	163.09	169.92	163.70	162.56	174.07	176.35	167.67

Very High Gas (VHGas)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	82.89	84.90	79.00	70.44	62.85	61.05	74.78	79.41	78.15	72.65	89.19	90.07	77.11
2011	85.53	86.44	76.30	69.72	62.03	60.27	73.61	80.60	74.44	69.45	83.84	86.73	75.75
2012	98.32	101.37	94.62	88.15	81.82	80.17	89.96	94.73	88.49	87.11	96.09	96.40	91.44
2013	107.78	109.95	102.07	98.45	91.29	89.44	102.42	109.25	100.68	99.35	104.33	106.21	101.77
2014	106.42	110.56	103.03	100.76	94.16	93.35	106.06	112.71	104.19	102.96	108.22	111.11	104.46
2015	109.21	112.85	106.48	103.64	97.15	97.76	109.78	115.19	107.63	106.51	111.96	115.30	107.79
2016	113.44	118.57	111.40	106.08	99.84	99.83	111.72	118.52	109.60	108.34	117.34	121.24	111.33
2017	120.47	123.79	116.57	110.73	105.06	104.47	116.51	123.25	113.64	113.90	122.14	124.95	116.29
2018	124.53	128.70	122.54	116.56	110.18	108.53	120.69	128.47	119.79	118.31	125.87	129.37	121.13
2019	128.81	132.88	126.84	121.28	115.94	113.71	125.97	133.26	125.24	123.46	129.92	133.31	125.89
2020	133.00	136.52	130.27	125.22	118.29	117.82	129.44	136.21	129.53	126.98	134.37	137.76	129.62
2021	138.40	142.51	136.45	129.97	123.50	123.48	133.93	141.37	133.78	131.27	140.58	143.15	134.87
2022	144.35	148.45	142.44	135.23	129.89	129.43	139.46	147.30	139.09	137.07	145.83	147.37	140.49
2023	149.37	152.62	146.39	139.40	136.18	134.55	144.25	152.73	143.80	142.76	151.58	151.31	145.41
2024	158.24	162.25	156.32	145.23	139.88	138.25	148.75	157.37	148.73	146.58	158.62	160.67	151.74
2025	163.58	166.34	160.51	149.50	144.38	143.65	153.63	160.37	152.72	150.64	162.52	164.41	156.02
2026	168.28	171.74	166.51	156.08	151.10	151.26	161.95	167.49	159.20	157.19	168.87	169.90	162.46
2027	173.12	177.69	172.50	162.10	157.37	157.90	167.43	174.16	165.03	163.33	176.03	176.36	168.58
2028	181.39	185.24	180.19	168.75	164.96	165.59	175.54	181.21	171.82	170.73	183.92	183.99	176.11
2029	189.67	194.03	188.68	177.79	171.49	171.20	181.65	188.03	179.59	178.08	189.05	192.19	183.45

Very Low Gas (VLGas)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	54.22	54.61	51.16	42.71	32.93	32.06	35.42	38.11	41.29	41.79	51.65	56.39	44.36
2011	50.15	49.84	46.67	37.77	29.81	28.70	31.25	33.91	36.83	37.57	46.66	50.77	39.99
2012	47.43	46.85	43.93	35.86	27.95	26.57	28.70	31.22	33.77	35.56	44.25	48.71	37.57
2013	48.92	48.35	45.30	36.69	28.14	26.67	29.16	31.71	34.59	35.69	44.11	50.24	38.30
2014	49.63	49.31	46.20	37.39	28.75	27.35	29.67	32.16	35.30	36.33	44.85	51.06	39.00
2015	50.43	50.10	47.14	38.83	29.30	28.17	30.18	32.61	35.86	37.20	45.79	51.61	39.77
2016	49.66	49.28	46.09	36.78	28.15	27.22	29.17	31.81	35.12	36.43	45.63	51.09	38.87
2017	50.68	50.06	46.82	37.56	28.89	27.85	29.82	32.30	35.50	37.12	46.29	51.74	39.55
2018	51.67	51.08	48.06	38.54	29.57	28.17	30.19	33.02	35.98	37.49	46.61	52.87	40.27
2019	52.80	52.02	48.60	39.49	30.15	28.65	30.66	33.40	36.55	38.06	47.04	53.88	40.94
2020	52.88	51.86	48.40	39.18	29.65	28.47	30.64	33.22	36.76	37.97	47.23	53.77	40.83
2021	53.72	52.93	49.66	40.04	30.59	29.45	31.25	33.97	37.43	38.62	48.34	54.79	41.73
2022	54.77	53.88	50.83	41.02	31.55	30.14	31.90	34.70	38.16	39.51	49.30	55.65	42.62
2023	55.82	54.55	51.51	41.33	32.00	30.56	32.31	35.15	38.31	40.00	49.88	56.30	43.14
2024	56.75	55.65	52.81	42.77	32.73	30.97	33.17	36.19	39.31	40.79	50.34	57.65	44.09
2025	57.35	56.37	53.88	43.83	33.25	31.28	33.52	36.70	40.15	41.61	50.98	58.49	44.78
2026	58.25	57.32	55.04	44.76	33.76	31.82	34.16	37.21	40.77	42.41	51.85	59.31	45.56
2027	59.26	58.27	56.10	45.35	34.32	32.25	34.45	37.57	41.37	43.06	52.77	60.30	46.26
2028	60.47	59.07	57.02	46.09	35.05	32.87	34.88	38.20	41.99	43.81	53.62	61.12	47.02
2029	61.68	60.19	58.37	47.11	35.64	33.19	35.42	38.95	42.68	44.28	54.11	62.22	47.82

2009 Trends

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	42.12	45.91	42.40	36.27	33.78	35.57	40.28	41.86	42.20	41.47	48.75	45.97	41.38
2011	46.42	49.85	45.46	37.57	35.59	37.34	42.49	44.39	44.53	43.45	50.07	46.38	43.63
2012	66.89	70.25	67.03	60.44	59.08	59.73	62.84	64.32	64.58	64.57	69.62	66.01	64.61
2013	69.70	73.13	69.93	63.44	61.80	62.29	65.53	67.52	67.62	66.56	71.50	69.03	67.34
2014	73.17	75.84	70.75	69.91	62.79	61.68	65.19	68.86	66.65	69.28	70.36	74.36	69.07
2015	76.98	77.82	73.21	73.43	64.54	64.23	67.05	71.41	68.82	72.26	73.58	78.99	71.86
2016	78.46	79.53	75.71	74.43	64.90	64.71	67.31	71.81	69.10	72.33	75.09	81.81	72.93
2017	83.75	83.98	79.98	78.21	68.30	67.44	70.56	74.88	72.43	75.43	78.72	85.20	76.57
2018	86.89	86.60	83.63	81.61	72.04	71.13	73.76	78.10	77.01	78.76	81.31	88.15	79.92
2019	89.42	89.71	86.32	84.39	74.98	73.92	76.33	80.83	80.51	82.07	84.00	90.46	82.75
2020	91.99	92.56	87.91	86.37	76.55	75.09	78.25	83.43	83.59	85.03	87.57	93.47	85.15
2021	95.97	96.63	92.83	89.85	80.32	77.83	80.82	87.46	87.60	88.76	91.71	97.28	88.92
2022	99.69	99.79	95.55	93.87	84.22	81.65	84.98	91.57	91.81	93.13	95.87	100.09	92.68
2023	103.36	103.12	98.27	97.25	87.93	85.45	88.52	95.49	95.27	97.59	99.39	103.28	96.24
2024	110.29	110.35	105.17	99.93	90.00	87.86	90.92	98.45	98.83	100.20	105.60	110.38	100.66
2025	113.92	113.77	108.05	102.57	92.87	89.95	93.66	101.44	101.81	103.24	108.26	113.71	103.60
2026	117.15	116.13	109.76	106.14	97.01	94.37	97.77	105.50	106.00	107.96	112.52	116.82	107.26
2027	120.34	119.97	113.79	109.79	100.83	98.06	101.45	109.19	109.31	111.95	118.20	121.97	111.24
2028	125.27	125.36	118.54	113.93	105.18	102.54	106.34	113.99	113.61	117.15	123.51	126.26	115.97
2029	130.30	130.62	123.29	119.60	109.03	106.82	110.92	118.16	118.81	121.12	127.09	131.16	120.58

2009 Business As Usual (BAU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
2010	53.70	54.13	50.73	42.51	32.66	31.82	35.30	38.06	41.05	41.67	51.38	55.78	44.07
2011	48.89	48.89	46.02	37.04	29.35	28.16	30.60	33.25	35.92	36.91	45.69	49.80	39.21
2012	46.46	46.45	43.62	35.34	27.79	26.50	28.59	30.90	33.51	35.19	43.46	47.91	37.14
2013	47.68	47.13	44.58	36.32	27.95	26.69	29.03	31.26	34.14	35.04	43.29	49.15	37.69
2014	48.73	48.17	45.52	37.00	28.74	27.34	29.46	31.68	34.87	35.70	43.96	50.11	38.44
2015	49.57	49.33	46.78	38.19	29.30	28.43	30.18	32.43	35.65	36.97	45.17	50.92	39.41
2016	48.67	48.42	45.40	36.48	28.19	27.38	29.48	31.91	34.93	36.20	44.94	50.20	38.52
2017	49.92	49.28	46.21	37.10	28.83	27.96	29.98	32.44	35.34	36.92	45.72	51.01	39.23
2018	50.94	50.33	47.38	38.25	29.27	28.20	30.40	33.01	35.98	37.39	45.95	52.14	39.94
2019	52.04	51.32	48.10	39.09	30.01	28.63	30.80	33.41	36.57	37.88	46.44	53.07	40.61
2020	51.95	50.92	47.44	38.61	29.16	28.07	30.51	33.10	36.51	37.58	46.47	52.94	40.27
2021	52.59	51.86	48.68	39.61	29.79	29.06	31.11	33.85	37.15	38.25	47.57	53.88	41.12
2022	53.90	52.98	50.06	40.53	30.94	29.67	31.79	34.51	37.86	39.23	48.64	54.69	42.07
2023	54.89	53.79	50.50	40.84	31.37	29.95	32.00	35.06	38.14	39.82	49.20	55.53	42.59
2024	55.92	54.84	51.89	42.31	32.21	30.42	32.81	35.79	39.02	40.47	49.80	56.82	43.52
2025	56.49	55.38	52.74	43.11	32.48	30.65	33.16	36.11	39.72	41.19	50.24	57.65	44.08
2026	57.32	56.40	54.07	44.04	33.18	31.33	33.77	36.55	40.31	41.69	50.94	58.54	44.84
2027	58.12	57.18	55.05	44.71	33.77	31.95	34.08	37.10	40.84	42.39	52.00	59.46	45.55
2028	59.21	58.10	55.81	45.10	34.59	32.36	34.49	37.57	41.40	43.20	52.68	59.91	46.20
2029	60.47	58.98	57.26	46.45	34.95	32.65	34.98	38.42	42.06	43.69	53.01	61.33	47.02

B. Electric Demand-Side Screening Results

The results in the following tables were part of the bundles provided by Cadmus Group. See Appendix L for a discussion of Cadmus' methodology and analysis.

Annual Energy Savings

(aMW)Bundles A through E includes Energy Efficiency, Fuel Conversion, Distributed Generation, and Distribution Efficiency

	Bundle A	Bundle B	Bundle C	Bundle D	Bundle D38	Bundle E	EISA
2010	27.3	39.4	44.2	47.3	41.9	51.3	0.0
2011	55.4	79.7	89.2	95.5	83.8	103.4	0.0
2012	84.5	120.9	135.0	144.8	126.4	156.6	1.1
2013	109.3	156.4	174.7	187.7	168.3	203.4	5.7
2014	133.5	191.3	213.6	230.3	210.8	249.9	11.3
2015	158.7	227.0	253.3	273.6	253.7	297.1	16.9
2016	185.1	264.3	294.8	318.3	296.8	345.8	22.6
2017	210.9	300.5	334.9	361.5	338.1	392.9	28.3
2018	237.9	338.4	376.9	406.7	380.6	442.0	34.0
2019	265.5	376.9	419.5	452.4	423.1	491.7	39.7
2020	270.9	384.2	428.3	461.6	461.6	501.7	45.4
2021	274.7	389.2	434.3	468.0	468.0	508.6	51.1
2022	279.4	395.5	441.8	475.9	475.9	517.2	56.8
2023	284.2	401.9	449.4	483.8	483.8	525.9	62.4
2024	290.1	409.9	459.0	493.8	493.8	536.7	68.0
2025	294.2	415.2	465.3	500.1	500.1	543.6	73.7
2026	299.4	421.9	473.2	508.3	508.3	552.5	79.3
2027	304.5	428.4	481.0	515.9	515.9	560.8	84.8
2028	310.7	436.5	490.4	525.9	525.9	571.7	90.4
2029	315.0	442.1	497.1	532.8	532.8	579.2	95.9

Total December Peak Reduction (MW)
Coincidental Peak with System
Bundles A through E includes Energy Efficiency, Fuel Conversion, Distributed Generation, Distribution Efficiency, and Demand Response

	Bundle A	Bundle B	Bundle C	Bundle D	Bundle D38	Bundle E	EISA
2010	38.6	57.3	63.1	68.5	65.5	75.8	0.0
2011	82.6	119.7	130.8	142.1	132.8	156.7	0.0
2012	135.3	190.8	207.8	224.4	204.5	245.4	1.0
2013	211.5	285.0	305.8	329.0	288.5	357.5	4.8
2014	305.4	396.7	422.9	451.2	383.6	486.9	9.8
2015	410.7	519.6	550.4	584.8	500.8	627.5	14.7
2016	485.5	612.1	650.9	688.9	597.2	739.4	19.3
2017	544.2	688.0	728.3	773.8	685.2	830.9	25.0
2018	587.3	748.3	792.1	839.5	771.6	903.7	30.1
2019	620.2	800.9	849.1	904.3	851.9	975.7	33.9
2020	633.6	813.7	864.2	921.0	916.5	993.6	39.4
2021	644.8	831.0	876.9	939.3	933.9	1013.6	44.2
2022	653.9	842.6	889.2	952.0	950.1	1027.4	48.4
2023	663.0	847.9	900.7	958.8	964.0	1035.0	55.2
2024	672.0	857.9	911.5	969.0	979.8	1046.2	58.1
2025	682.8	871.6	925.9	984.6	999.2	1063.0	63.9
2026	694.1	884.0	938.9	997.7	1016.5	1077.3	68.7
2027	705.2	902.6	953.3	1017.3	1034.0	1098.2	73.5
2028	714.7	907.7	964.0	1023.3	1049.1	1105.0	79.9
2029	724.2	918.4	976.1	1034.6	1064.3	1117.3	84.8

Annual Costs (Thousands $)

Bundles A through E includes Energy Efficiency, Fuel Conversion, Distributed Generation, Distribution Efficiency, and Demand Response

	Bundle A	Bundle B	Bundle C	Bundle D	Bundle D38	Bundle E	EISA
2010	$36,695	$95,345	$138,329	$165,537	$147,990	$206,501	$0
2011	$37,904	$98,004	$140,744	$168,273	$149,183	$209,523	$0
2012	$41,933	$102,354	$143,843	$172,653	$149,946	$214,174	$0
2013	$41,816	$98,605	$136,971	$166,710	$157,083	$208,592	$0
2014	$45,708	$103,320	$140,822	$173,207	$171,800	$217,610	$0
2015	$57,505	$116,846	$154,308	$189,227	$188,560	$234,256	$0
2016	$57,005	$118,377	$156,058	$192,319	$186,198	$238,101	$0
2017	$57,461	$120,187	$156,673	$193,793	$187,929	$239,357	$0
2018	$56,789	$117,568	$152,297	$190,133	$185,959	$236,681	$0
2019	$58,972	$117,937	$151,748	$190,617	$180,892	$243,539	$0
2020	$34,106	$51,248	$67,454	$94,809	$182,324	$118,821	$0
2021	$34,729	$51,686	$66,876	$94,972	$94,972	$119,082	$0
2022	$39,394	$56,722	$71,070	$99,572	$99,572	$125,194	$0
2023	$39,091	$58,533	$71,503	$100,932	$100,932	$125,691	$0
2024	$40,827	$76,843	$96,616	$130,124	$130,124	$158,786	$0
2025	$40,480	$75,319	$93,142	$125,774	$125,774	$154,189	$0
2026	$38,084	$67,215	$81,765	$112,845	$112,845	$140,249	$0
2027	$36,218	$58,082	$69,345	$97,462	$97,462	$118,989	$0
2028	$35,835	$52,007	$60,125	$86,850	$86,850	$103,320	$0
2029	$32,230	$42,443	$46,497	$71,518	$71,518	$79,830	$0

C. Electric Integrated Portfolio Results

This chart summarizes the expected costs of the different portfolios in different scenarios. Some portfolios were tested in more than one scenario. At the very least, each portfolio was tested in its "home" scenario. For example, high growth was tested only in the high growth scenario. For comparison purposes, 2007 Trends and 2007 Business as Usual (BAU) portfolios were tested in all scenarios.

Portfolio – Expected Portfolio cost NPV (Millions $)	Scenario: 2007 Trends	2007 BAU	Green World	Low Growth	High Growth	Very High Gas	Very Low Gas	High Resource Cost	Low Resource Cost	Transport Load	2009 Trends	2009 BAU
2007 Trends No DSR	$27,172											
2007 Trends	$23,292	$18,455	$27,918	$15,348	$26,287	$26,895	$14,265				$20,222	
2007 BAU	$23,424	$18,374	$28,159	$15,084	$26,264	$27,009	$13,985				$20,159	
Green World			$28,913									
Low Growth				$15,307								
High Growth					$28,191							
Very High Gas						$26,622						
Very Low Gas							$14,051					
High Resource Cost								$24,206				
Low Resource Cost									$22,619			
Transport Load										$24,263		
High RPS	$23,689											
Low RPS	$22,278											
B2 Energy_2007	$23,672	$18,946									$20,060	
2009 Trends	$23,513	$18,287									$20,186	
2009 BAU												$13,292
All Peaker											$19,661	
All Baseload											$20,010	
2009 Trends: Full Cap											$19,673	
Resource Plan											$20,053	

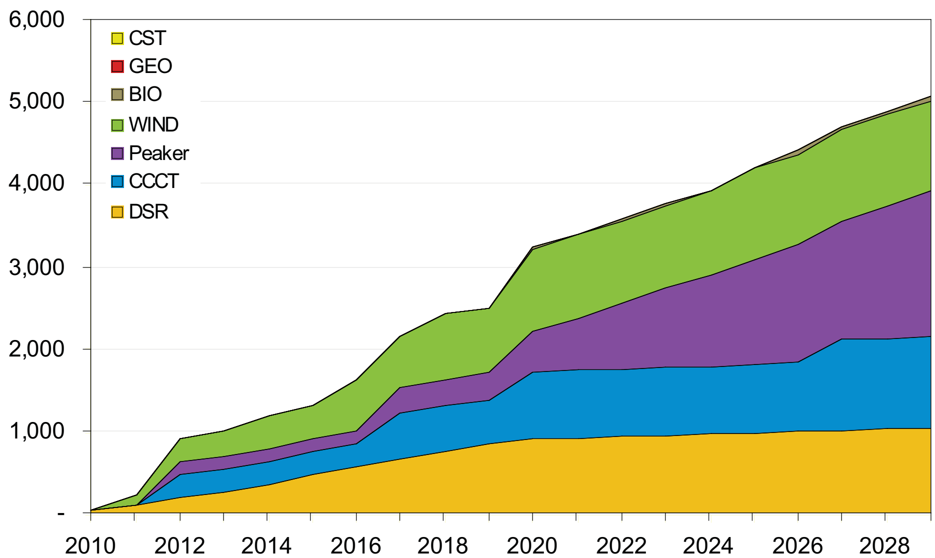
Risk Simulations (blue-shaded cells)

Portfolio: 2009 IRP Resource Plan
DSR Bundle: D38

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	66	66
2011	-	-	-	-	-	100	67	167
2012	-	160	275	-	-	200	72	707
2013	-	-	-	-	-	-	84	84
2014	-	-	-	-	-	100	95	195
2015	-	-	-	-	-	-	117	117
2016	-	-	-	-	-	200	96	296
2017	-	160	275	-	-	-	88	523
2018	-	-	-	-	-	200	86	286
2019	-	-	-	-	-	-	80	80
2020	20	160	275	-	-	200	65	720
2021	-	160	-	-	-	-	17	177
2022	-	160	-	-	-	-	16	176
2023	-	160	-	-	-	-	14	174
2024	-	160	-	-	-	-	16	176
2025	-	160	-	-	-	100	19	279
2026	20	160	-	-	-	-	17	197
2027	-	-	275	-	-	-	18	293
2028	-	160	-	-	-	-	15	175
2029	-	160	-	-	-	-	15	175
Total Additions	40	1,760	1,100	-	-	1,100	1,064	5,064
Percent	1%	35%	22%	0%	0%	22%	21%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2009 Trends
Revenue from Power Sales	($307)
Cost of Power Purchase	$5,411
Demand Side Resources	$1,042
Generic Revenue Requirement	$7,226
Variable Cost of Existing Fleet	$5,628
End Effects Generic	$1,054
Expected Cost	$20,053
Expected Cost $/MWh	75.09

Expected Revenue Requirements with Input Simulations - 100 trials

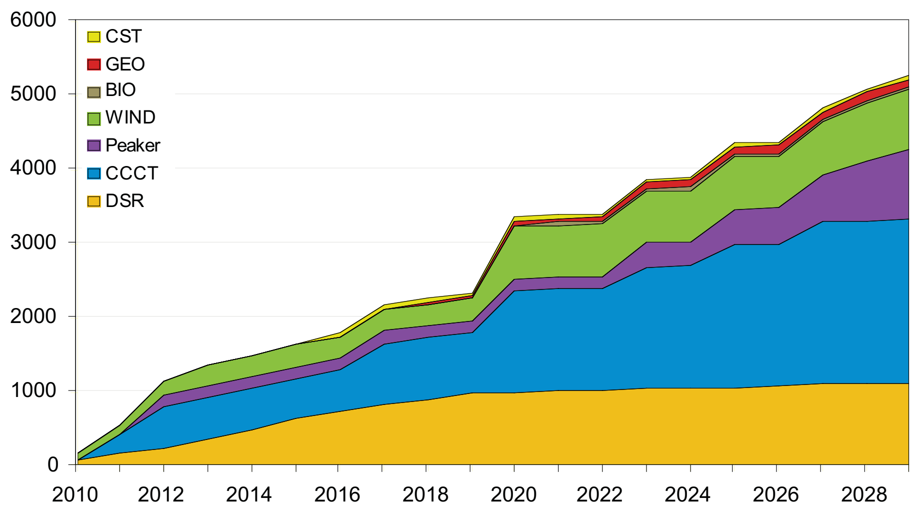
Mean	$19,946
Average of 10 Worst	$20,676
Annual Volatility	13%

Portfolio: 2007 Trends
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	100	76	176
2011	-	-	275	-	-	-	81	356
2012	-	160	275	-	-	100	89	624
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	50	-	112	162
2017	-	-	275	-	-	-	92	367
2018	-	-	-	25	-	-	73	98
2019	-	-	-	-	-	-	72	72
2020	20	-	550	25	-	400	18	1,013
2021	20	-	-	-	-	-	20	40
2022	-	-	-	-	-	-	14	14
2023	-	160	275	25	-	-	8	468
2024	-	-	-	25	-	-	11	36
2025	-	160	275	-	-	-	17	452
2026	-	-	-	-	-	-	14	14
2027	-	160	275	-	-	-	21	456
2028	-	160	-	-	-	100	7	267
2029	-	160	-	-	-	-	12	172
Total Additions	40	960	2,200	100	50	800	1,117	5,267
Percent	1%	18%	42%	2%	1%	15%	21%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for Each Scenario

20-year NPV in Millions $	2007 Trends	2007 BAU	2009 Trends	Green World	Low Growth	High Growth	Very High Gas	Very Low Gas
Revenue from Power Sales	($211)	($151)	($478)	($141)	($1,017)	($125)	($108)	($1,098)
Cost of Power Purchase	$5,185	$4,174	$3,636	$8,945	$955	$8,160	$9,853	$610
Demand Side Resources	$1,369	$1,369	$1,369	$1,369	$1,369	$1,369	$1,369	$1,369
Generic Revenue Requirement	$9,599	$7,495	$8,936	$10,886	$7,190	$9,591	$9,543	$7,107
Variable Cost of Existing Fleet	$6,404	$4,178	$5,628	$5,870	$5,474	$6,452	$5,402	$4,782
End Effects Generic	$946	$1,390	$1,132	$990	$1,377	$841	$837	$1,495
Expected Cost	$23,292	$18,455	$20,222	$27,918	$15,348	$26,287	$26,895	$14,265
Expected Cost $/MWh	85.36	67.59	75.80	104.76	57.56	93.35	98.57	52.21

Expected Revenue Requirements with Input Simulations - 100 trials

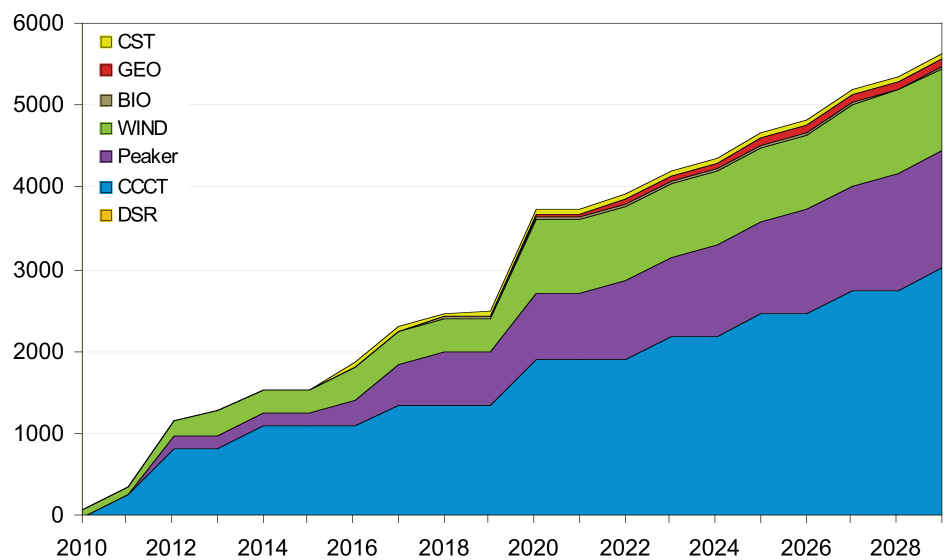
Mean	$22,979	$18,196
Average of 10 Worst	$23,852	$18,729
Annual Volatility	12%	9%

Portfolio: 2007 Trends No DSR
DSR Bundle: None

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	100	-	100
2011	-	-	275	-	-	-	-	275
2012	-	160	550	-	-	100	-	810
2013	20	-	-	-	-	100	-	120
2014	-	-	275	-	-	-	-	275
2015	-	-	-	-	-	-	-	-
2016	-	160	-	-	50	100	-	310
2017	-	160	275	-	-	-	-	435
2018	-	160	-	-	-	-	-	160
2019	20	-	-	25	-	-	-	45
2020	-	160	550	25	-	500	-	1,235
2021	20	-	-	-	-	-	-	20
2022	-	160	-	25	-	-	-	185
2023	-	-	275	-	-	-	-	275
2024	-	160	-	-	-	-	-	160
2025	-	-	275	25	-	-	-	300
2026	-	160	-	-	-	-	-	160
2027	-	-	275	-	-	100	-	375
2028	-	160	-	-	-	-	-	160
2029	-	-	275	-	-	-	-	275
Total Additions	60	1,440	3,025	100	50	1,000	-	5,675
Percent	1%	25%	53%	2%	1%	18%	0%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for Each Scenario

20-year NPV in Millions $	2007 Trends
Revenue from Power Sales	($113)
Cost of Power Purchase	$6,692
Demand Side Resources	$0
Generic Revenue Requirement	$12,917
Variable Cost of Existing Fleet	$6,405
End Effects Generic	$1,270
Expected Cost	$27,172

Expected Cost $/MWh	99.46

Expected Revenue Requirements with Input Simulations - 100 trials

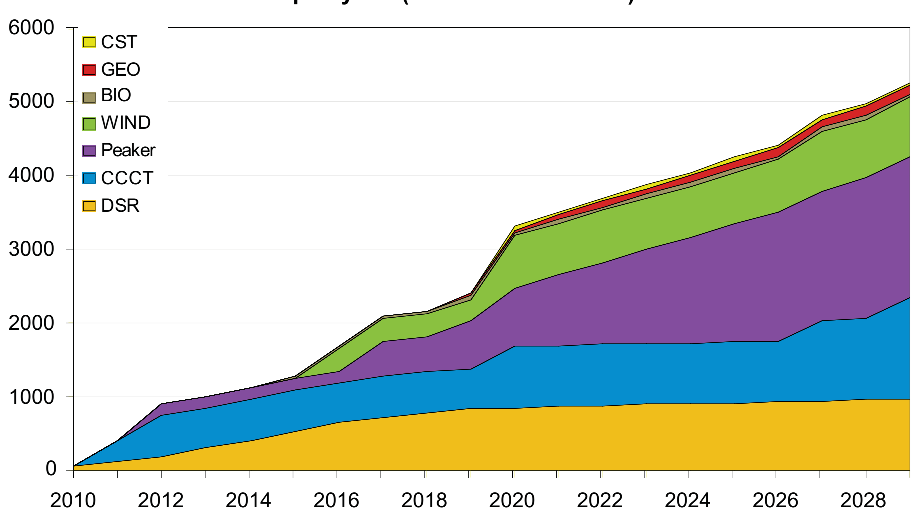
Mean	$26,833
Average of 10 Worst	$27,864
Annual Volatility	13%

Portfolio: 2009 Business As Usual
DSR Bundle: C

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	63	63
2011	-	-	275	-	-	-	68	343
2012	-	160	275	-	-	-	77	512
2013	-	-	-	-	-	-	98	98
2014	-	-	-	-	-	-	117	117
2015	20	-	-	-	-	-	128	148
2016	20	-	-	-	-	300	101	421
2017	-	320	-	-	-	-	77	397
2018	-	-	-	-	-	-	64	64
2019	-	160	-	25	-	-	57	242
2020	-	160	275	25	50	400	15	925
2021	20	160	-	-	-	-	13	193
2022	-	160	-	25	-	-	12	197
2023	-	160	-	-	-	-	12	172
2024	-	160	-	-	-	-	11	171
2025	-	160	-	25	-	-	14	199
2026	-	160	-	-	-	-	13	173
2027	-	-	275	-	-	100	14	389
2028	-	160	-	-	-	-	11	171
2029	-	-	275	-	-	-	12	287
Total Additions	60	1,920	1,375	100	50	800	976	5,281
Percent	1%	36%	26%	2%	1%	15%	18%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for Each Scenario

20-year NPV in Millions $	2007 Trends	2007 BAU	2009 Trends	Green World	Low Growth	High Growth	Very High Gas	Very Low Gas
Revenue from Power Sales	($97)	($97)	($310)	($60)	($692)	($74)	($62)	($794)
Cost of Power Purchase	$7,469	$5,420	$5,618	$12,110	$1,699	$10,540	$12,373	$1,196
Demand Side Resources	$844	$844	$844	$844	$844	$844	$844	$844
Generic Revenue Requirement	$7,828	$6,484	$7,719	$8,458	$6,248	$7,727	$7,661	$6,300
Variable Cost of Existing Fleet	$6,404	$4,178	$5,628	$5,870	$5,474	$6,452	$5,402	$4,782
End Effects Generic	$975	$1,546	$1,161	$936	$1,510	$775	$791	$1,658
Expected Cost	$23,424	$18,374	$20,660	$28,159	$15,084	$26,264	$27,009	$13,985
Expected Cost $/MWh	85.74	67.26	77.36	105.55	56.54	93.15	98.86	51.19

Expected Revenue Requirements with Input Simulations - 100 trials

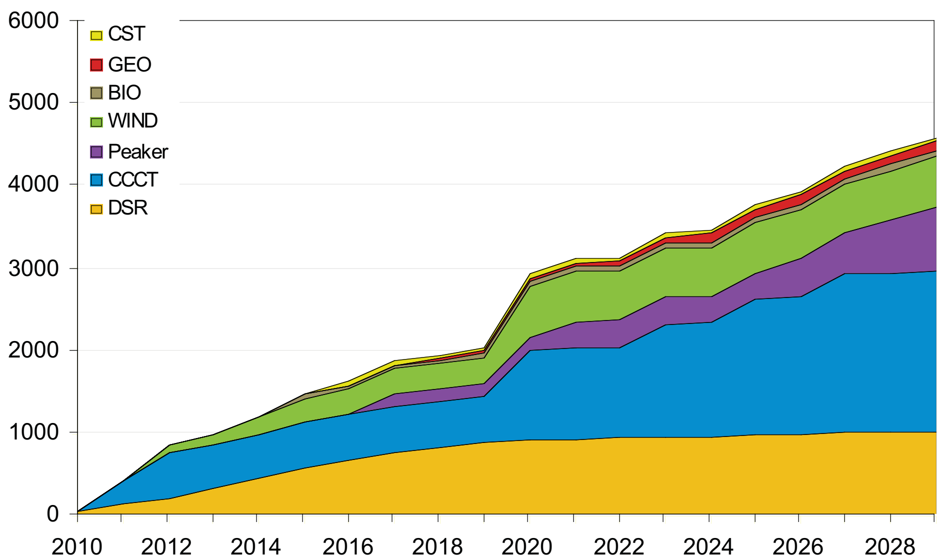
Mean	$23,171	$18,185
Average of 10 Worst	$24,041	$18,719
Annual Volatility	12%	10%

Portfolio: Green World
DSR Bundle: D

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	69	69
2011	-	-	275	-	-	-	74	349
2012	-	-	275	-	-	100	82	457
2013	-	-	-	-	-	-	105	105
2014	20	-	-	-	-	100	122	242
2015	20	-	-	-	-	100	134	254
2016	-	-	-	-	50	-	104	154
2017	-	160	-	-	-	-	85	245
2018	-	-	-	25	-	-	66	91
2019	20	-	-	-	-	-	65	85
2020	-	-	550	25	-	300	17	892
2021	-	160	-	-	-	-	18	178
2022	-	-	-	-	-	-	13	13
2023	-	-	275	25	-	-	7	307
2024	-	-	-	25	-	-	10	35
2025	-	-	275	-	-	-	16	291
2026	-	160	-	-	-	-	13	173
2027	-	-	275	-	-	-	20	295
2028	20	160	-	-	-	-	6	186
2029	-	160	-	-	-	-	11	171
Total Additions	80	800	1,925	100	50	600	1,035	4,590
Percent	2%	17%	42%	2%	1%	13%	23%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	Green World
Revenue from Power Sales	($83)
Cost of Power Purchase	$10,173
Demand Side Resources	$1,078
Generic Revenue Requirement	$10,565
Variable Cost of Existing Fleet	$5,870
End Effects Generic	$1,310
Expected Cost	$28,913

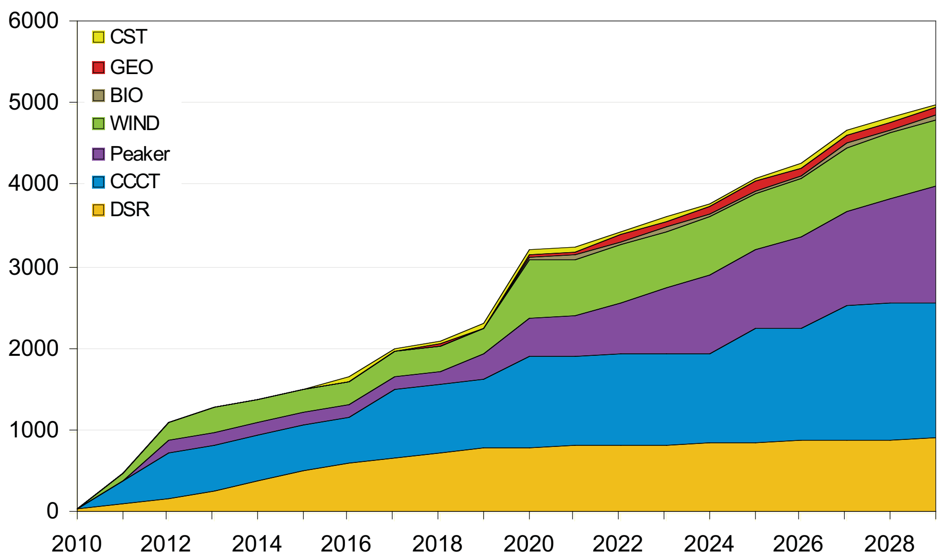
Expected Cost $/MWh	108.38

Portfolio: Low Growth
DSR Bundle: B

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	57	57
2011	-	-	275	-	-	100	62	437
2012	-	160	275	-	-	100	71	606
2013	-	-	-	-	-	100	94	194
2014	-	-	-	-	-	-	112	112
2015	-	-	-	-	-	-	123	123
2016	-	-	-	-	50	-	93	143
2017	-	-	275	-	-	-	76	351
2018	-	-	-	25	-	-	60	85
2019	-	160	-	-	-	-	53	213
2020	20	160	275	25	-	400	13	893
2021	20	-	-	-	-	-	17	37
2022	-	160	-	25	-	-	12	197
2023	-	160	-	-	-	-	5	165
2024	-	160	-	-	-	-	10	170
2025	-	-	275	25	-	-	14	314
2026	-	160	-	-	-	-	12	172
2027	-	-	275	-	-	100	19	394
2028	-	160	-	-	-	-	5	165
2029	-	160	-	-	-	-	11	171
Total Additions	40	1,440	1,650	100	50	800	918	4,998
Percent	1%	29%	33%	2%	1%	16%	18%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	Low Growth
Revenue from Power Sales	($385)
Cost of Power Purchase	$1,981
Demand Side Resources	$598
Generic Revenue Requirement	$6,791
Variable Cost of Existing Fleet	$4,913
End Effects Generic	$1,408
Expected Cost	$15,307

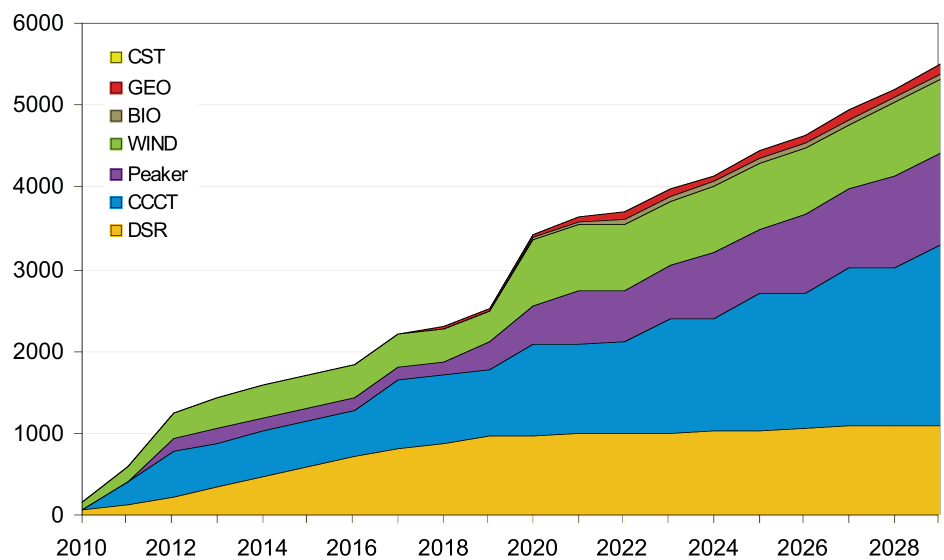
Expected Cost $/MWh	57.38

Portfolio: High Growth
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	100	76	176
2011	-	-	275	-	-	100	81	456
2012	-	160	275	-	-	100	89	624
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	-	-	112	112
2017	-	-	275	-	-	-	92	367
2018	-	-	-	25	-	-	73	98
2019	-	160	-	-	-	-	72	232
2020	20	160	275	25	-	400	18	898
2021	20	160	-	-	-	-	20	200
2022	20	-	-	25	-	-	14	59
2023	-	-	275	-	-	-	8	283
2024	-	160	-	-	-	-	11	171
2025	-	-	275	-	-	-	17	292
2026	-	160	-	25	-	-	14	199
2027	-	-	275	-	-	-	21	296
2028	-	160	-	-	-	100	7	267
2029	-	-	275	-	-	-	12	287
Total Additions	60	1,120	2,200	100	-	900	1,117	5,497
Percent	1%	20%	40%	2%	0%	16%	20%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

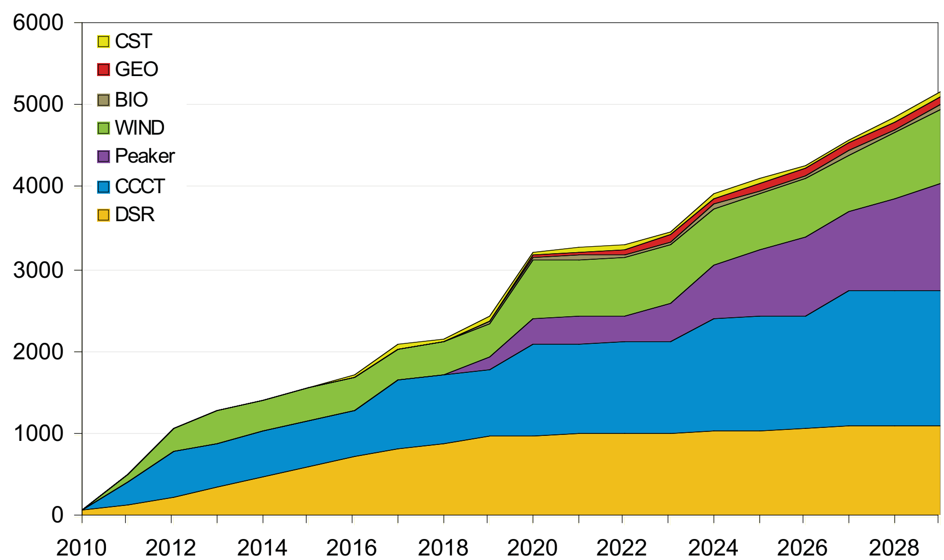
20-year NPV in Millions $	High Growth
Revenue from Power Sales	($124)
Cost of Power Purchase	$8,396
Demand Side Resources	$1,369
Generic Revenue Requirement	$10,783
Variable Cost of Existing Fleet	$6,452
End Effects Generic	$1,316
Expected Cost	$28,191
Expected Cost $/MWh	99.99

Portfolio: Very High Gas
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	76	76
2011	-	-	275	-	-	100	81	456
2012	-	-	275	-	-	200	89	564
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	50	-	112	162
2017	-	-	275	-	-	-	92	367
2018	-	-	-	-	-	-	73	73
2019	20	160	-	-	-	-	72	252
2020	20	160	275	25	-	300	18	798
2021	-	-	-	25	-	-	20	45
2022	-	-	-	25	-	-	14	39
2023	-	160	-	-	-	-	8	168
2024	-	160	275	-	-	-	11	446
2025	-	160	-	-	-	-	17	177
2026	-	160	-	-	-	-	14	174
2027	-	-	275	25	-	-	21	321
2028	-	160	-	-	-	100	7	267
2029	20	160	-	-	-	100	12	292
Total Additions	60	1,280	1,650	100	50	900	1,117	5,157
Percent	1%	25%	32%	2%	1%	17%	22%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	Very High Gas
Revenue from Power Sales	($90)
Cost of Power Purchase	$10,631
Demand Side Resources	$1,369
Generic Revenue Requirement	$8,514
Variable Cost of Existing Fleet	$5,402
End Effects Generic	$796
Expected Cost	$26,622

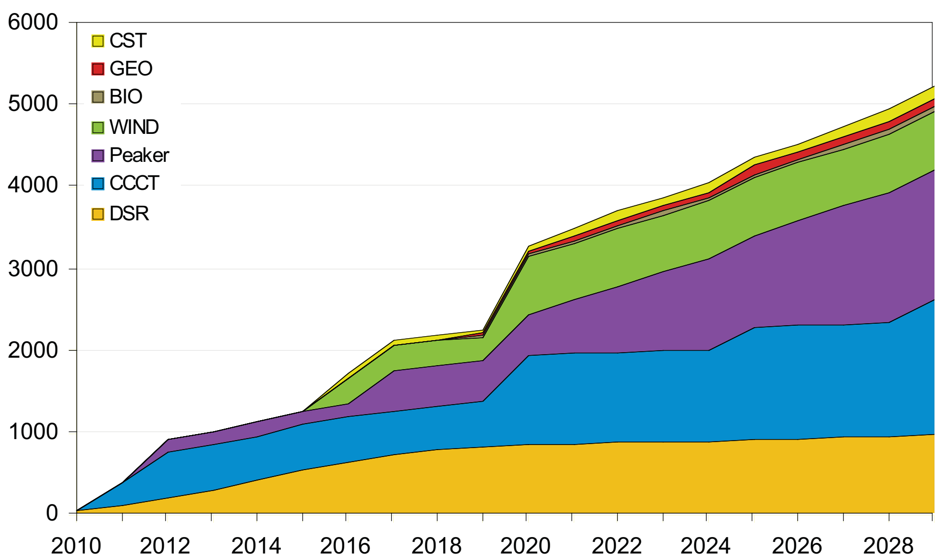
Expected Cost $/MWh	97.45

Portfolio: Very Low Gas
DSR Bundle: C

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	63	63
2011	-	-	275	-	-	-	68	343
2012	-	160	275	-	-	-	77	512
2013	-	-	-	-	-	-	98	98
2014	-	-	-	-	-	-	117	117
2015	-	-	-	-	-	-	128	128
2016	20	-	-	-	50	300	101	471
2017	-	320	-	-	-	-	77	397
2018	-	-	-	-	-	-	64	64
2019	-	-	-	25	-	-	57	82
2020	20	-	550	25	-	400	15	1,010
2021	-	160	-	-	50	-	13	223
2022	-	160	-	25	-	-	12	197
2023	-	160	-	-	-	-	12	172
2024	-	160	-	-	-	-	11	171
2025	-	-	275	25	-	-	14	314
2026	-	160	-	-	-	-	13	173
2027	20	160	-	-	-	-	14	194
2028	-	160	-	-	50	-	11	221
2029	-	-	275	-	-	-	12	287
Total Additions	60	1,600	1,650	100	150	700	976	5,236
Percent	1%	31%	32%	2%	3%	13%	19%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	Very Low Gas
Revenue from Power Sales	($826)
Cost of Power Purchase	$1,014
Demand Side Resources	$844
Generic Revenue Requirement	$6,552
Variable Cost of Existing Fleet	$4,782
End Effects Generic	$1,684
Expected Cost	$14,051

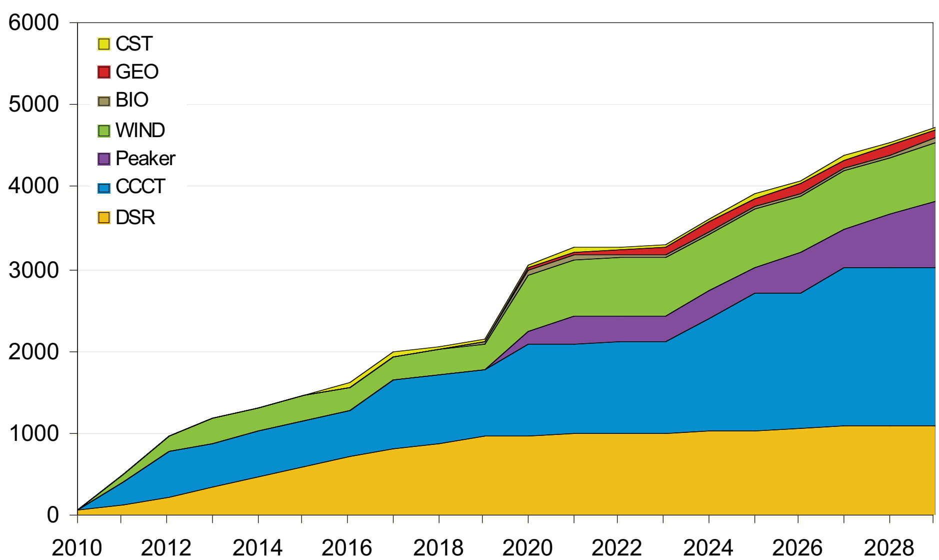
Expected Cost $/MWh	51.43

Portfolio: High Resource Cost
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	76	76
2011	-	-	275	-	-	100	81	456
2012	-	-	275	-	-	100	89	464
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	50	-	112	162
2017	-	-	275	-	-	-	92	367
2018	-	-	-	-	-	-	73	73
2019	20	-	-	-	-	-	72	92
2020	20	160	275	25	-	400	18	898
2021	-	160	-	25	-	-	20	205
2022	-	-	-	-	-	-	14	14
2023	-	-	-	25	-	-	8	33
2024	-	-	275	25	-	-	11	311
2025	-	-	275	-	-	-	17	292
2026	-	160	-	-	-	-	14	174
2027	-	-	275	-	-	-	21	296
2028	-	160	-	-	-	-	7	167
2029	20	160	-	-	-	-	12	192
Total Additions	60	800	1,925	100	50	700	1,117	4,752
Percent	1%	17%	41%	2%	1%	15%	24%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

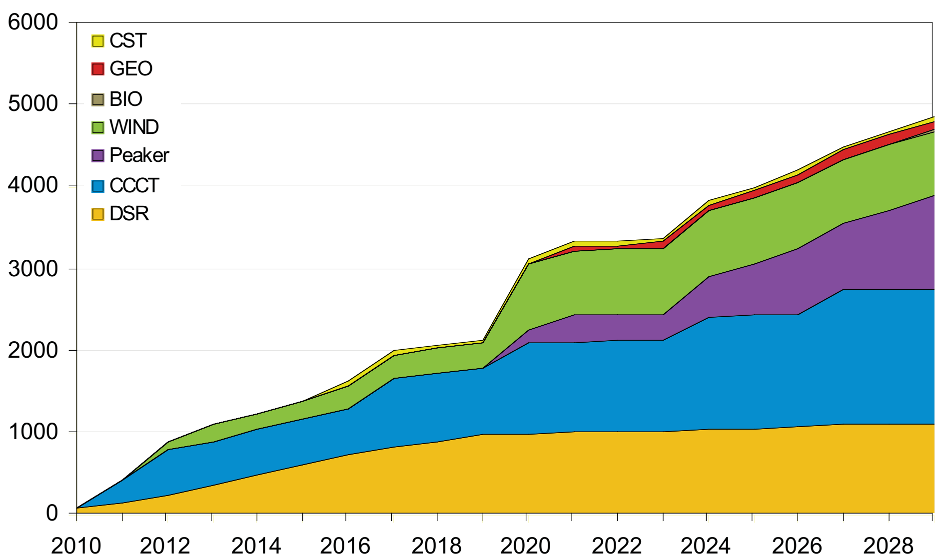
20-year NPV in Millions $	2007 Trends with High Resource
Revenue from Power Sales	($155)
Cost of Power Purchase	$5,777
Demand Side Resources	$1,369
Generic Revenue Requirement	$9,530
Variable Cost of Existing Fleet	$6,404
End Effects Generic	$1,282
Expected Cost	$24,206
Expected Cost $/MWh	88.60

Portfolio: Low Resource Cost
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	76	76
2011	-	-	275	-	-	-	81	356
2012	-	-	275	-	-	100	89	464
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	50	100	112	262
2017	-	-	275	-	-	-	92	367
2018	-	-	-	-	-	-	73	73
2019	-	-	-	-	-	-	72	72
2020	-	160	275	25	-	500	18	978
2021	-	160	-	25	-	-	20	205
2022	-	-	-	-	-	-	14	14
2023	-	-	-	25	-	-	8	33
2024	-	160	275	-	-	-	11	446
2025	-	160	-	-	-	-	17	177
2026	-	160	-	25	-	-	14	199
2027	-	-	275	-	-	-	21	296
2028	20	160	-	-	-	-	7	187
2029	-	160	-	-	-	-	12	172
Total Additions	20	1,120	1,650	100	50	800	1,117	4,857
Percent	0%	23%	34%	2%	1%	16%	23%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

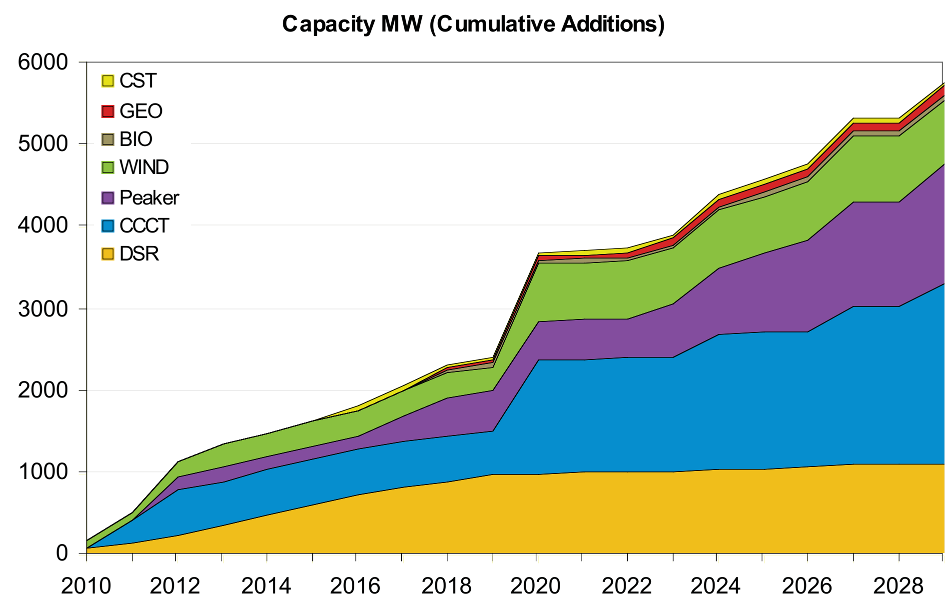
20-year NPV in Millions $	2007 Trends with Low Resource
Revenue from Power Sales	($133)
Cost of Power Purchase	$6,110
Demand Side Resources	$1,369
Generic Revenue Requirement	$8,016
Variable Cost of Existing Fleet	$6,404
End Effects Generic	$854
Expected Cost	$22,619

Expected Cost $/MWh	82.79

Portfolio: Transport Load
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	100	76	176
2011	-	-	275	-	-	-	81	356
2012	-	160	275	-	-	100	89	624
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	20	-	-	-	50	-	112	182
2017	-	160	-	-	-	-	92	252
2018	-	160	-	25	-	-	73	258
2019	20	-	-	-	-	-	72	92
2020	-	-	825	25	-	400	18	1,268
2021	-	-	-	-	-	-	20	20
2022	-	-	-	25	-	-	14	39
2023	-	160	-	-	-	-	8	168
2024	-	160	275	25	-	-	11	471
2025	20	160	-	-	-	-	17	197
2026	-	160	-	-	-	-	14	174
2027	-	160	275	-	-	100	21	556
2028	-	-	-	-	-	-	7	7
2029	-	160	275	-	-	-	12	447
Total Additions	60	1,440	2,200	100	50	800	1,117	5,767
Percent	1%	25%	38%	2%	1%	14%	19%	100%



Revenue Requirements with Expected Inputs for the Scenario

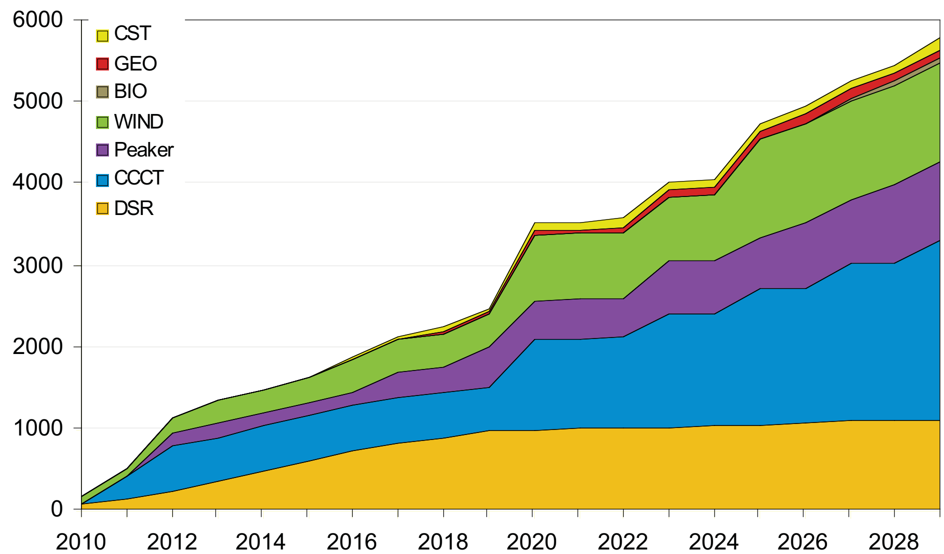
20-year NPV in Millions $	2007 Trends with Transport
Revenue from Power Sales	($152)
Cost of Power Purchase	$6,002
Demand Side Resources	$1,369
Generic Revenue Requirement	$9,581
Variable Cost of Existing Fleet	$6,404
End Effects Generic	$1,059
Expected Cost	$24,263
Expected Cost $/MWh	87.15

Portfolio: High RPS
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	100	76	176
2011	-	-	275	-	-	-	81	356
2012	-	160	275	-	-	100	89	624
2013	-	-	-	-	-	100	112	212
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	50	100	112	262
2017	-	160	-	-	-	-	92	252
2018	-	-	-	25	-	-	73	98
2019	-	160	-	-	-	-	72	232
2020	-	-	550	25	50	400	18	1,043
2021	-	-	-	-	-	-	20	20
2022	-	-	-	25	-	-	14	39
2023	-	160	275	-	-	-	8	443
2024	-	-	-	25	-	-	11	36
2025	-	-	275	-	-	400	17	692
2026	20	160	-	-	-	-	14	194
2027	20	-	275	-	-	-	21	316
2028	20	160	-	-	-	-	7	187
2029	-	-	275	-	50	-	12	337
Total Additions	60	960	2,200	100	150	1,200	1,117	5,787
Percent	1%	17%	38%	2%	3%	21%	19%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2007 Trends
Revenue from Power Sales	($198)
Cost of Power Purchase	$5,489
Demand Side Resources	$1,369
Generic Revenue Requirement	$9,571
Variable Cost of Existing Fleet	$6,410
End Effects Generic	$1,047
Expected Cost	$23,689

Expected Cost $/MWh	86.71

Expected Revenue Requirements with Input Simulations - 100 trials

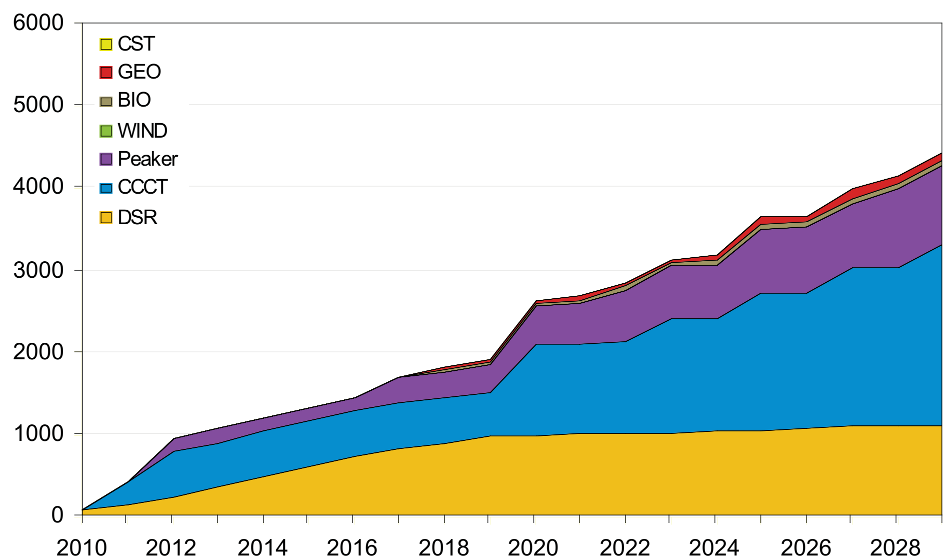
Mean	$23,450
Average of 10 Worst	$24,433
Annual Volatility	11%

Portfolio: Low RPS
DSR Bundle: E

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	76	76
2011	-	-	275	-	-	-	81	356
2012	-	160	275	-	-	-	89	524
2013	-	-	-	-	-	-	112	112
2014	-	-	-	-	-	-	129	129
2015	-	-	-	-	-	-	141	141
2016	-	-	-	-	-	-	112	112
2017	-	160	-	-	-	-	92	252
2018	20	-	-	25	-	-	73	118
2019	20	-	-	-	-	-	72	92
2020	-	160	550	-	-	-	18	728
2021	-	-	-	25	-	-	20	45
2022	-	160	-	-	-	-	14	174
2023	-	-	275	-	-	-	8	283
2024	20	-	-	25	-	-	11	56
2025	-	160	275	-	-	-	17	452
2026	-	-	-	-	-	-	14	14
2027	-	-	275	25	-	-	21	321
2028	-	160	-	-	-	-	7	167
2029	-	-	275	-	-	-	12	287
Total Additions	60	960	2,200	100	-	-	1,117	4,437
Percent	1%	22%	50%	2%	0%	0%	25%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2007 Trends
Revenue from Power Sales	($110)
Cost of Power Purchase	$6,882
Demand Side Resources	$1,369
Generic Revenue Requirement	$6,928
Variable Cost of Existing Fleet	$6,369
End Effects Generic	$842
Expected Cost	$22,278

Expected Cost $/MWh	81.55

Expected Revenue Requirements with Input Simulations - 100 trials

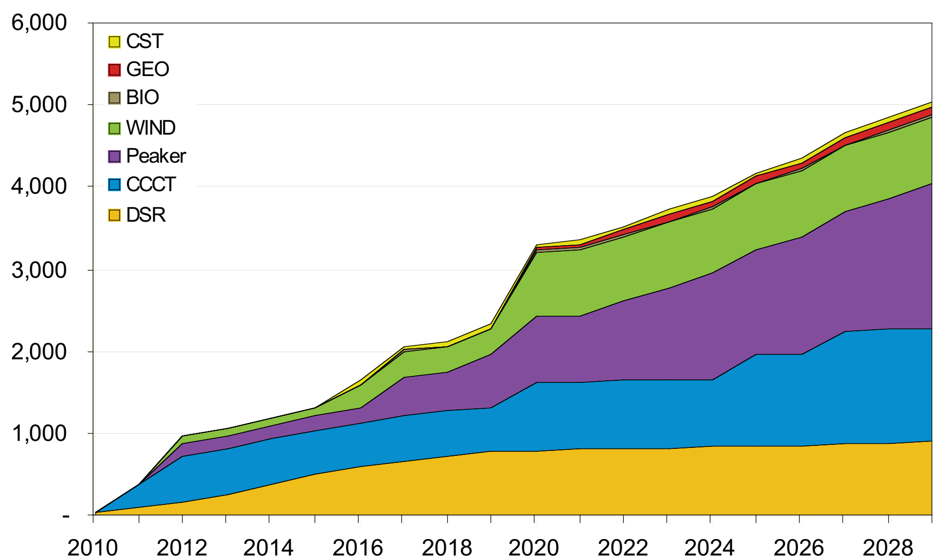
Mean	$22,505
Average of 10 Worst	$23,410
Annual Volatility	13%

Portfolio: 2009 Trends
DSR Bundle: B

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	58	58
2011	-	-	275	-	-	-	63	338
2012	-	160	275	-	-	100	71	606
2013	-	-	-	-	-	-	91	91
2014	-	-	-	-	-	-	110	110
2015	-	-	-	-	-	-	122	122
2016	-	-	-	-	50	200	90	340
2017	20	320	-	-	-	-	76	416
2018	-	-	-	-	-	-	58	58
2019	-	160	-	-	-	-	57	217
2020	-	160	275	25	-	500	13	973
2021	-	-	-	25	-	-	14	39
2022	-	160	-	-	-	-	11	171
2023	-	160	-	25	-	-	8	193
2024	-	160	-	-	-	-	10	170
2025	-	-	275	-	-	-	15	290
2026	-	160	-	-	-	-	12	172
2027	-	-	275	25	-	-	13	313
2028	-	160	-	-	-	-	10	170
2029	20	160	-	-	-	-	12	192
Total Additions	40	1,760	1,375	100	50	800	914	5,039
Percent	1%	35%	27%	2%	1%	16%	18%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2007 Trends	2007 BAU	2009 Trends
Revenue from Power Sales	($93)	($94)	($307)
Cost of Power Purchase	$7,510	$5,497	$5,617
Demand Side Resources	$598	$598	$598
Generic Revenue Requirement	$7,984	$6,600	$7,413
Variable Cost of Existing Fleet	$6,404	$4,179	$5,628
End Effects Generic	$1,110	$1,507	$1,237
Expected Cost	$23,513	$18,287	$20,186
Expected Cost $/MWh	86.07	66.94	75.59

Expected Revenue Requirements with Input Simulations - 100 trials

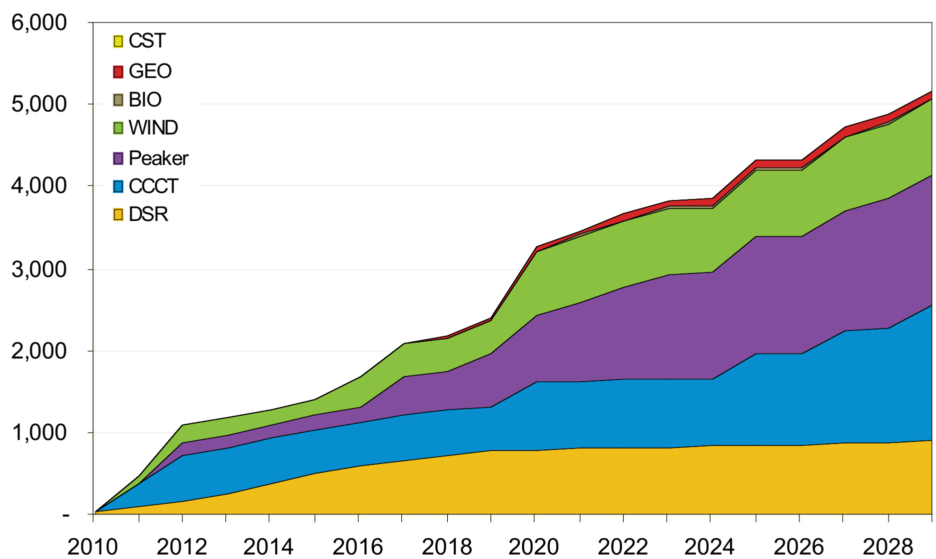
Mean	$20,075
Average of 10 Worst	$20,824
Annual Volatility	13%

Portfolio: 2009 Business As Usual
DSR Bundle: B

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	58	58
2011	-	-	275	-	-	100	63	438
2012	-	160	275	-	-	100	71	606
2013	-	-	-	-	-	-	91	91
2014	-	-	-	-	-	-	110	110
2015	-	-	-	-	-	-	122	122
2016	-	-	-	-	-	200	90	290
2017	-	320	-	-	-	-	76	396
2018	-	-	-	25	-	-	58	83
2019	-	160	-	-	-	-	57	217
2020	-	160	275	25	-	400	13	873
2021	20	160	-	-	-	-	14	194
2022	-	160	-	25	-	-	11	196
2023	-	160	-	-	-	-	8	168
2024	-	-	-	25	-	-	10	35
2025	-	160	275	-	-	-	15	450
2026	-	-	-	-	-	-	12	12
2027	-	-	275	-	-	100	13	388
2028	-	160	-	-	-	-	10	170
2029	-	-	275	-	-	-	12	287
Total Additions	20	1,600	1,650	100	-	900	914	5,184
Percent	0%	31%	32%	2%	0%	17%	18%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

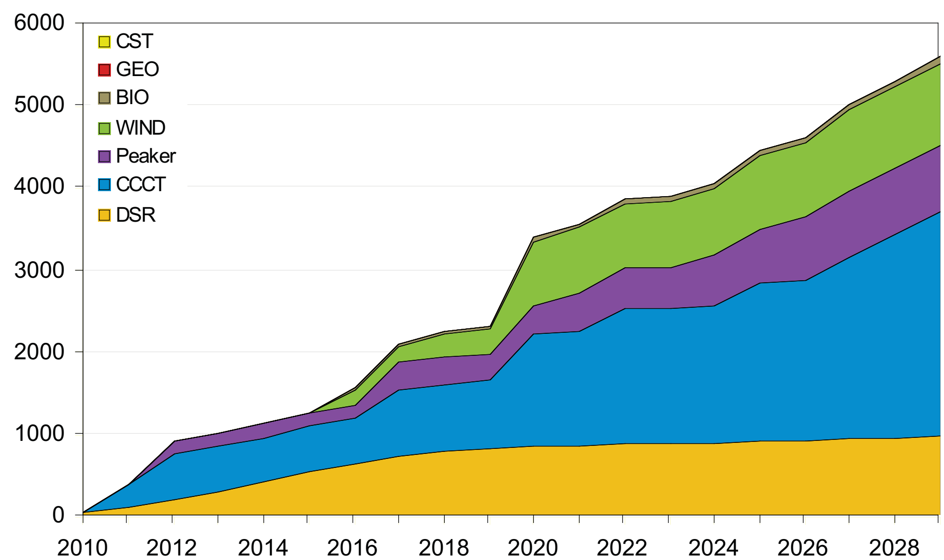
20-year NPV in Millions $	2009 BAU
Revenue from Power Sales	($875)
Cost of Power Purchase	$1,069
Demand Side Resources	$598
Generic Revenue Requirement	$6,279
Variable Cost of Existing Fleet	$4,718
End Effects Generic	$1,503
Expected Cost	$13,292
Expected Cost $/MWh	49.77

Portfolio: B2 Energy Planning Standard
DSR Bundle: C

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	63	63
2011	-	-	275	-	-	-	68	343
2012	-	160	275	-	-	-	77	512
2013	-	-	-	-	-	-	98	98
2014	-	-	-	-	-	-	117	117
2015	-	-	-	-	-	-	128	128
2016	20	-	-	-	-	200	101	321
2017	-	160	275	-	-	-	77	512
2018	-	-	-	-	-	100	64	164
2019	-	-	-	-	-	-	57	57
2020	20	-	550	-	-	500	15	1,085
2021	-	160	-	-	-	-	13	173
2022	20	-	275	-	-	-	12	307
2023	-	-	-	-	-	-	12	12
2024	-	160	-	-	-	-	11	171
2025	-	-	275	-	-	100	14	389
2026	-	160	-	-	-	-	13	173
2027	-	-	275	-	-	100	14	389
2028	-	-	275	-	-	-	11	286
2029	20	-	275	-	-	-	12	307
Total Additions	80	800	2,750	-	-	1,000	976	5,606
Percent	1%	14%	49%	0%	0%	18%	17%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for Each Scenario

20-year NPV in Millions $	2007 Trends	2007 BAU	2009 Trends
Revenue from Power Sales	($186)	($120)	($421)
Cost of Power Purchase	$5,721	$4,564	$4,054
Demand Side Resources	$844	$844	$844
Generic Revenue Requirement	$9,975	$7,744	$9,167
Variable Cost of Existing Fleet	$6,404	$4,178	$5,628
End Effects Generic	$914	$1,736	$788
Expected Cost	$23,672	$18,946	$20,060
Expected Cost $/MWh	86.65	69.35	75.11

Expected Revenue Requirements with Input Simulations - 100 trials

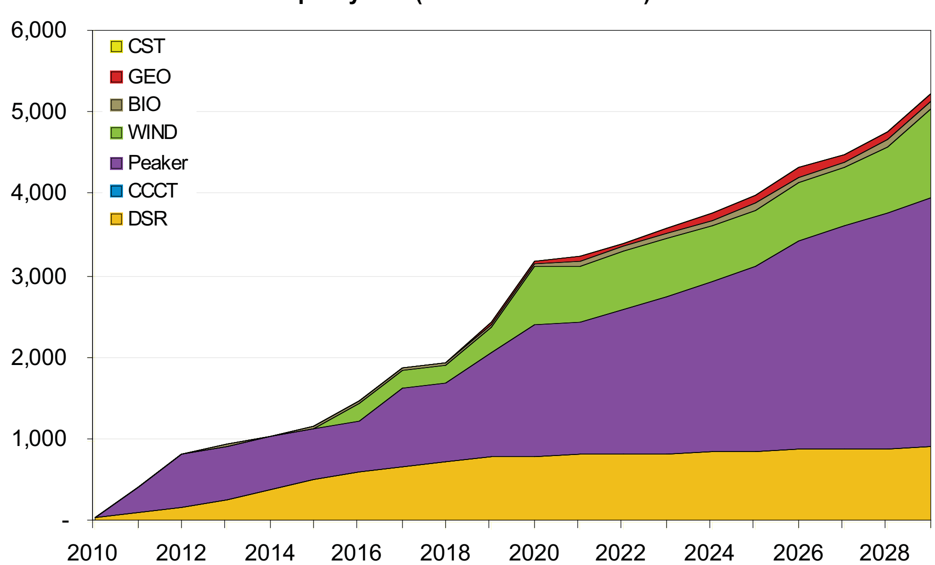
Mean	$23,348	$18,605
Average of 10 Worst	$24,348	$19,221
Annual Volatility	12%	10%

Portfolio: All Peaker
DSR Bundle: B

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	57	57
2011	-	320	-	-	-	-	62	382
2012	-	320	-	-	-	-	71	391
2013	20	-	-	-	-	-	94	114
2014	-	-	-	-	-	-	112	112
2015	-	-	-	-	-	-	123	123
2016	20	-	-	-	-	200	93	313
2017	-	320	-	-	-	-	76	396
2018	-	-	-	-	-	-	60	60
2019	-	320	-	25	-	100	53	498
2020	-	320	-	25	-	400	13	758
2021	20	-	-	-	-	-	17	37
2022	-	160	-	-	-	-	12	172
2023	-	160	-	-	-	-	5	165
2024	-	160	-	25	-	-	10	195
2025	20	160	-	25	-	-	14	219
2026	-	320	-	-	-	-	12	332
2027	-	160	-	-	-	-	19	179
2028	-	160	-	-	-	100	5	265
2029	-	160	-	-	-	300	11	471
Total Additions	80	3,040	-	100	-	1,100	918	5,238
Percent	2%	58%	0%	2%	0%	21%	18%	100%

Capacity MW (Cumulative Additions)



Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2009 Trends
Revenue from Power Sales	($326)
Cost of Power Purchase	$8,114
Demand Side Resources	$598
Generic Revenue Requirement	$4,502
Variable Cost of Existing Fleet	$5,628
End Effects Generic	$1,145
Expected Cost	$19,661
Expected Cost $/MWh	73.62

Expected Revenue Requirements with Input Simulations - 100 trials

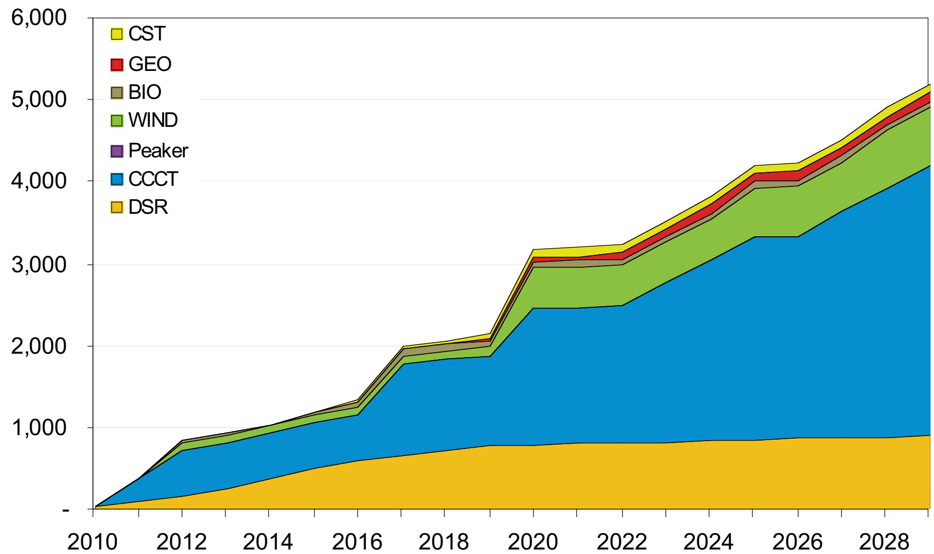
Mean	$20,053
Average of 10 Worst	$20,798
Annual Volatility	13%

Portfolio: All CCCT Baseload
DSR Bundle: B

Supply Side Additions (Nameplate Capacity in MW)

	BIO	Peaker	CCCT	GEO	CST	WIND	DSR	Annual Additions
2010	-	-	-	-	-	-	57	57
2011	-	-	275	-	-	-	62	337
2012	20	-	275	-	-	100	71	466
2013	-	-	-	-	-	-	94	94
2014	-	-	-	-	-	-	112	112
2015	20	-	-	-	-	-	123	143
2016	20	-	-	-	50	-	93	163
2017	20	-	550	-	-	-	76	646
2018	-	-	-	-	-	-	60	60
2019	-	-	-	25	-	-	53	78
2020	-	-	550	25	50	400	13	1,038
2021	-	-	-	-	-	-	17	17
2022	-	-	-	25	-	-	12	37
2023	-	-	275	-	-	-	5	280
2024	-	-	275	25	-	-	10	310
2025	-	-	275	-	-	100	14	389
2026	-	-	-	-	-	-	12	12
2027	-	-	275	-	-	-	19	294
2028	-	-	275	-	-	100	5	380
2029	-	-	275	-	-	-	11	286
Total Additions	80	-	3,300	100	100	700	918	5,198
Percent	2%	0%	63%	2%	2%	13%	18%	100%

Capacity MW (Cumulative Additions)

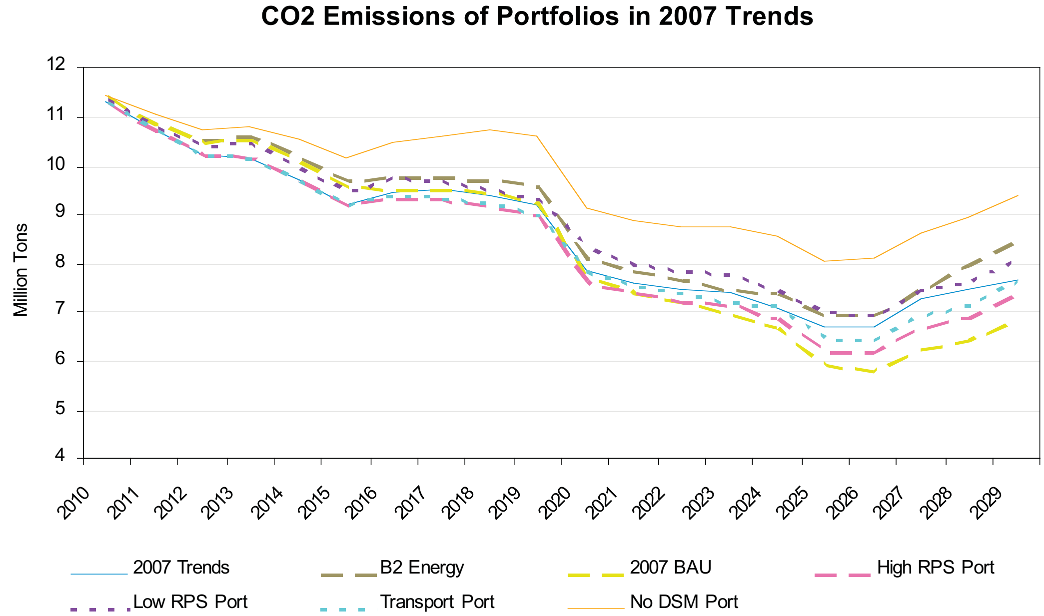


Revenue Requirements with Expected Inputs for the Scenario

20-year NPV in Millions $	2009 Trends
Revenue from Power Sales	($326)
Cost of Power Purchase	$3,056
Demand Side Resources	$598
Generic Revenue Requirement	$9,856
Variable Cost of Existing Fleet	$5,628
End Effects Generic	$1,199
Expected Cost	$20,010
Expected Cost $/MWh	74.93

Expected Revenue Requirements with Input Simulations - 100 trials

Mean	$19,982
Average of 10 Worst	$20,793
Annual Volatility	13%



D. Electric Integrated Portfolio Results: Full Capacity

Below are the results of updating the analysis so that the full nameplate capability of each plant is reflected instead of the nameplate less operating reserves. A discussion on this can be found in Chapter 5. The Strategist step was run for 5 scenarios to see the effect on portfolio builds.

2009 Trends

DSR Bundle B	BIO	Peaker	CCCT	GEO	CST	WIND	DSR
2010	-	-	-	-	-	-	58
2011	-	-	-	-	-	-	63
2012	20	160	275	-	-	200	71
2013	-	-	-	-	-	-	91
2014	-	-	-	-	-	-	110
2015	-	-	-	-	-	-	122
2016	20	-	-	-	-	100	90
2017	-	320	-	-	-	-	76
2018	-	160	-	-	-	-	58
2019	-	-	-	-	-	-	57
2020	-	-	550	25	-	500	13
2021	-	-	-	25	-	-	14
2022	-	160	-	-	-	-	11
2023	-	160	-	25	-	-	8
2024	-	160	-	-	-	-	10
2025	-	-	275	-	-	-	15
2026	-	160	-	25	-	-	12
2027	20	160	-	-	-	-	13
2028	-	160	-	-	-	-	10
2029	-	-	275	-	-	-	12
Total	60	1,600	1,375	100	-	800	914

2007 Trends

DSR Bundle E	BIO	Peaker	CCCT	GEO	CST	WIND	DSR
2010	-	-	-	-	-	-	76
2011	-	-	-	-	-	100	81
2012	-	-	550	-	-	100	89
2013	-	-	-	-	-	100	112
2014	-	-	-	-	-	-	129
2015	-	-	-	-	-	-	141
2016	-	-	-	-	50	-	112
2017	20	160	-	-	-	-	92
2018	20	-	-	25	-	-	73
2019	-	160	-	-	-	-	72
2020	-	-	550	25	-	400	18
2021	-	-	-	-	-	-	20
2022	-	-	-	-	-	-	14
2023	-	160	275	25	-	-	8
2024	-	-	-	-	-	-	11
2025	-	-	275	25	-	-	17
2026	-	160	-	-	-	-	14
2027	-	-	275	-	-	-	21
2028	-	160	-	-	-	100	7
2029	-	-	275	-	-	-	12
Total	40	800	2,200	100	50	800	1,117

2007 BAU

DSR Bundle C	BIO	Peaker	CCCT	GEO	CST	WIND	DSR
2010	-	-	-	-	-	-	63
2011	-	-	-	-	-	-	68
2012	-	-	550	-	-	-	77
2013	-	-	-	-	-	-	98
2014	-	-	-	-	-	-	117
2015	20	-	-	-	-	-	128
2016	20	-	-	-	-	300	101
2017	-	320	-	-	-	-	77
2018	-	-	-	-	-	-	64
2019	-	160	-	25	-	-	57
2020	-	160	275	25	50	400	15
2021	20	160	-	-	-	-	13
2022	-	160	-	25	-	-	12
2023	-	160	-	-	-	-	12
2024	-	160	-	-	-	-	11
2025	-	160	-	25	-	-	14
2026	-	160	-	-	-	-	13
2027	-	-	275	-	-	100	14
2028	-	160	-	-	-	-	11
2029	-	-	275	-	-	-	12
Total	60	1,760	1,375	100	50	800	976

Green World

DSR Bundle D	BIO	Peaker	CCCT	GEO	CST	WIND	DSR
2010	-	-	-	-	-	-	69
2011	-	-	-	-	-	100	74
2012	-	160	275	-	-	100	82
2013	-	-	-	-	-	-	105
2014	-	-	-	-	-	100	122
2015	20	-	-	-	-	100	134
2016	-	-	-	-	50	-	104
2017	-	-	275	-	-	-	85
2018	-	-	-	-	-	-	66
2019	-	-	-	25	-	-	65
2020	20	-	550	25	-	200	17
2021	20	160	-	-	-	-	18
2022	-	-	-	-	-	-	13
2023	-	-	275	25	-	-	7
2024	-	-	-	25	-	-	10
2025	-	160	275	-	-	-	16
2026	-	160	-	-	-	-	13
2027	-	160	-	-	-	-	20
2028	-	160	-	-	50	-	6
2029	-	160	-	-	-	-	11
Total	60	1,120	1,650	100	100	600	1,035

High Growth

DSR Bundle E	BIO	Peaker	CCCT	GEO	CST	WIND	DSR
2010	-	-	-	-	-	-	76
2011	-	-	275	-	-	100	81
2012	20	-	275	-	-	100	89
2013	-	-	-	-	-	100	112
2014	-	-	-	-	-	-	129
2015	-	-	-	-	-	-	141
2016	20	-	-	-	-	-	112
2017	-	160	275	-	-	-	92
2018	-	-	-	-	-	-	73
2019	-	-	-	-	-	-	72
2020	20	-	550	25	-	500	18
2021	-	160	-	-	-	-	20
2022	-	160	-	25	-	-	14
2023	-	160	-	-	-	-	8
2024	-	160	-	25	-	-	11
2025	-	-	275	-	-	-	17
2026	-	160	-	25	-	-	14
2027	-	160	275	-	-	-	21
2028	20	160	-	-	-	-	7
2029	-	160	-	-	-	-	12
Total	80	1,440	1,925	100	-	800	1,117

Gas Analysis

I. Analytical Models

PSE uses the SENDOUT software model from Ventyx for long-term gas supply portfolio planning. SENDOUT is a widely used model that helps identify the long-term least cost combination of resources to meet stated loads. Avista, Cascade Natural Gas, and Terasen all use the SENDOUT model as well. In past IRP analyses, PSE has used the add-in product Vector Gas with Sendout to incorporate uncertainty about future prices and weather driven loads. Installation of SENDOUT Version 12.1.1 integrated Vector Gas's Monte Carlo capability into SENDOUT. The following provides a description of SENDOUT, including the Monte Carlo features.

SENDOUT is an integrated tool set for gas resource analysis. SENDOUT models the gas supply network and the portfolio of supply, storage, and transportation to meet demand requirements. The Monte Carlo capabilities allow simulation of uncertainties regarding weather and commodity prices. It then runs the SENDOUT portfolio over many draws to provide a probability distribution of results from which to make decisions.

A. SENDOUT

SENDOUT can operate in two different modes: It can be used to determine the optimal set of resources (energy efficiency, supply, storage, and transport) to minimize costs over a defined planning period. Alternatively, specific portfolios can be defined, and the model will determine the least cost dispatch to meet demand requirements for each portfolio. SENDOUT solves both problems using a linear program (LP). SENDOUT determines how a portfolio of resources (energy efficiency, supply, storage, and transport), including associated costs and contractual or physical constraints, should be added and dispatched to meet demand in a least-cost fashion. By using an LP, SENDOUT considers thousands of variables and evaluates tens of thousands of possible solutions in order to generate the least cost solution. A standard dispatch considers the capacity level of all resources as given, and therefore performs a variable-cost dispatch. A resource mix dispatch can look at a range of potential capacity and size resources, including their capacities and fixed costs in addition to variable costs.

Energy Efficiency

SENDOUT provides a comprehensive set of inputs to model a variety of energy efficiency programs. Costs can be modeled at an overall program level or broken down into a variety of detailed accounts. The impact of efficiency programs on load can be modeled at the same detail level as demand. SENDOUT has the ability to determine the most cost-effective size of energy efficiency programs on an integrated basis with supply-side alternatives in a long-run resource mix analysis.

Supply

SENDOUT allows a system to be supplied by either flowing gas contracts or a spot market. Specific physical and contractual constraints can be modeled, such as maximum flow levels and minimum flow percentages, on a daily, monthly, seasonal, or annual basis. SENDOUT uses standard gas contract costs; the rates may be changed on a monthly or daily basis.

Storage

SENDOUT allows storage sources (either leased or company owned) to serve the system. Storage input data include the minimum or maximum inventory levels, minimum or maximum injection and withdrawal rates, injection and withdrawal fuel loss, *to* and *from* interconnects, and the period of activity (i.e., when the gas is available for injection or withdrawal). There is also the option to define and name volume-dependent injection and withdrawal percentage tables (ratchets), which can be applied to one or more storage sources.

Transportation

SENDOUT provides the means to model transportation segments to define flows, costs, and fuel loss. Flow values include minimum and maximum daily quantities available for sale to gas markets or for release. Cost values include standard fixed and variable transportation rates, as well as a per-unit cost generated for released capacity. Seasonal transportation contracts can also be modeled.

Demand

SENDOUT allows the user to define multiple demand areas, and it can compute a demand forecast by class based on weather.

B. Monte Carlo Analysis

Monte Carlo simulation is a statistical modeling method used to imitate the many possibilities that exist within a real-life system. By describing the expectation, variability, behavior, and correlation among potential events, it is possible through repeated random draws to derive a numerical landscape of the many potential futures. The goal of Monte Carlo is for this quantitative landscape to reflect both the magnitude and the likelihood of these events, thereby providing a risk-based viewpoint from which to base decisions.

Traditional optimization is deterministic. That is, the inputs for a given scenario are fixed (one value to one cell), and there is a single solution for this set of assumptions. Monte Carlo simulation allows the user to generate the inputs for optimization with hundreds or thousands of values (draws) for weather and price possibilities. The SENDOUT network optimizer provides a detailed dispatch for each Monte Carlo draw.

The advanced probability-based metrics yield a more insightful picture of the portfolio, and form the basis for risk-based resource decisions. The most common of these probability measures include: Expected Value (μ) - EV is then more meaningful than the traditional deterministic measure (total system costs, for example) for a normal scenario since it directly and proportionately captures the portfolio's response to the whole range of weather and price events. Variability (σ) – the level of variance for critical objectives (e.g., cost exposure) should be a key component when comparing portfolios. Probability (P) – measures the likelihood of a key event (10% to exceed $500 million in annual costs, for example).

Another application for Monte Carlo and optimization is to study the resource trade-off economics by optimally sizing the contract or asset level of various and competing resources for each draw. This can be especially helpful in determining the right resource mix that will lower expected costs. This mix of resources is difficult to identify using deterministic methods, since it is difficult to determine at which points various resources are better or worse.

Monte Carlo Uncertainty Inputs

Monte Carlo analysis provides helpful information to guide long-term resource planning as well as to support specific resource acquisitions. Monte Carlo analysis is performed by creating a large number of price and temperature (and thus demand) scenarios that are analyzed in SENDOUT. Creating hundreds or thousands of reasonable scenarios of prices at each relevant supply basin with different temperatures requires a new and significant set of data inputs that are not required for a single static optimization model run. The following discussion identifies the uncertainty factors included for Monte Carlo analyses and explains the analysis used to define each factor.

But first is a list and brief description of each input needed to create reasonable sets of scenarios:

- *Expected Monthly Heating Degree Days.* The expected summation of daily heating degree days (HDD) for each month is required. Daily heating degree days are calculated 65 minus the average daily temperature.
- *Standard Deviation of Monthly HDD.* A measure of variability in total monthly HDD that can be assigned a different value for every month.
- *Daily HDD Pattern.* Daily HDDs are derived by applying a historic daily HDD pattern to each monthly HDD draw. This daily pattern can be drawn independently from the monthly HDD level or can be set to reflect a different historic period in each month. Different months can have different daily pattern settings.
- *Expected Monthly Gas Price Draw.* The basis of determining prices each month, this measure can be considered the average of daily gas prices prior to factoring in effects of daily temperature.
- Standard Deviation of Monthly Price Draw: This is a measure of the variability of prices at each basin, such as at AECO. Standard deviation is expressed in dollars. A different standard deviation can be assigned to each month for the planning period.
- *Temperature to Price Correlations at each Basin.* Ensures that a reasonable relationship exists between prices and temperatures in each Monte Carlo scenario. Linear/simple temperature to price correlation coefficients are used and a different value can be assigned to each month.

- *Price to Price Correlations between Basins.* Ensures reasonable relationships for prices between each basin for the Monte Carlo scenarios. Linear/simple temperature to price correlation coefficients are used.
- *Daily Price to Temperature Coefficients.* Daily temperatures drive changes from the monthly price draw. Daily price is modeled as an exponential function of daily temperature and has the ability to include a second level of sensitivity to model a price "blow-out" due to an extreme temperature.

Basis of Each Uncertainty Factor

Expected Monthly HDD. PSE is using the average monthly HDD for each month based on temperature data going back over the most recent 30 years. This period was chosen because it includes the period during which PSE has hourly temperature data with which to calculate HDD, and because it is consistent with the period used to establish the company's gas peak day planning standard.

Standard Deviation of Monthly HDD. The standard deviation for each month was calculated using the monthly data above. That is, the standard deviation of monthly HDD totals was calculated.

Daily HDD Pattern. The daily HDD pattern for each month was prevented from varying randomly, independent of the monthly HDD draw. Preliminary analysis showed that randomly pairing monthly HDD levels with daily patterns can result in temperatures significantly colder than those recorded in history. To avoid overstating temperature variability, PSE applied the daily temperature pattern from the coldest month in the historical period.

Expected Monthly Price Draw. The gas price forecast is used as the expected monthly price draw.

Standard Deviation of Monthly Price Draw. Historical data was used to establish the range of variability for each price basin. Selecting a consistent time period for all four basins provides a reasonably consistent basis for calculating the standard deviation.

Temperature to Price Correlations. Historic price correlations for each supply basin to SeaTac HDD were calculated. There are a number of different ways such correlations could reasonably be calculated. The correlation between HDD and prices was calculated based on daily temperatures and daily prices by season. The correlations produced using this approach show a positive, but weak correlation of prices at Sumas, AECO, Rockies, and San Juan to SeaTac temperatures.

Price Correlations between Basins. Similar to the price-to-weather correlations, price-to-price correlations were calculated seasonally. Price correlations between supply basins are strongly positive, which is to be expected given the infrastructure in the Pacific Northwest.

Temperature Effects on Daily Price-normal Variation. Deviations between daily price and monthly price draw are driven solely by daily HDD, which is a combination of the monthly HDD draw and daily shape, as noted above. Effects of daily temperatures are modeled as an exponential effect on prices, as daily temperature moves up and down relative to the average daily temperature. A different daily price/temperature factor was calculated for each month of the year and applied to the full 20-year period. To calculate the daily price-temperature factor, a target standard deviation of daily prices was selected. Then the factor estimated that, when applied to expected daily temperatures and the 20-year average monthly price, it would result in daily prices exhibiting the target standard deviation.

Temperature Effects on Daily Price-jump Statistics. The jump statistics to estimate a price blow-out require defining the temperature threshold at which such daily price events can occur, the probability of occurrence if that temperature threshold is exceeded, and the magnitude of the blow-out. Using daily price data back to 1999, the first step was to develop a definition of "price blow-out." Analysis of the data shows a few instances where daily prices exceed the daily average price by more than 40%. This was used as the definition of a blow-out event. The warmest temperature at which daily prices exceeded the average daily price for the month occurred at 21 HDD (39 degrees average daily temperature). The probability of a jump event occurring was calculated by examining the number of days that a jump event occurred at each basin, divided by the total number of days in the historic period with HDD at 21 HDD or higher. For example, during the period, there were 257 days where HDD was 21 HDD or greater. Daily prices were 40% or greater on 9 of those days. Thus, at the HDD threshold of 21 HDD, the probability of a jump event occurring was calculated to be 9/257= 3.5%. If the jump occurred, the magnitude was calculated as follows: When the spread between daily prices exceeded average daily prices by 40% or more, the average percentage increase was used. For Sumas, this was a jump multiplier of 1.53.

II. Analytical Results

Seven planning scenarios and three sensitivity tests for the gas sales only portfolio were analyzed using the Sendout Model. As discussed in Chapter 3, the planning scenarios are:

1. 2007 Trends
2. 2007 Business As Usual
3. Low Growth
4. High Growth
5. Green World
6. 2009 Trends
7. 2009 Business As Usual

The sensitivity tests analyzed are:

1. Very Low gas prices
2. Very High gas prices
3. Transport Load

A total of four cases were analyzed for the combined gas sales and gas for generation portfolio. The focus of these analyses is to estimate the cost of implementing a goal of diversifying PSE's gas supply to be balanced between the WCSB and Rockies supply basins. The four cases are:

1. 2007 Trends with diversity (with the Cross Cascades pipeline)
2. 2007 Trends without diversity (excluding the Cross Cascades pipeline)
3. 2009 Trends with diversity (with the Cross Cascades pipeline)
4. 2009 Trends without diversity (excluding the Cross Cascades pipeline)

The optimal portfolios of supply and energy efficiency resources for each of the scenarios were identified using SENDOUT. The results of the analyses are shown in the following figures. The specific resource additions for each of these scenarios are described in Chapter 6, Section V.

Figure J-1
2007 Trends Optimal Portfolio – Gas Sales

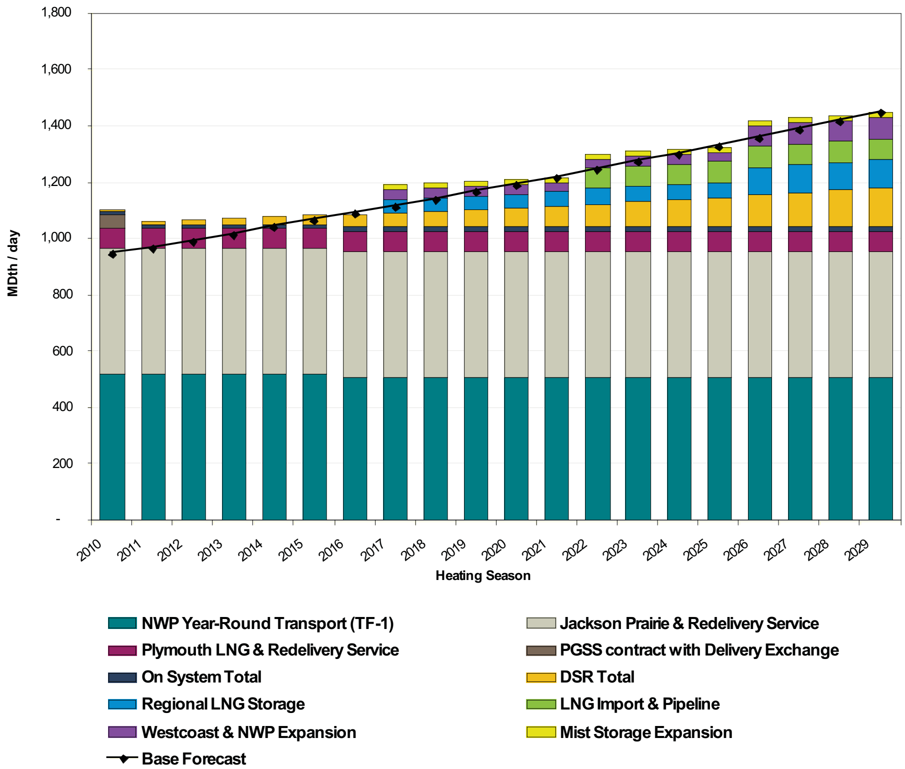


Figure J-2
2007 Business As Usual Optimal Portfolio – Gas Sales

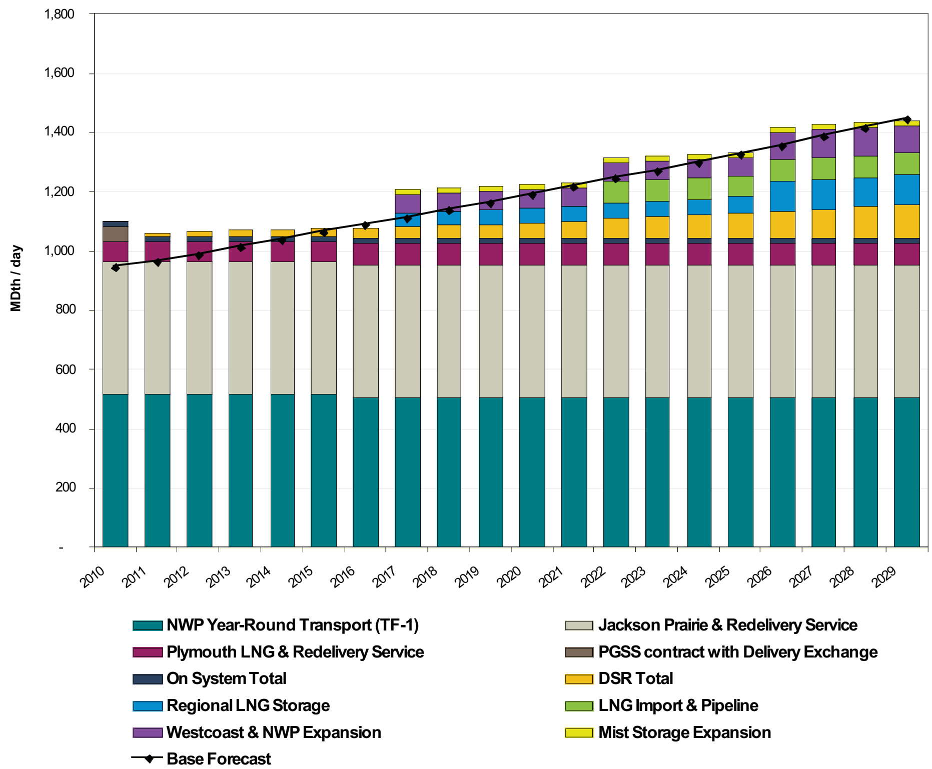


Figure J-3
Low Growth Optimal Portfolio – Gas Sales

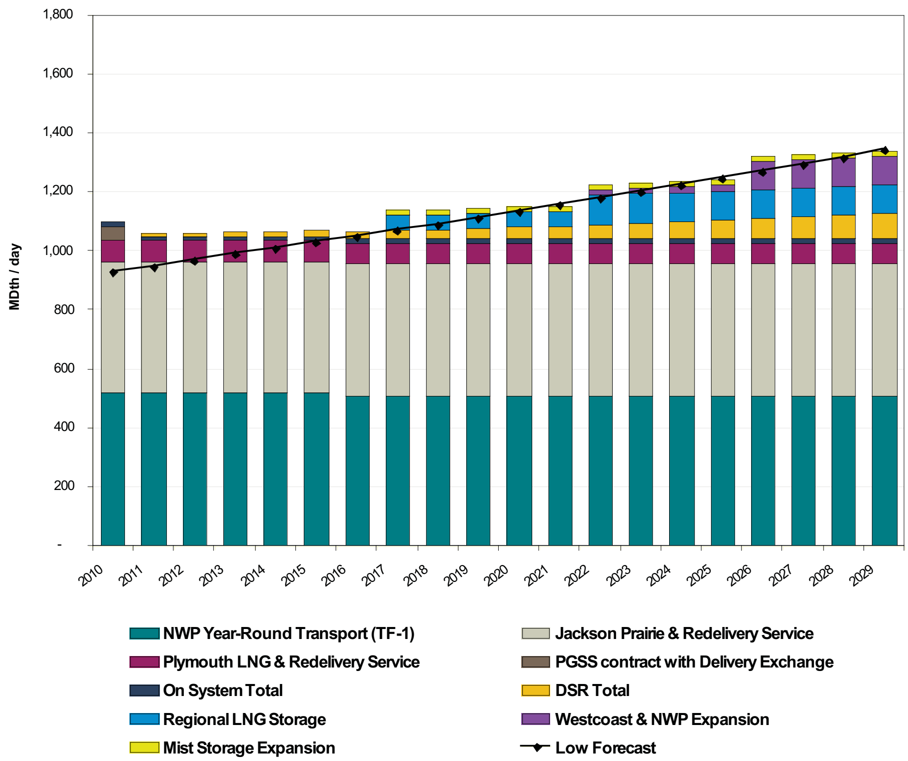


Figure J-4
High Growth Optimal Portfolio – Gas Sales

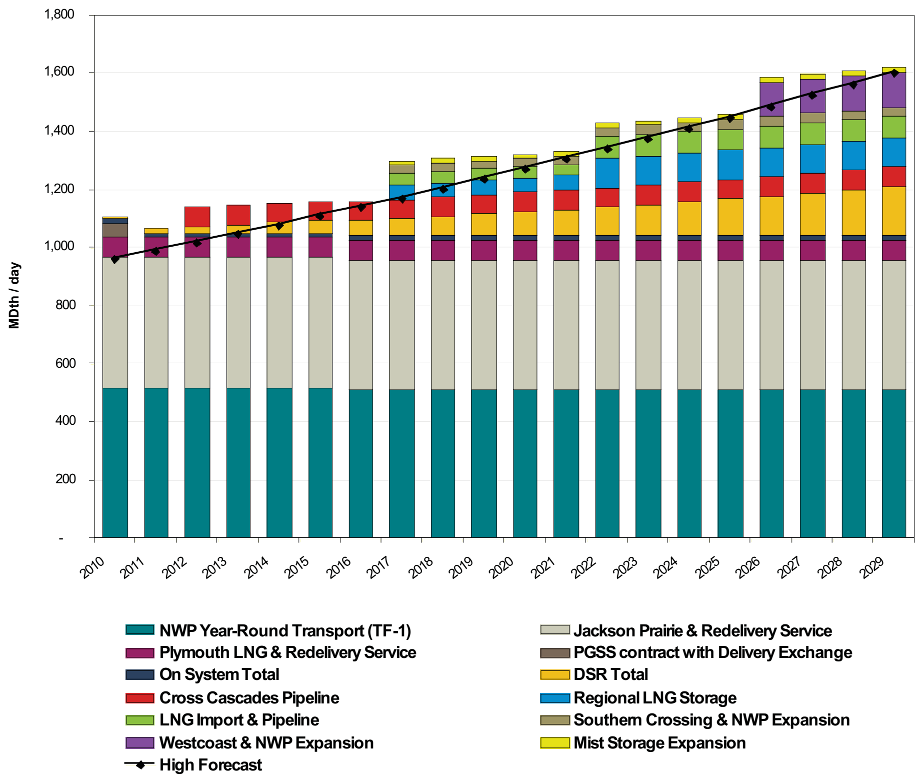


Figure J-5
Green World Optimal Portfolio – Gas Sales

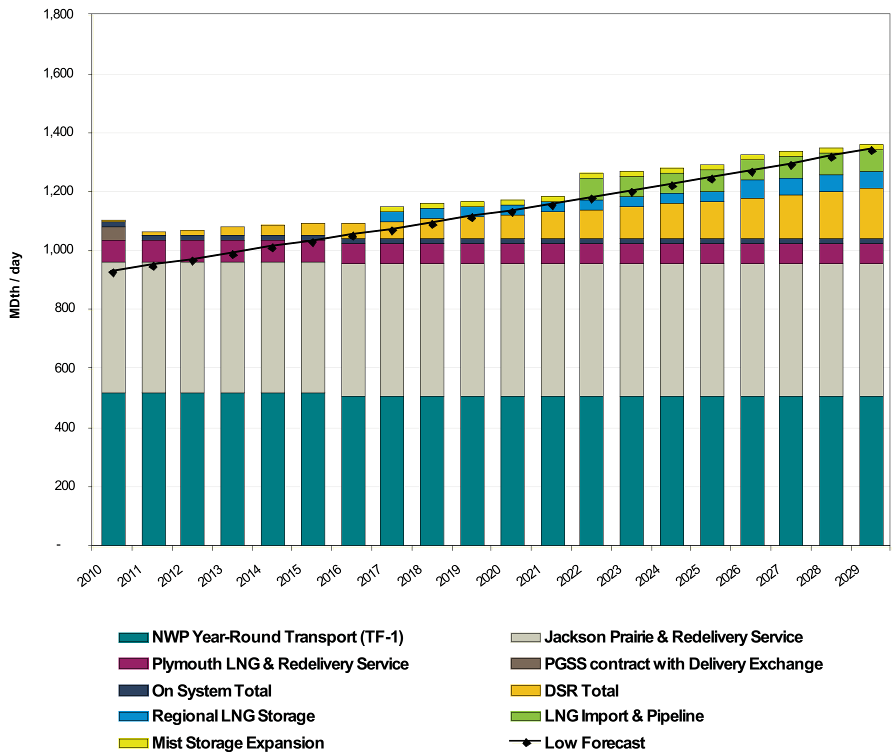


Figure J-6
2009 Trends Optimal Portfolio – Gas Sales

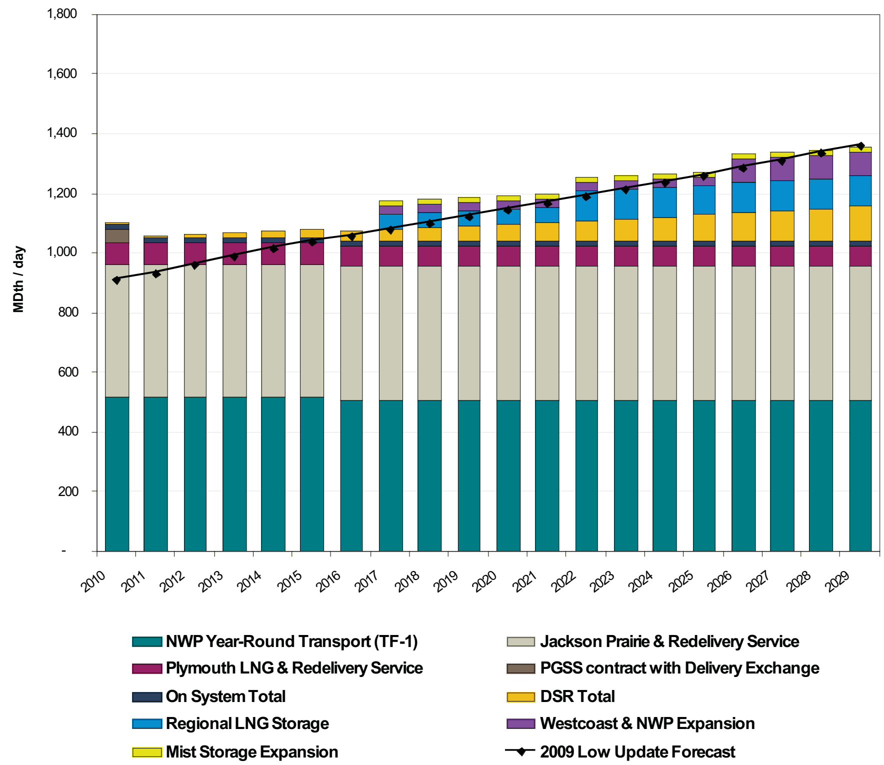


Figure J-7
2009 Business As Usual Optimal Portfolio – Gas Sales

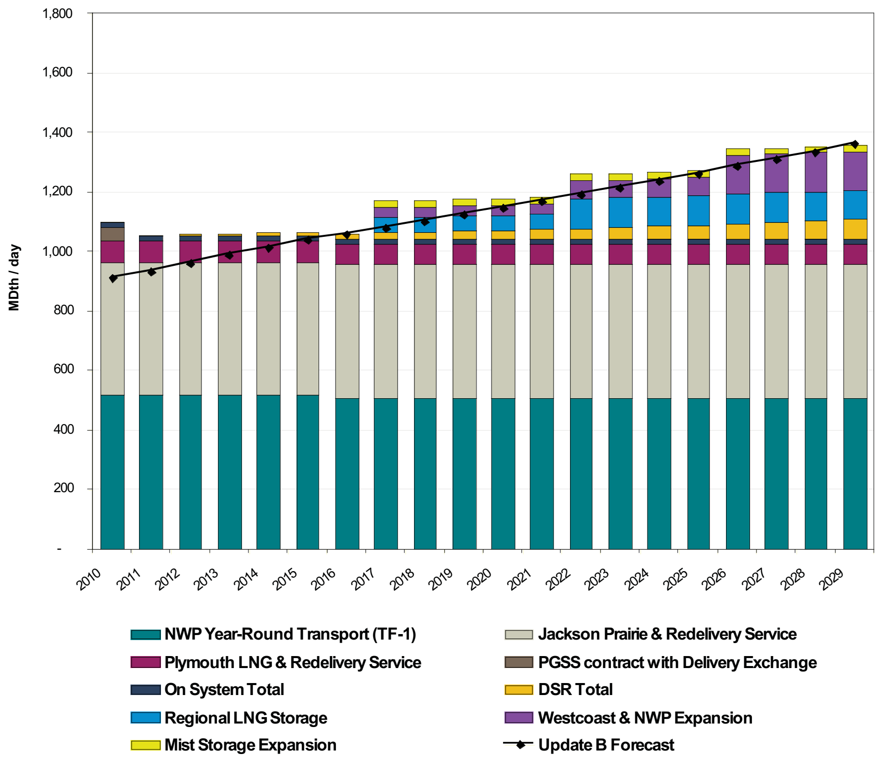


Figure J-8
Very Low Gas Price Sensitivity Optimal Portfolio – Gas Sales

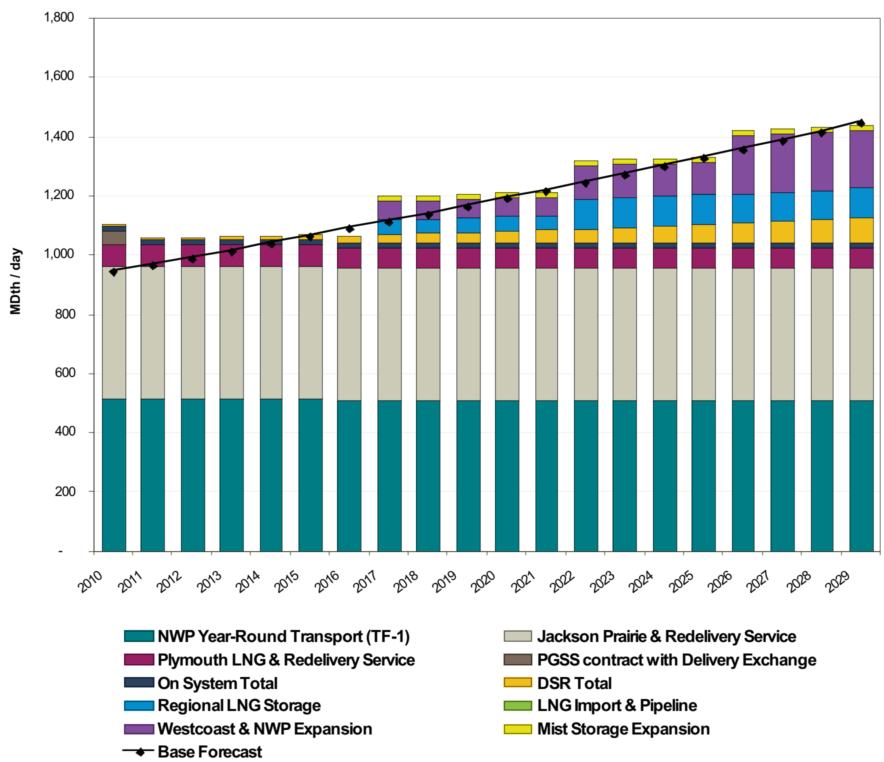


Figure J-9
Very High Gas Price Sensitivity Optimal Portfolio – Gas Sales

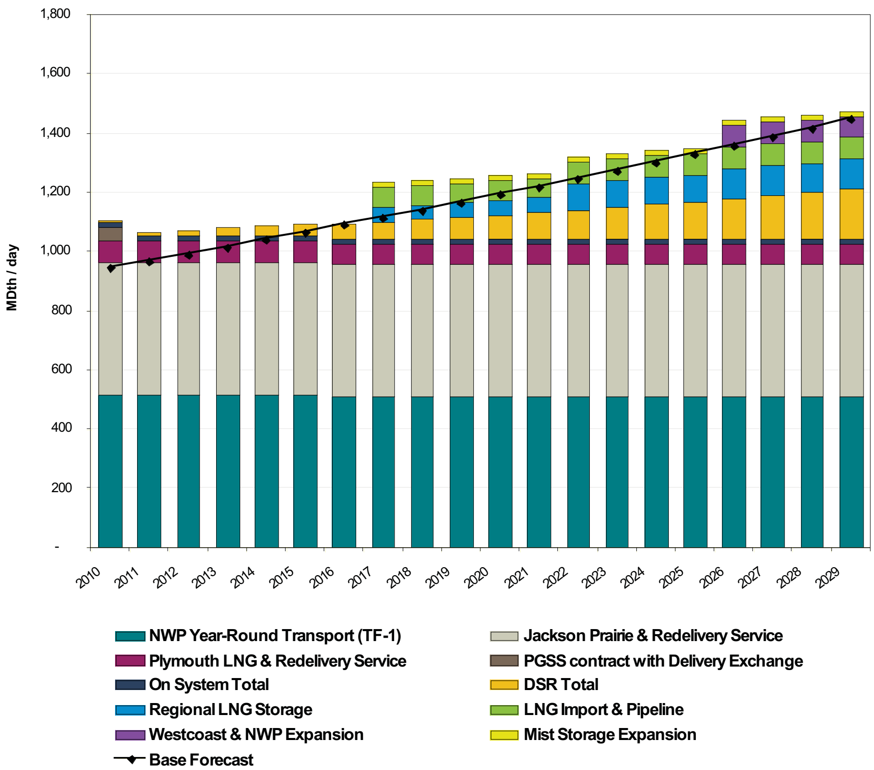


Figure J-10
Transport Load Sensitivity Optimal Portfolio – Gas Sales

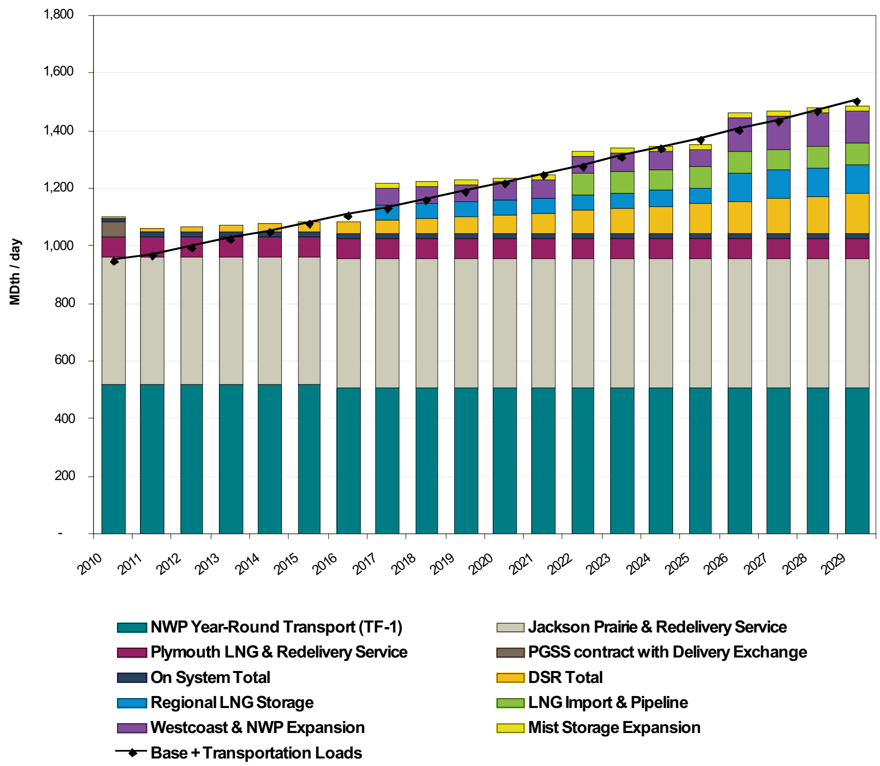


Figure J-11
Resource Plan Portfolio – Gas Sales

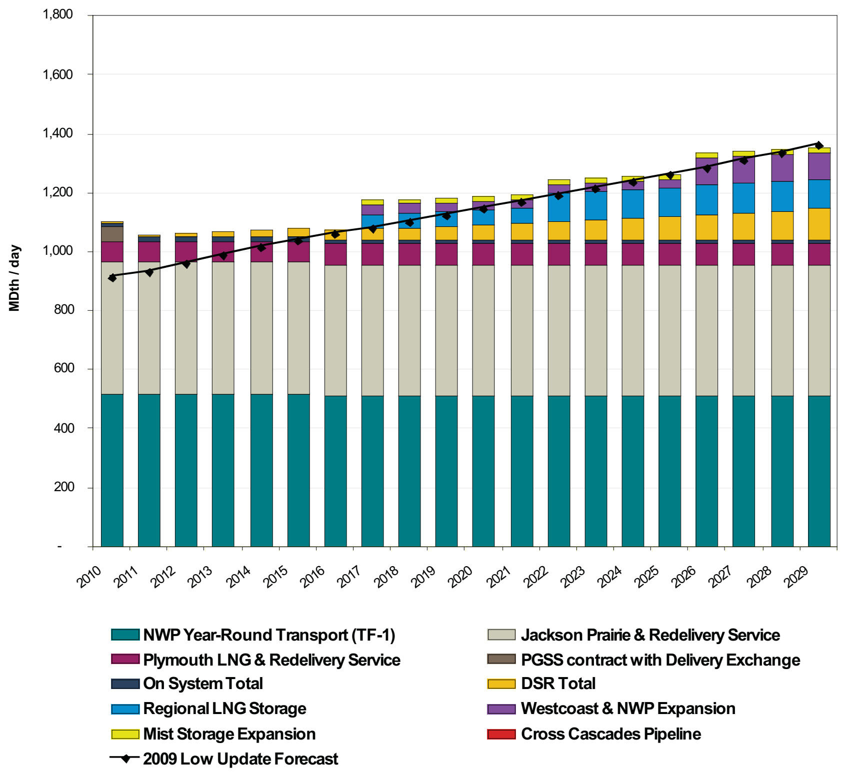


Figure J-12
2007 Trends with diversity (with the Cross Cascades pipeline)
Combined Portfolio

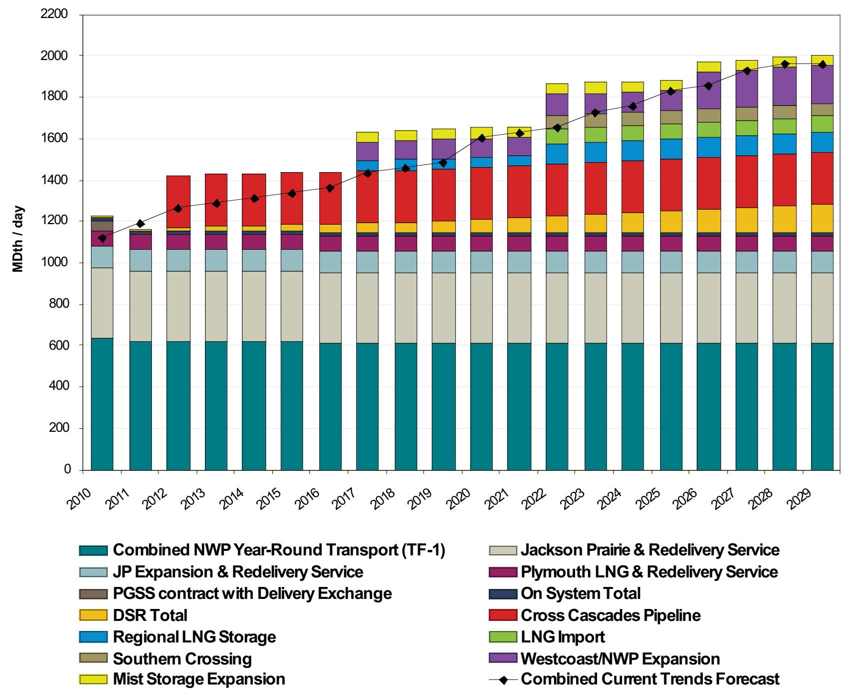


Figure J-13
2007 Trends without diversity (without the Cross Cascades pipeline)
Combined Portfolio

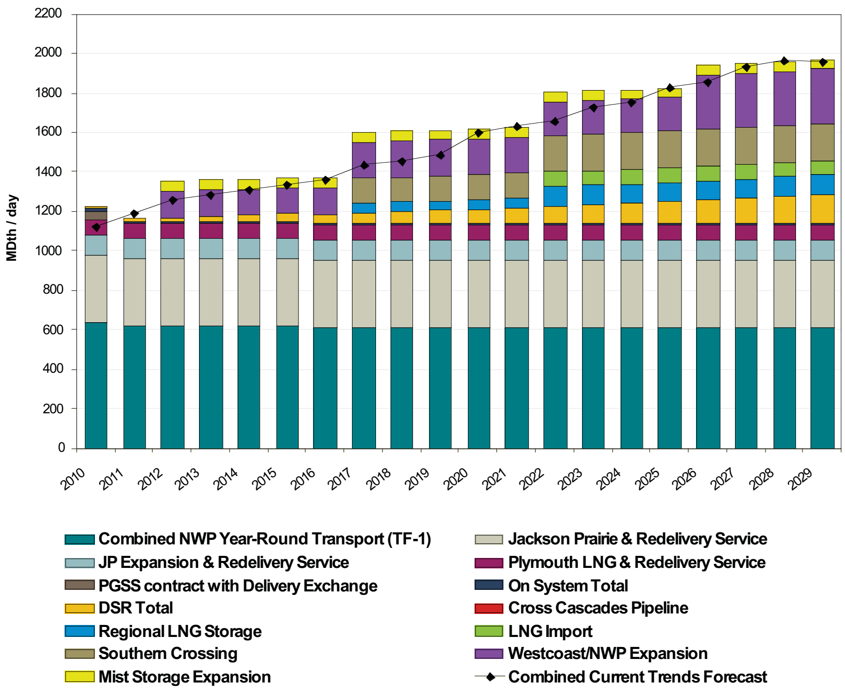


Figure J-14
2009 Trends with diversity (with the Cross Cascades pipeline)
Combined Portfolio

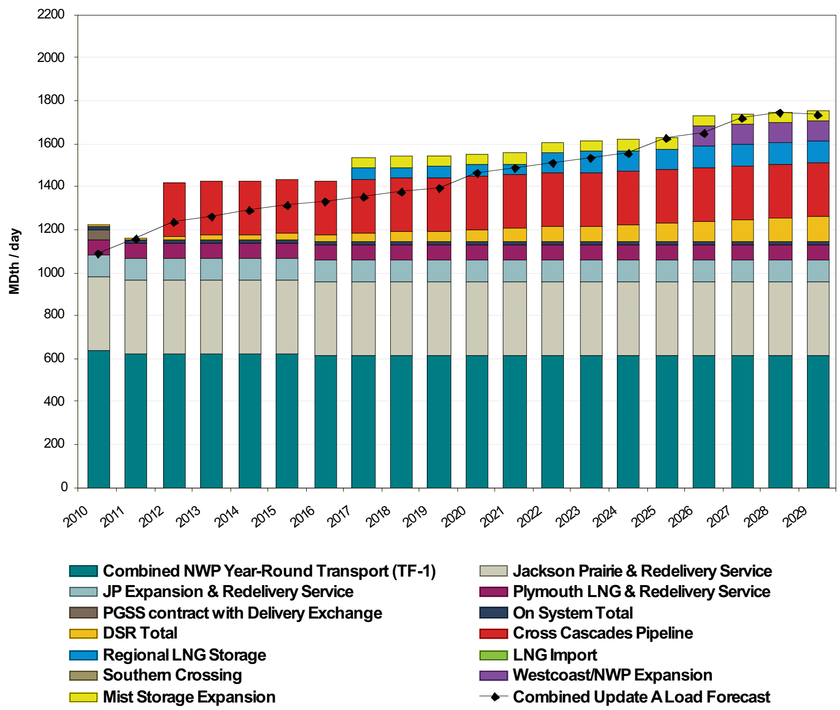


Figure J-15
2009 Trends without diversity (without the Cross Cascades pipeline)
Combined Portfolio

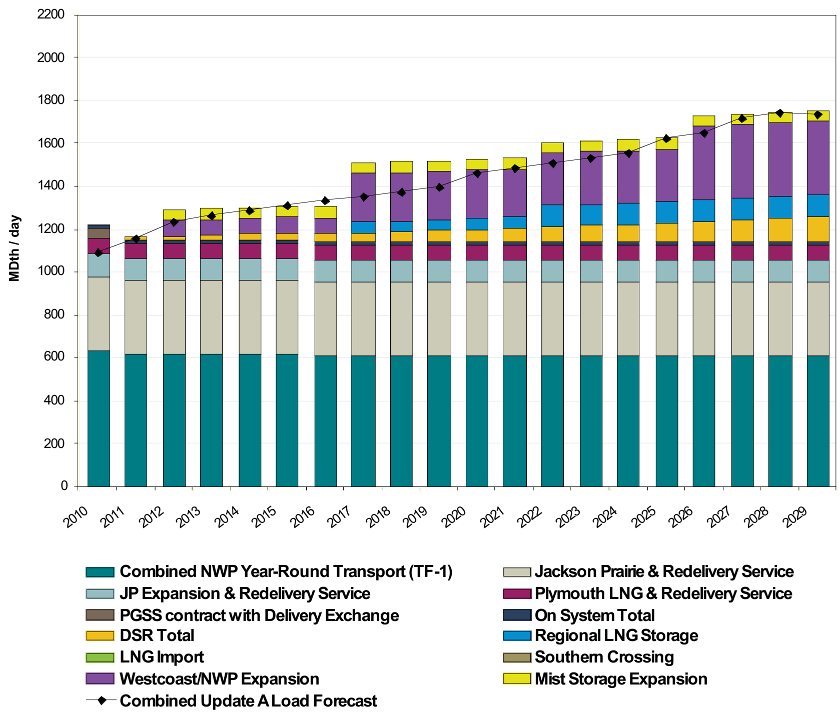


Figure J-16
2009 Trends (Full-Cap) without diversity - Combined Portfolio

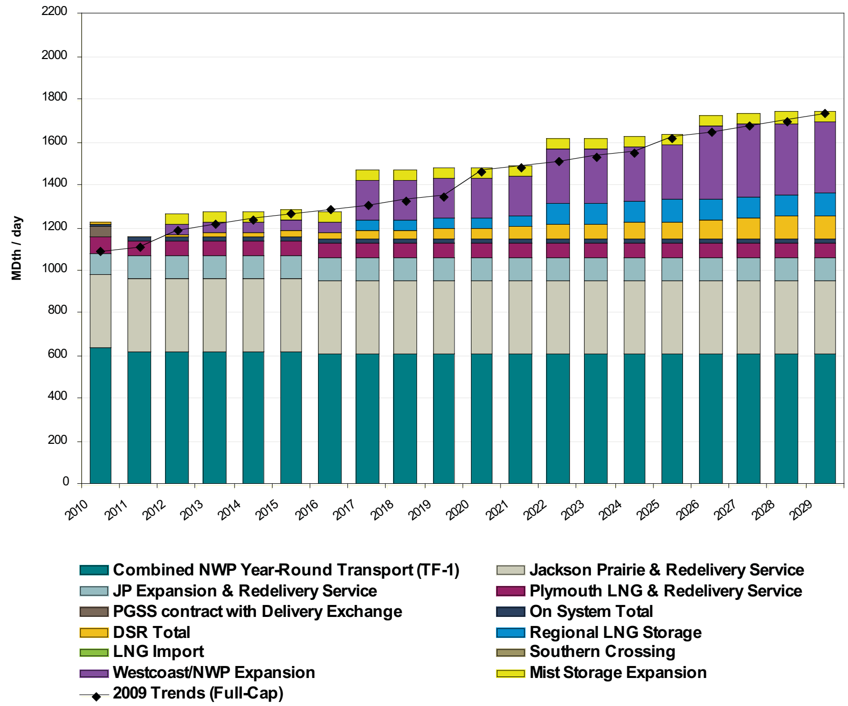
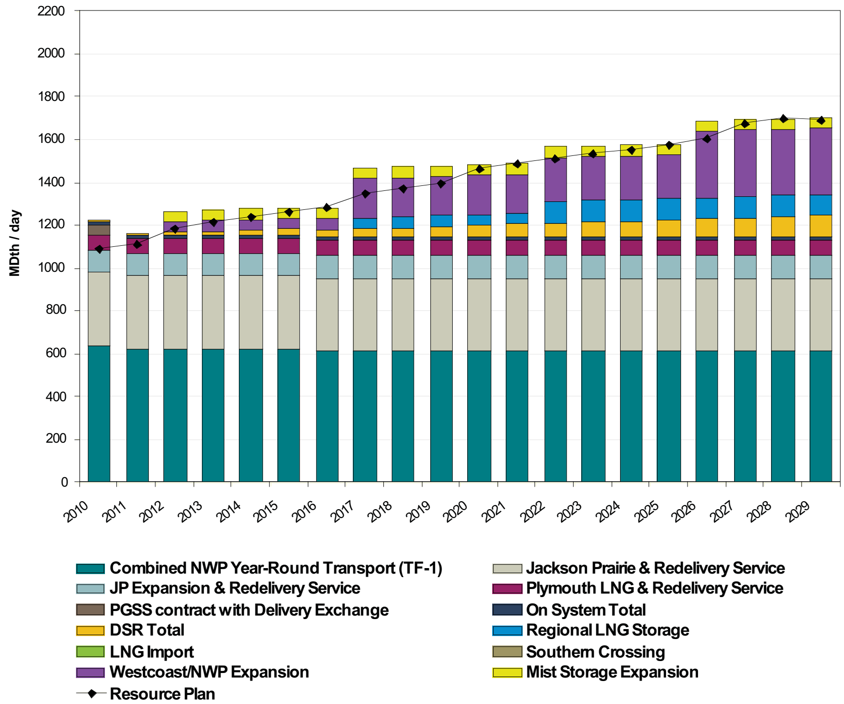


Figure J-17
Combined Portfolio Resource Plan



III. Portfolio Delivered Gas Costs

The total delivered portfolio gas costs for gas sales are shown graphically in Figure 6-22. They are presented below in tabular form in Figure J-18.

Figure J-18
Avoided Portfolio Gas Costs ($/Dth)

Year	2007 Trends	2007 Business As Usual	Low Growth	Green World	High Growth	Very High Gas Prices	Trans-port Loads	Very Low Gas Prices	2009 Trends	2009 Business As Usual
2010	10.89	10.74	8.98	14.27	14.12	14.22	10.86	7.96	7.69	8.04
2011	11.54	10.80	8.79	14.66	14.54	14.57	11.49	7.18	8.88	7.26
2012	13.25	11.48	8.57	17.15	15.93	16.81	13.27	7.05	10.54	7.12
2013	13.69	11.16	8.29	17.89	15.90	17.31	13.48	6.68	11.14	6.77
2014	13.43	10.65	8.00	17.60	15.98	18.40	13.36	6.75	11.33	6.79
2015	14.17	10.95	8.38	19.45	16.88	19.03	14.04	6.83	11.45	6.83
2016	14.18	11.10	8.52	20.09	17.14	20.09	14.10	6.86	11.85	6.89
2017	15.08	11.41	8.83	21.12	17.92	19.62	14.93	7.02	12.32	7.04
2018	15.53	11.90	9.07	21.91	18.77	21.08	15.41	7.12	12.79	7.08
2019	16.21	12.12	9.18	23.01	19.57	21.69	16.00	7.14	13.36	7.09
2020	16.70	12.41	9.37	23.71	20.18	22.31	16.48	7.20	13.63	7.13
2021	17.30	12.69	9.50	24.49	20.44	22.82	17.05	7.29	14.19	7.19
2022	17.55	12.71	9.77	24.98	21.60	23.21	17.41	7.43	14.79	7.35
2023	18.42	12.90	10.04	25.50	22.46	24.60	18.80	7.57	15.23	7.43
2024	19.29	13.09	9.87	25.85	22.48	24.43	18.99	7.59	15.86	7.51
2025	19.25	13.46	10.10	26.11	23.24	25.24	18.99	7.68	16.17	7.61
2026	20.46	13.65	10.28	26.42	24.09	26.00	20.06	7.82	16.88	7.72
2027	21.18	14.00	10.76	26.89	25.21	27.08	20.71	8.25	17.99	8.12
2028	21.94	14.21	10.67	27.10	26.11	27.98	21.46	8.44	18.12	8.30
2029	22.46	14.37	10.93	27.62	26.43	28.03	21.88	8.33	18.77	8.19

GLOBAL INSIGHT

Security of Natural Gas Supply for the Pacific Northwest

Prepared for
Puget Sound Energy

October 2008

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Table of Contents

Summary of Forecast Comparisons

Introduction:

Global Insight has prepared a report for Puget Sound to tabulate and compare its own and publicly available forecasts of the North American natural gas market focused upon the security of natural gas supply for the Pacific Northwest to include discussion of the natural gas supply and demand balance for the U.S. and Canada, the supply basins serving the Pacific Northwest and the prospects for LNG imports to the West Coast.

Publicly available forecasts and energy information were gathered from the energy departments or ministries of the U.S. and Canada and from industry associations and agencies that report upon natural gas resources.

Energy Information from Public Sources.

U.S. Energy Information Sources	Canadian Energy Information Sources
California Energy Commission	British Columbia Ministry of Energy, Mines and Resources
Energy Information Administration, Department of Energy	Canadian Association of Petroleum Producers
Federal Energy Regulatory Commission	Energy Resources Conservation Board, Alberta
National Petroleum Council	National Energy Board
U.S. Geological Survey, Department of the Interior	

Resources for the U.S. and Canada are discussed together followed by separate discussions of the U.S. and Canadian supply and demand forecasts. For the U.S., forecasts from Global Insight and the EIA are compared for price, supply and demand. For Canada, we compare forecasts from the NEB, Alberta and Global Insight.

Forecast Summary: Consumers can Continue to Rely upon Natural Gas to Meet Their Energy Needs

- The supply of natural gas in all three dimensions of production, reserves and resources has increased in the Rockies and in northern B.C. These expanded supplies are mainly due to development of unconventional sources (shale gas, coaled methane and tight formation gas). These supplies appear sufficient to meet the future gas needs of the region.
- World oil prices as well as U.S. natural gas prices are expected to remain relatively high by historical standards which will provide "support" for the development and production of the expanded supplies.
- Demand is growing in the Pacific and Northwest region - mainly due to increased demand for gas for electrical generation. Global Insight forecasts a 20% increase in gas demand for Washington and Oregon from 2007 to 2030.
- There is a need for more pipeline capacity from the Rockies to the Northwest, particularly as Canada will require a higher share of Alberta's natural gas production. Since generation demand is volatile, there may be a need for expanded gas storage facilities in the NW.
- LNG imports do not appear likely for the near to mid-term (until beyond 2015 or so). While numerous LNG terminals have been proposed, they lack commercial support in terms of dedicated supplies of LNG from producing countries.
- Arctic pipelines face cost escalation and a lengthy political process that continue to move an actual project further into the future. Most forecasts expect Arctic pipelines from Alaska and Canada's Mackenzie Delta to be available after 2020.

Resource Summary

Natural gas resources include reserves and estimates by experts in petroleum geology such as the Potential Gas Committee, the U.S. Geologic Survey and the National Petroleum Council. Also, official forecasting agencies develop rigorous assumptions on resource availability including the Energy Information Agency in the U.S. and Canadian agencies such as the National Energy Board, B.C. Ministry of Energy Mines and Resources and the Energy Resources Conservation Board in Alberta.

Recoverable proved reserves: The proved reserves of natural gas as of December 31 of any given year are "the estimated quantities of natural gas which geological and engineering data demonstrates with reasonable certainty to be recoverable in the future from known natural oil and gas reservoirs under existing economic and operating conditions, i.e., prices and costs as of the date the estimate is made."

The Securities and Exchange Commission(SEC) rule 4-10(a)(2) of Regulation S-X quoted above is being revised. The new rules for reporting natural gas reserves in financial statements will to:

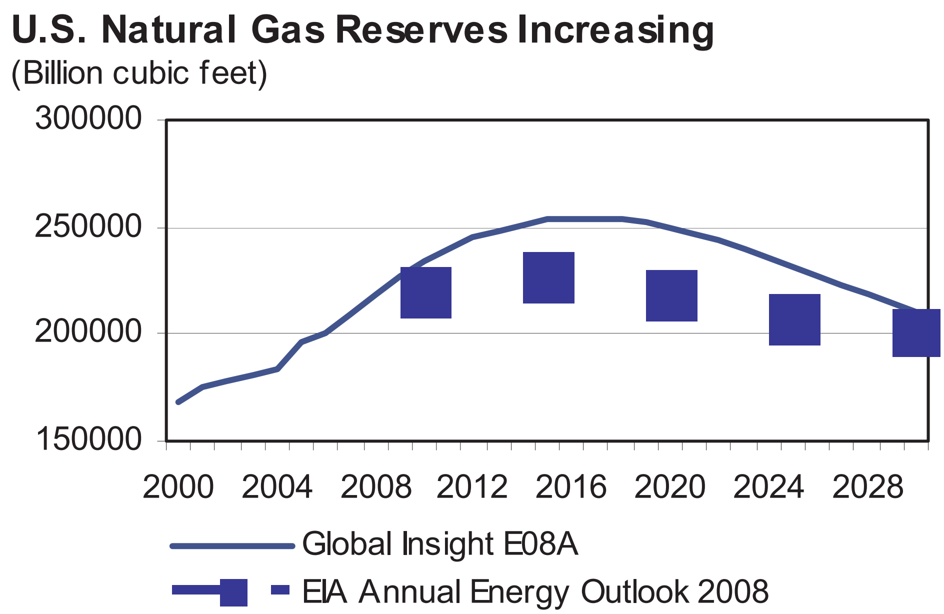
- allow previously excluded resources such as coalbed methane and shale gas to be classified as reserves,
- require companies to report reserves using an average price for the prior 12 month period(as opposed to year-end prices), and;
- permit the use of new technologies to determine proved reserves if they have been demonstrated reliable such as advances in seismic technology that precisely define petroleum reservoirs.

Resources: Natural gas resources are determined with various degree of probability such as the probable, possible and speculative categories used by the U.S. Geologic Survey (USGS) to be ultimately recoverable with know technology. Reporting agencies rely upon the judgments of professional geologists and industry participants. Starting with the known plays and geologic characteristics, judgments are made with respect to the size and frequency with which natural gas deposits will be encountered in the play and the portion that will be ultimately recoverable.

Unconventional resources are estimated separately as shale gas and coal bed methane occur in basin centered or continuous deposits rather than in conventional reservoirs. Recent upward revisions in resource estimates reflect the inclusion of unconventional resources.

Estimates of Natural Gas Reserves are Increasing

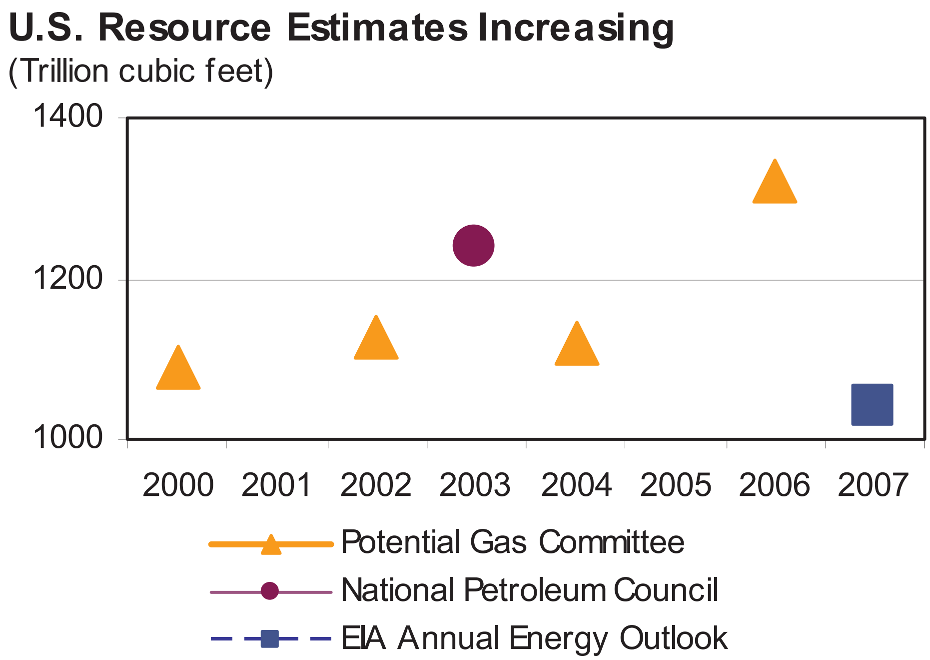
A more secure part of the resource base is proven reserves which are incremental to the estimates of unproven resources. Proven reserves as of year end 2006 add 211 tcf to the U.S. total supplies of natural gas available to meet future demand. Canadian reserves are 67.2 tcf for 2006. Preliminary reserve estimates for 2007 are 237.7 tcf for the U.S., an increase of 26 tcf during the year. Further increases are expected from the change in definition of reserves proposed by the SEC for 2010 but as the rules are still in process, reserves forecasts reflect the current rules in place.



Estimates of Natural Gas Resources are Increasing

Despite depletion of U.S. resources from the cumulative production of natural gas at the rate of more than 20 tcf per year, estimates of the remaining resources are increasing. Thus remaining resources are adequate to not only sustain the level of natural gas production achieved in 2008 in the lower 48 states but to further increase it.

- In 2006, the Potential Gas Committee raised its estimate of resources to 1525 tcf (1320 tcf of undiscovered) the equivalent of 82 years of production at current rates and a 17% increase since 2004.
- The National Petroleum Council estimated resources at 1027 tcf in 2003 but only included 7 tcf for shale gas in the Barnett shale play.
- The Energy Information Agency used 1040 tcf for its resource estimate in its 2008 forecast and included 125 tcf of shale gas resource but had a small contribution from Alaska of 30.7 tcf compared to the 250 tcf and 258 tcf estimated by the PGC 2006 and NPC 2003.
- The USGS estimates resources by area and does not try to provide an overall estimate for the U.S. However, it did estimate Barnett Shale resources of 26 tcf in 2003 a dramatic increase over the 7 tcf estimate provided by the NPC.



The Potential Gas Committee reports every two years upon the probable, potential and speculative resources located within the U.S. and has increased its estimates of resources for 16 years. More recently, the estimate of the remaining natural gas resources was increased by 17% or 200 tcf from 1119 tcf in 2004 to 1320 tcf in 2006 as the contribution of unconventional resources became recognized.

The EIA has also increased its estimate of remaining resources. In particular, shale gas resources have increased from almost nothing to the 125 tcf estimated by the EIA in 2007 while industry operators claims range from 200 tcf to as high as 800 tcf of shale gas resources.

Total resources are increasing because of the contribution of tight formations, coal bed methane and shale gas. The EIA includes 52% or 540 tcf of conventional resource and 48% or 500 tcf of unconventional resources. The NEB includes 302.3 tcf of conventional and 62 tcf of unconventional resource for Canada.

While the EIA includes only 30.7 tcf for Alaskan resource, the National Petroleum Council study in 2003 included 258 tcf.

North American Natural Gas Resources (Trillion cubic feet)

	Reserves 2006	Total Resources NPC - 2003	USGS partial assessments	EIA-2007	PGC-2006
U.S.					
California	**2.2**	23	2.2	**13.5**	
West Coast Offshore	**0.6**	21			
Rocky Mountains	**46.9**	209	147.4	**265.4**	287.2
San Juan	**14.0**		50.6		
Permian	**16.4**	27	41	**79.8**	
Mid Continent	**36.7**	32	26.7	**139.5**	239.7
Gulf Coast Onshore	**46.0**	86	130.2	**194.2**	333
Gulf Coast Offshore	**15.3**	244		**223**	
Other U.S. Onshore	**22.7**	94	85.6	**93.9**	205.8
East Coast Offshore		33			
Alaska	**10.2**	258		**30.7**	250.8
Total U.S.	**211.1**	1,027		**1,040**	*1320.9*
Canada				**NEB-2007**	
Western Canada Sedimentary Basin				**139.0**	
Alberta	**40.2**				
British Columbia	**13.0**				
Saskatchewan	**3.5**				
Mackenzie Delta	**9.0**			**76.3**	
Other	**1.5**			**149.0**	
	67.2			**364.3**	

North American Natural Gas Resources (Trillion cubic feet)

			Conventional Resources			
U.S.	**EIA -2007**	**EIA -2007**		**PGC-2006**	**Alberta-2004**	**B.C. 2006**
California	7	7				
West Coast Offshore						
Rocky Mountains	31	31		233.6		
San Juan						
Permian	28	28				
Mid Continent	71	71		232.2		
Gulf Coast Onshore	144.3	144.3		329.6		
Gulf Coast Offshore	223	223				
Other U.S. Onshore	5.1	5.1		169.3		
East Coast Offshore						
Alaska	30.7	30.7		193.8		
Total U.S.	540	540		*1154.8*		
		NEB - 2003	**NEB - 2005**	**NEB-2007**		
Canada						
Western Canada Sedimentary Basin				77.0		
Alberta		59.0	61.0		62	
British Columbia		10.0	27.0			35
Saskatchewan		1.0	1.0			
Mackenzie Delta		55.0	52.0	76.3		
Other		172.0	144.0	149.0		
		296.9	285.0	302.3		

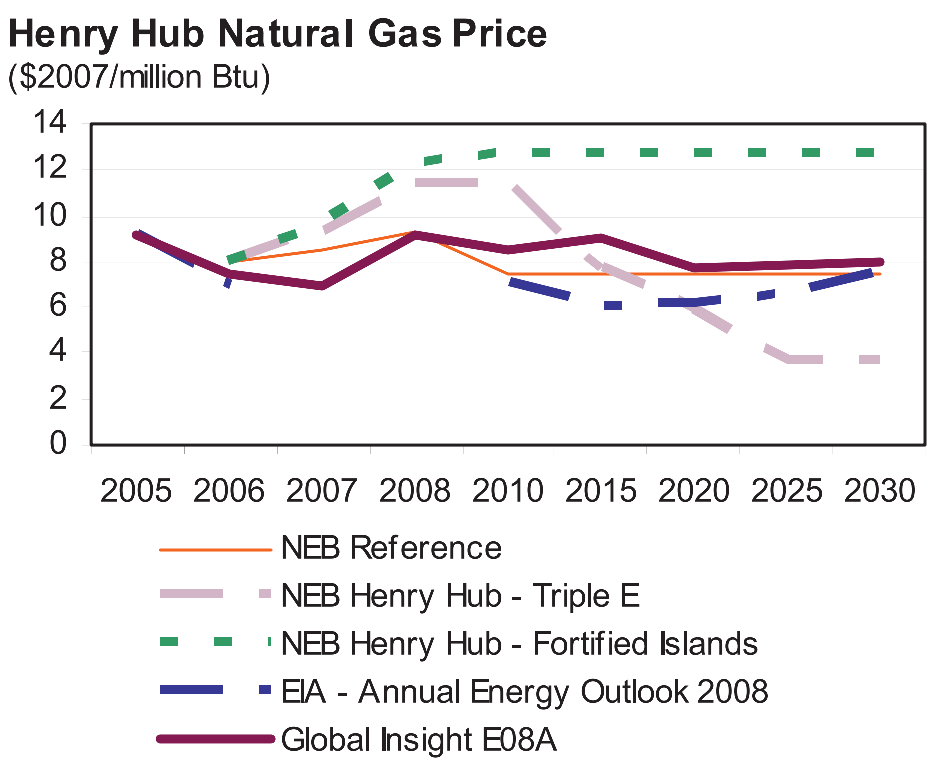
North American Natural Gas Unconventional Resources (Trillion cubic feet)

		EIA - 2007		PGC - 2006
	Tight	**Shale**	**Coalbed**	**Coalbed**
U.S.	6.5			
California				
West Coast Offshore	164.2	14.3	55.9	53.6
Rocky Mountains				
San Juan	13.8	38		
Permian	17.5	45	6	7.5
Mid Continent	46.2	0	3.7	3.4
Gulf Coast Onshore				
Gulf Coast Offshore	56	27.7	5.1	36.5
Other U.S. Onshore				
East Coast Offshore				57
Alaska	304	125	71	*166.1*
Total U.S.				
	NEB Tight	**NEB Shale**	**NEB Coalbed**	
Canada	21	6	35	
Western Canada Sedimentary Basin				
Alberta				
British Columbia				
Saskatchewan				
Mackenzie Delta				
Other	21.0	6.0	35.0	

NATURAL GAS PRICE FORECASTS

Prices Remain High by Historical Standards

- Henry Hub prices have been between $4 and $13 in the past four years, with an average of $8 during this period.
- Henry Hub prices in 2006 dollars average $6.64 for 2010 to 2030 in the EIA forecast, $7.41 in the NEB forecast and $8.21 in the Global Insight E08A forecast.
- Henry Hub natural gas prices during the decade of the 1990's averaged $2.60 in 2007 dollars and will average about $6.50 in the 2000 to 2009 period and then increase further with the forecast of $8 for the 2010 to 2019 decade.
- Crude oil prices are expected to decrease from the record high levels of mid 2008. West Texas Intermediate prices in 2006 dollars average $62.67 for 2010 to 2030 in the EIA forecast, $52.95 in the NEB forecast and $82.85 in the Global Insight E08A forecast.
- West Texas Intermediate crude oil prices averaged $26 per barrel in 2007 dollars for 1990 to 1999 and will average about $55 per barrel for 2000 to 2009. Forecasts point to even higher prices in the next decade.



Security of Natural Gas Supply for the Pacific Northwest

Natural gas prices remain volatile with a range of $4 to $13 for Henry Hub over the past four years. Forecasts of natural gas prices indicate long term averages and provide numerous alternative scenarios as a consequence. Global Insight expects three distinct phases to the natural gas market through to 2030:

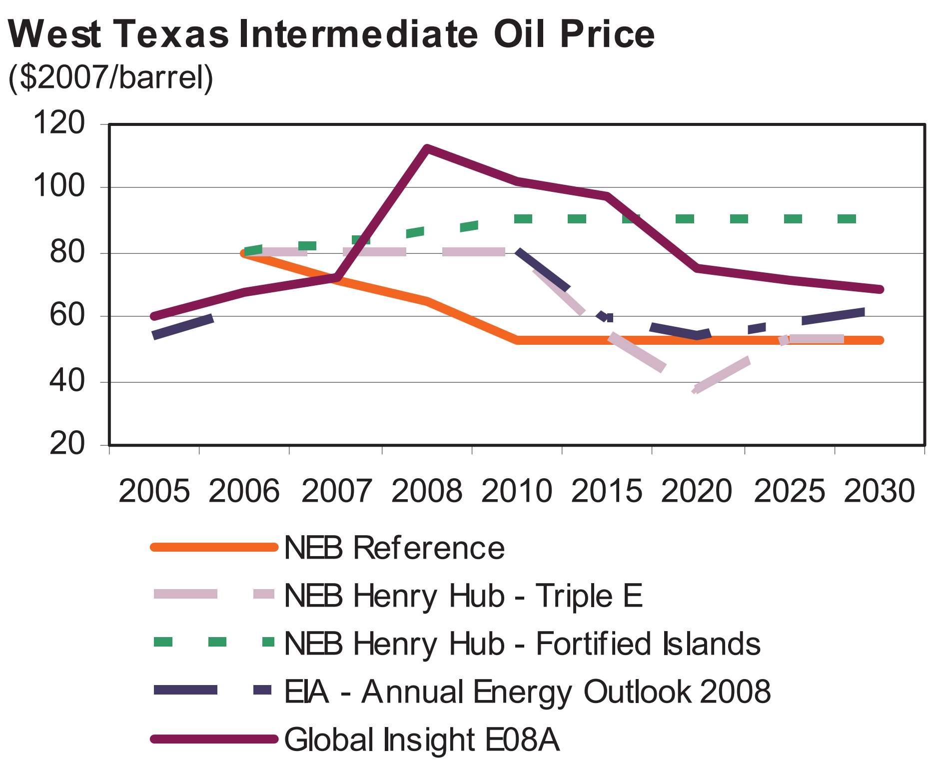
- **Near-term (2008-2010)**: All forecasters expect natural gas prices to begin at a high level in 2008 due to a combination of strong growth in power sector demand, high oil prices and delays in development of LNG projects. From a high starting point, prices decline due to an increase in supply from unconventional sources and LNG. While new pipeline construction is adding competitive pressures in regional markets, advance development of supplies in the Rockies and shale gas plays to fill the pipelines is further depressing prices.
- **Medium-term (2010-2015)**: Forecasters generally show prices declining during this period as supply increases and demand growth slows though they have a mixed view of the contribution of unconventional gas and LNG to North American supply with the most recent forecasts more optimistic on unconventional and less optimistic on LNG. While all of the LNG projects that will be completed by 2012 are well known as lead times are 5 to 8 years, there have been almost no additional investment decisions in LNG since 2006. Supply costs for LNG projects have more than doubled since 2005 with delays and cost escalation slowing progress on projects not yet completed. Thus LNG supply after 2012 may not increase. A particularly important player is Russia which plans development of Arctic LNG by 2014, a project which is almost certain to be delayed. A shortfall in LNG is offset by more aggressive results from unconventional gas with shale gas supplies still on the uprise in 2015. There are risks arising from the demand in the power sector which will certainly be impacted by environmental policy but the specifics of carbon regulation are unknown and the net direction of the change varies across forecasters.
- **Long-term (2015-):** Global Insight expects to see a slowing of natural gas demand growth as renewable energy and conservation policies impact the power generation sector. The contribution of shale gas peaks around 2018 and attention turns to developing the Arctic pipelines. Further development of LNG proceeds across West Africa, Latin America, Australia and Oceania as the projects under discussion today complete a rather slow journey into fruition. High prices for natural gas support improved efficiency, new investment in unconventional production in the U.S. and Canada as well as the LNG development. North American gas prices follow oil prices down to some degree but are constrained by the marginal costs of production. Natural gas prices rise relative to oil prices even though real prices are constant. The dependence upon conservation and alternative energy for electric power supply presents an upside potential for natural gas demand rather than declining after 2020 with a consequent upside price risk.

Long-term Oil Price Outlook for Declining Real Prices

We would highlight that oil prices are volatile and that the forecasts assume long term averages and provide numerous alternative scenarios as a consequence. Global Insight expects three distinct phases to the oil market through to 2020:

- **Near-term (2008-2010)**: All forecasters expect prices to decline due to combination of weaker demand (credit crunch, slowdown in non-OECD) and surge in new supply. This will result in a significant increase in spare capacity, which should restore more confidence in supply. The upside and downside risks are balanced – weaker economic growth could unbalance the market more substantially and push prices lower, though with most new supply coming from OPEC. Upside risks relate to supply, particularly geopolitical risks in the Middle East.

- **Medium-term (2010-2015)**: Forecasters have a relatively good idea of new supply though to 2013 (3 to 5-year lead-in times for major new projects are the norm.) At about the time when OECD and non-OECD economies may again be growing strongly, we can see a worrying gap in supply. At this time new projects from 2010—13 are scarce and time is growing short, and even with modest demand growth, the spare capacity increase we see over the next 2 years will be entirely eroded. There are very significant risks of another price spike in this period. Upside risks predominate here. The only thing which might moderate a price rise will be a very sharp reduction in global demand. There is virtually no chance of supply coming in above expectations in this period.
- **Long-term (2015-):** Global Insight expects to see the effects of recent price rises and government policies already enacted beginning to have a more sustained effect on both supply and demand over the longer term. Improved efficiency, new investment in production and the more widespread use of alternative energy supplies should all begin to bring oil prices back down to the marginal cost of production in the more distant future. Consequently we forecast a falling real price out through the remainder of the forecast period, but would highlight upside price risks if it proves more difficult to shift away from oil (or reach new sources of supply). The risks to this period are driven primarily by policy responses, geopolitics and OPEC behavior.



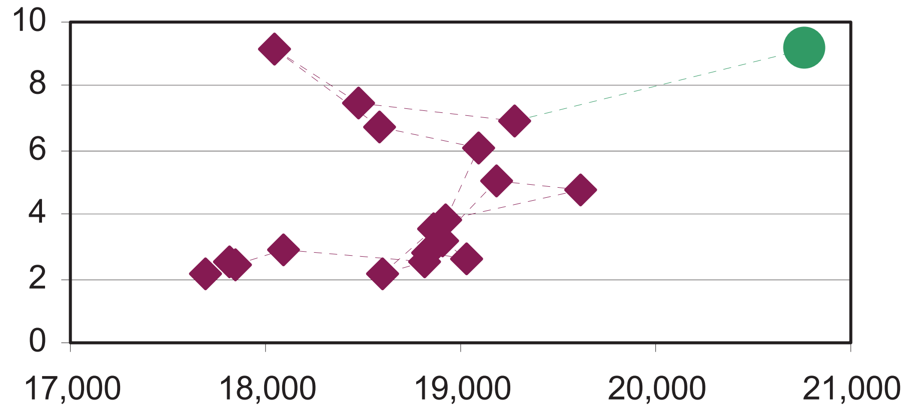
NATURAL GAS SUPPLY FORECASTS

Highlights:

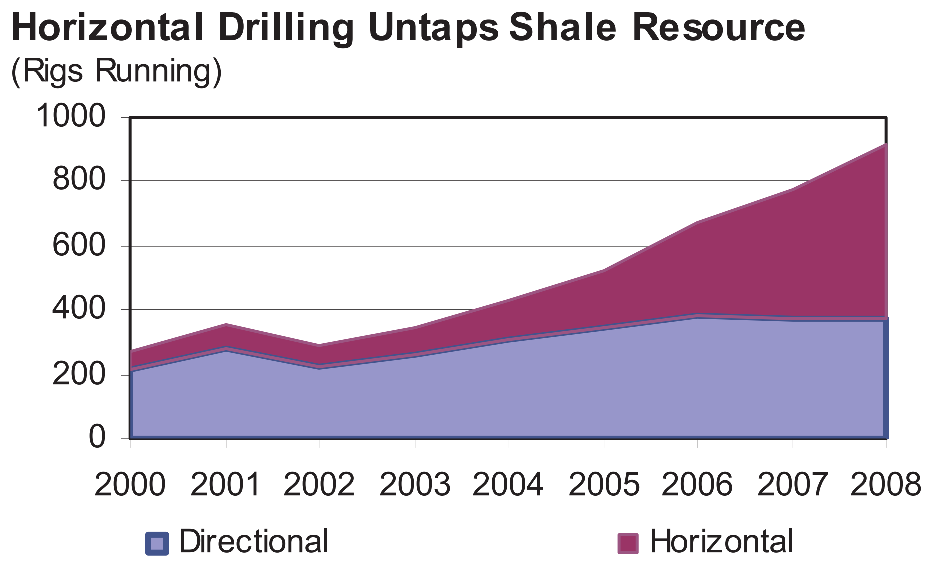
With prices rising for oil and natural gas during the first half of 2008, U.S. domestic natural gas production increases to 20.5 trillion cubic feet in 2008 up from 19.28 tcf in 2007. Recent trends in natural gas production reflect the higher prices as production increases are coming from unconventional resources with supply costs of $4 to $6. With price forecasts above the supply cost, both the EIA and Global Insight forecast that natural gas production will hold at or above the 2007 level.

- In the EIA forecast, U.S. natural gas production averages 19.5 tcf per year for 2010 to 2030.
- In the Global Insight forecast, U.S. natural gas production averages 21.6 tcf per year for 2010 to 2030.

Supply Responds to Price, 1990 to 2008
(Dollars per million Btu, Billion Cubic Feet)



Much of the production increase comes from unconventional resources. Production of natural gas from shale will increase substantially from 3.4 billion cubic feet per day in 2007 to 4.6 bcf/day in 2008 and 6.1 bcf/day in 2009. In the Global Insight forecast, shale gas production reaches 12 bcf/day by 2015. Production of shale gas and tight formation gas results from new technology that features horizontal drilling and precise fracturing of the formation. The number of rigs drilling horizontal wells has increased from 50 in 2002 to nearly 600 in 2008, indicating the strength of the production response to higher prices and technological advances.



U.S. Production is Expanding

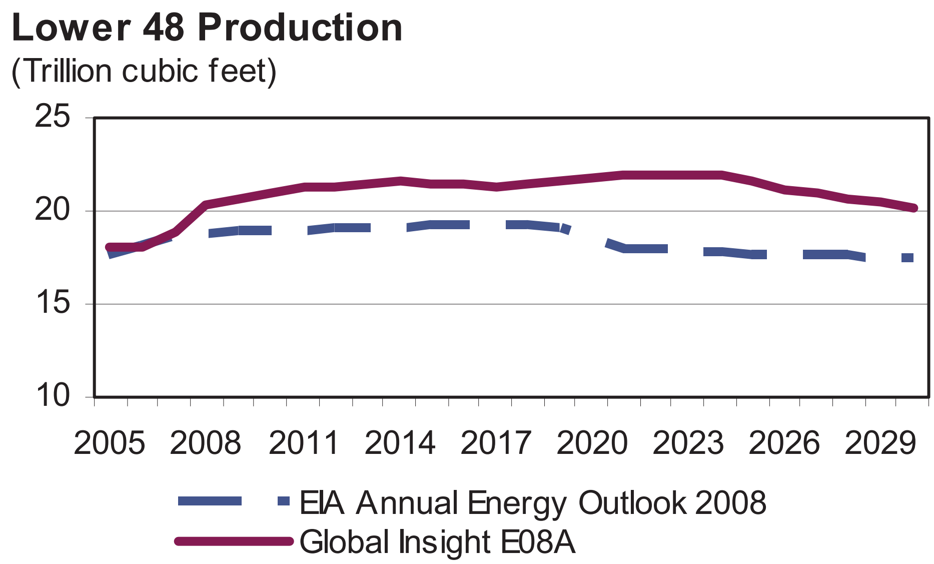
Rocky Mountain production is expected to increase by all forecasters. The EIA forecasts a 22% increase or 3.2 bcf/day from 12.3 bcf/day in 2007 to 15.5 bcf/day in 2030. Global Insight forecasts a 22% increase of 2.7 bcf/day to 15.1 bcf/day by 2030.

B.C. production is expected to decrease by 16% or 0.4 bcf/day in the National Energy Board forecast form 2.7 bcf/day in 2007 to 2.2 bcf/day in 2030. Global Insight expects a smaller decrease of 0.3 bcf/day. The B.C. government is more expansive about resources and future developments but does not produce a forecast.

Natural Gas Production Shifting
(Billion cubic feet per day)

	2007	2030	% Change
Rocky Mountains and San Juan			
EIA	12.33	15.51	**26%**
Global Insight	12.36	15.07	**22%**
British Columbia			
NEB	2.65	2.22	-16%
Global Insight	2.76	2.44	-12%
Alberta			
NEB	12.65	4.94	**-61%**
Global Insight	13.25	7.59	**-43%**

Supply is also responding to price, particularly in 2008. Shale resources became widely developed after prices surpassed $8 in 2005. Thus more recent forecasts are more optimistic about U.S. supply. In particular, the EIA short term forecast expects U.S. lower 48 dry natural gas production to reach 20.4 tcf in 2008 whereas the EIA 2008 Annual Energy Outlook projects 18.77 tcf. Global Insight forecasts 20.36 tcf for the lower 48 in 2008 in the E08A outlook.



Production Depends upon Reserves

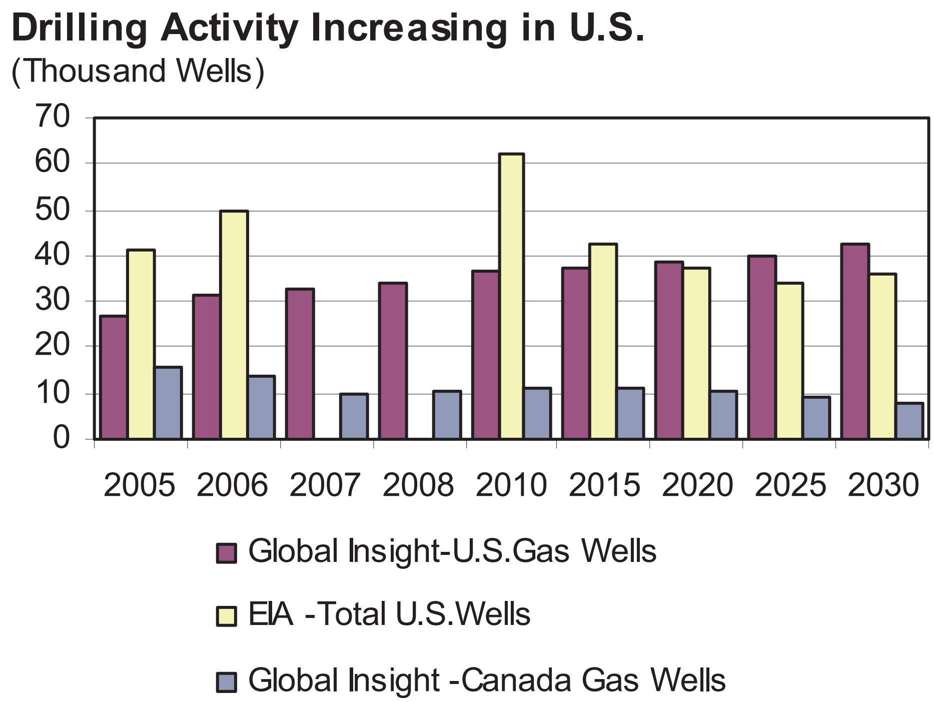
Natural gas reserves are increasing in the U.S. from a low of 162 tcf in 1993 to 211 tcf in 2006 and a preliminary estimate of 238 tcf for 2007. Global Insight forecasts reserves in the lower 48 to peak at 254 tcf in 2017. In addition, Alaskan reserves add 11.9 tcf in 2007 and more than 30 tcf when the Prudhoe Bay gas field is included. The EIA expects reserves to peak at 227 tcf in 2015.

Drilling Activity on Rise

U.S. gas well drilling increases from 33,000 wells in 2007 to 42,200 in 2030 in the Global Insight forecast.

EIA expects U.S. drilling to rise from 49,700 wells in 2007 to 62,300 in 2010 then decline to 35,700 by 2030.

Canadian drilling of gas wells peaked at 15,900 in 2006 and fell to 9,600 in 2007. Global Insight expects Canadian drilling activity to rise until 2015 to reach 11,400 gas wells before entering a gradual decline.

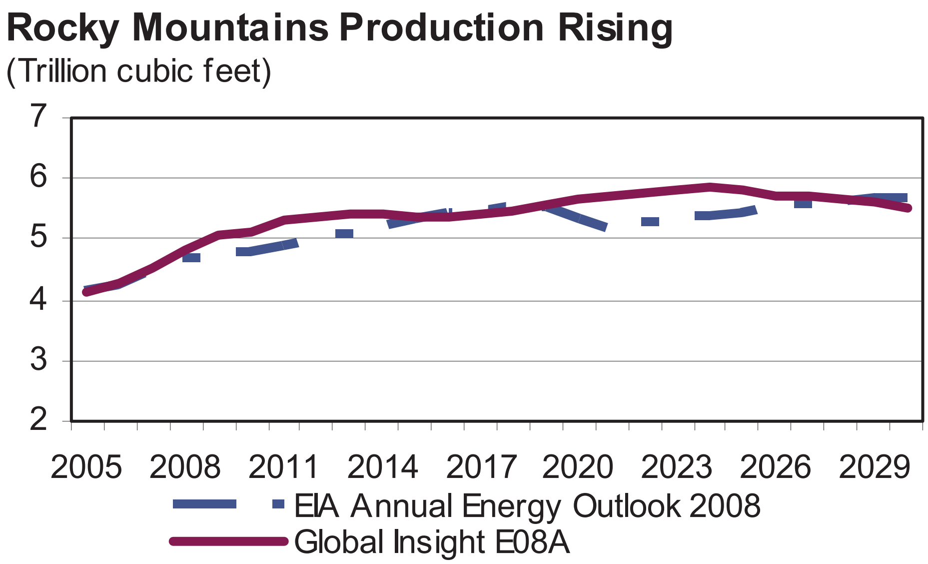


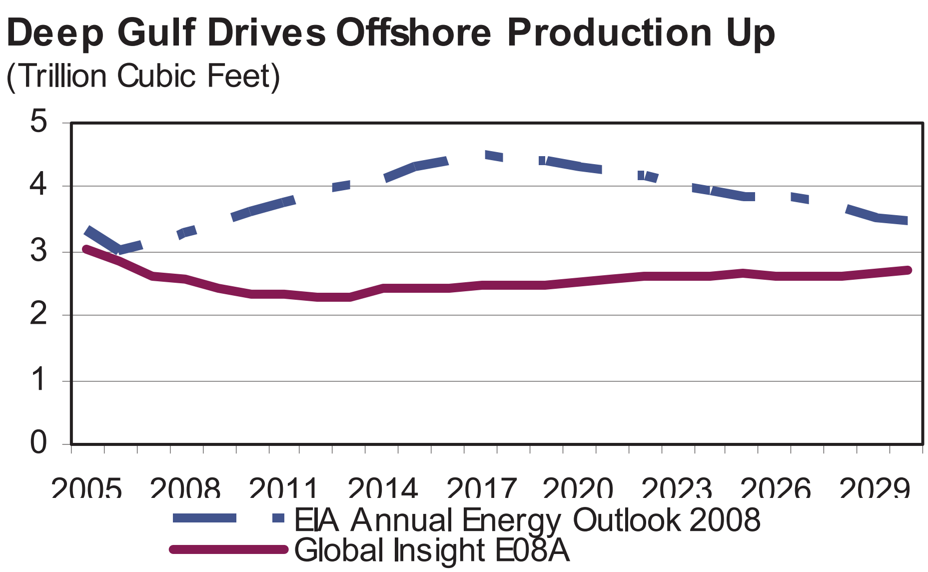
U.S. production will increase as horizontal drilling opens up the abundant resources of shale and tight formation. U.S. resources in shale and tight formations have long been known but have been too costly and difficult to produce in large scale until the recent application of horizontal drilling and fracturing technology.

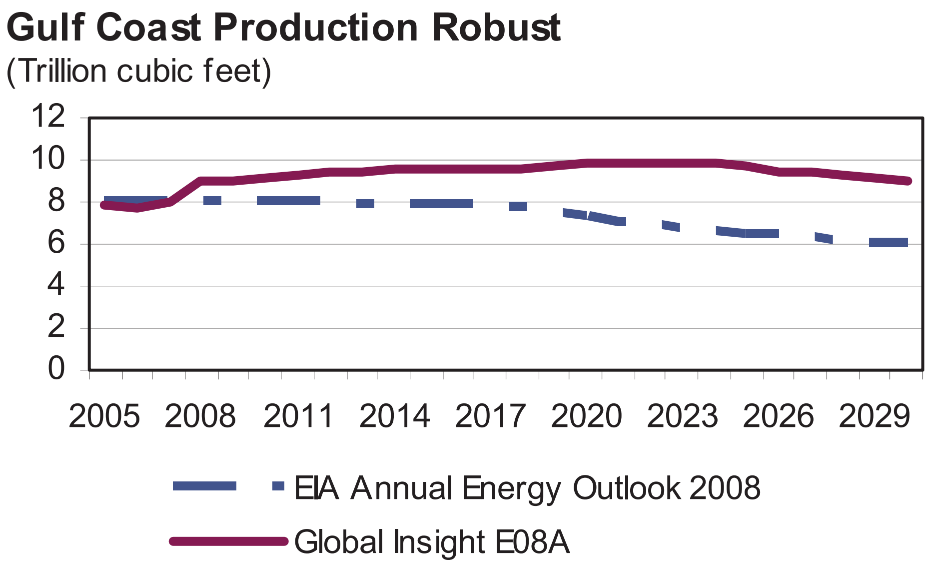
- Horizontal rigs have increased from 50 in 2002 to 550 in 2008. Productivity of the new rigs is enhanced in many ways including pad drilling where one rig can drill up to two dozen wells from one location thus eliminating the time and expense of moving and setting up prior to drilling.

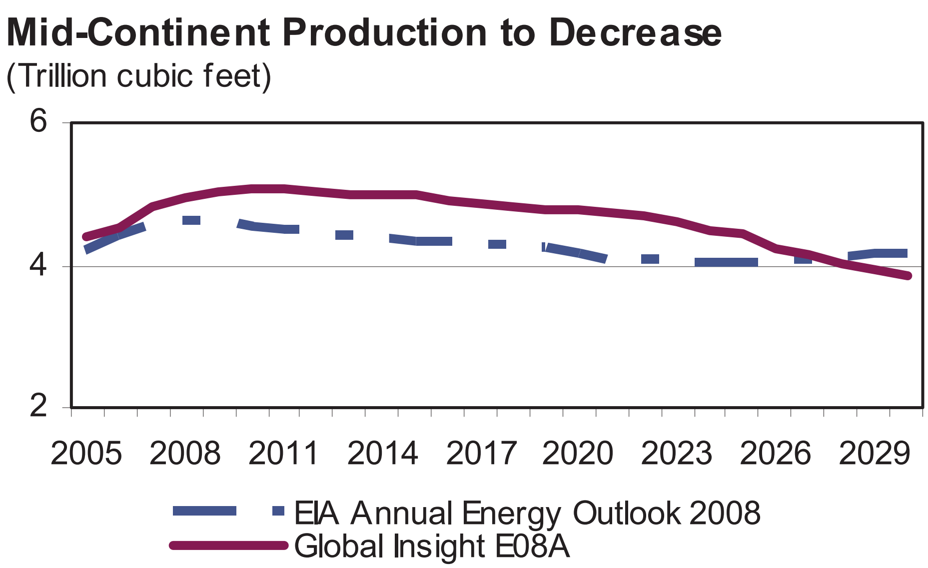
- Resource estimates for the U.S. were increased by 270 trillion cubic feet (tcf) for the shale and tight sands regions of the Rocky Mountains, Mid continent and Gulf Coast onshore from 327 Tcf in the 2003 National Petroleum Council study to 598 tcf in the 2007 Energy Information Agency assessment. Industry estimates of the contribution of Fayetteville, Haynesville and Marcellus shale deposits would add up to 100 tcf more.

Rocky Mountain production is expected to increase by all forecasters. The EIA forecasts a 22% increase or 3.2 bcf/day from 12.3 bcf/day in 2007 to 15.5 bcf/day in 2030. Global Insight forecasts a 22% increase of 2.7 bcf/day to 15.1 bcf/day by 2030.

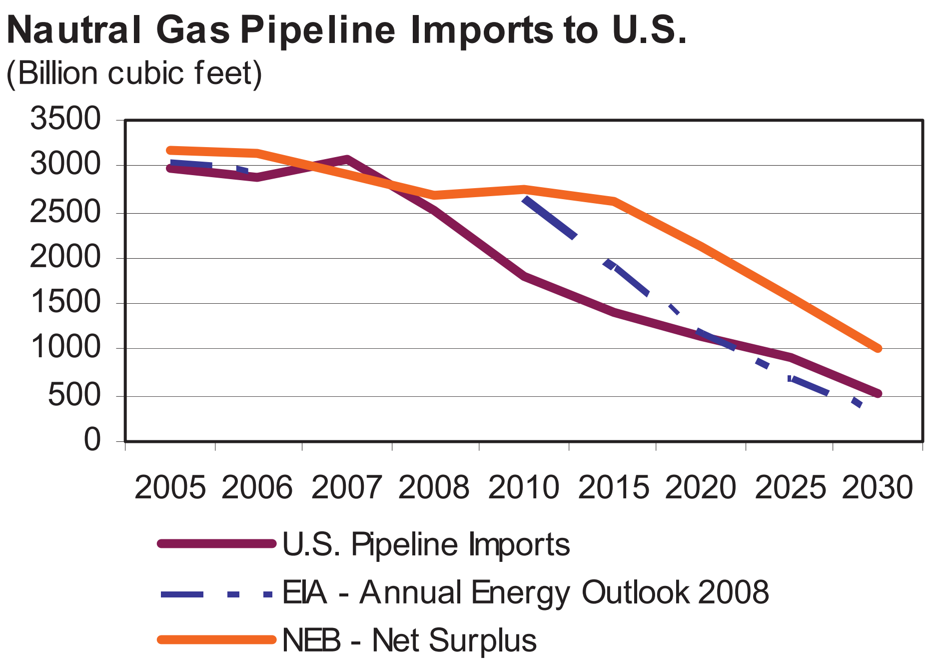

Rocky Mountains Production Rising
(Trillion cubic feet)
7
6
5
4
3
2
2005
2008
2011
2014
2017
2020
2023
2026
2029
EIA Annual Energy Outlook 2008
Global Insight E08A

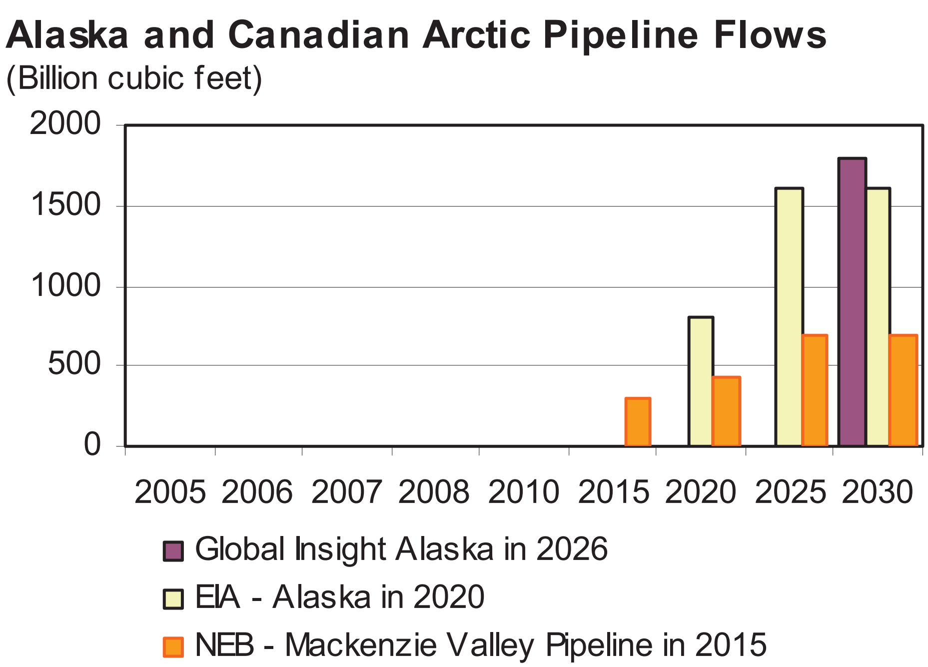

Deep Gulf Drives Offshore Production Up
(Trillion Cubic Feet)
5
4
3
2
1
0
2005
2008
2011
2014
2017
2020
2023
2026
2029
EIA Annual Energy Outlook 2008
Global Insight E08A


Gulf Coast Production Robust
(Trillion cubic feet)
12
10
8
6
4
2
0
2005
2008
2011
2014
2017
2020
2023
2026
2029
EIA Annual Energy Outlook 2008
Global Insight E08A


Mid-Continent Production to Decrease
(Trillion cubic feet)
6
4
2
2005
2008
2011
2014
2017
2020
2023
2026
2029
EIA Annual Energy Outlook 2008
Global Insight E08A

Pipeline Imports

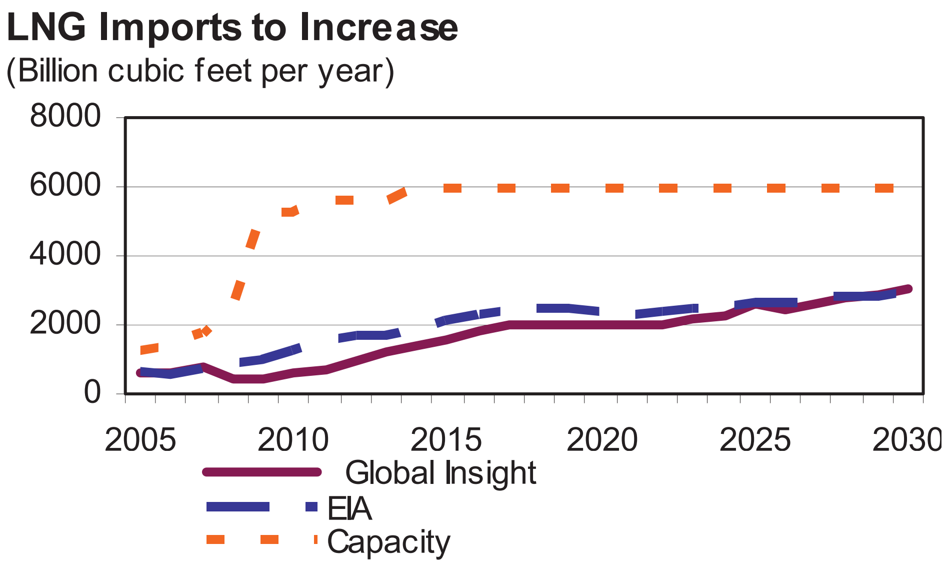


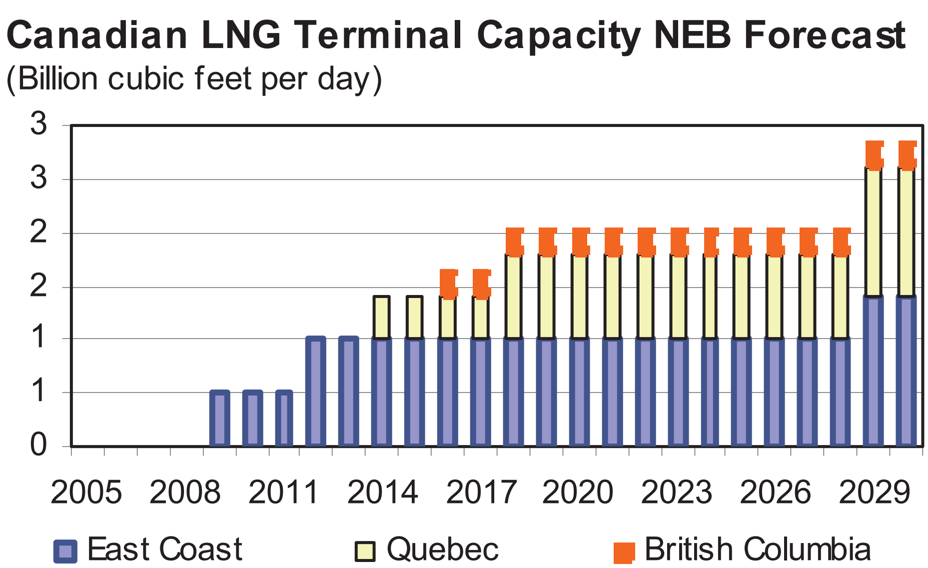


LNG Imports

The Sempra Energia Costa Azul LNG terminal is ready for operation but will receive few cargoes in 2008 and 2009. Sempra has diverted its Tangguh LNG supplies to South Korea under a 3 year contract at a value approaching $20 per million Btu. Imports to the Sempra LNG terminal are expected to begin in 2009 at a reduced rate.

- No additional LNG terminals are included on the West Coast of the U.S. or Canada in the Global Insight forecast. Lack of supply of LNG in the near term and competition from Alaskan gas in the long term make LNG terminals questionable investments. Most U.S. LNG terminals are sitting idle in 2008.
- The NEB includes a small LNG terminal in British Columbia starting in 2017. The terminal would have capacity of 0.25 bcf/day.
- Mexico is going ahead with a second west coast LNG terminal which will be supplied from Peru LNG. Chile is also developing an LNG terminal.

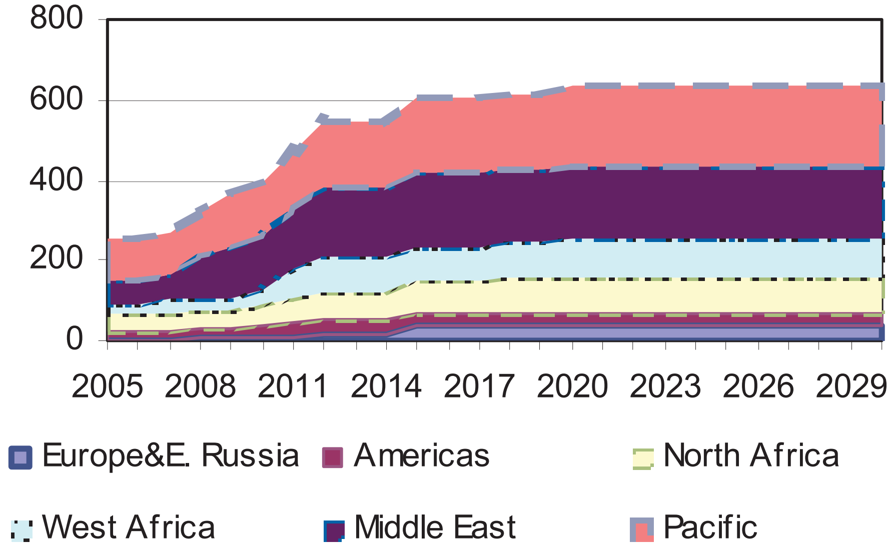




World LNG liquefaction capacity reached 259 billion cubic metres (BCM) in 2007 with production of 226 BCM. In the Global Insight forecast, world LNG capacity will increase by 120% by 2015.

- There are 129 BCM of new LNG plants under construction which will raise capacity to 395 BCM by 2010 with exports of 291 BCM, an increase of 30% or 65 BCM from 2007.
- By 2025, world capacity reaches 577 BCM with exports of 450 BCM, an increase of 100% from 2007 levels.

World LNG Liquefaction Capacity
(Billion cubic metres)



World LNG Capacity Expansion
(Billion Cubic Metres)

	Operational	Under Construction	Planned and Feasibile	Global Insight View Capacity	Global Insight View Exports
Asia Pacific	**102.8**	18.1	65.0		
2010				**120.9**	97.4
2015				**144.8**	125.5
2025				**160.4**	151.5
Europe/Russia	0.0	18.9	28.0		
2010				18.9	5.6
2015				46.9	17.6
2025				46.9	17.6
Africa	69.9	13.6	107.1		
2010				89.6	75.5
2015				165.8	121.2
2025				183.7	150.6
Middle East	64.4	73.1	60.3		
2010				137.5	87.5
2015				184.1	160.0
2025				184.1	135.4
Americas	22.4	6.2	14.4		
2010				28.6	25.4
2015				35.8	26.4
2025				35.8	28.3
World	259.5	129.9	274.9		
2010				395.6	291.4
2015				577.3	450.8
2025				610.8	483.4

LNG Terminal Capacity Expanding

Country/Region	Year Expected	Capacity (bcf/day)	Capacity holder	Supply Sources
Canada				
Irving	2009	**1.00**	Repsol	Trinidad
Rapaska	2014	**0.40**	EdF, HydroQuebec, Gaz Metro	Russia
U.S. East Coast				
Distrigas		**0.70**	Suez	Trinidad
NE Gateway		**0.40**	Excelerate Energy	
Neptune		**0.40**	Suez	
Cove Point		**1.00**	Shell, BP, Statoil	Trinidad, Norway, Nigeria
Cove Point Expansion	2009	**0.80**	Statoil	
Elba Island		**0.80**	Shell, BG Group	Trinidad, Nigeria, Eqypt, Eq. Guinea
Elba Island Expansion	2011	**0.90**		
U.S. Gulf Coast				
Lake Charles		**1.80**	BG Group	Trinidad, Nigeria, Eqypt, Eq. Guinea
Excelerate Energy		**0.50**	Excelerate Energy	
Freeport LNG		**1.75**	ConocoPhillips, Dow	
Sabine Pass		**2.60**	Chevron, Total	Nigeria, Yemen, Qatar
Cameron		**1.50**	ENI	
Golden Pass		**2.00**	ExxonMobil, Qatargas, ConocoPhillips	Qatar
U.S. West Coast				
(none included in forecast)				
British Columbia				
NEB forecast	2016	**0.25**	unspecified	unspecified
Mexico				
Altamira		**0.70**	Shell, Total	Nigeria, Trinidad
Energia Costa Azul		**1.00**	Sempra, Shell	Indonesia, Russia and Australia
Manzanillo	2011	**0.50**	Repsol	Peru
Total LNG Terminal		**19.00**		

NATURAL GAS DEMAND FORECASTS

- In the Global Insight forecast, the long term growth rate for natural gas demand is 0.5% for the U.S. with 0.6% for Pacific and 1.2% for the Mountain region.
- In the EIA forecast, the long term growth rate for natural gas demand is -0.03%, showing a decline from 2007 to 2030.
- The NEB forecast projects long term growth at 0.8% for Canada, 0.6% for B.C. and 0.4% for Alberta.
- Global Insight growth rates for Canada are 0.6% and 0.7% for both B.C. and Alberta.

Natural Gas Demand Growth In Question
(Average Annual Growth Rate, 2007 to 203

	EIA	Global Insight
U.S.	-0.03	0.5
Pacific	0.5	0.6
Mountain	-0.9	1.2
	NEB	**Global Insight**
Canada	0.8	0.6
B.C.	0.6	0.7
Alberta	0.4	0.7

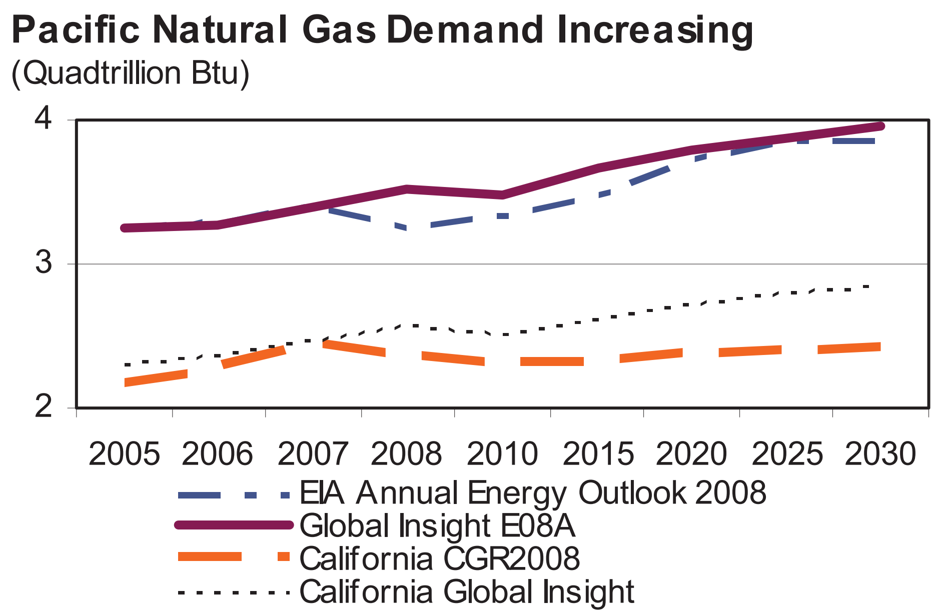
U.S. natural gas demand increases by 12% or 2.8 trillion cubic feet (tcf) from 23.07 tcf in 2008 to 25.87 tcf in 2030 in the Global Insight forecast. Most of the demand growth occurs in the power sector as a consequence of environmental restrictions on other fossil fuels.

U.S. natural gas demand actually decreases in the Energy Information Agency (EIA) forecast by 0.8% or 0.3 tcf from 23 tcf in 2007 to 22.7 tcf in 2030 under the assumption of indefinite extension of existing energy policy under which, the power sector turns to less expensive coal generation to displace natural gas.

Pacific Northwest natural gas demand increases in the view of both the EIA and Global Insight. Natural gas demand in the Pacific region including Washington, Oregon, Alaska and California, is expected to grow by 13% from 2007 to 2030 in the EIA Annual Energy Outlook 2008. Global Insight expects a 16% increase in demand of 0.6 tcf from 3.2 tcf in 2007 to 3.8 tcf equivalent to 1.7 billion cubic feet per day (bcf/day).

There are, however, divergent views for **California** demand which contributes three quarters of Pacific demand. California demand as forecast by utilities within their own service territories remains at or below 2007 levels all the way to 2030. Global Insight expects an increase in California natural gas demand of 15% or 0.4 tcf from 2.4 tcf in 2007 to 2.8 tcf in 2030. While the EIA and Global Insight include the impacts from California's renewable energy and conservation initiatives, the California utilities are much more aggressive in their forecasts of natural gas demand reductions.

Natural gas demand in the states of **Oregon and Washington** increases by 20% or 0.3 bcf/day from 1.46 bcf/day in 2007 to 1.76 bcf/.day in 2030 in the Global Insight forecast.



New Infrastructure Required to Meet Demand Growth in the Pacific Northwest

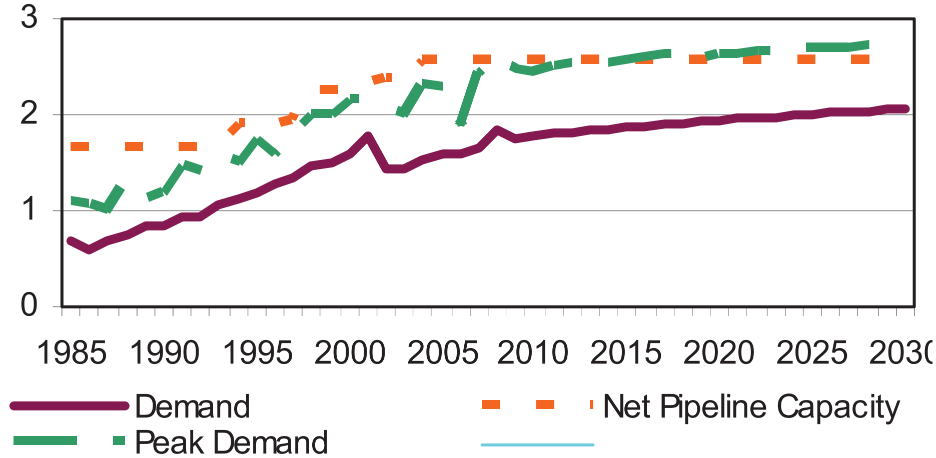
Natural gas supply for the Pacific Northwest faces limitations in meeting the projected demand growth. The primary limitation on Pacific Northwest natural gas supply is from pipeline capacity. Net pipeline capacity available to Washington and Oregon during peak winter periods is about 2.4 bcf/day.

- Total pipeline capacity coming into the states of Washington and Oregon totals 4.7 bcf/day while capacity exiting the region to California and Nevada is 2.3 bcf/day.
- Part of the Northwest pipeline capacity is also used to supply Idaho and the Paiute pipeline with peak demand of 0.3 bcf/day in Idaho and capacity of 0.2 bcf/day to Reno, Nevada.
- The capacity dedicated to the Pacific Northwest is also augmented by whatever California does not use of the 2.3 bcf/day capacity on the Gas Transmission Northwest (GTN) pipeline at its terminus at Malin, Oregon.

With demand during winter months reaching 2.6 bcf/day for Washington, Oregon and Idaho and up to a further 0.2 bcf/day sent to Nevada from the Northwest pipeline on the Paiute pipeline, peak demand exceeds the pipeline capacity reserved for the Pacific Northwest. Supply is augmented by storage withdrawals that average 0.25 bcf/day in January and 0.23 bcf/day in February resulting in a tight balance.

Demand Growth Requires New Infrastructure

(Billion cubic feet per day)

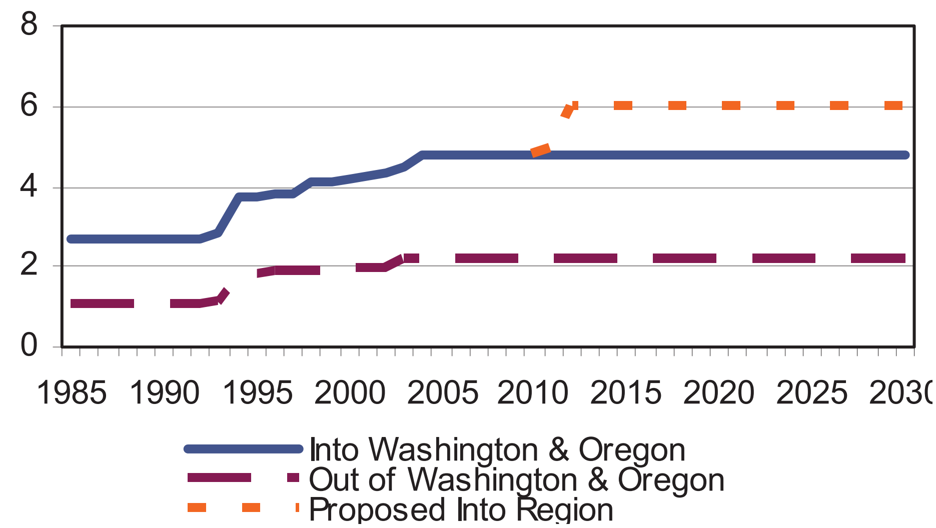


Supply limitations will be overcome by infrastructure expansions in all forecasts, mostly by expansion of pipelines from the Rocky Mountains. At present, the only pipeline serving the Rocky Mountains to the Pacific Northwest is Northwest pipeline from Opal, Wyoming but it has capacity to meet less than one third of annual demand and less than one quarter of peak demand.

Additional pipeline capacity from the Rocky Mountains is expected from either the $3 billion Ruby project of El Paso connecting Opal to Malin, Oregon or the TransCanada Sunstone project which parallels the existing Northwest pipeline from Opal, Wyoming to Stanfield, Washington. In addition, all forecasters expect Arctic pipelines to be built after 2020. Finally, though LNG terminals have been proposed they are not included in all forecasts.

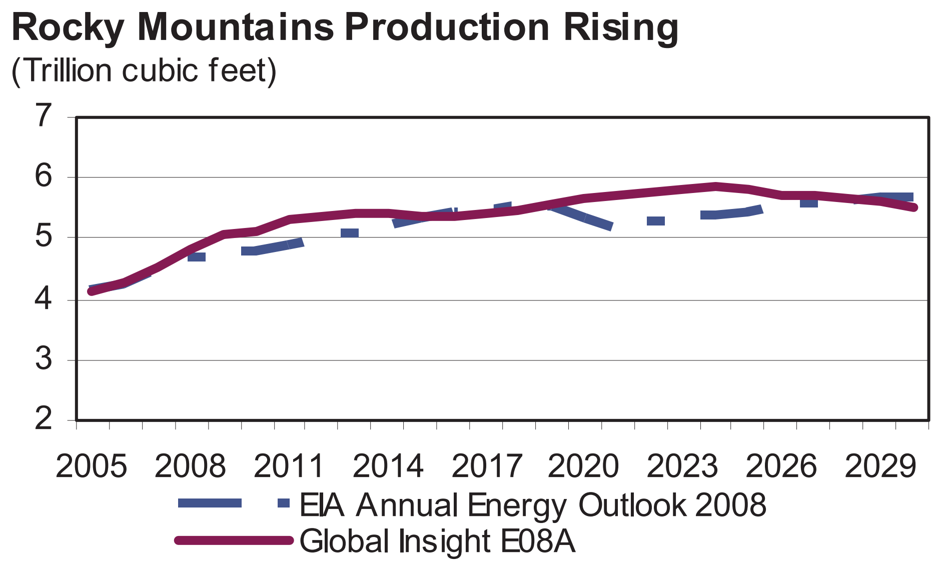
Pipeline Capacity Into Pacific Northwest

(Billion cubic feet per day)



Security of Natural Gas Supply for the Pacific Northwest

The most likely source of new gas supply for the Pacific Northwest is the Rocky Mountain region where production is expected to increase by all forecasters. The EIA forecast projects an increase of 26% or 1.16 tcf from 4.5 tcf in 2007 to 5.66 tcf in 2030. The Global Insight forecast results in an increase of 22% or 1 tcf from 4.5 tcf in 2007 to 5.5 tcf in 2030.



The Pacific Northwest receives most of its existing supply of natural gas from Canada, a source which will contract in the forecast according to the national Energy Board (NEB). While British Columbia (B.C.) production forecasts vary from small increase to decrease, Alberta production is expected to decline precipitously by every forecaster.

Power Generation Outlook Mixed

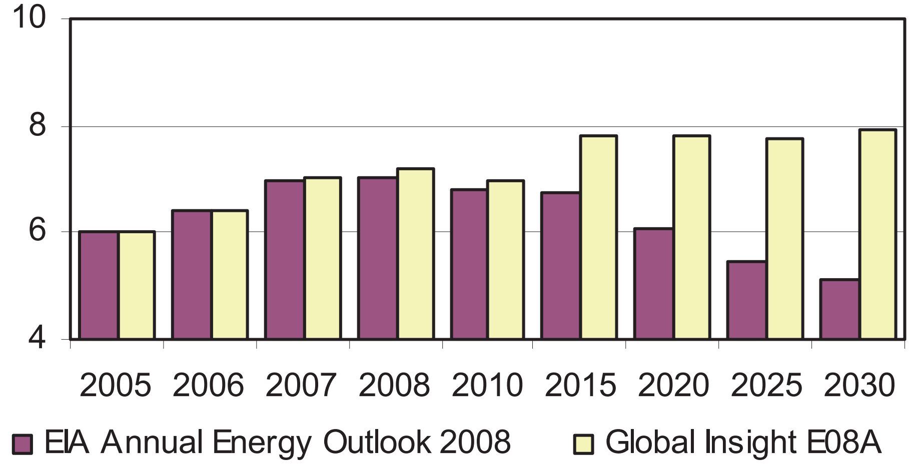
In all the forecasts, natural gas demand growth depends upon the power generation sector and reconciliation of diverse economic, energy and environmental drivers of power generation. Natural gas use for power generation grows because of environmental preferences relative to other fossil fuels. While the share of natural gas in total energy demand has eroded over the past decade, it will rise between 2005 and 2009. After 2010, the surge in renewable sources of energy will result in a trend decline in natural gases share of total energy.

- In the EIA forecast, natural gas consumption in power generation consumption declines precipitously, especially in those regions that use coal.

- In the Global insight forecast, natural gas consumption in power generation increases to meet baseload requirements in regions that cannot build coal plants and to provide backup to renewable generation.

Views Differ on Power Sector Demand Growth

(Quadtrillion Btus)



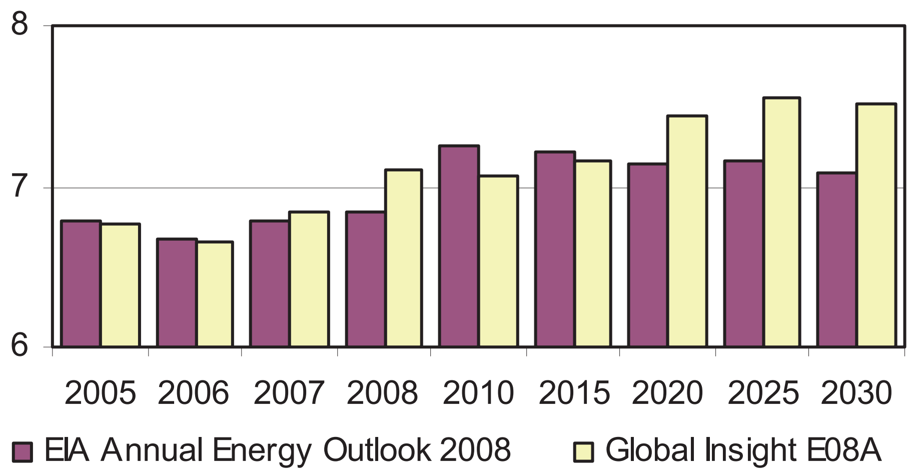
Industrial Natural Gas Demand Benefits from High Oil Prices

Industrial demand growth has resulted from the high oil prices as U.S. products made from natural gas are very competitive in world markets.

- U.S. ammonia production using natural gas is growing by 25% in 2008.
- Petroleum refiners are more intensively converting petroleum streams to products and relying more on natural gas as process fuel.
- U.S. petrochemical producers have a huge price advantage in using natural gas derivatives such as ethane as a feedstock versus the oil based feedstocks used in Europe and Japan.
- Similarly, U.S. industrial production fueled by natural gas can more readily replace imported goods made from petroleum abroad.

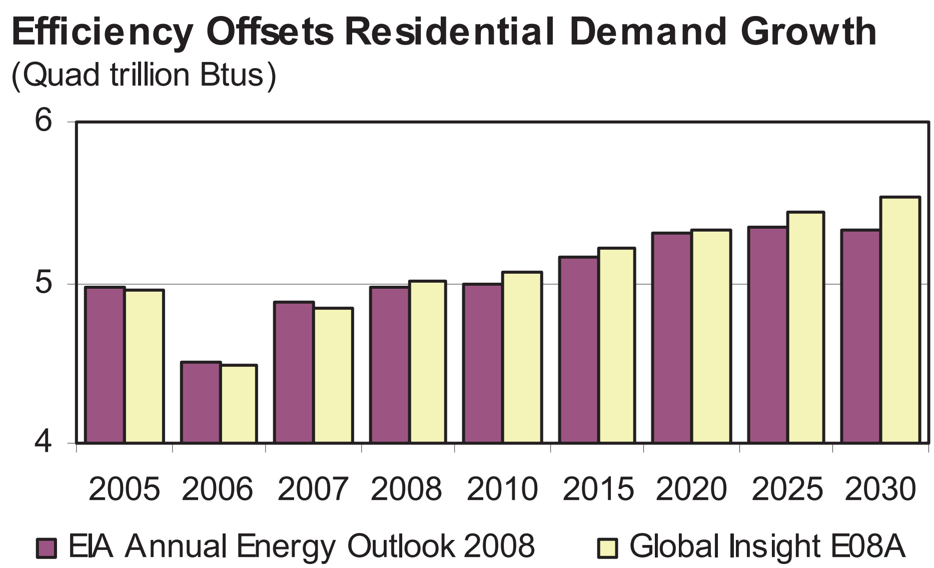
Industrial Demand Growth is Modest

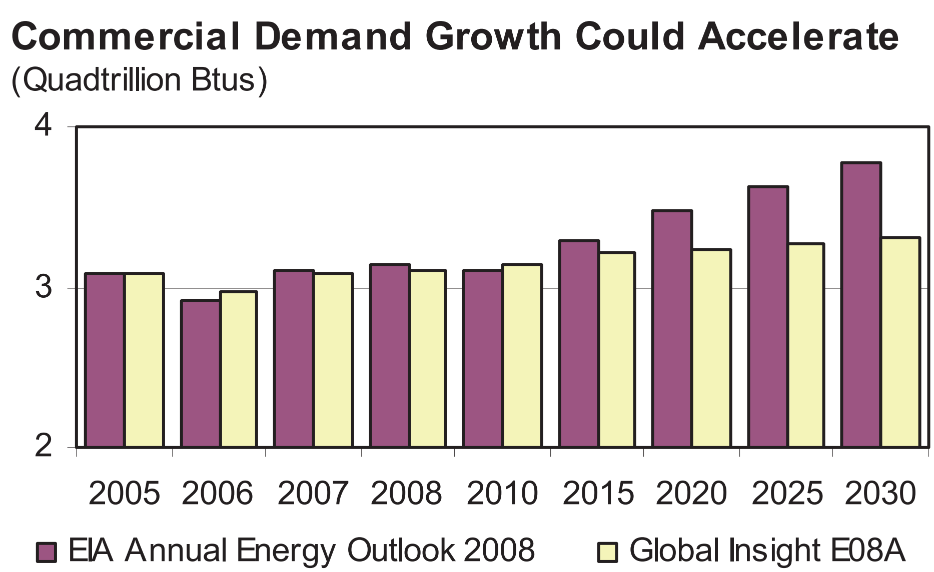
(Quadtrillion Btus)



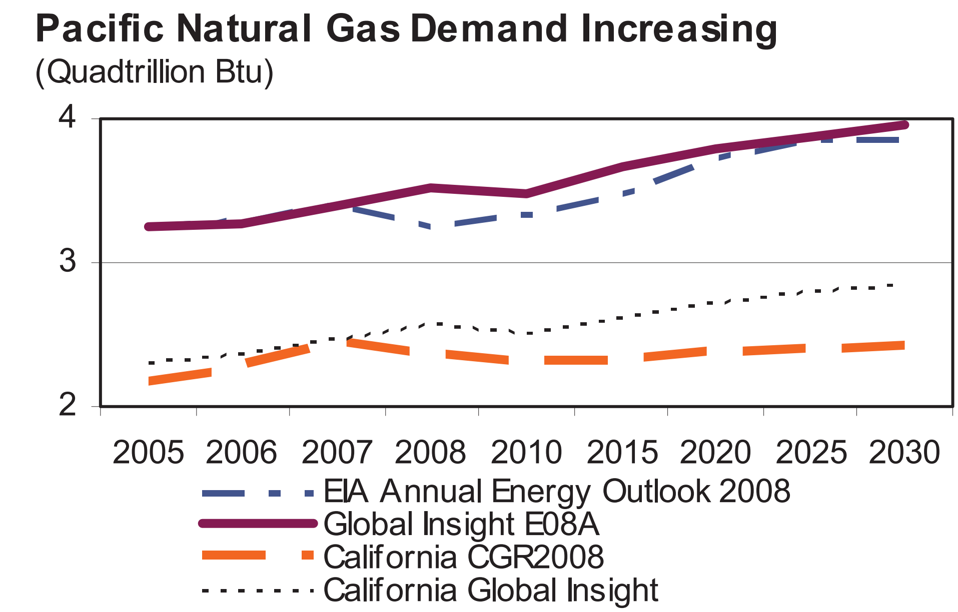
Residential and Commercial Natural Gas Demand Will Increase Slowly.

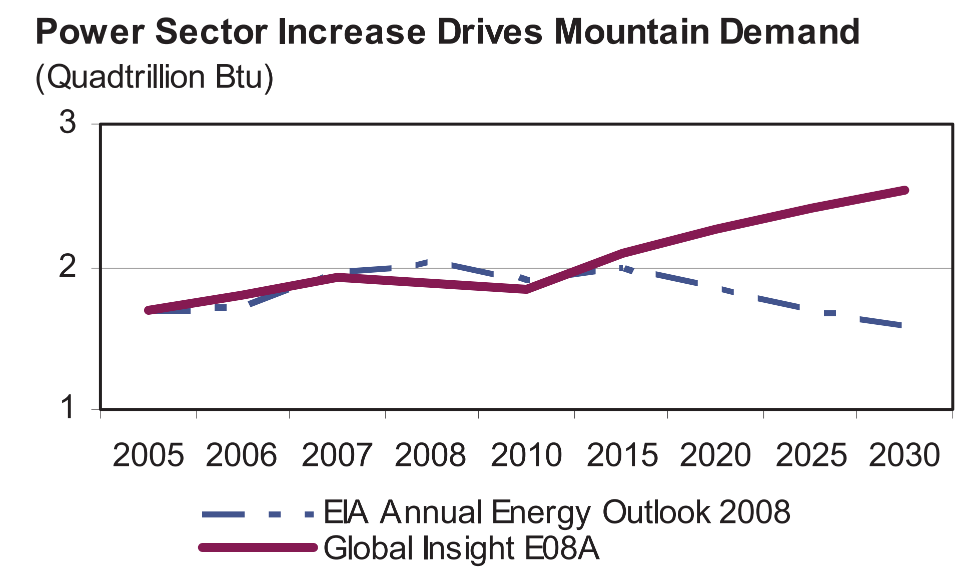
Demand growth for residential and commercial energy is driven down by the proliferation of Demand Side Management programs at the state level, more stringent appliance efficiency standards at the federal level and a decrease in energy intensity of typical applications. This results in significantly slower demand growth rates than in the 1990s, when energy prices were much lower.





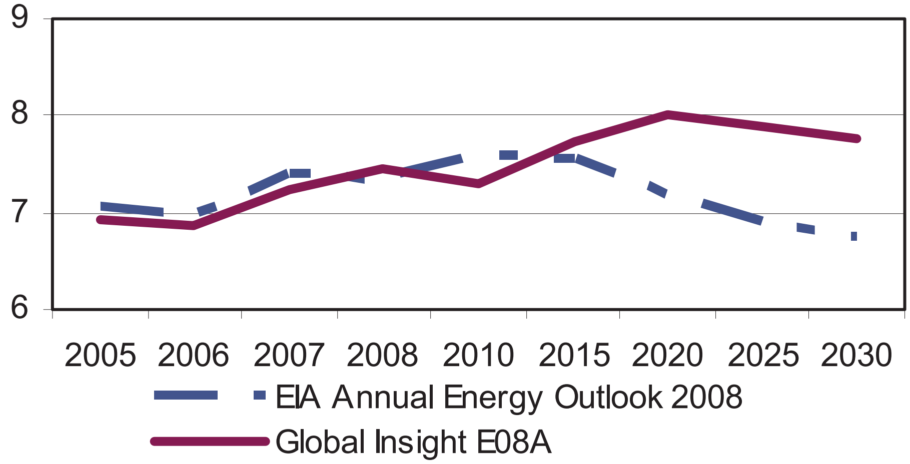
Regional Natural Gas Demand Comparison





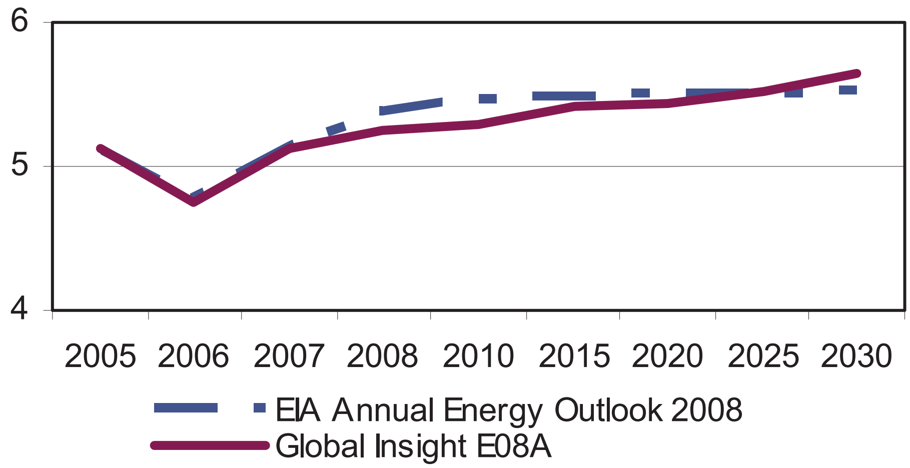
Power Sector Increases South Central Demand

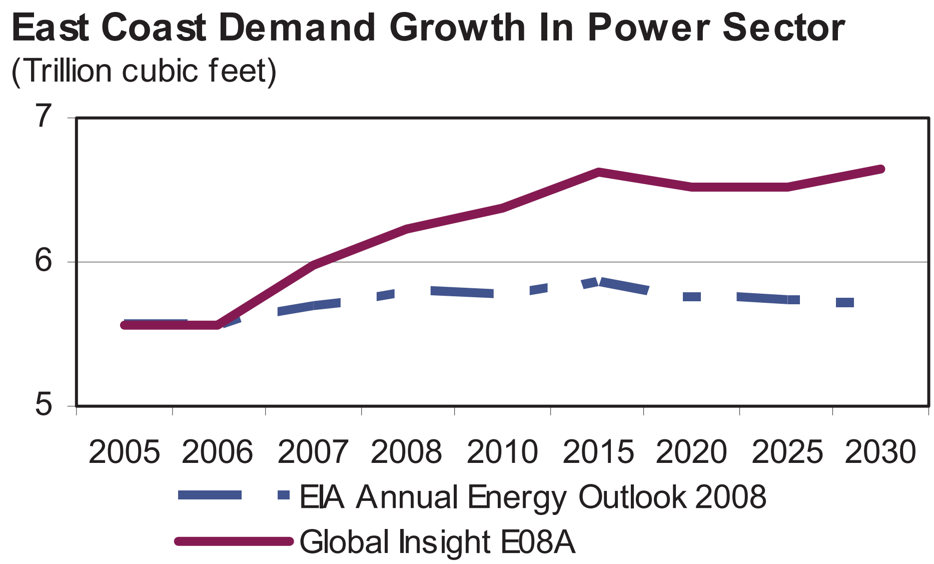
(Trillion cubic feet)



Slow Growth in North Central Demand

(Trillion cubic feet)



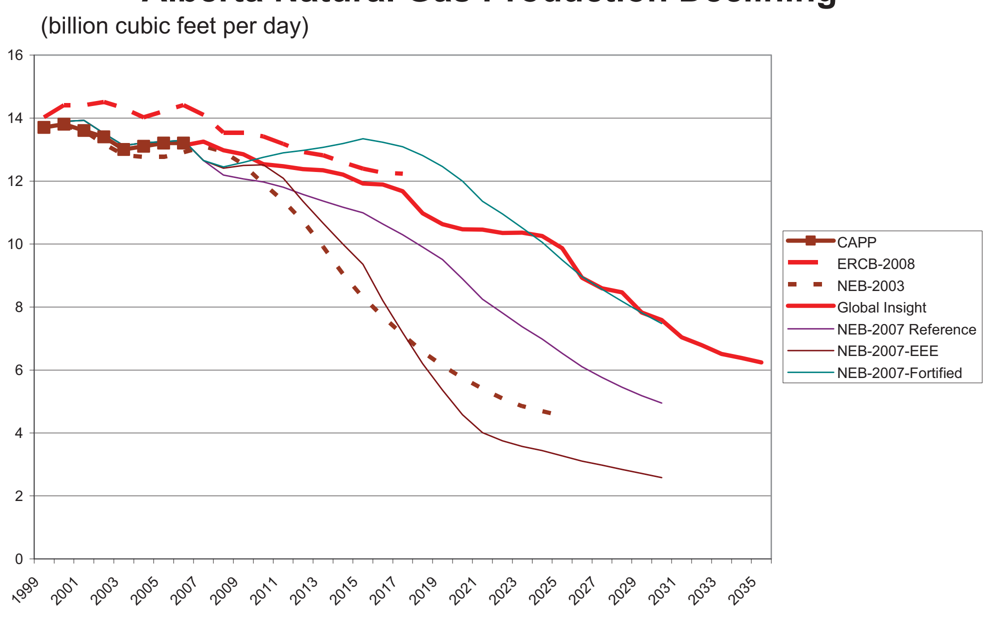

East Coast Demand Growth In Power Sector
(Trillion cubic feet)
7
6
5
2005
2006
2007
2008
2010
2015
2020
2025
2030
EIA Annual Energy Outlook 2008
Global Insight E08A

NATIONAL ENERGY BOARD ENERGY SUPPLY AND DEMAND 2007

National Energy Board forecast was released in 2007 and expressed the following conclusions.

- Demand for natural gas is growing. In the reference case, gas demand rises 45% between 2005 and 2030 on the strength of gas used in oil sands and electricity generation. Energy demand growth depends upon population, the Canadian economy and energy prices.
- Conventional natural gas from the Western Canadian Sedimentary basin is declining. Though some of the production decline will be offset by development of unconventional resources, the decline is accelerated in those cases where lower gas prices cannot absorb the high costs of producing unconventional gas or developing the north.
- There may be more natural gas imports than exports by 2030. This happens more rapidly in the case where imports cost less than developing and bringing northern gas and unconventional gas to market.
- Gradual declines in western Canada conventional natural gas production could lead to the development of additional northern, offshore and unconventional gas sources and to imports of LNG. Relatively flat to declining overall production and growing natural gas demand for use in oil sands extraction and electricity generation could eventually diminish Canada's role as a natural gas exporter.

Alberta Natural Gas Production Declining



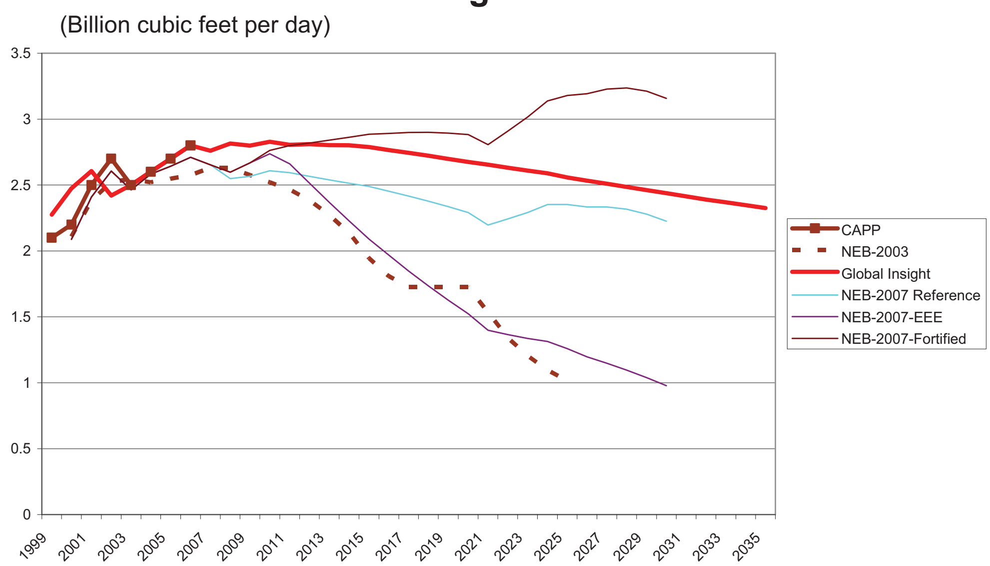
The NEB analyzed three scenarios, Reference/Continuing Trends, Fortified Islands and Triple E for a balancing of Energy, Economic and Environmental goals.

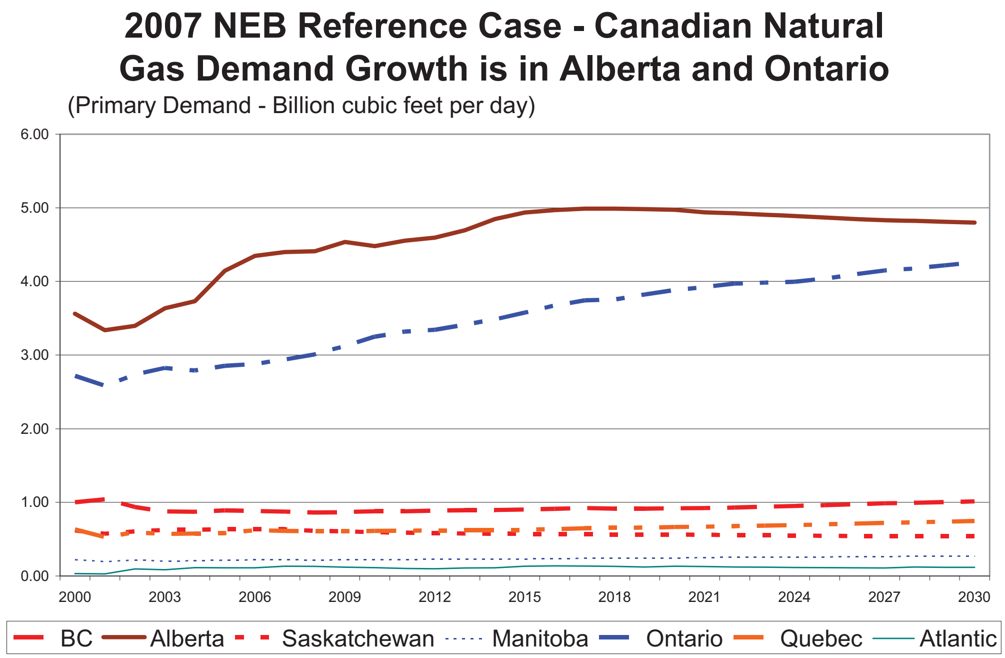
Northeast B.C. Shale Resources to be Developed

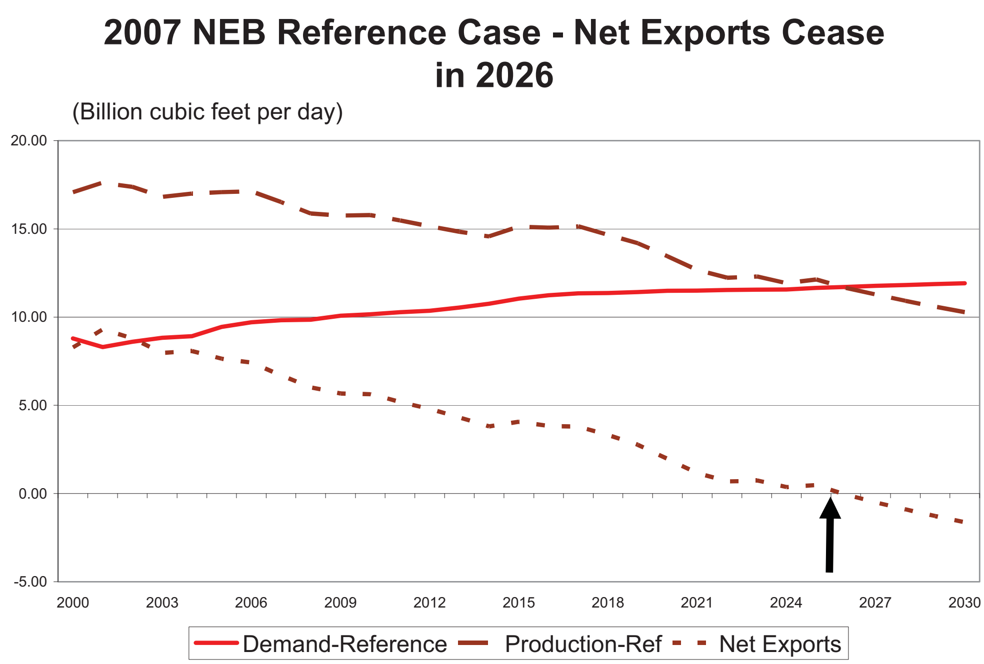
The Montney and Horn River shale resource in Northeast B.C. is expected to be developed by 2011. The high cost of shale gas development in a remote area of B.C. coupled with the lack of infrastructure will delay development. Resource estimates are expansive with several companies suggesting from 2 tcf to 5 tcf or more of gas resource on land holdings. The B.C. Ministry of Energy, Mines and Petroleum Resources estimates a potential capacity of 250 tcf to 1000 tcf of gas-in-place of which producible gas would be a much lesser amount. Also, B.C. received 2 billion dollars from lease sales in 2008 which indicates a large and valuable resource base.

- The Global Insight forecast includes a significant contribution from the Horn River and Montney shale gas.
- The NEB forecasts were developed in 2007 and with preliminary information on shale gas development in B.C. projected production above 2 tcf per year compared to a decline to 1 tcf per year in the 2003 report

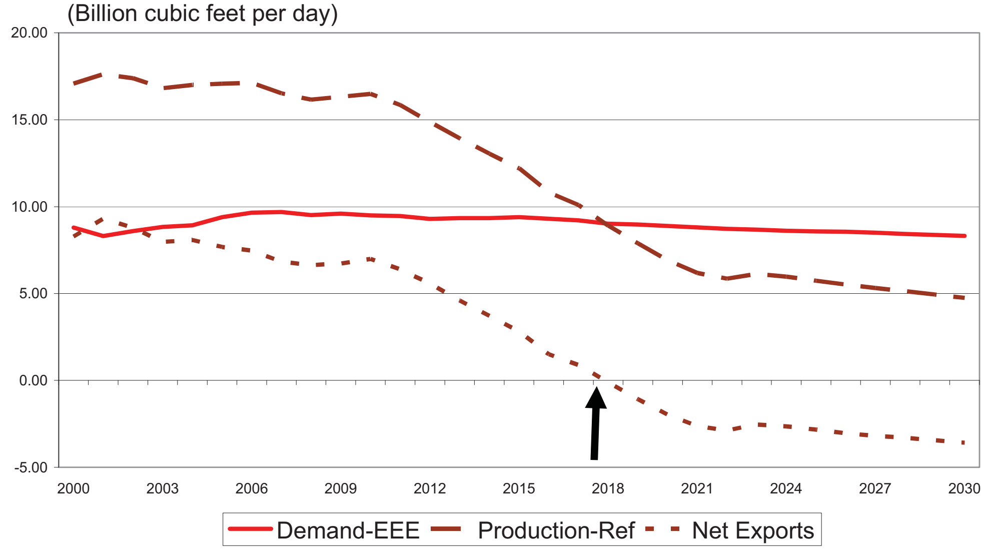
British Columbia Natural Gas Production is Increasing Near Term



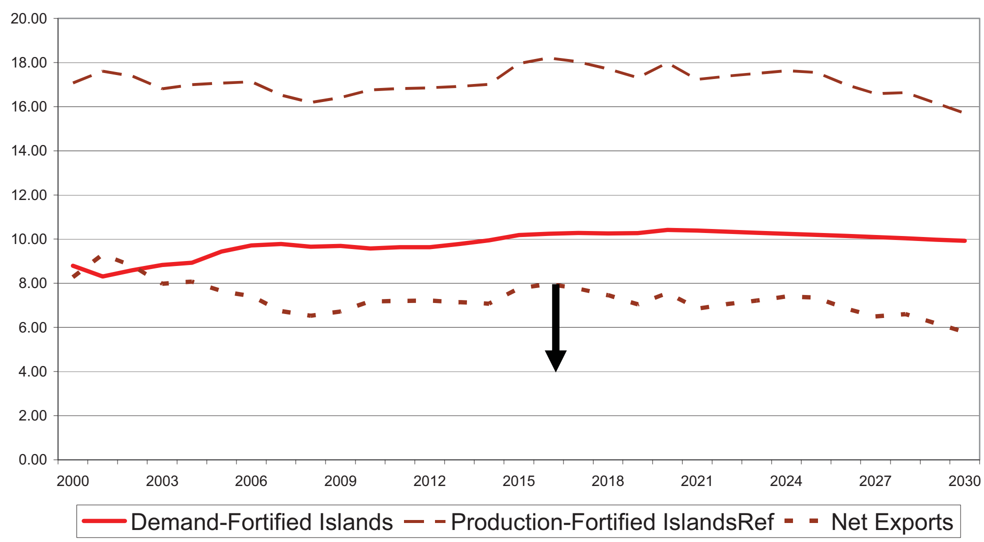

2007 NEB Reference Case - Canadian Natural Gas Demand Growth is in Alberta and Ontario
(Primary Demand - Billion cubic feet per day)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
2000
2003
2006
2009
2012
2015
2018
2021
2024
2027
2030
BC
Alberta
Saskatchewan
Manitoba
Ontario
Quebec
Atlantic


2007 NEB Reference Case - Net Exports Cease in 2026
(Billion cubic feet per day)
20.00
15.00
10.00
5.00
0.00
-5.00
2000
2003
2006
2009
2012
2015
2018
2021
2024
2027
2030
Demand-Reference
Production-Ref
Net Exports

2007 NEB Triple E Case - Net Exports Cease in 2018

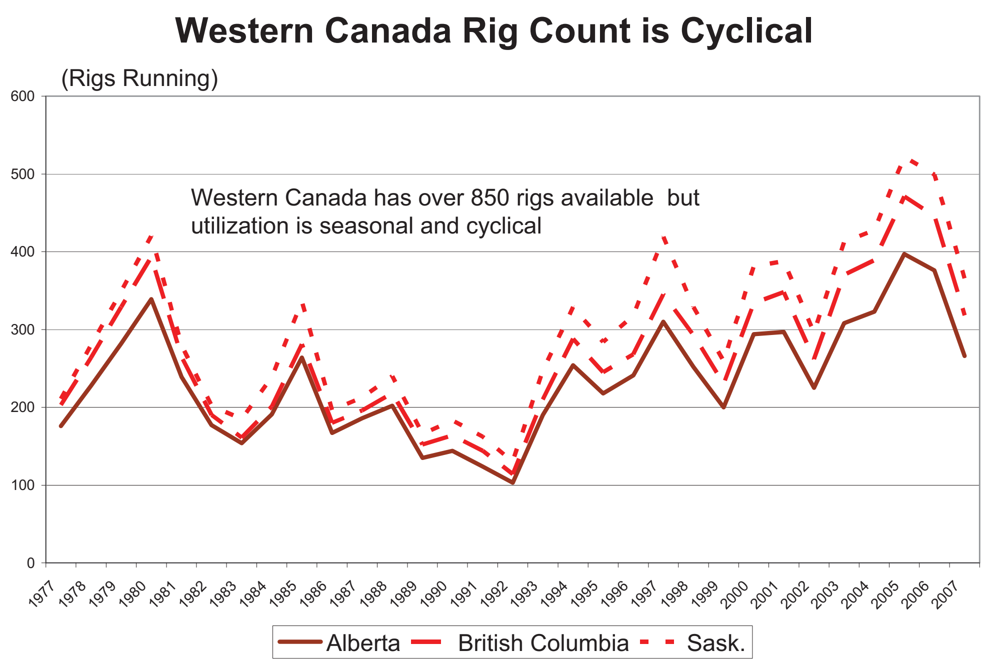


2007 NEB Fortified Islands Case - Net Exports Decline Slowly After 2017



Canadian Drilling Activity is Very Low Relative to Capacity

- Existing Canadian natural gas supply reflects the drilling of 9,000 to 15,000 natural gas wells per year in western Canada.
- The Canadian rig stock reached 872 in 2007 with the capability of drilling more than twice as many wells as the 9636 gas wells drilled in that year.
- Rig utilization fell to 43% in 2007 from 71% in 2005.
- Gas wells drilled fell from 15,895 in 2005 to 9,636 in 2007. The Canadian Association of Oil Drilling Contractors forecasts an increase in drilling in 2008.



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THE CADMUS GROUP, INC.

Comprehensive Assessment of Demand-Side Resource Potentials (2010-2029)

Volume I

July 10, 2009

FINAL REPORT

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Table of Contents: Volume I

Table of Contents: Volume II

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Executive Summary

Overview

This report summarizes the results of an independent study of the potentials for electric and natural gas demand-side management (DSM) resources in Puget Sound Energy's (PSE's) service area from 2010 to 2029. The study was commissioned by PSE as part of its biennial integrated resource planning (IRP) process.

The study builds upon previous efforts and incorporates improvements over the previous assessment in 2006 with respect to the scope of the assessment and its methodology, particularly in the areas of distributed generation, including renewables and fuel conversion. As in the previous study, the assessment included electric and natural gas energy efficiency, fuel conversion, demand response, and a full range of small-scale (customer-sited) generation resources. This study benefited from updated baseline and DSM data informed by primary and secondary data collection as well as the efforts of other entities in the region such as the Northwest Power and Conservation Council (the Council). The methods used to evaluate the technical potentials for and cost-effectiveness of resources draw upon the best practices in the utility industry and are consistent with the methodology used by the Council in its assessment of regional conservation potentials in the Northwest.

Summary of the Results

The potentials identified in this study are summarized in Table 1. As shown, electric DSM resources account for 760 aMW and 1,359 MW of achievable technical potential by 2029. These potentials represent 21% of retail energy sales and 28% of winter peak demand[1]. Similarly, technical achievable natural gas potential accounts for 19% of forecasted 2029 retail sales. High-level potentials by resource are presented below, with more detailed results in the sections of this report that follow.

[1] Demand response potentials do not account for program interactions, and thus, this potential would likely be reduced if multiple programs were competing for participants.

Table 1. Summary of Energy and Capacity Saving Potentials (2029)

	Energy (aMW / million therms)		Winter Peak Capacity (MW)	
Resource	Technical Potential	Achievable Technical Potential	Technical Potential	Achievable Technical Potential
Electric Resources				
Energy Efficiency	739	589	1,162	926
Fuel Conversion	231	105	391	178
Demand Response	N/A	N/A	1,909	178
Distributed Generation	3,493	66	4,075	77
Electric Resources Total	**4,463**	**760**	**7,537**	**1,359**
Natural Gas Resources				
Energy Efficiency (million therms)	407	254	N/A	N/A

Energy Efficiency

Table 2 shows 2029 forecasted baseline electric sales and potential by sector. As shown, the results of this study indicate 739 aMW of technically feasible electric energy-efficiency potential will be available by 2029, the end of the 20-year planning horizon. Once market constraints are taken into account, this translates to an achievable potential of 589 aMW. Were all of this potential cost-effective and realizable, it would amount to a 16% reduction in 2029 forecasted retail sales and a 51% reduction of load growth from 2010 to 2029.

Table 2. Technical and Achievable Technical Electric Energy-Efficiency Potential (aMW in 2029) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Achievable Technical Potential	Achievable Technical Potential as % of Baseline
Residential	1,756	343	20%	273	16%
Commercial	1,813	378	21%	301	17%
Industrial	135	17	13%	14	11%
Total	**3,704**	**739**	**20%**	**589**	**16%**

Table 3 shows 2029 forecasted baseline gas sales and potential by sector. As shown, the results of this study indicate roughly 407 million therms of technically feasible, gas energy-efficiency potential by 2029, the end of the 20-year planning horizon. This translates to an achievable technical potential of 254 million therms. If all of this potential was cost-effective and realizable, it would amount to a 19% reduction in 2029 forecasted retail sales and a 61% reduction in load growth from 2010 to 2029.

Table 3. Technical and Achievable Technical Gas Energy-Efficiency Potential (Million therms in 2029) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Achievable Technical Potential	Achievable Technical Potential as % of Baseline
Residential	854	263	31%	162	19%
Commercial	440	132	30%	84	19%
Industrial	53	12	22%	9	17%
Total	**1,348**	**407**	**30%**	**254**	**19%**

Fuel Conversion

A summary of 2029 fuel conversion potentials is provided in Table 4. This represents a combination of current PSE gas customers and current PSE electric-only customers in either Cascade Natural Gas or PSE natural gas territory.

Table 4. Summary of Fuel Conversion Potentials

	Electric-Only Customers		Existing Gas Customers	Total
	PSE Gas Territory	Cascade Natural Gas Territory		
Technical Potential				
Electric Savings (aMW)	53.4	82.5	37.9	173.8
Additional Gas Usage (million therms)	32.9	53.5	20.7	107.1
Achievable Technical Potential				
Electric Savings (aMW)	20.3	29.8	15.2	64.9
Additional Gas Usage (million therms)	12.6	20.0	7.4	40.0

Demand Response

Table 5 and Table 6 present estimated resource potentials for all DR resources for the residential, commercial, and industrial sectors for summer and winter. As shown, demand response achievable technical potential represents a 3% and 1% reduction in 2029 winter and summer peak demand, respectively.

Table 5. Technical and Achievable Technical Potential for Demand Response Resources (MW in 2029) - Winter

Sector	2029 Sector Peak	2029 Technical Potential	2029 Achievable Technical Potential	Achievable Technical Potential As Percent of 2029 Sector Peak
Residential	3,577	1,729	170	5%
Commercial	2,901	135	14	<1%
Industrial	130	43	5	4%
Total	**6,608**	**1,909**	**189**	**3%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs have not been taken into account.
Note: Residential technical potential and achievable technical potential for residential potential for direct load control do not include AMR converted to AMI or existing AMI due to overlap with no AMR meter installed.

Table 6. Technical and Achievable Technical Potential for Demand Response Resources (MW in 2029) - Summer

Sector	2029 Sector Peak	2029 Technical Potential	2029 Achievable technical Potential	Achievable Technical Potential As Percent of 2029 Sector Peak
Residential	2,428	676	48	2%
Commercial	2,334	136	14	1%
Industrial	157	43	5	3%
Total	**4,919**	**855**	**68**	**1%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs has not been taken into account.
Note: Residential technical potential and achievable technical potential for direct load control do not include AMR converted to AMI or existing AMI due to overlap with no AMR meter installed.

Distributed Generation

The total technical potential from distributed generation resources, excluding existing installed capacity, is 3,493 aMW in 2029 (Table 7). More than half of the technical potential for DG comes from PV (51%), followed by non-renewable CHP (28%), small hydro (14%), renewable CHP (5%), and small wind (2%). The achievable technical potential is significantly lower than the technical potential due to economic considerations, low awareness of technologies, and other permitting or interconnection concerns. Among these resources, non-renewable CHP composes the largest percentage of achievable technical potential (34 aMW), followed by photovoltaics (21 aMW), renewable CHP (8.7 aMW), small hydro (0.12 aMW) and small wind (0.04 aMW).

Table 7. Technical and Achievable Technical Potential for Distributed Generation Resources (aMW in 2029)

Resource	Technical Potential	Achievable Technical Potential
Non-Renewable CHP	1,039	34
Renewable CHP	211	9
Building Photovoltaics	1,912	21
Small Hydro	265	<1
Small Wind	66	<1
Total	**3,493**	**66**

Energy Efficiency Potentials under Alternative Scenarios

To provide additional perspective on future availability of DSM resources and to take into account uncertainties around current economic conditions, an alternate scenario was analyzed. This scenario assumed that customer and load growth would be significantly slightly lower than that included in the baseline forecast. In this scenario, by 2029, electric and gas sales have decreased by 3% and 6%, respectively. As Table 8 shows, this translated into similar reductions in potential. The industrial sector was affected the most, followed by the residential and commercial sectors.

Table 8. Energy Efficiency Technical Potential Comparison

Sector	Electric Technical Potential in 2029 (aMW)			Gas Technical Potential in 2029 (million therms)		
	Base Case	Low Growth Scenario	Percent Reduction	Base Case	Low Growth Scenario	Percent Reduction
Residential	343	332	3.2%	263	244	7.2%
Commercial	378	370	2.1%	132	126	4.5%
Industrial	17	16	5.9%	12	11	8.3%
Total	**739**	**718**	**2.8%**	**407**	**381**	**6.4%**

Although this analysis was not performed for all resources, it is expected that changes in potential, in percentage terms, would be similar.

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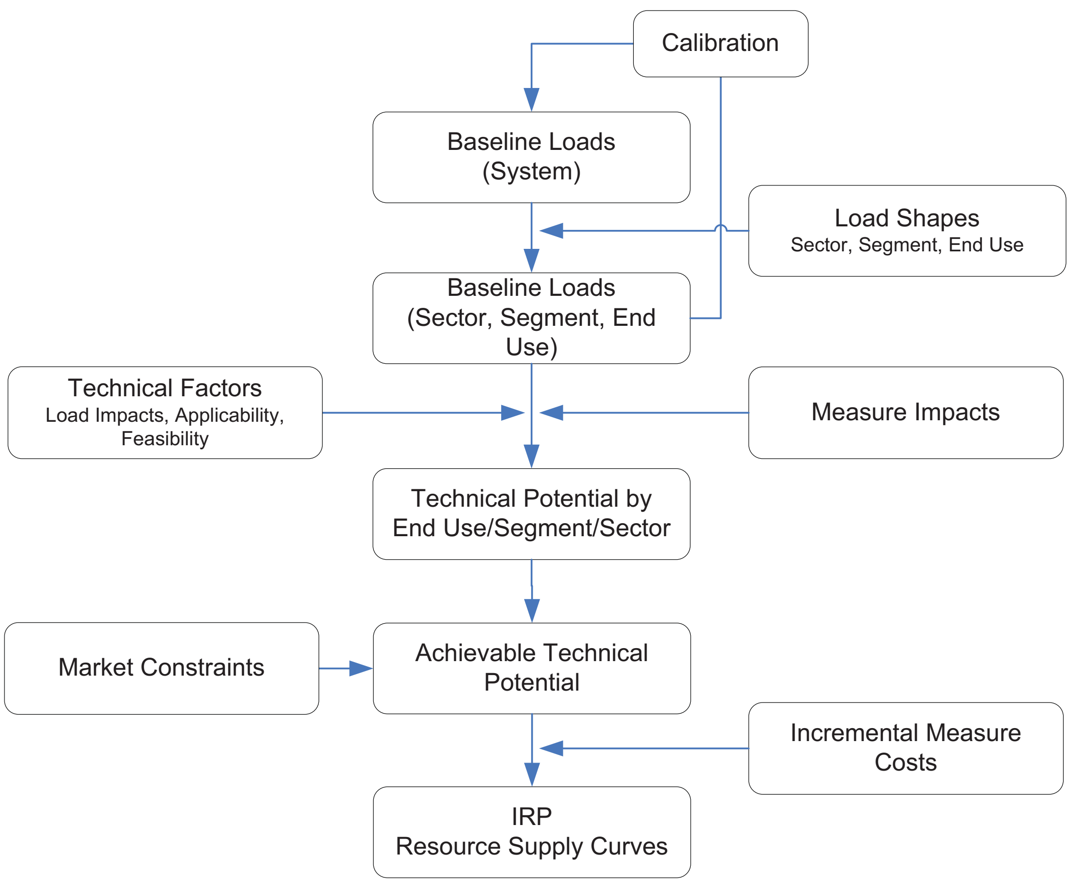
1. Introduction

General Approach and Methodology

The DSM resources analyzed in this study differ with respect to technology, availability, type of load impact, and target consumer markets. Analysis of their potentials, therefore, requires customized methods that can address the unique characteristics of each resource. These methods, however, spring from the same conceptual framework and the general analytic approach.

The general methodology is best described as a hybrid "top-down/bottom-up" approach. As illustrated in Figure 1, it begins with the current load forecast, decomposes it into its constituent customer-class and end-use components, and examines the effect of the range of demand-side measures and practices on each end use, taking into account fuel shares, current market saturations, technical feasibility, and costs. These unique impacts are then aggregated to produce estimates of resource potentials at the end-use, customer-class, and system levels.

Figure 1. General Methodology for Assessment of Demand-Side Resource Potentials



The standard methodology for determination of DSM potentials generally distinguishes four distinct, yet related, definitions of resource potential that are widely used in utility resource planning: naturally occurring conservation, "technical potential," "economic potential," and "achievable potential."

Naturally occurring conservation refers to gains in energy efficiency that occur as a result of normal market forces such as technological change, energy prices, market transformation efforts, and improved energy codes and standards. In this analysis, the market effects components of naturally occurring conservation are taken into account by explicitly incorporating changes to codes and standards and marginal efficiency shares in the development of the base-case forecasts.

Technical potential assumes that all resource opportunities may be captured, regardless of their costs or market barriers. For demand-side resources such as energy efficiency and fuel conversion, technical potentials further fall into two classes: "instantaneous" (retrofit) and "phased-in" (lost-opportunity) resources. It is important to note that the notion of "technical potentials" is less relevant to resources such as demand response and distributed generation—nearly all end-use loads may be subject to interruption or displacement by on-site generation from a strictly "technical" point of view.

Economic potential represents a subset of technical potential consisting of only those measures that are deemed cost-effective based on a cost-effectiveness criterion, usually the total resource cost (TRC) test. For each measure, the test is structured as the ratio of the net present values of the measure's benefits and costs. Only those measures with a benefit-to-cost ratio of equal or greater than 1.0 are deemed cost-effective and are retained for further analysis.

Achievable potential is defined as that portion of economic potential that might be assumed to be achievable in the course of the planning horizon, given market barriers that may impede customer participation in demand-side management programs sponsored by the utility. The assumed levels of achievable potentials are meant to serve principally as planning guidelines. Ultimately, the actual levels of achievable opportunities will depend on the customers' willingness and ability to participate in the demand-side programs, administrative constraints, and availability of an effective delivery infrastructure. The customer's willingness to participate in demand-side programs also depends on the amount of incentive that is offered.

For the purpose of the current IRP, the screening of energy efficiency resources will take place as part of the optimization process. Therefore, the measures included in the technical potential were not screened for cost-effectiveness. Instead, fixed ramp rates were directly applied to technical potential to create a supply curve for IRP modeling.

The methodology used for estimating the technical energy efficiency potential is based on standard industry practices and consistent wit the methodology used by the Northwest Power and Conservation Council (the Council) in its assessments of conservation potentials for the 6th Northwest Regional Power Plan. Electric energy efficiency technologies and measures considered in this include those approved by the Northwest Regional Technical Forum (RTF) and measures used in the 6th Power Plan. As described in Section 2, the ramp rates used to determine achievable potential for retrofit opportunities are comparable to – and in the case of phased-in, normal replacement higher than – those currently being proposed by the Council for calculating achievable potentials in the 6th Power Plan.

In compliance with the rules established in Chapter 480-109 of the Washington Administrative Code (WAC), this report fully describes the technologies, data inputs, data sources, data collection processes, and all assumptions used in calculation of technical and achievable long-term potentials. The results of the electric conservation potential reported here are reflected in PSE's upcoming IRP and will provide the basis for compliance with the requirements of WAC Chapter 480-109.

Comparison to 2007 IRP

Energy Efficiency

While the results of this study are similar to those presented in the 2008 IRP, there are a number of reasons why we would expect some differences. These include:

- Updated baseline data from primary and secondary data collection efforts (See Appendix A)
- Updated consumption estimates from building simulation and conditional demand modeling
- Changes in codes and standards
- New measures included in the analysis (Table 9).
- New information on measure costs, savings, and applicability

Table 9. Number of measures considered in 2008 and 2010 IRP

Sector	Electric Measures Considered		Gas Measures Considered	
	2007 IRP	2009 IRP	2007 IRP	2009 IRP
Residential	65	118	30	51
Commercial	73	105	32	51
Industrial	9	16	4	8

Changes in any of these factors can lead to significant changes in identified potentials, especially when comparing at a granular level, such as by end use or measure.

Table 10 presents a comparison of the electric and natural gas technical potentials from this study and the 2007 IRP. Because no economic screen was performed as part of this study, it is difficult to compare quantities of economic or achievable potential. Some of the key differences are:

- Air conditioning – the new saturation survey showed an increased saturation of residential cooling equipment. This, combined with changes in available efficiency levels, led to a significantly higher technical potential.

- Electric cooking and drying – no measures were analyzed for these end uses in the previous study.

- HVAC Auxiliary – the 2009 assessment identified a large potential for high efficiency ventilation systems through electrically commutated motors and variable speed drives.

- Lighting – lighting decreased substantially both because of the effect of EISA described in the Executive Summary and because of the aggressiveness of PSE's lighting program over the past two years.

- Refrigerators and freezers – updated impacts for Energy Star appliances and appliance recycling.

- Plug loads – this is primarily driven by the increase in saturation of consumer electronics in the past two years, including flat-screen televisions and set-top boxes.

- Gas space and water heating – technical potential for these end uses increased dramatically, mainly due to differences in the measures analyzed. For space heating, new measures were included and some that were considered "emerging" in the last study, were deemed mature enough for inclusion in the energy efficiency potential (e.g. leak-proof duct fittings). For water heating, the major difference was in the efficiency level of equipment considered. This study analyzed a 0.86 EF water heater, while the most efficient level considered in the previous study was 0.64 EF.

Table 10. Residential Energy Efficiency Technical Potential Comparison

	20-Year Electric Technical Potential (aMW)		20-Year Gas Technical Potential (million therms)	
End Use	**2007 IRP**	**2009 IRP**	**2007 IRP**	**2009 IRP**
Central AC	2.1	8.8		
Cooking	-	5.5	1.5	0.4
Dryer	-	4.1	-	0.3
Freezer	2.1	13.1		
HVAC Auxiliary	-	23.8		
Heat Pump	11.6	14.5		
Lighting	137.9	74.5		
Plug Loads	30.0	39.4		
Pool Heating	-	-	0.7	0.2
Refrigerator	12.0	25.5		
Room AC	0.2	1.0		
Space Heating	65.8	71.4	92.3	162.2
Water Heating	48.5	48.5	32.8	100.4
Total	**310**	**330**	**127**	**263**

In the commercial sector, estimates of total technical potentials are very close (Table 11). The major difference was the reclassification of some of the heating and cooling potential into the HVAC Auxiliary (ventilation) end use. Refrigeration and plug load potential also increased due to inclusion of additional measures and updated consumption and saturation numbers. Lighting potential decreased based on the updated data from the Commercial Building Stock Assessment.

Table 11. Commercial Energy Efficiency Technical Potential Comparison

End Use	20-Year Technical Potential (aMW) 2007 IRP	20-Year Technical Potential (aMW) 2009 IRP	20-Year Gas Technical Potential (million therms) 2007 IRP	20-Year Gas Technical Potential (million therms) 2009 IRP
Cooking	-	1.6	1.52	4.0
Cooling Chillers	32.6	14.0		
Cooling DX	58.1	19.5		
HVAC Auxiliary	1.4	44.8		
Heat Pump	18.6	27.8		
Heating	61.4	27.3	92.3	94.7
Lighting	176.6	138.2		
Plug Loads	4.9	51.3		
Pool Heating	-	-	0.7	0.5
Refrigeration	10.9	42.4		
Water Heating	9.3	11.1	32.8	32.5
Total	**374**	**378**	**127**	**132**

The industrial sector saw only minor changes on the electric side (Table 12). For gas customers, additional potential in process heating was identified.

Table 12. Industrial Energy Efficiency Technical Potential Comparison

End Use	20-Year Technical Potential (aMW) 2007 IRP	20-Year Technical Potential (aMW) 2009 IRP	20-Year Gas Technical Potential (million therms) 2007 IRP	20-Year Gas Technical Potential (million therms) 2009 IRP
Boiler			3.5	2.2
HVAC	2.0	2.4	0.9	1.4
Lighting	1.6	0.7		
Process Cooling	1.4	0.9		
Process Heating	-	2.3	-	8.0
Process Motors Air Compression	3.2	3.8		
Process Motors Fans	1.3	0.8		
Process Motors Other	2.4	3.4		
Process Motors Pumps	5.9	1.5		
Process Motors Refrigeration	0.8	1.0		
Process Other			-	0.2
Total	**19**	**17**	**4**	**12**

Fuel Conversion

In the 2007 IRP, the potential from fuel conversion only included single-family homes in PSE's combined electric and gas service areas. This time, the potential was expanded to consider new multifamily structures and commercial structures (new and existing). In addition, PSE considered fuel conversion for customers in its electric service area being served by other natural gas providers. The total potential from fuel conversion is thus significantly more than in the 2007 IRP (increase from a technical potential of 97 to 174 aMW).

Demand Response

The methodologies used to estimate the technical and achievable potentials in 2007 were the same as those used in the 2007 analysis. The results of the analysis of DR potentials are shown by sector in Table 13.

Peak demand reduction potential in the residential sector increased significantly due to an increase in expected market penetration of direct load control (DLC) from an assumed 10% to 35% and inclusion of inclusion of room heating (primarily baseboard heating) as a potential target end use. There was also an increase in expected peal impacts of critical peak pricing (CPP) from 10% in the 2007 IRP to 27% in the 2009 IRP.

Peak demand reduction potentials in the commercial and industrial sectors were found to be lower than those estimated in the 2007 IRP. The primary change in the potentials for these sectors were the result of an increase in minimum load eligibility threshold from 250 kW in the 2007 IRP to 500 kW in the 2009 IRP for the C&I interruptible tariffs. Moreover, expected market penetration for the demand buyback program was reduced from 25% in the 2007 IRP to 10% in the 2009 IRP.

Table 13. Demand Response Technical and Achievable Technical Potential Comparison by Sector

	20 Year Technical Potential		20 Year Achievable Technical Potential	
Sector	**2007 IRP**	**2009 IRP**	**2007 IRP**	**2009 IRP**
Residential	765	1729	56	170
Commercial	320	135	25	14
Industrial	114	43	8	5
Total	**1,199**	**1,909**	**89**	**189**

Note: Individual results may not sum to total due to rounding.

Note: Interactions between programs has not been taken into account.

Note: Residential technical potential and achievable technical potential for direct load control do not include AMR converted to AMI or existing AMI due to overlap with no AMR meter installed.

Distributed Generation

In this assessment, the methodology used to estimate distributed generation potential was more rigorous as compared to the 2007 IRP. In general, with growing interest in distributed generation, and renewables specifically, more secondary data are now available allowing for a more sophisticated analysis. Better data and enhanced methodology for estimating the achievable technical potential led to about a 50% increase in the potential over the previous study (Table 14. This increase is primarily from the additional opportunities in building photovoltaic (PV) applications. Given the increasing interest in PV, expanding federal and state tax credits and recent program activity, the potential from PV is likely significantly more than what was estimated in 2007.

Table 14. Distributed Generation Achievable Technical Potential Comparison by Resource

Resource	20-year Achievable Technical Potential (aMW)	
	2007 IRP	2009 IRP
Non-Renewable CHP	25.9	34.0
Renewable CHP	16.2	8.7
Building Photovoltaics	0.07	21.0
Small Hydro	NA	0.12
Small Wind	0.04	0.04
Total	**42.3**	**66.4**

Effects of the Energy Independence and Security Act of 2007

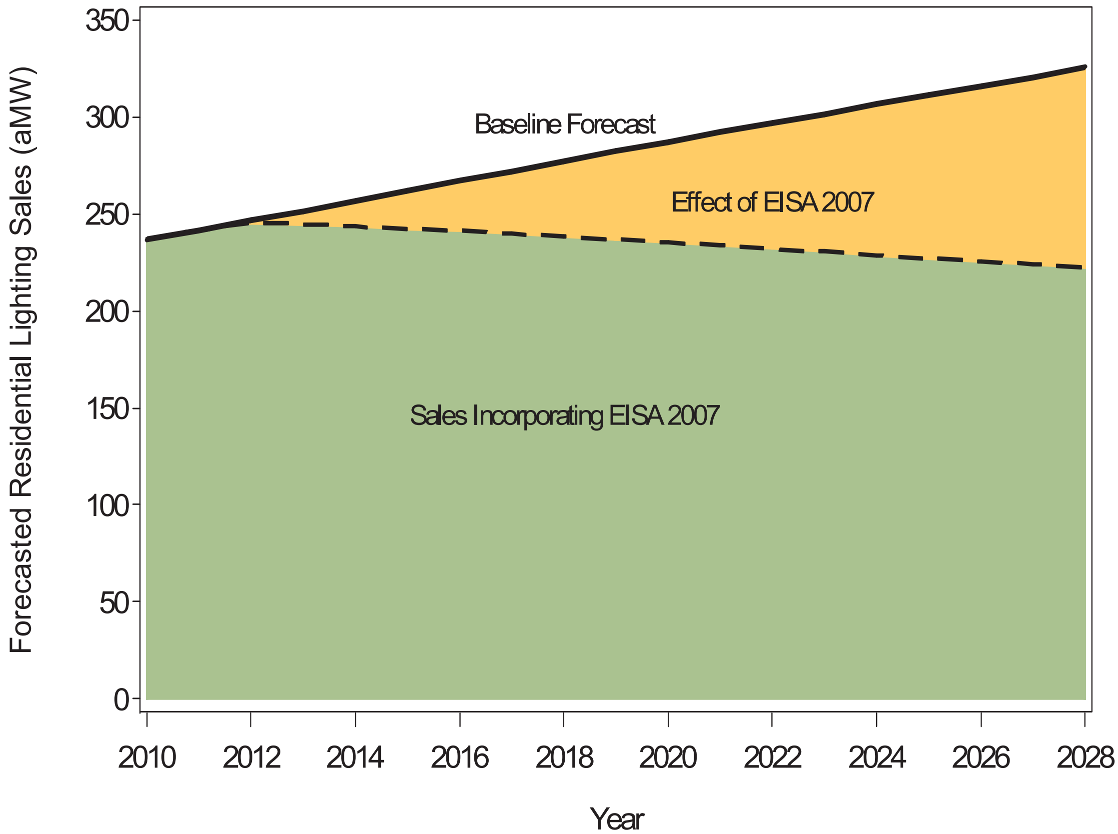
While this analysis does not attempt to predict how energy codes and standards may change in the future, it does capture legislation that has already been enacted, even if it will not go into effect for several years. The most notable of these is the Energy Independence and Security Act (EISA) of 2007, which sets new standards for general service lighting, motors, and other end-use equipment. Because of the large role residential lighting plays in PSE's energy-efficiency programs, it was particularly important to capture the effects of this legislation. EISA requires general service lighting becomes roughly 30% more efficient, with standards phased in by wattage beginning in 2012.

PSE and Cadmus coordinated with the Council to ensure consistency in assumptions about how lighting standards would affect loads and potential going forward. These discussions led to the following conclusions:

- As no technology currently available meets the EISA standards and costs less than a Compact Fluorescent Light (CFL) bulb, it is assumed CFLs will become the de facto baseline.
- When the legislation takes effect, standard incandescent light bulbs will still be in use and in reserve; so switchover will not occur all at once. Thus, it is assumed sockets will convert to CFLs (roughly) equally from 2012 to 2029.
- Because EISA requirements only apply to general service lighting, there will still be some CFL potential for non-standard applications.
- LED technology may become viable for general service applications, creating another source of savings.

Figure 2 shows the effect EISA is expected to have on PSE's residential lighting sales over the planning horizon. It is anticipated these new lighting standards will reduce sales in 2029 by nearly 110 aMW, or 33% of baseline lighting consumption.

Figure 2. Baseline and EISA 2007 Residential Lighting Forecasts



Organization of the Report

This report is organized in four sections with one section presenting the results of each resource type: energy efficiency, fuel conversion, demand response, and distributed generation. Additional technical information, descriptions of data and their sources are presented in the appendices to this document.

2. Energy-Efficiency Potentials

Scope of Analysis

The primary objective in this assessment was to develop accurate estimates of available energy-efficiency potential, essential for PSE's IRP and program planning efforts. To support these efforts, Cadmus performed an in-depth assessment of technical and "achievable technical" potential for electric and gas resources in the residential, commercial, and industrial sectors. This potential was then bundled in terms of cost of conserved energy, allowing the IRP model to determine the optimal amount of energy-efficiency potential to select. This represents a change in methodology from previous IRPs, where the achievable potential was prescreened for cost-effectiveness and put into the IRP model as a must-take resource.

To bundle potential by cost, data on measure costs, savings, and market size were collected at the most granular level possible. Within each fuel and sector, the study distinguished between customer segments or facility types and their respective applicable end uses. Six residential segments (existing and new construction for single-family, multifamily, and manufactured homes), 20 commercial segments (10 building types within the existing and new construction vintages), and 34 industrial segments (17 facility types, also within existing and new construction vintages) were analyzed.

The study includes a comprehensive set of energy-efficiency electric and natural gas measures applicable to the climate and customer characteristics of PSE's service territory. This list includes both measures analyzed for the previous IRP and new measures that have become commercially available since the last study. The analysis began by assessing the technical potential for 239 *unique* electric and 110 unique gas energy-efficiency measures (Table 15). Considering all permutations of these measures across all customer sectors, segments, and fuels, customized data had to be compiled and analyzed for over 6,700 measures.

Table 15. Energy-Efficiency Measure Counts by Fuel

Sector	Electric Measure Counts	Gas Measure Counts
Residential	118 unique, 1,198 permutations across segments	51 unique, 435 permutations across segments
Commercial	105 unique, 2,866 permutations across segments	51 unique, 1,430 permutations across segments
Industrial	16 unique process improvements, 664 permutations across segments	8 unique process improvements, 125 permutations across segments

The remainder of this section is divided into three parts: a brief description of the methodology for estimating technical and achievable technical potential; a summary of resource potentials by fuel; and, finally, detailed sector-level results.

Methodology

The basic methodology for estimating energy-efficiency potential is consistent for all six sector-fuel combinations:

- **Develop baseline forecast:** A baseline forecast is created based on end-use consumption estimates, calibrated to PSE's base year sales and official forecast. This provides accurate estimates of consumption by fuel, sector, customer segment, end use, and year.
- **Compile measure lists:** All measures applicable to PSE's climate and customers were analyzed to accurately depict the energy-efficiency potential over the 20-year planning horizon. When expanded by fuel, customer segment, end use, and vintage, this list totaled over 6,700 measures (as discussed above).
- **Estimate technical potential:** An alternate forecast was created where all technically feasible measures were assumed to be installed. The difference between this forecast and the baseline represents the technical potential in each year. The effects of EISA 2007 were removed from this potential, as described in the Executive Summary.
- **Estimate "achievable technical" potential:** A subset of the technical potential was taken to reflect the maximum that could be achieved after accounting for market barriers, assuming PSE was willing to pay up to 100% of incremental cost in incentives. The percent of technical potential deemed "achievable" is consistent with the previous IRP and the Northwest Power & Conservation Council (Table 16)

Table 16. 20 Year Market Penetration Rates by Fuel and Sector

	Electric		Gas	
Sector	Existing Construction	New Construction	Existing Construction	New Construction
Residential	85%	65%	75%	55%
Commercial	85%	65%	75%	55%
Industrial	85%	65%	75%	55%

- **Create IRP bundles by cost:** The achievable technical potential was finally grouped into bundles by the cost of conserved energy for inclusion in the IRP model. Price points were defined based on estimates of PSE's avoided energy costs under several different scenarios.

A detailed discussion of the methodology for estimating energy-efficiency potential is presented in Volume II, Appendix C.

Summary of Resource Potential—Electric

Table 17 shows 2029 forecasted baseline electric sales and potential by sector. As shown, the results of this study indicate 739 aMW of technically feasible electric energy-efficiency potential will be available by 2029, the end of the 20-year planning horizon. This translates to an achievable technical potential of 589 aMW. Were all of this potential cost-effective and realizable, it would amount to a 16% reduction in 2029 forecasted retail sales and a 51% reduction of load growth from 2010 to 2029.

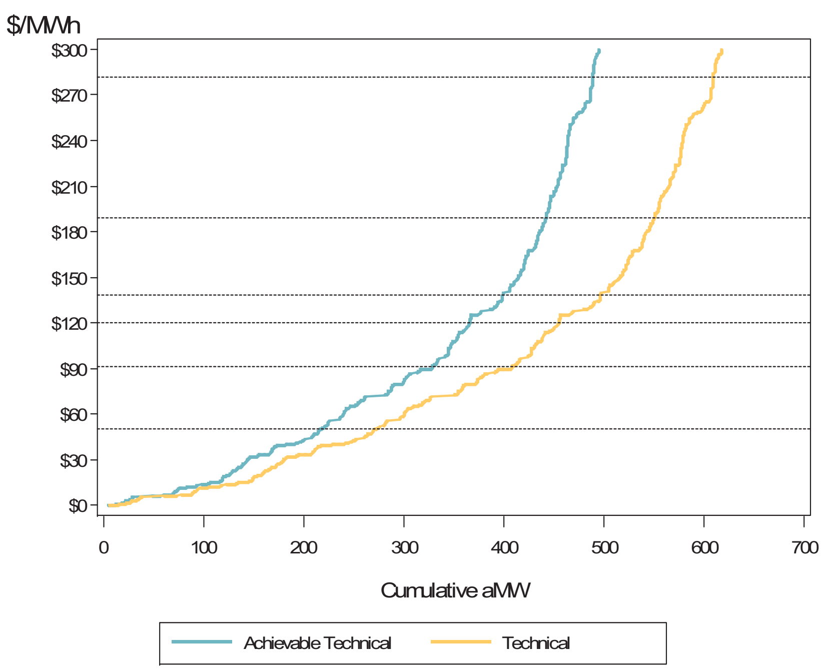
Table 17. Technical and Achievable Technical Electric Energy-Efficiency Potential (aMW in 2029) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Achievable Technical Potential	Achievable Technical Potential as % of Baseline
Residential	1,756	343	20%	273	16%
Commercial	1,813	378	21%	301	17%
Industrial	135	17	13%	14	11%
Total	**3,704**	**739**	**20%**	**589**	**16%**

These savings are based on forecasts of future consumption absent any utility program activities. While consumption forecasts account for the past savings PSE has acquired, the estimated potential is inclusive of—not in addition to—current or forecasted program savings.

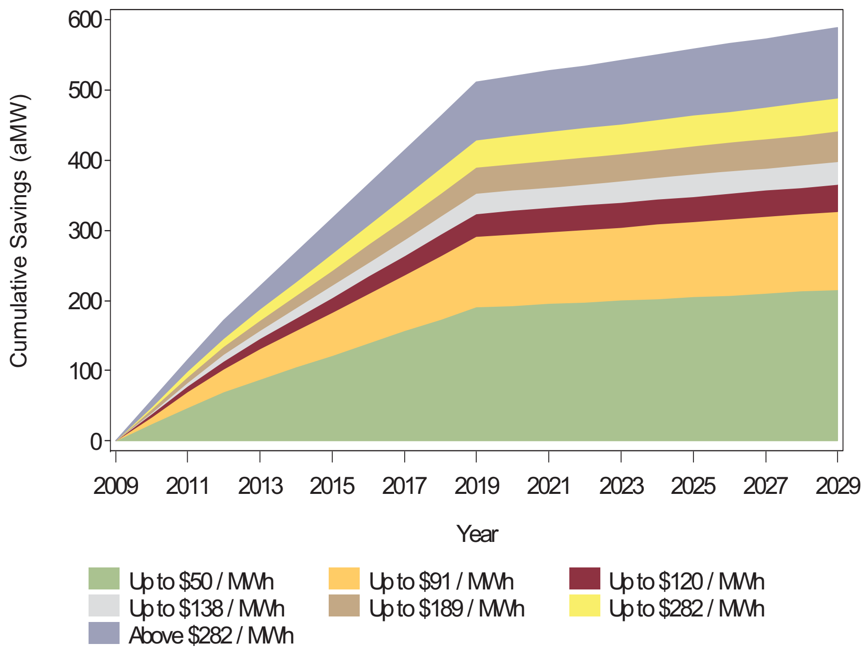
Figure 3 illustrates how identified potential translates into IRP bundles by cost of conserved energy. The horizontal dashed lines represent the cost cutoffs that identify the bundles. For example, roughly 200 aMW of achievable potential was offered to the IRP model at a cost below $50 per MWh. Measures with a levelized cost above $282 per MWh were not included in IRP modeling.

Figure 3. Electric Potential by IRP Cost Bundle – Cumulative 2029



The cumulative potential available is presented in Figure 4 by year and cost group. It is assumed retrofit opportunities in existing buildings can be captured within 10 years, whereas new construction and equipment replacement potential can only be captured as it becomes available over the 20-year planning horizon.

Figure 4. Acquisition Schedule for Achievable Technical Electric Savings by Cost Group



Summary of Resource Potential – Gas

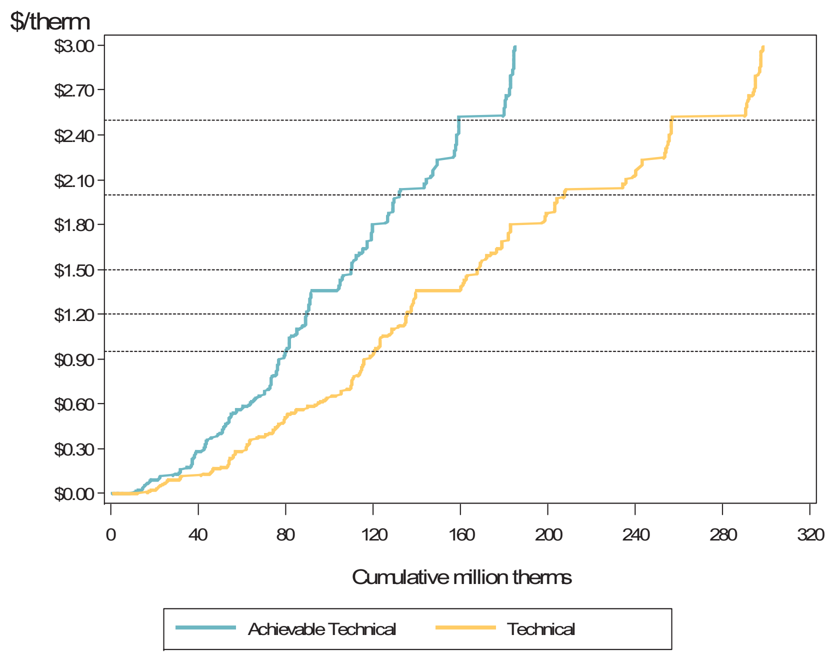
Table 18 shows 2029 forecasted baseline gas sales and potential by sector. As shown, the results of this study indicate roughly 407 million therms of technically feasible, gas energy-efficiency potential by 2029, the end of the 20-year planning horizon. This translates to an achievable technical potential of 254 million therms. If all of this potential was cost-effective and realizable, it would amount to a 19% reduction in 2029 forecasted retail sales and a 61% reduction in load growth from 2010 to 2029.

Table 18. Technical and Achievable Technical Gas Energy-Efficiency Potential (Million therms in 2029) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Achievable Technical Potential	Achievable Technical Potential as % of Baseline
Residential	854	263	31%	162	19%
Commercial	440	132	30%	84	19%
Industrial	53	12	22%	9	17%
Total	**1,348**	**407**	**30%**	**254**	**19%**

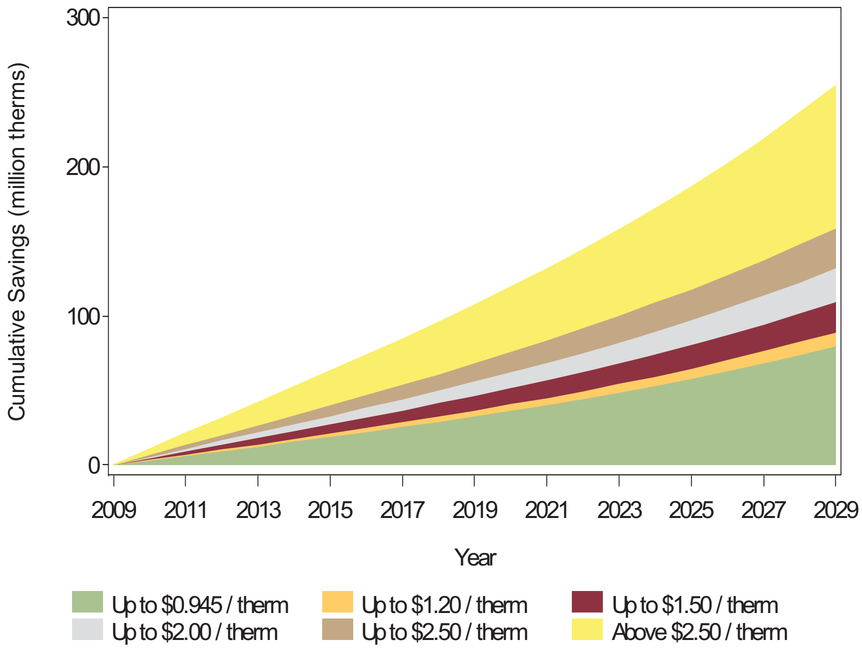
Figure 5 illustrates how identified potential translates into IRP bundles by cost of conserved energy for gas measures. The horizontal dashed lines represent the cost cutoffs that identify the bundles. For example, roughly 75 million therms of achievable potential were offered to the IRP model at a cost below $0.95 per therm. Measures with a levelized cost above $2.50 per therm were not included in IRP modeling.

Figure 5. Natural Gas Potential by IRP Cost Bundle—Cumulative 2029



The cumulative potential available is presented in Figure 6 by year and cost group. As PSE's natural gas energy-efficiency programs are still relatively new, the assumptions regarding timing of resource acquisition are less aggressive than for electric resources. It is assumed it will take the full 20 years to capture retrofit opportunities in existing construction and that program activity will ramp up over time.

Figure 6. Acquisition Schedule for Achievable Technical Natural Gas Savings by Cost Group



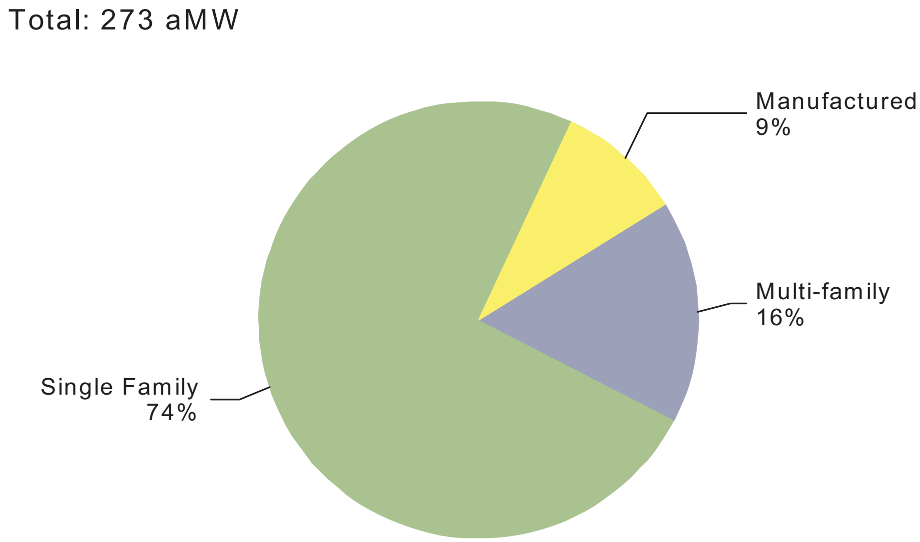
Detailed Resource Potential

Residential Sector—Electric

Residential customers in PSE's service territory are expected to account for almost one-half of baseline electricity retail sales by 2029. The single-family, manufactured, and multifamily dwellings that comprise this sector present a variety of potential savings sources, including equipment efficiency upgrades (e.g., air conditioning, refrigerators), improvements to building shells (e.g., insulation, windows, air sealing), and increases in lighting efficiency (e.g., compact fluorescent light bulbs, LED interior lighting). As described in the Executive Summary, the expected impacts of new lighting standards created in EISA 2007 have been removed from the potential presented in this section.

As shown in Figure 7, single-family homes represent 74% of the total achievable technical residential electric potential, followed by multifamily and manufactured homes (16% and 9%, respectively). The main driver of these results is each home type's proportion of baseline sales, but other factors, such as heating fuel sources, play an important role in determining potential. For example, manufactured homes typically have more electric heating than other home types, which increases their relative share of the potential. On the other hand, the lower use per customer for manufactured units serves to decrease this potential, as the same measure may save less in a manufactured home than in a single-family home. A comprehensive list of the specific factors affecting the results are included in the segment-specific data, provided in Volume II, Appendix C.

Figure 7. Residential Sector Electric Achievable Technical Potential by Segment



Despite the effects of EISA 2007, lighting represents the largest portion (26%) of achievable technical potential, followed closely by heating savings (21%). Appliances (refrigerators, freezers, dryers, etc.), water heating, and plug loads each represent over 10% of the total identified potential. Figure 8 shows the total achievable technical potential by end-use group. Detailed potentials by end use and cost group are presented in Table 19.

Figure 8. Residential Sector Electric Achievable Technical Potential by End Use

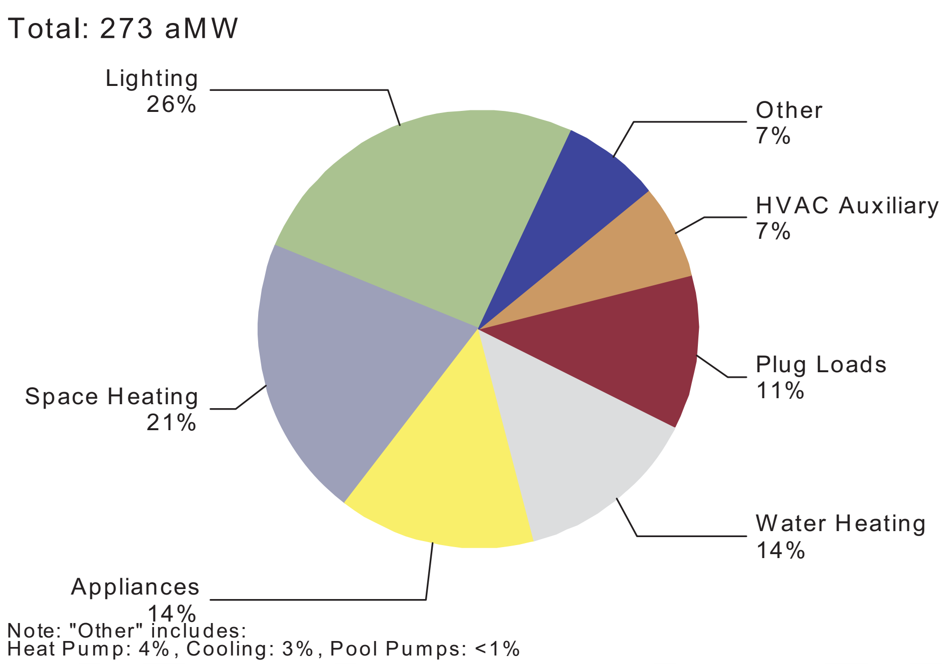


Table 19. Residential Sector Electric Energy-Efficiency Potential by End Use (aMW in 2029)

			Achievable Technical Potential						
End Use	**Baseline Sales**	**Technical Potential**	**Under $50/MWh**	**Under $91/MWh**	**Under $120/MWh**	**Under $138/MWh**	**Under $189/MWh**	**Under $282/MWh**	**All Costs**
Central AC	17.2	8.8	0.3	0.4	0.5	0.6	0.6	1.6	6.9
Cooking	127.6	5.5	-	-	-	-	-	-	4.3
Dryer	87.0	4.1	-	3.2	3.2	3.2	3.2	3.2	3.2
Freezer	44.4	13.1	8.5	10.7	10.7	10.7	10.7	10.7	11.0
HVAC Auxiliary	79.1	23.8	-	-	0.9	9.0	12.2	12.3	19.1
Heat Pump	40.1	14.5	2.1	5.6	6.1	6.2	6.4	7.1	11.6
Lighting	330.0	74.5	37.5	51.8	54.8	64.0	64.3	68.8	70.3
Plug Loads	458.4	39.4	0.0	8.3	8.6	9.0	17.3	23.6	31.1
Refrigerator	89.3	25.5	13.6	14.4	14.4	14.4	16.6	16.6	20.9
Room AC	4.6	1.0	0.0	0.0	0.0	0.0	0.1	0.2	0.8
Space Heating	284.9	71.4	10.4	22.8	25.6	26.7	32.4	34.9	57.1
Water Heat	192.8	48.5	23.6	23.9	25.5	28.4	32.2	34.4	37.1
Total	**1,756**	**330**	**96**	**141**	**150**	**172**	**196**	**213**	**273**

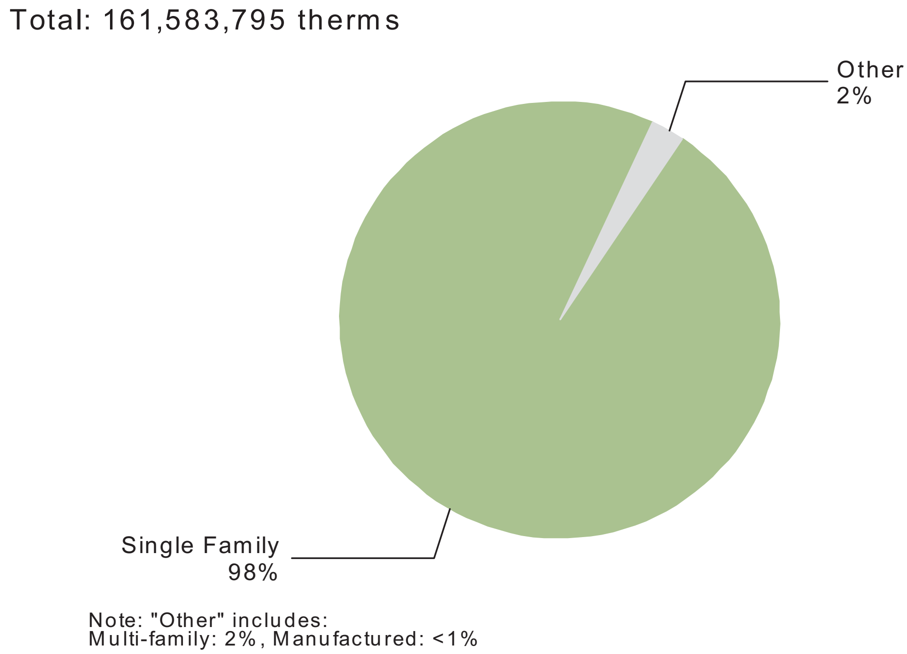
Additional details regarding the savings associated with specific measures assessed within each end use are provided in Volume II, Appendix C.

Residential Sector—Natural Gas

By 2029, residential customers are expected to account for over 60% of PSE's gas sales. Unlike residential electricity consumption, relatively few gas-fired end uses exist (primarily, space heat, water heat, and appliances); however, significant energy savings opportunities still exist. Based on resources included in this assessment, gas achievable technical potential in the residential sector is expected to be about 162 million therms over 20 years, corresponding to a 19% reduction of forecasted 2029 sales.

Single-family homes account for 71% of PSE's residential customers and 73% of baseline sales. Because of this, these homes account for 98% of the identified achievable technical potential, as shown in Figure 9. There is a small amount (2%) of potential in multifamily residences, but very little in manufactured homes due to lack of gas connections.

Figure 9. Residential Sector Gas Achievable Technical Potential by Segment



Space and water heating account for over 99% of the identified potential (Figure 10). This potential is a combination of high-efficient equipment (e.g., furnaces and water heaters) and retrofits, such as shell measures, duct and pipe insulation, and low-flow showerheads. Table 20 presents 2029 baseline sales, as well as technical and achievable technical potential by cost group for each end-use analyzed. The "other" category refers to end uses not easily characterized, such as gas fireplaces, hot tubs, and saunas.

Figure 10. Residential Sector Gas Achievable Technical Potential by End Use

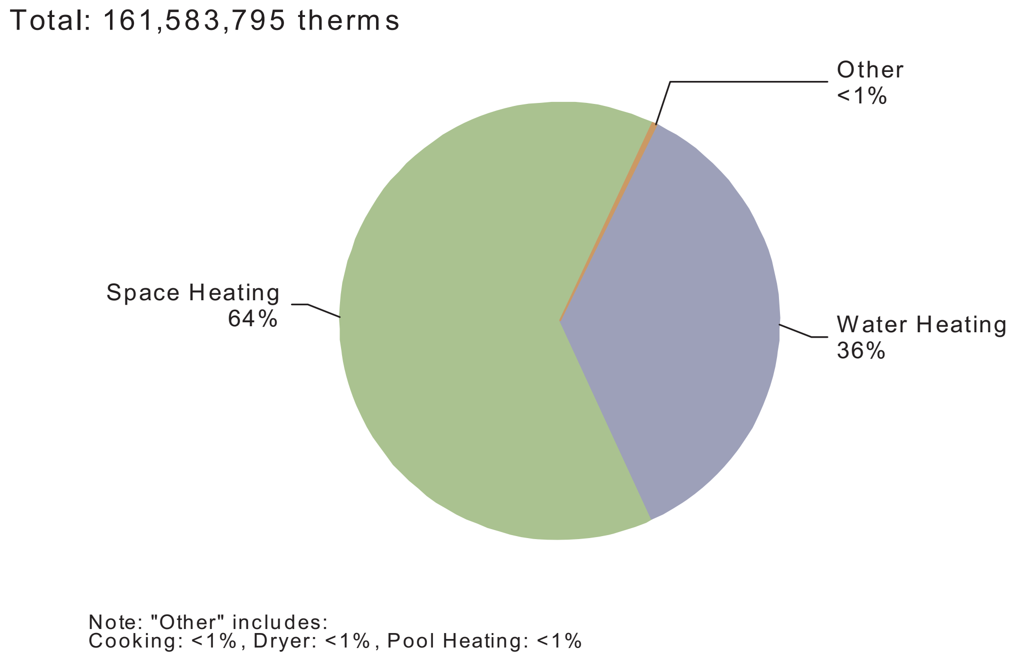


Table 20. Residential Sector Gas Energy-Efficiency Potential by End Use (Million therms in 2029)

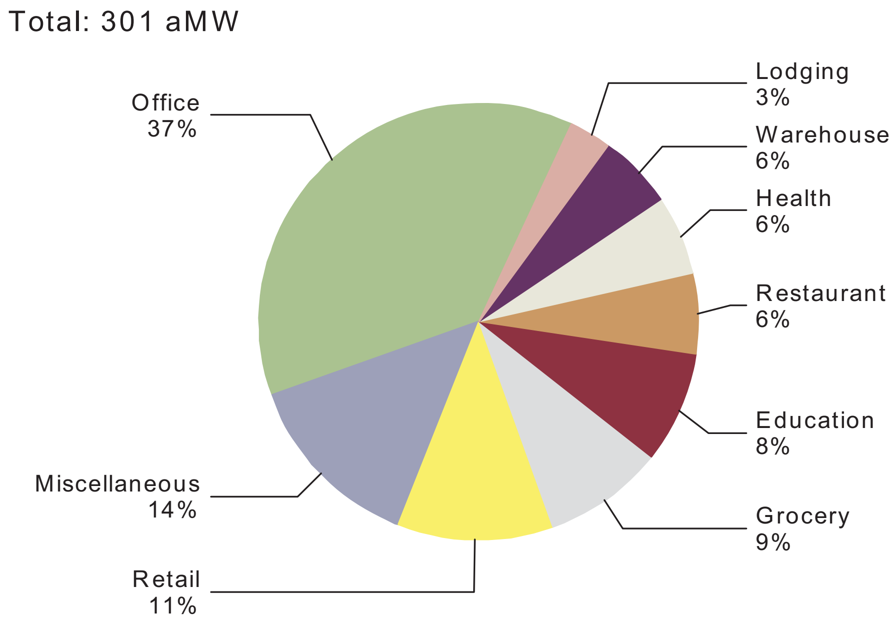
End Use	Baseline Sales	Technical Potential	Achievable Technical Potential Under $0.95/therm	Under $1.20/therm	Under $1.50/therm	Under $2.00/therm	Under $2.50/therm	All Costs
Cooking	16.5	0.4	-	-	-	-	-	0.3
Dryer	5.9	0.3	-	-	0.1	0.1	0.1	0.1
Other	29.6	-	-	-	-	-	-	-
Pool Heating	5.5	0.2	-	-	-	-	-	0.1
Space Heating	555.9	162.2	35.1	37.3	53.6	59.9	69.7	103.2
Water Heating	240.8	100.4	13.0	13.0	13.0	23.0	33.6	57.9
Total	**854**	**263**	**48**	**50**	**67**	**83**	**103**	**162**

Commercial Sector—Electricity

Based on resources included in this assessment, electric achievable technical potential in the commercial sector is expected to be just over 300 aMW over 20 years, corresponding to a 17% reduction of forecasted 2029 commercial consumption. Though similar in percentage terms, this potential is slightly higher than that of the residential sector, due to larger baseline sales.

As shown in Figure 11, offices and miscellaneous buildings combined represent just over half of the available potential (51%), 37% and 14%, respectively. The miscellaneous segment is a combination of customers that do not fit into one of the other categories or do not have enough information to be classified. Considerable savings opportunities are also expected in the commercial sector's retail (11%), grocery (9%), and education (8%) segments. Moderate savings amounts are expected to be available in health, restaurants, and lodging facilities.

Figure 11. Commercial Sector Electric Achievable Technical Potential by Segment



As in the residential sector, lighting efficiency represents by far the largest portion of achievable technical potential in the commercial sector (37%), followed by plug loads (13%), HVAC auxiliary (12%), and refrigeration (11%), as shown in Figure 12. The large lighting potential includes bringing existing buildings to code and exceeding code in new and existing structures. Table 21 shows how baseline sales and savings are distributed across end uses.

Figure 12. Commercial Sector Electric Achievable Technical Potential by End Use

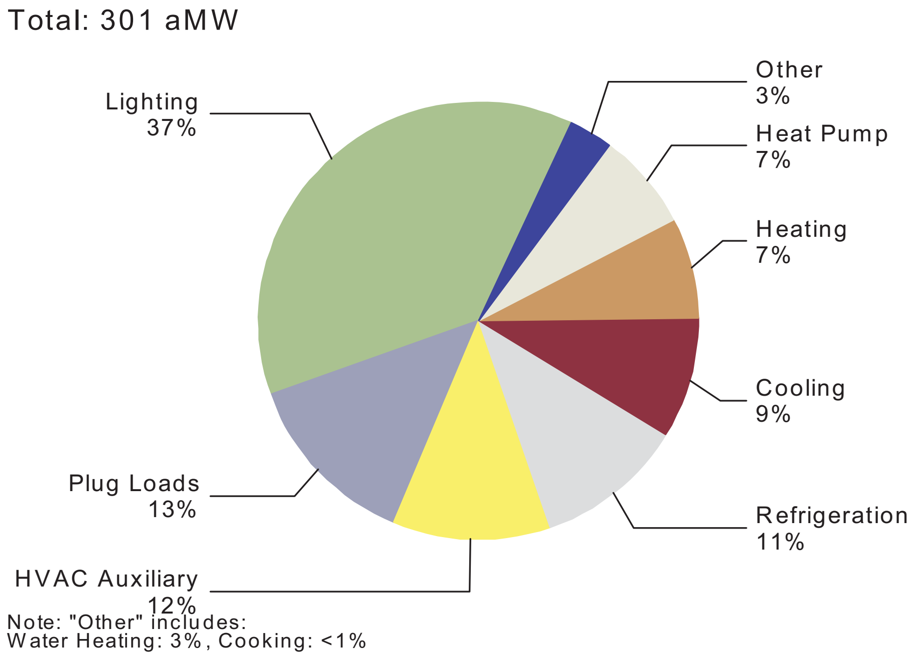


Table 21. Commercial Sector Electric Energy-Efficiency Potential by End Use (aMW in 2029)

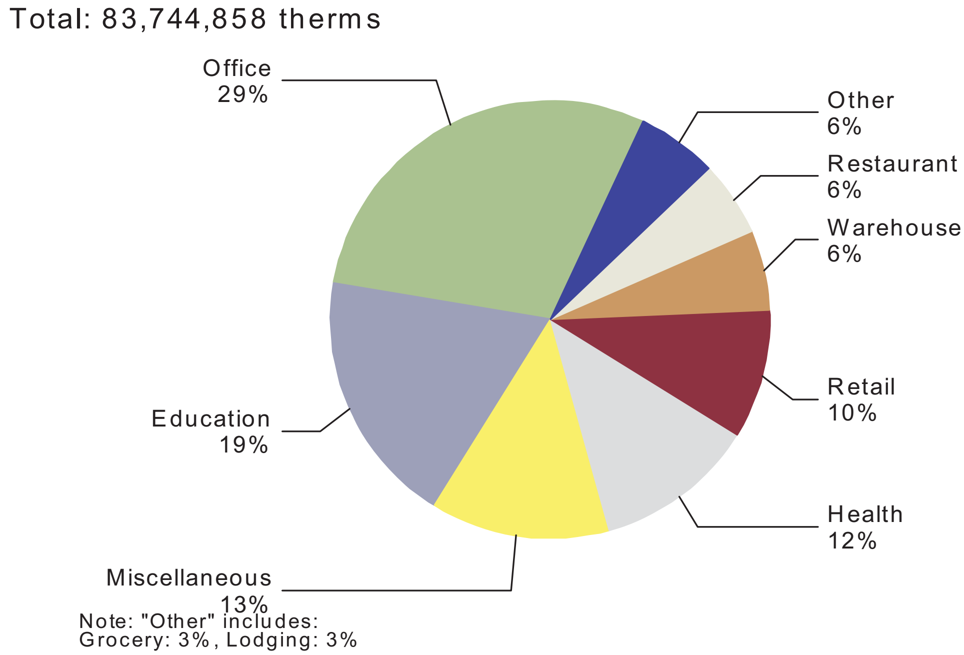
			Achievable Technical Potential						
End Use	**Baseline Sales**	**Technical Potential**	**Under $50/MWh**	**Under $91/MWh**	**Under $120/MWh**	**Under $138/MWh**	**Under $189/MWh**	**Under $282/MWh**	**All Costs**
Cooking	24.2	1.6	0.1	0.3	0.3	0.4	0.6	0.7	1.3
Cooling Chillers	22.2	14.0	0.3	0.8	2.1	2.7	3.2	6.7	11.2
Cooling DX	51.3	19.5	0.0	0.2	0.3	0.3	0.7	2.4	15.6
Dryer	43.3	-	-	-	-	-	-	-	-
HVAC Aux	229.1	44.8	24.1	29.4	31.3	32.3	32.8	33.2	35.0
Heat Pump	71.8	27.8	0.1	2.0	6.8	7.8	10.3	15.3	21.8
Heating	82.0	27.3	1.3	2.2	3.1	3.3	4.4	13.0	22.3
Lighting	554.8	138.2	21.9	73.1	91.2	96.9	109.6	111.7	112.6
Miscellaneous End Uses	36.1	-	-	-	-	-	-	-	-
Plug Loads	534.7	51.3	28.6	31.6	31.7	33.4	33.4	39.5	39.8
Refrigeration	102.0	42.4	26.7	28.7	30.0	30.0	30.8	32.4	33.0
Water Heating	61.4	11.1	2.3	3.5	4.0	4.2	4.8	5.3	8.4
Total	**1,813**	**378**	**106**	**172**	**201**	**211**	**231**	**260**	**301**

Commercial Sector—Natural Gas

Achievable technical natural gas potential in the commercial sector represents about a third of the total identified potential. The 84 million therms identified represent a 19% reduction in forecasted 2029 sales.

As for electric potential in the commercial sector, office buildings are the segment with the largest identified potential (29%, Figure 13). Significant amounts of achievable technical potential are also available in education (19%), miscellaneous buildings (13%), health facilities (12%), and retail (10%). Moderate savings amounts are expected to be available in warehouses, restaurants, grocery stores, and lodging facilities.

Figure 13. Commercial Sector Gas Achievable Technical Potential by Segment



As in the residential sector, there are far fewer gas-fired end uses than electric. Space heating accounts for over 70% of the identified potential. The remaining potential is almost entirely in water heating (25%), with small amounts in cooking and pool heating (Figure 14 and Table 22).

Figure 14. Commercial Sector Gas Achievable Technical Potential by End Use

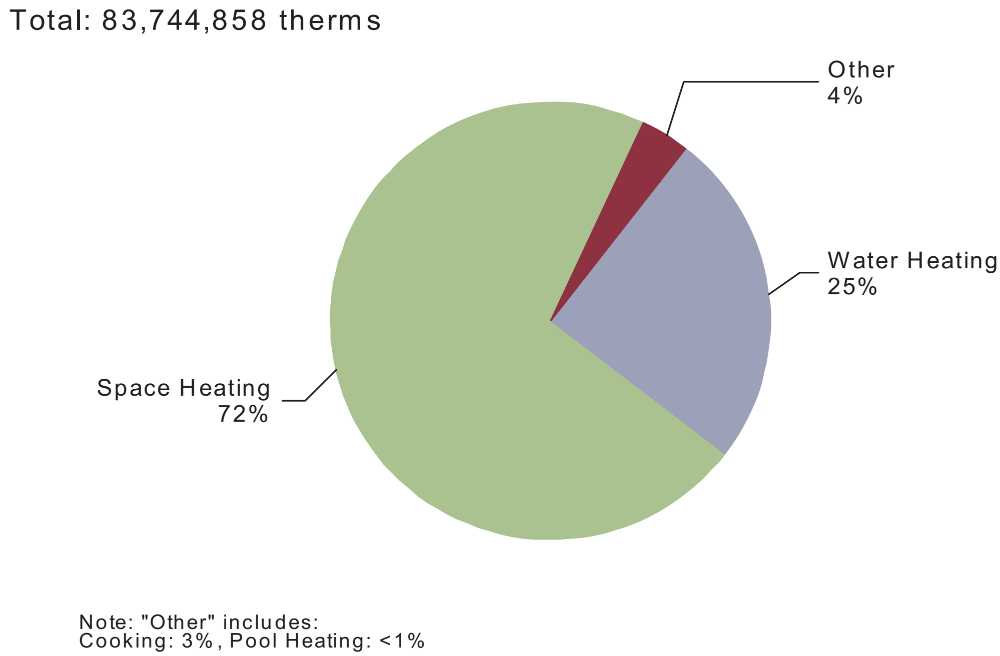


Table 22. Commercial Sector Gas Energy-Efficiency Potential by End Use (Million therms in 2029)

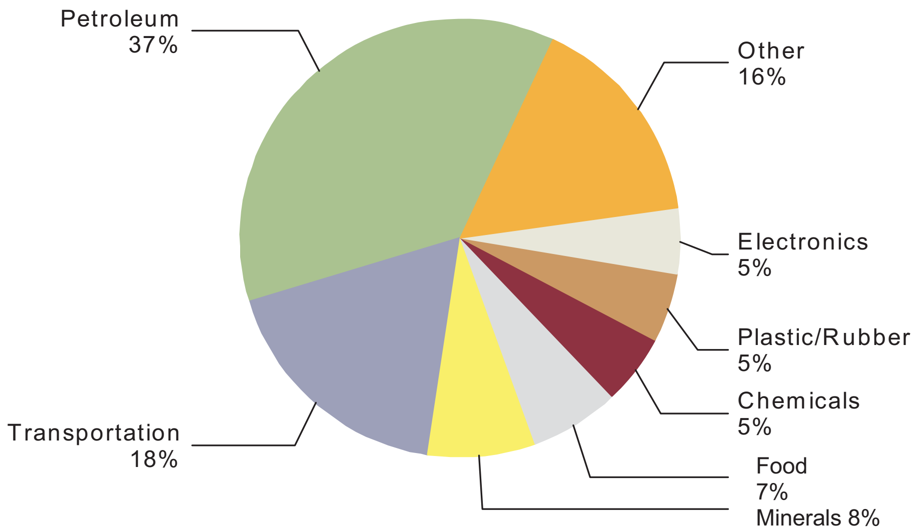
			Achievable Technical Potential					
End Use	Baseline Sales	Technical Potential	Under $0.95/therm	Under $1.20/therm	Under $1.50/therm	Under $2.00/therm	Under $2.50/therm	All Costs
Cooking	56.2	4.0	0.4	1.5	2.2	2.2	2.3	2.7
Dryer	24.1	-	-	-	-	-	-	-
Miscellaneous End Uses	6.3	-	-	-	-	-	-	-
Pool Heating	2.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3
Space Heating	255.8	94.7	13.9	17.4	19.2	24.5	30.4	59.9
Water Heating	94.7	32.5	8.4	10.9	12.2	13.0	13.7	20.8
Total	**440**	**132**	**23**	**30**	**34**	**40**	**47**	**84**

Industrial Sector - Electricity

Technical and achievable technical energy-efficiency potentials were estimated for major end uses within 17 major industrial sectors. For a list of these industries, along with baseline information, see Volume II, Appendix C. Across all industries, achievable technical potential totals approximately 14 aMW over the 20-year planning horizon, corresponding to an 11% reduction of forecasted 2029 industrial consumption. Note that in the industrial sector, most of the achievable technical potential is included in the lower-cost bundles.

Figure 15. Industrial Sector Electric Achievable Technical Potential by Segment

Total: 14 aMW

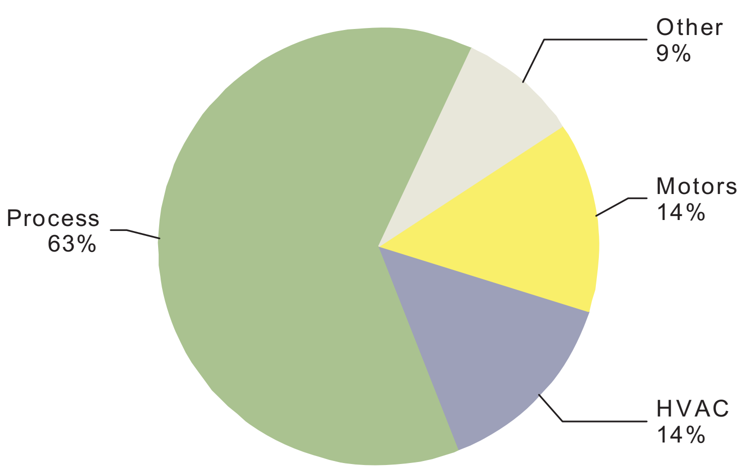


Note: "Other" includes:
Wood: 5%, Machinery: 3%, Miscellaneous: 3%, Minerals: 2%, Paper: 2%, Printing: 1%

The majority of electric achievable technical potentials in the industrial sector (63%) are attributable to efficiency gains in process efficiency (heating, cooling, compressed air, etc.), followed by HVAC improvements (14%) and motor system improvements (mainly fans and pumps). A small amount of additional potential exists for lighting and other facility improvements (Figure 16 and Table 23).

Figure 16. Industrial Sector Electric Achievable Technical Potential by End Use

Total: 14 aMW



Note: "Other" includes:
Miscellaneous: 4%, Lighting: 4%, Boiler: <1%

Table 23. Industrial Sector Electric Energy-Efficiency Potential by End Use (aMW in 2029)

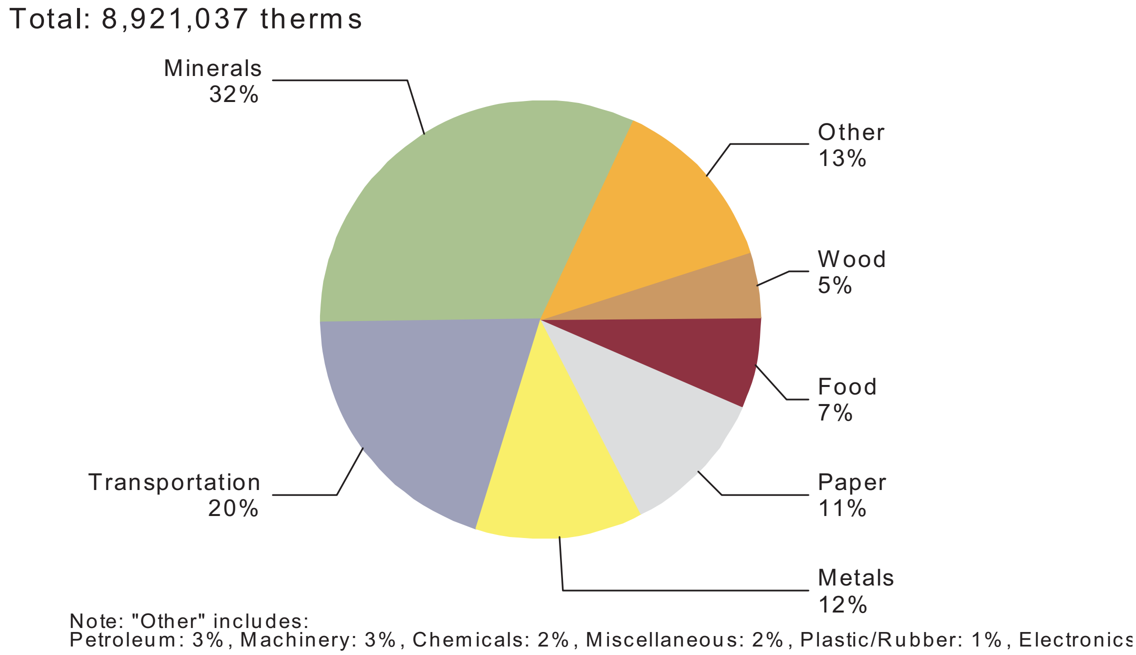
End Use	Baseline Sales	Technical Potential	Achievable Technical Potential						
			Under $50/MWh	Under $91/MWh	Under $120/MWh	Under $138/MWh	Under $189/MWh	Under $282/MWh	All Costs
HVAC	14.3	2.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Lighting	9.9	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Process Cooling	8.5	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Process Electro-Chemical	2.4	-	-	-	-	-	-	-	-
Process Heating	10.8	2.3	1.9	2.0	2.0	2.0	2.0	2.0	2.0
Process Motors Air Compression	14.7	3.8	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Process Motors Fans	10.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Process Motors Other	35.9	3.4	2.8	2.9	2.9	2.9	2.9	2.9	2.9
Process Motors Pumps	22.1	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Process Motors Refrigeration	6.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Total	**135**	**17**	**14**	**14**	**14**	**14**	**14**	**14**	**14**

Industrial Sector—Natural Gas

Most industrial processes and end uses use electricity, and, therefore, the industrial sector represents an extremely small portion of natural gas baseline sales and potential. Across all industries, achievable technical potential totals approximately 9 million therms over 20 years. Though this represents 17% of forecasted 2029 industrial sales, it only accounts for 3.5% of the achievable technical potential across the three sectors.

Due to the nature of industries using natural gas in PSE's service territory, over half of the achievable technical potential lies in minerals (32%) and transportation (20%). As Figure 17 shows, there are also substantial savings opportunities in metals (12%), paper (11%), and food (7%).

Figure 17. Industrial Sector Gas Achievable Technical Potential by Segment



Almost 80% of baseline consumption is in boilers and process heating; thus, these end uses account for almost 86% of the achievable technical potential. The remaining potentials are in HVAC improvements and other (non-heating) process improvements (Figure 18 and Table 24**).**

Figure 18. Industrial Sector Gas Achievable Technical Potential by End Use

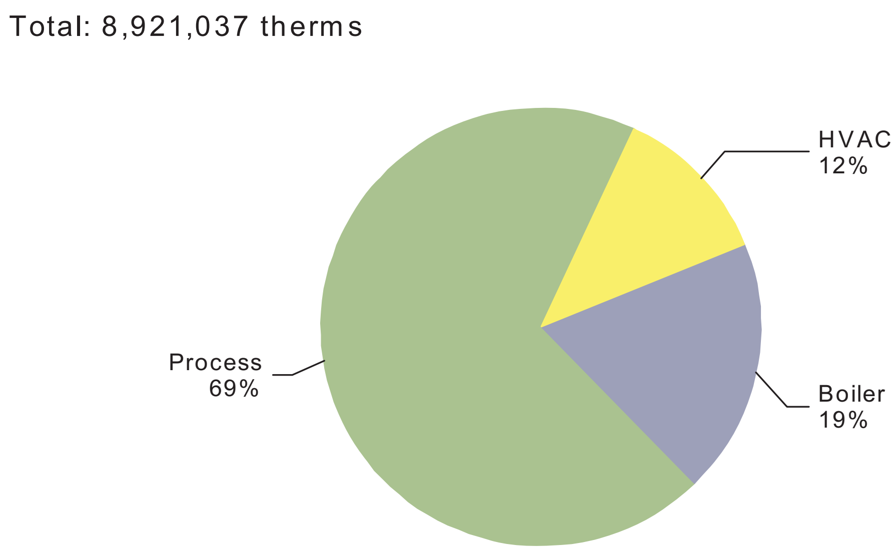


Table 24. Industrial Sector Gas Energy-Efficiency Potential by End Use (million therms in 2029)

End Use	Baseline Sales	Technical Potential	Achievable Technical Potential Under $0.95/therm	Under $1.20/therm	Under $1.50/therm	Under $2.00/therm	Under $2.50/therm	- All Costs
Boiler	15.3	2.2	1.7	1.7	1.7	1.7	1.7	1.7
HVAC	6.9	1.4	1.0	1.0	1.0	1.0	1.0	1.1
Process Heat	27.8	8.0	5.9	6.0	6.0	6.0	6.0	6.0
Process Other	3.6	0.2	0.1	0.1	0.2	0.2	0.2	0.2
Total	**54**	**12**	**9**	**9**	**9**	**9**	**9**	**9**

3. Fuel Conversion Potentials

Scope of Analysis

In the context of this study, "fuel conversion" refers to electricity saving opportunities involving substitution of natural gas for electricity through replacement of space heating systems, water heating equipment, and appliances. Fuel conversion potentials were examined for existing residential single-family homes, existing and new commercial buildings, and new multifamily structures in PSE's electric service area. For existing customers, conversion potentials were analyzed regardless of whether the customer was within PSE gas territory or Cascade Natural Gas territory. For new construction, only PSE combined territory (areas where PSE serves both electricity and natural gas) was considered. Four end uses were include in the analysis for single- and multifamily homes: (1) space heating; (2) zonal heating; (3) water heating; and (4) appliances (clothes dryer and cooking range). For commercial buildings, only space and water heating end uses were analyzed.

Methodology

The methodology for determining fuel conversion potential consisted of four steps:

1. Evaluate alternative technologies in terms of their life cycle costs (including full fixed installation and ongoing O&M expenses) and benefits as measured in terms of the value of displaced electricity.
2. Estimate technical potentials by determining the number of potential customers and applicable end uses.
3. Conduct survey of single-family homes in PSE electric territory to determine customer interest in fuel conversion.
4. Calculate annual achievable technical potential based on realizable percentage of technical potential and assumed resource acquisition rate.

Summary of Findings

Measures Considered

The analysis of fuel conversion considered opportunities in four major end uses in single-family dwellings: central heating, room heating, water heating, and appliances (clothes dryer and cooking range). Applicable measures and their assumed technical specifications are shown in Table 25.

Examination of room (or zonal) heating assumed conversion to strictly similar gas-fired equipment such as gas wall heaters (rather than central systems) for existing buildings. For new construction, central systems are assumed. Clothes dryers and cooking ranges were the only appliances considered in the study. Although the range of efficiencies for dryers tends to be narrow, a moisture sensor can be installed that will automatically shut off the dryer once the moisture level drops below a certain level. This can result in a 15% decrease in energy usage over a standard dryer due to reduced run-time.[2] Similarly, there are minor differences in the efficiency level of ranges. However, a 20% energy savings can be achieved by using a convection oven.[3] These measures, aside from wall heaters, are equivalent to those used for the energy efficiency analysis and detailed descriptions can be found in Volume II, Appendix B. Wall heaters are natural-gas powered room space heaters.

Table 25. List of End Uses and Measures Used

End Use	Gas Measure	Electric Baseline
Space heating	90 AFUE condensing furnace	Electric furnace
Room heating	84% efficient wall heater	Electric wall/ baseboard
Water heating	EF=0.80 storage water heater EF=0.82 tankless water heater	Electric water heater
Appliances	Gas dryer w/ moisture sensor Convection gas range	Electric dryer w/ moisture sensor Convection electric range

Gas Availability

Gas availability and its implications in terms of service extension costs is an important consideration in determining the potential for fuel conversion. This availability varies by sector. Figure 19 and Figure 20 give the breakout by segment for the single-family and multifamily segments. The fuel conversion potential for the single-family segment targets existing customers, while the multifamily conversion targets new construction. The new construction market size is cumulative over 20 years. Note that the potential market size accounts for current measure saturation. For example, some existing single-family homes already have a gas water heater. Those customers are not considered for water heater conversion. In addition, the potential market size for new construction excludes the percentage of customers that have historically included gas systems.

Residential

For existing single-family residential customers, data from several sources, including PSE's 2008 Residential End Use Survey (REUS) were used to determine availability. PSE currently serves gas to approximately 50% of single-family homes in its electric service area. As these customers use at least one piece of gas-using equipment (generally a gas furnace), they are considered candidates for only *additional* gas-using equipment, without imposing additional line extension costs. In addition, consideration was given to differing size ranges of single-family

[2] http://www.aceee.org/consumerguide/topwash.htm

[3] http://www.aceee.org/consumerguide/cooking.htm A convection oven includes a fan within the oven cavity that results in air circulation around the food, increasing overall heat transfer to the food. This allows for lowered oven temperatures and shortened cooking times.

homes, given that larger homes are likely to use more energy for space heat. Homes sizes analyzed were 1,800, 2,100 and 2,400 square feet.

Another portion of the fuel conversion technical potential is attributable to extension of service to existing, electric-only customers or new multifamily customers. The REUS results have shown about 17% of existing single-family residential electric customers are within PSE's gas service area, but do not have gas hookup. The remaining 33% of electric customers are in another utility's gas service territory.

For the multifamily segment, a previous residential survey (2004 Residential Energy Study) was used to determine the distribution of market share as the more recent REUS had only a small sample of multifamily homes. For new multifamily customers, approximately 14% are in PSE combo territory.

Based on the latest data available from PSE, delivery of gas service to the single-family electric customers would depend on whether they are on a gas main (24%), or require a short (12%), medium (24%) or long (64%) extension if they are off main. Short extensions are assumed to be around 50 feet, medium extensions around 300 feet, and long extensions 500 feet. Customers requiring long extensions were excluded from the analysis as being too economically and technically impractical.

Figure 19. Single-Family Customers Available for Fuel Conversion

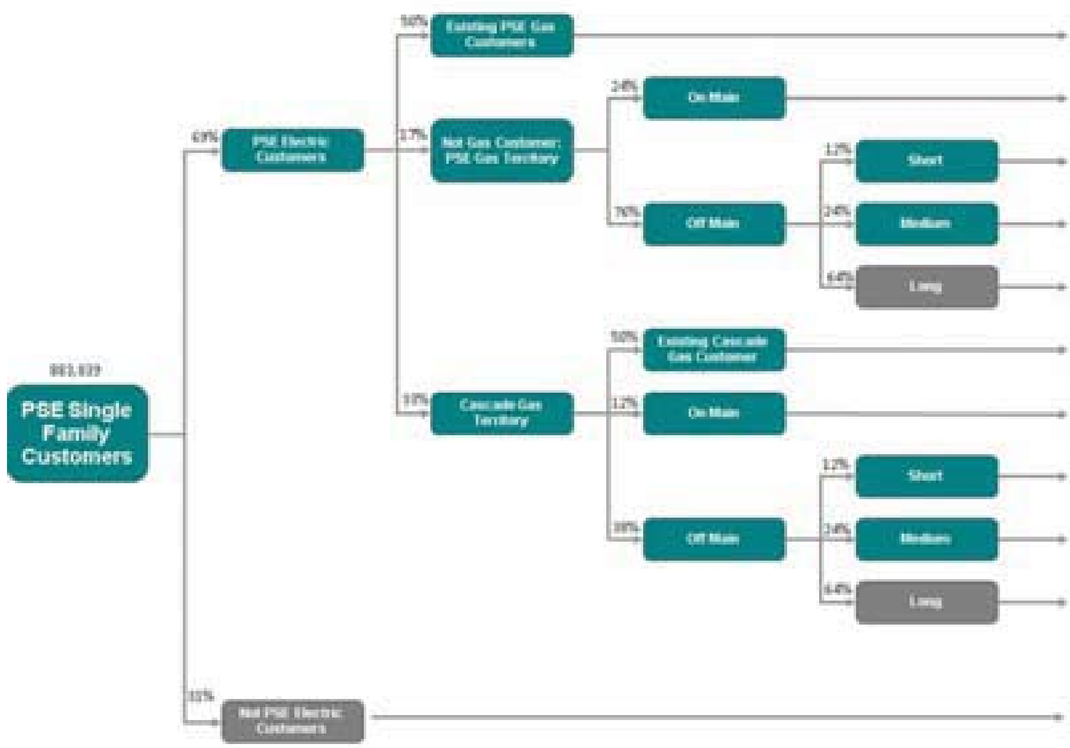
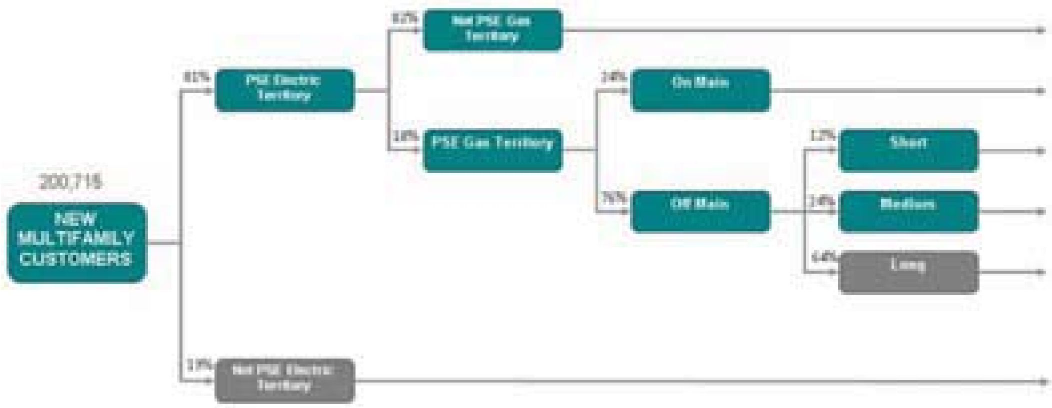


Figure 20. Potential New Multi-Family Customers (over 20 years)



Commercial

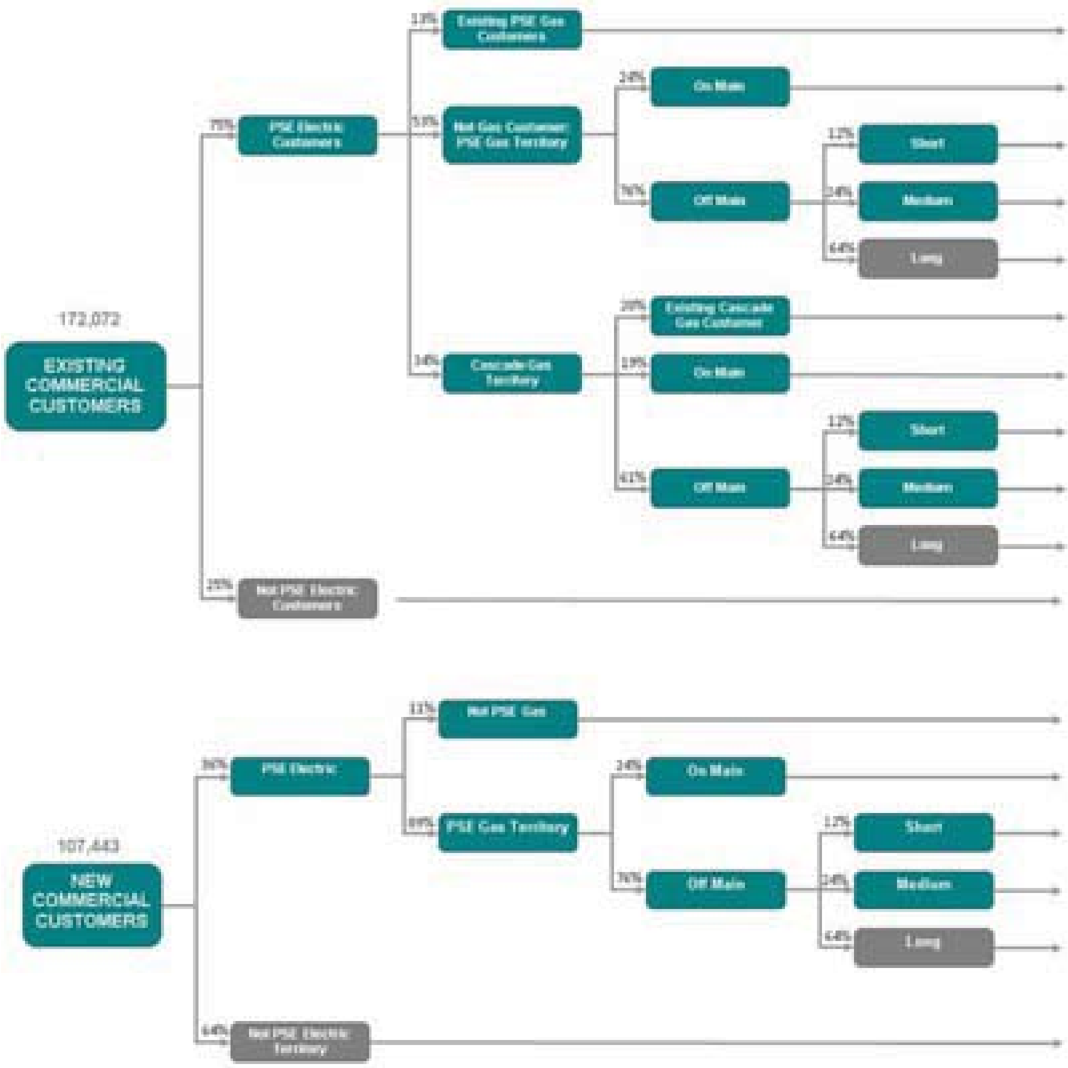
In the commercial sector, conversion potentials from both existing and new construction vintages were estimated. Data from the 2008 Commercial Building Stock Assessment (CBSA), coupled with PSE's non-residential database, provided the market shares by territory and end use. Of existing customers, approximately 40% of the current electric-only customers are in PSE gas territory. For new customers, approximately 32% are expected to be in the combo service territory. The customer breakout is shown in Figure 21. The new construction market size is cumulative over 20 years. Again, note this potential market size only includes customers who do not already have gas water heaters (for existing gas customers) and who are not expected to install a gas line (for new customers).

Conversion Costs and Benefits

In analyzing conversion costs, the TRC was considered; that is, the assumed installed cost of the gas measure, including gas line extension costs was used. For electric-only customers, connecting a house to the gas main is assumed to require either a service-line extension (no charge) or a short or medium main extension (approximately $40/ft). Since it is expected current electric customers would at least install a gas furnace, the cost to add the gas line to the house is only added to the furnace costs. Other end uses will have an additional cost only for interior piping ($200 per piece of equipment, as determined through interviews with local HVAC contractors on PSE's Contract Referral Service List). Detailed assumptions on various cost elements are described in Volume II, Appendix D.

Conversion benefits were estimated based on electric and gas avoided costs and the assumed levels of unit energy consumption (UEC), consistent with those used in the energy-efficiency analysis described in Section 2. Avoided cost benefits were calculated from a net present value of the first-year electric ($/kWh) or gas ($/therm) avoided cost data for the different end-use load shapes and measure lives. Electric UECs (kWh/yr) and gas UECs (therms/year) used in the energy-efficiency model for existing single-family and new multifamily homes were used for baseline values. For simplicity, commercial buildings were modeled assuming an energy consumption that was the weighted average of all segments.

Figure 21. Commercial Achievable Technical Potential by Vintage



Resource Potentials

Technical Potential

Fuel conversion technical potentials were calculated by assuming all applicable customers and end uses are converted. At the meter, the technical potential was found to be 174 aMW. Acquisition of the indicated electricity savings would, however, result in increased gas consumption at the meter of about 107 million therms by 2029.

Achievable Technical Potential

A survey of residential customers was conducted to help determine the willingness of customers to switch from an electric heating system to a gas heating system. Details on the survey, including the survey instrument and tabulated results, can be found in Appendix A.3. The survey, administered to 318 PSE electric-only customers, provided an estimate of achievable technical potential as a function of rebate level. Additionally, participants were asked about their general understanding of the costs and benefits of conversion. The sample size was designed to obtain 90% confidence/10% precision for each proposed rebate level.

Based on this survey, approximately 63% of respondents indicated they would be likely or highly likely to convert from electric to gas space heating, if the utility were to pay 100% of the cost. As such, 63% of the technical potential is used to determine the achievable technical potential. Due to the lack of similar data, the same percentage was used for the commercial sector. Of those who would be interested in converting their furnace to a gas unit, nearly 70% would convert a water heater as well.

Based on the results of the survey and previous PSE experience, it is assumed, within the residential sector, of the new gas customers that convert a space heater, 70% will also convert a water heater, and 5% will convert a range and/or dryer. For existing gas customers, all will convert a water heater, and 5% will convert a range and/or dryer. Similar percentages are assumed for the water heating conversions in the commercial sector.

The total achievable technical electric savings potential of fuel conversion in year 20 for residential, single-family homes was estimated at 37 aMW, corresponding to an increase in gas use of 19 million therms, as measured at the meter. For multifamily homes, the potential electric savings would be 16 aMW and increased gas use would be 12 million therms. Finally, for the commercial sector, the achievable technical electric savings potential in year 20 would be 12 aMW, corresponding to an increase in gas use of 8.9 million therms, as measured at the meter. A summary of these potentials is provided in Table 26, and the achievable technical potential by building type is provided in Table 27. As shown in Figure 22, deployment of fuel conversion resources begins with a slow growth period during the first three years, allowing for program development, followed by a strong, linear growth rate for the remainder of the planning horizon.

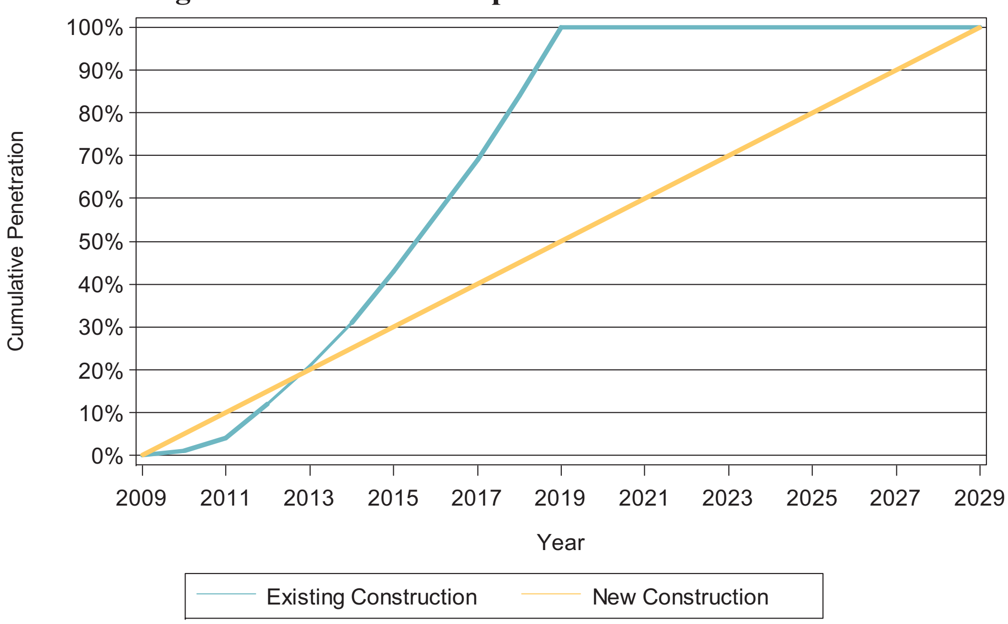
Table 26. Summary of Fuel Conversion Potentials

	Electric-Only Customers		Existing Gas Customers	Total
	PSE Gas Territory	Cascade Natural Gas Territory		
Technical Potential				
Electric Savings (aMW)	53.4	82.5	37.9	173.8
Additional Gas Usage (million therms)	32.9	53.5	20.7	107.1
Achievable Technical Potential				
Electric Savings (aMW)	20.3	29.8	15.2	64.9
Additional Gas Usage (million therms)	12.6	20.0	7.4	40.0

Table 27. Achievable Technical Potential by Building Type

	Electric-Only Customers: PSE Gas Territory	Electric-Only Customers: Cascade Natural Gas Territory	Existing Gas Customers	Total
Single Family				
Electric Savings (aMW)	11.2	10.3	15.0	36.1
Additional Gas Usage (million therms)	6.1	5.8	7.2	19.1
Multifamily				
Electric Savings (aMW)	0.6	15.7	NA	16.3
Additional Gas Usage (million therms)	0.4	11.6	NA	12.0
Commercial				
Electric Savings (aMW)	8.5	3.7	0.2	12.5
Additional Gas Usage (million therms)	6.1	2.6	0.1	8.9

Figure 22. Assumed Ramp Rate for Fuel Conversion



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4. Demand Response Potential

Scope of Analysis

Demand response (DR) or load reduction programs, focused on reducing a utility's capacity needs, are comprised of flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. These programs are designed to help reduce peak demand, promote improved system reliability, and, in some cases, may lead to the deferment of investments in delivery and generation infrastructure. Objectives of DR may be met through a broad range of price-based (e.g., time-varying rates and interruptible tariffs) or incentive-based (e.g., direct load control) strategies. In this assessment, the following demand-response strategies were analyzed:

1. ***Direct Load Control*** (DLC) programs allow a utility to remotely interrupt or cycle electrical equipment and appliances at a customer's facility. In this study, the assessment of DLC program potential is analyzed for three programs in the residential sector: central electric heating (including heat pumps) and electric water heating combination program; room heating and electric water heating combination program; and central AC (including heat pumps) and water heating combination program. For large commercial customers, DLC is modeled, using integration with existing energy management systems (EMS), to have additional controls on lighting, HVAC, and plug loads. The large DLC program is included for summer and winter demand reduction. This analysis assumes such programs target commercial customers with average monthly demand greater than 500 kW.

2. ***Interruptible Tariffs*** refer to contractual arrangements between the utility and its customers, who agree to curtail or interrupt their loads in whole or part for a predetermined period when requested. In most cases, mandatory participation is required once the customer enrolls in the program; however, these programs may include provisions for customers to exercise an economic buy-through of a curtailment event. Incentives are paid regardless of the quantity of events called each year (less any penalties associated with an event buy-through). This analysis assumes such programs target nonresidential customers with average monthly loads greater than 500 kW.

3. ***Demand-Bidding or Demand Buy-Back*** programs offer payments to customers for voluntarily reducing their demand at the utility's request. The buyback amount generally depends on market prices published by the utility in advance of the event, coupled with the customer's ability to curtail use during the hours load curtailment is requested. The reduction level achieved is verified using an agreed-upon baseline usage level specific to the participating customer. This analysis assumes such programs target nonresidential customers with loads greater than 200 kW.

4. ***Critical Peak Pricing*** (CPP) or extreme-day pricing refers to programs aiming to reduce system demand by encouraging customers to reduce their loads for a limited number of hours during the year. During such events, customers have the option of curtailing their usage or paying substantially higher-than-standard retail rates. CPP programs integrate a pricing structure similar to a TOU (time of use) program with the distinction of more

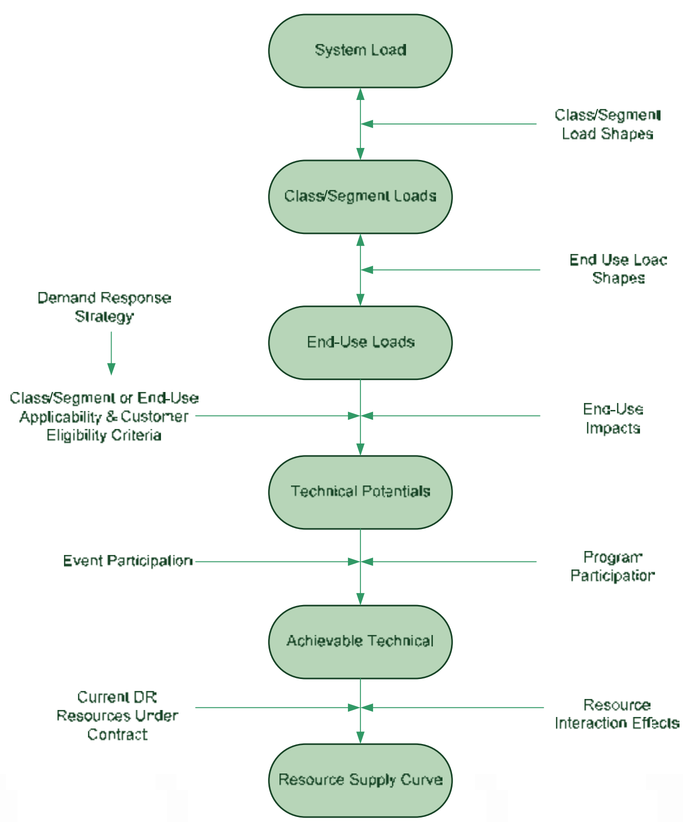
extreme pricing signals for the critical events. For the residential sector, it is assumed enabling technology is installed (e.g., smart thermostats).

Program options listed above are based on a thorough review of literature cataloging and classifying DR strategies offered by utilities and regional transmission organizations across the country. For each program offering, data were collected on the offering's main features, such as objectives, program periods, eligibility criteria, curtailment event triggers, incentive structures, and technology requirements. These program options are described in more detail later in this section.

Methodology

The methodology for estimating DR potential was based on a combined "top-down"/"bottom-up" approach. Cadmus's DRPro® Model provided the basic framework for this analysis. As shown schematically in Figure 23, the approach begins with utility system loads, disaggregating them into sector, segment, and applicable end uses. For each DR program (or program component), potential technical impacts are calculated for all applicable end uses. The end-use load impacts are aggregated to obtain estimates of technical potentials. Market factors such as probabilities of program and event participation then are applied to technical potentials to obtain estimates of achievable technical potentials. The methodology for calculating technical and achievable technical potentials is described in greater detail below.

Figure 23. Schematic Overview of Demand Response Assessment Methodology



Estimating Technical Potential

DR technical potentials are first estimated at the end-use level, and then are aggregated to market segment, sector, and system levels. This approach was implemented in the following four steps.

1. **Define customer sectors, market segments and applicable end uses**. The first step in the process involved defining appropriate sectors, market segments, and end uses within each segment for each utility. We used the following classification scheme for demand response:

   Customer classes/sectors: residential, commercial, and industrial.

   Market segments:

   1. Residential: single-family, multifamily, and manufactured homes.
   2. Commercial: education, grocery, health, lodging, office, restaurant, retail, warehouse, and other commercial.
   3. Industrial: food manufacturing, primary metal manufacturing, paper manufacturing, plastics rubber manufacturing, chemical manufacturing, nonmetallic mineral products, industrial machinery, fabricated metal products, printing related support, transportation equipment manufacturing, electronic equipment manufacturing, wood product manufacturing, miscellaneous manufacturing, petroleum manufacturing, computer manufacturing, and waste water and water treatment.

   Large accounts: the largest nonresidential customers were researched for each utility, and unique segments were created as necessary to appropriately account for their characteristics.

   End uses: space heating, room heating, central cooling, water-heating, lighting, plug loads, process (industrial), etc.

2. **Screen customer segments and end uses for eligibility**. This step involved screening end uses for applicability of specific DR strategies. For example, hot water loads in hospitals and cooking loads were excluded (if no backup generation was available).
3. **Compile utility-specific sector/end-use loads**. Reliable estimates of DR potential depend on the correct characterization of sector, segment, and end-use loads. Load profiles were developed for each end use. Contributions to system peak for each end use were estimated based on end-use load shapes.
4. **Estimate technical potential**. Technical potential for each DR program is assumed to be a function of customer eligibility in each class, affected end uses in that class, and the expected impact of the strategy on the targeted end uses. Analytically, technical potential (*TP*) for a demand-response program *(s)* is calculated as the sum of impacts at the end-use level (*e*), generated in customer class (*c*), by the program; that is:

   Error! Objects cannot be created from editing field codes.

   and

   $$TP_{sce} = LE_{cs} \times EUS_{cs} \times LI_{se}$$

   where,

LE_{cs} (load eligibility) represents the percent of customer class loads that are eligible for strategy *s*

EUS_{cse} represents the share of end use *e* in customer class *c* eligible for DR strategy *s*

LI_{se} (load impact) is percent reduction in end-use load *e* resulting from program *s*

Load eligibility thresholds were established by calculating the percent of load by customer class and market segment that met minimum (or maximum) load criteria for each program, based on program filings.

Estimate Achievable Technical Potential

As discussed above, estimates of expected load impacts resulting from various DR programs (LI_{se}) are based on a comprehensive review and assessment of DR program impacts offered by utilities throughout the United States. Program participation indicates the percent of participating customers, while event participation summarizes the percent of program participation that will participate in any one event. Note that, as with other resources, no economic screen was performed in this study.

Develop Supply Curves

Achievable technical potentials were determined based on applicable program costs along with event participation and program participation. To add additional perspective, achievable technical potentials for each DR program strategy were combined with per-unit resource costs to produce "cumulative" resource supply curves. The supply curves show price/quantity relationships at the aggregate level. Interactive program impacts were not taken into consideration.

Program implementation costs were researched and documented by our engineering staff. All categories of costs were considered, generally falling into two categories:

1. Fixed program expenses, such as program infrastructure, administration, maintenance, and communication.

2. Variable costs, such as incentive payments to participants, customer-site hardware, customer-specific marketing/recruiting, and metering.

Summary of Resource Potential

Table 28 and Table 29 present estimated resource potentials for all DR resources for the residential, commercial, and industrial sectors for summer and winter. Achievable technical potential is highest in the residential sector due to the direct load control programs. As noted above, however, the analysis does not account for program interactions and overlap; thus, the total technical and achievable technical potential estimates are not fully attainable.

Table 28. Technical and Achievable Technical Potential (MW in 2029) - Winter

Sector	2029 Sector Peak	2029 Technical Potential	2029 Achievable Technical Potential	Achievable Technical Potential As Percent of 2029 Sector Peak
Residential	3,577	1,729	170	5%
Commercial	2,901	135	14	<1%
Industrial	130	43	5	4%
Total	**6,608**	**1,909**	**178**	**3%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs have not been taken into account.
Note: Residential technical potential and achievable technical potential for residential potential for direct load control do not include AMR converted to AMI or existing AMI due to overlap with no AMR meter installed.

Table 29. Technical and Achievable Technical Potential (MW in 2029) - Summer

Sector	2029 Sector Peak	2029 Technical Potential	2029 Achievable technical Potential	Achievable Technical Potential As Percent of 2029 Sector Peak
Residential	2,428	676	48	2%
Commercial	2,334	136	14	1%
Industrial	157	43	5	3%
Total	**4,919**	**855**	**68**	**1%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs has not been taken into account.
Note: Residential technical potential and achievable technical potential for direct load control do not include AMR converted to AMI or existing AMI due to overlap with no AMR meter installed.

Resource Costs and Supply Curves

Utility costs for DR program options can vary significantly. Where possible, cost estimates were developed for each program option based on data available from comparable programs across the region and nation. In certain cases, this level of specificity was difficult to establish as many utilities do not track or report program costs in sufficient detail. For example, development of a new DR program can be a significant effort for a utility, requiring enrollment, call centers, program management, load research, development of evaluation protocols, changes to billing systems, and marketing. Background research on utilities across the nation indicated large variations in direct program costs. Based on the experiences of utilities, this analysis assumed $400,000 as a "typical" first cost for program development for large-scale residential sector programs and $200,000 for nonresidential customer programs.

In developing estimates of per-unit costs, program expenses were allocated annually over the expected program life cycle (20 years), then were discounted by PSE's weighted average cost of capital to estimate the total discounted cost. The ratio of this value and the average annual kW reduction produced the levelized per-kW cost for each resource. Additionally, attrition rates were used to account for program turnover due to changes in electric service (i.e., housing stock turnover) and program drop-outs. The basic assumption for this analysis was an attrition rate of 7% for the residential sector and 2% for the commercial sector, based on averaged values experienced by other utilities such as PacifiCorp. Attrition requires reinvestment of new customer costs, including technology, installation, and marketing. In addition, the analysis assumed a measure life for the installed technology, and all costs were adjusted upward by $60,000 for residential and $50,000 for nonresidential programs to account for administrative expenses.

Table 30 displays the per-unit ($/kW-year) costs by season for the estimated achievable technical potential. The first cost associated with starting a DR program was included only for the winter programs. Summer programs and the DLC program for room heating and water heating was considered to be an addition to the existing winter and DLC space heating and water heating programs as the infrastructure for these programs already existed.

The interruptible tariffs program for large non-residential customers was estimated to be the least expensive option, with a levelized cost of $57/kW a year for winter, while demand bidding is the least expensive option for summer, with a levelized cost of $11/kW-year.[4]

Table 30. Levelized Costs and Achievable Technical Potential (MW in 2029)

	Winter		Summer	
Strategy	Achievable Technical Potential (MW)	Levelized Cost ($/kW)	Achievable Technical Potential (MW)	Levelized Cost ($/kW)
Direct Load Control (DLC)				
Residential (SH and WH/ AC and WH) AMR Meter	47	$74	8	$177
Residential (RH and WH) AMR Meter	54	$71	NA	NA
Residential (SH and WH/ AC and WH) AMR Meter Converter to AMI Meter	47	$93	8	$224
Residential (RH and WH) AMR Meter Converter to AMI Meter	54	$85	NA	NA
Residential (SH and WH/ AC and WH) Existing AMI Meter	47	$81	8	$195
Residential (RH and WH) Existing AMI Meter	54	$76	NA	NA
Critical Peak Pricing (CPP) Residential	69	$83	40	$138
Direct Load Control (DLC) Large Commercial	24	$126	23	$95
Interruptible Tariffs (Large Non-Residential	14	$57	15	$49
Demand Bidding (Medium and Large Non-Residential)	2	$83	2	$11

Note: Direct Load Control RH & WH and all summer programs do not have a first cost included due to the cost included to start the program being incorporated in winter programs or DLC SH & WH. Levelized cost would be higher if the program was implemented without the inclusion of the winter program.

[4] This levelized cost would only incur if the demand bidding program is also run for the winter season, due to the start-up cost being included only in the winter season.

Supply curves were constructed from quantities of estimated market resource potential and per-unit costs of each resource option. The capacity-focused supply curves, shown in Figure 24 and

Figure 25, represent the quantity of each resource (cumulative achievable technical MW) that can be achieved at or below a given cost in the winter and summer, respectively. The DLC residential program chosen for display in each of the figures below is the AMR meter option. This type of meter strategy was chosen because it is the most popular strategy and has the lowest levelized cost. Note that in the winter, although it costs $81/kW to obtain 64 MW, an additional 178 MW is available if the cost threshold is increased to $85/kW. Program interactions were not accounted for in this study.

Figure 24. Winter Supply Curve (Cumulative MW in 2029)

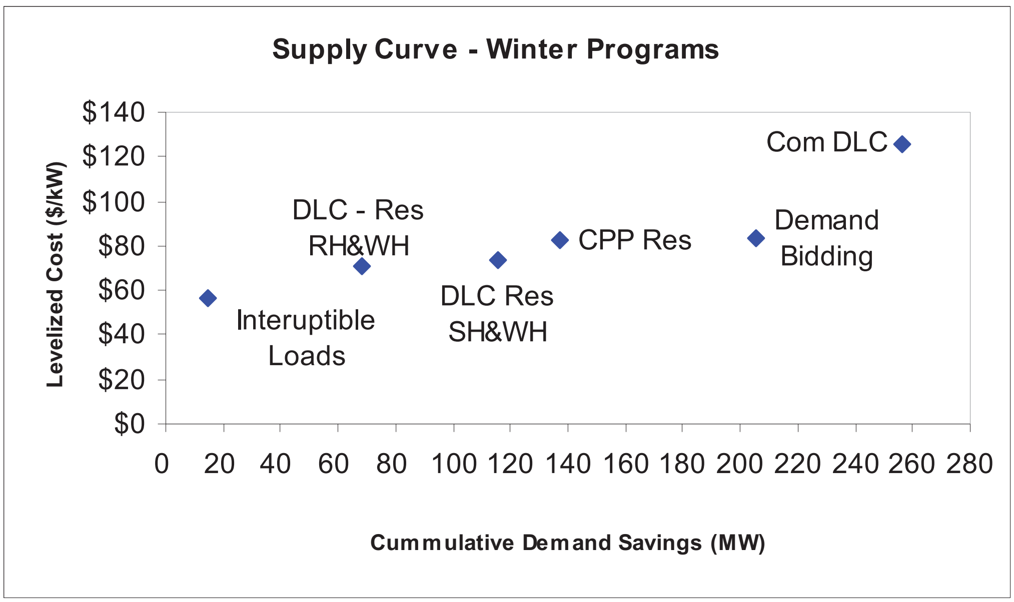
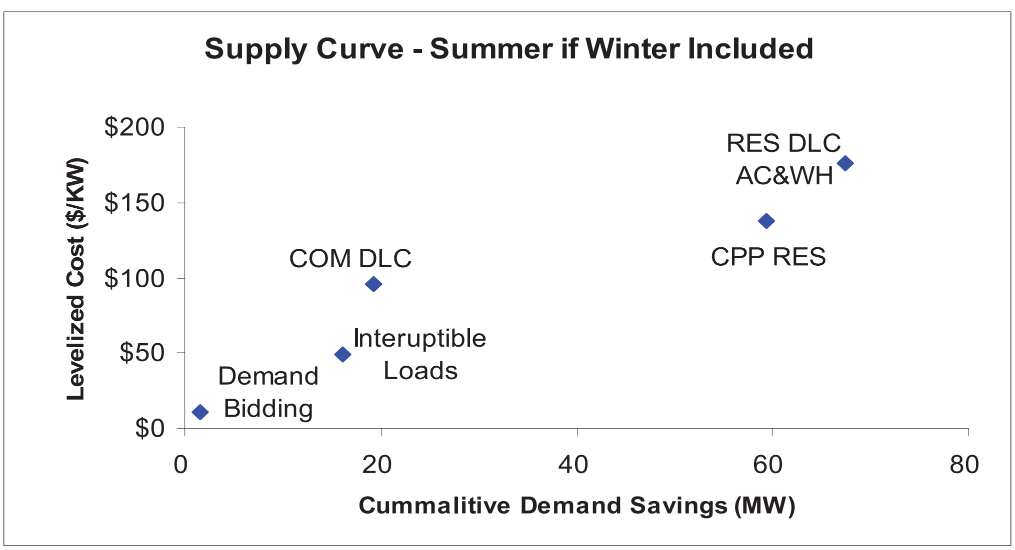


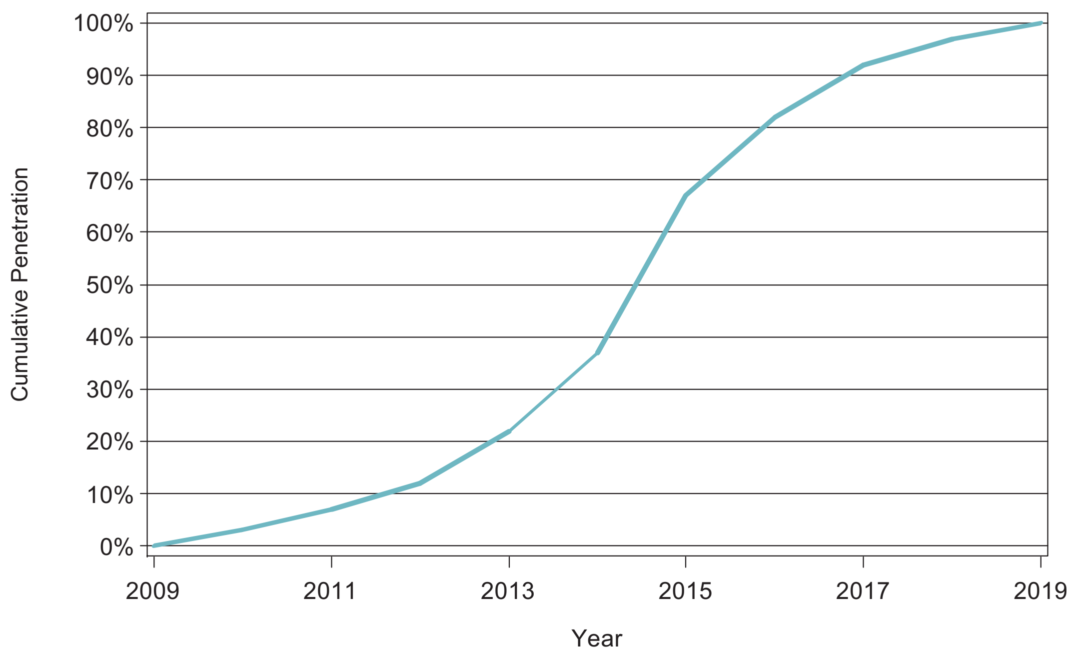
Figure 25. Summer Supply Curve (Cumulative MW in 2029)



Resource Acquisition Schedule

Each program option has an associated ramping rate (Figure 26). The general logic holds that it requires 10 years to grow a new program from inception to full potential, and the first three years have relatively slow growth; as more customers become aware of the DR programs, the participation rate will increase (years four through eight). Years nine and ten have a slow rate of increase due to the program reaching the maximum number of participating customers. After Year 10, the program levels increase at the rate of sales growth (by sector) only.

Figure 26. DR 10-Year Ramp Rate



Detailed Resource Potentials

Direct Load Control

DLC programs are designed to interrupt specific end-use loads at customer facilities through utility-directed control. When deemed necessary, the utility is authorized to cycle or shut off participating appliances or equipment for a limited number of hours on a limited number of occasions. Customers do not have to pay for the equipment or installation of control systems and are given incentives that are usually paid through monthly credits on their utility bills. For this type of program, receiver systems are installed on the customer equipment to enable communications from the utility and to execute controls. Historically, DLC programs have become mandatory once a customer elects to participate; however, voluntary participation is now an option for some programs with more intelligent control systems and override capabilities at the customer facility.[5]

Recently, DLC of air-conditioning has emerged as the most common load management program type. In addition to reviewing meta-studies on DLC, we researched many key utility programs, including Florida Power and Light, Nevada Power, Sacramento Municipal Utility District, Southern California Edison, Pacific Gas and Electric, Austin Energy, Consolidated Edison, Long Island Power Authority, Idaho Power, Xcel-MN, PacifiCorp, Alliant, MidAmerican, and Wisconsin Public Service.[6]

This analysis covers residential and commercial DLC programs and reviewed multiple types of available end uses, with four program options:

1. Residential central heating and water heating.
2. Residential room heating and water heating.
3. Residential air-conditioning and water heating.
4. Large commercial programs.

Values used in modeling have been standardized based on DR program research.

For the residential DLC programs, three different types of meter approaches were evaluated. A receiver attached to the appliance allowing the machine to cycle or shut-off is required in all three cases. Currently, PSE has Automatic Meter Reading (AMR) meters installed. This type of technology does not allow for two-way communication. The utility can receive a signal from the meter but cannot send a signal to the meter.

1. AMR meter: Only a receiver installed on a specific appliance.

2. AMR meter converted to Advanced Metering Infrastructure (AMI) meter (additional receiver attached to AMR meter to allow for two-way communication and data storage charge).

3. Existing AMI meter (data storage charge).

The first strategy is primarily chosen by most utilities, though there is a major drawback in that the utility does not receive confirmation that the appliance has actually shut off. As only a one-way communication receiver is attached to the appliance, no signal can be sent back to the utility to confirm the event. This is, however, the least expensive approach as one receiver would be the only additional cost.

The other two strategies are similar. Strategy two involves converting an existing AMR meter to an AMI. This would involve two additional charges: a two-way communication receiver ($150/meter) replacing the existing one-way communication receiver for the AMR meter; and a

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[5] Typically, penalties are associated with non-compliance or opt-outs.

[6] DOE. *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them*. Report to Congress. February 2006.

data storage charge ($15/customer). Strategy three assumes the meter is already an AMI, and the only additional charge would be the data storage charge. Although both of these strategies would be more expensive than the AMR meter approach, two major advantages could improve reliability and save money on evaluation studies:

1. Notification the equipment has shut off. Utilities have performed evaluation studies and determined not all receivers attached to appliances work properly. Using either of these two strategies would allow PSE to confirm the appliance shuts off and would allow PSE to replace any nonfunctional receivers without having to field-test every unit.

2. As an AMI meter is capable of producing interval data, an evaluation study would be significantly less expensive (no additional metering would be needed), and would involve actual metered data.

Space Heating and Water Heating (Residential)

Although residential DLC for air conditioning has been one of the most well-established programs in the nation (PacifiCorp, MidAmerican, Alliant, Florida Power and Light, Xcel Energy, etc.), a space heating DLC program is a relatively new idea with minimal data available through secondary research.

Table 31 shows the technical and achievable technical potential results for the PSE service territory, by customer class. If PSE were to offer this program, the levelized cost would be $85/kW-year with an AMR meter, $107 for an AMR converted to AMI, and $94 for an existing AMI meter.

Table 31. Residential DLC Space Heating and Water Heating: Technical and Achievable Technical Potential (MW in 2029)

Sector	Winter		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	375	47	2%
Commercial	---	---	---
Industrial	---	---	---
Total	**376**	**41**	**<1%**

Utility incentives for residential DLC programs can vary widely, from a free programmable thermostat to a set incentive amount per month to a 15% discount on customers' summer electricity bills (which can sum to $50-$60 annually for many participants). Incentives for this analysis are set at $32/year for space heat cycling (50%) and $8 for water heating cycling (100%). Additional costs are assessed for this program, including: $30 per new customer of marketing; $7 for each existing customer for communications, replacement of technology every 15 years; $400,000 for program start-up; and an attrition rate (requiring reinvestment of new-customer costs) of 7% based on 5% change of service and 2% removals. Detailed assumptions are provided in Table 32.

Table 32. Assumptions for Residential DLC Space and Water Heating Potential

Program Concept	Assumptions
Customer Sectors Eligible	All Residential
End Uses Eligible for Program	Electric Central Heating (or Air-Source Heat Pump) and Electric Water Heater
Customer Size Requirements, if any	N/A
Summer Load Basis	N/A
Winter Load Basis	Top 20 Winter Hours

Inputs	Model Values	Model Assumptions
Annual Attrition (%)	7%	Studies have found 7% (composed of 5% change of service and 2% removals) from utilities, including RMP, Xcel, Eon US, SMUD, FP&L (removals range from 1%–3%).
Per Customer Impacts (kW)	1.8 Space Heating 0.5 Water Heating	Space Heating – Adjustment based on central AC savings from other utilities (PacifiCorp and Alliant). Water Heating – Reduction level for Alliant program. Adjustment of 0.2 to 0.5 made to account for part of winter load occurring in the morning during shower operation.
Total kW reduction per program	N/A	PSE does not currently offer this program.
Annual Administrative Costs (% of First-year Cost)	$60,000	An administrative adder of 15% was typically assumed for all residential program strategies (assuming that since 15% will be taken from a first cost of $400,000, the annual administrative cost will be $60,000).
Technology Cost	$150	$150 is indicated in the CEC report from 2004 (for the installed cost of ratio frequency load control devices). WH controls will require another switch, doubling this cost.
Marketing Cost	Space Heating $30 Water Heating $0	Marketing costs are set at $30 based on data available from other utilities. No additional marketing costs for water heaters.
Incentive (annual costs)	Space Heating $32 Water Heating $8	Incentives range from $30 to $35 for most utilities for one piece of equipment DLC program and $8 for additional equipment.
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a two-way transmission system.
Overhead: First Costs	$400,000	$200k for labor and $200k for IT.
Per Customer First Cost	Space Heating $180 Water Heating $150	Sum of technology cost plus marketing cost
Per Customer Ongoing	Space Heating $62 Water Heating $31	For Space Heating, ongoing costs are calculated from summing annual customer incentives, annual communication costs, and 15% of technology costs for repair and/or replacement of equipment.
Eligible Load (%)	100% of the Cooling Load	Eligible load is the percentage of customers eligible for this program.
Technical Potential (as % of Gross)	Space Heating 50% Water Heating 100%	The space heating program is modeled as a 50% cycling program. Due to the tank, water heating can be shut off for the entire event (100% reduction).
Program Participation (%)	Space Heating 35% Water Heating 2%	Of customers with space heating, the assumption is 35% of these customers will participate. All customers with electric space heating will also include water heating in the program.
Event Participation (%)	90%	It is assumed each customer will be allowed to miss one event a year.

Residential Room Heating and Water Heating

Similar to a central space heating DLC program, a room heating DLC program is a relatively new idea with minimal to no data available through secondary research.

Table 33 shows the technical and achievable technical potential results for the PSE service territory, by customer class. If PSE was to offer this program, the levelized cost would be $81/kW-year for AMR meter, $97 for AMR converted to AMI, and $87 for existing AMI meter.

Table 33. Residential DLC Room Heating and Water Heating: Technical and Achievable Technical Potential (MW in 2029)

Sector	Winter		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	592	54	2%
Commercial	- - -	- - -	- - -
Industrial	- - -	- - -	- - -
Total	**594**	**49**	**<1%**

Detailed assumptions providing values and sources that derived potential and levelized costs are shown in Table 34.

Table 34. Assumptions for Residential DLC Room Heating and Water Heating Potential

Program Concept	Assumptions
Customer Sectors Eligible	All Residential
End Uses Eligible for Program	Electric Room Heating (baseboard) and Electric Water Heater
Customer Size Requirements, if any	N/A
Summer Load Basis	N/A
Winter Load Basis	Top 20 Winter Hours

Inputs	Model Values	Model Assumptions
Annual Attrition (%)	7%	Studies have found 7% (composed of 5% change of service and 2% removals) from utilities, including RMP, Xcel, Eon US, SMUD, FP&L (removals range from 1%–3%).
Per Customer Impacts (kW)	2.5 Room Heating 0.5 Water Heating	Room Heating – Adjustment based on central AC savings from other utilities (PacifiCorp and Alliant). Water Heating – Reduction level for Alliant program. Adjustment of 0.2 to 0.5 made to account for part of winter load occurring in the morning during shower operation.
Total kW reduction per program	N/A	PSE does not currently offer this program.
Annual Administrative Costs (% of First-year Cost)	$60,000	An administrative adder of 15% was typically assumed for all residential program strategies (assuming that since 15% will be taken from a first cost of $400,000, the annual administrative cost will be $60,000).
Technology Cost	$450	Assumes 3 baseboard units at $150. $150 is indicated in the CEC report from 2004 (for the installed cost of ratio frequency load control devices). WH controls will require another switch and result in doubling this cost.

Marketing Cost	Room Heating $30 Water Heating $0	Marketing costs are set at $30 based on data available from other utilities. No additional marketing costs for water heaters.
Incentive (annual costs)	Room Heating $32 Water Heating $8	Incentives range from $30 to 35$ for most utilities for one piece of equipment DLC program and $8 for additional equipment.
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a two-way transmission system.
Overhead: First Costs	$0	Charge occurs for set up on DLC Space and Water Heating.
Per Customer First Cost	Room Heating $480 Water Heating $150	Sum of technology cost plus marketing cost.
Per Customer Ongoing	Room Heating $62 Water Heating $31	For Space Heating, ongoing costs are calculated from summing annual customer incentives, annual communication costs, and 15% of Technology costs for repair and/or replacement of equipment.
Eligible Load (%)	100% of the Cooling Load	Eligible load is the percentage of customers eligible for this program.
Technical Potential (as % of Gross)	Room Heating 50% Water Heating 100%	The space heating program is modeled as a 50% cycling program. Due to the tank, water heating can be shut off for the entire event (100% reduction).
Program Participation (%)	Room Heating 35% Water Heating 2%	Of customers with space heating, the assumption is 35% of these customers will participate. All customers with electric space heating will also include water heating in the program.
Event Participation (%)	90%	It is assumed each customer will be allowed to miss one event a year.

Residential Central Air-conditioning and Water Heating

Residential DLC for a central AC system is one of the most well-established programs in the nation (PacifiCorp, MidAmerican, Alliant, Florida Power and Light, Xcel Energy, etc.).

Table 35 shows the technical and achievable technical potentials by customer class. If PSE was to offer this program, the levelized cost would be $177/kW-year for AMR meter, $224 for AMR converted to AMI, and $195 for existing AMI meter. The high levelized cost is due primarily to a small number of homes in PSE territory with Central AC.

Table 35. Residential DLC Air-conditioning and Water Heating: Technical and Achievable Technical Potential (MW in 2029)

Sector	Summer		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	232	8	<1%
Commercial	---	---	---
Industrial	---	---	---
Total	**232**	**8**	**<1%**

Detailed assumptions providing values and sources that derived potential and levelized costs are shown in Table 36.

Table 36. Assumptions for Residential DLC Air-conditioning and Water Heating Potential

Program Concept	Assumptions
Customer Sectors Eligible	All Residential
End Uses Eligible for Program	Central AC (or Heat Pump) and Electric Water Heater
Customer Size Requirements, if any	N/A
Summer Load Basis	Top 20 Summer Hours
Winter Load Basis	N/A

Inputs	Model Values	Model Assumptions
Annual Attrition (%)	7%	Studies have found 7% (composed of 5% change of service and 2% removals) from utilities, including RMP, Xcel, Eon US, SMUD, FP&L (removals range from 1%–3%).
Per Customer Impacts (kW)	0.7 Central AC 0.2 Water Heating	Central AC – Adjustment based on central AC savings from other utilities (PacifiCorp [0.8] and Alliant [0.85]). Water Heating – Reduction level for Alliant program.
Total kW reduction per program	N/A	PSE does not currently offer this program.
Annual Administrative Costs (% of First-year Cost)	$60,000	An administrative adder of 15% was typically assumed for all residential program strategies (assuming that since 15% will be taken from a first cost of $400,000, the annual administrative cost will be $60,000).
Technology Cost	$150	$150 is indicated in the CEC report from 2004 (for the installed cost of ratio frequency load control devices). WH controls will require another switch and result in doubling this cost.
Marketing Cost	Central AC $30 Water Heating $0	Marketing costs are set at $30 based on data available from other utilities. No additional marketing costs for water heaters.
Incentive (annual costs)	Central AC $32 Water Heating $8	Incentives range from $30 to $35 for most utilities for one piece of equipment DLC program and $8 for additional equipment.
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a two-way transmission system.
Overhead: First Costs	$0	Charge occurs for set up of DLC Space and Water Heating.
Per Customer First Cost	Central AC $180 Water Heating $150	Sum of technology cost plus marketing cost.
Per Customer Ongoing	Central AC $62 Water Heating $31	For Central AC, ongoing costs are calculated from summing annual customer incentives, annual communication costs, and 15% of Technology costs for repair and/or replacement of equipment.
Eligible Load (%)	100% of the Cooling Load	Eligible load is the percentage of customers eligible for this program.
Technical Potential (as % of Gross)	Central AC 50% Water Heating 100%	The central AC program is modeled as a 50% cycling program. Due to the tank, water heating can be shut off for the entire event (100% reduction).
Program Participation (%)	Central AC 35% Water Heating 2%	Of customers with central AC, the assumption is 35% of these customers will participate. All customers with electric space heating will also include water heating in the program.
Event Participation (%)	90%	It is assumed each customer will be allowed to miss one event a year.

Large Commercial DLC

Direct control of commercial customers is an enticing option for utilities due to the large size of loads and the reliability of direct control. Yet, this option requires significant technological investment in coordination with existing EMS, and it is generally not favored by customers. Utilities offering programs to large nonresidential customers include: Florida Power and Light, Xcel Energy, Otter Tail Power and Light, Madison Gas and Electric, Wisconsin Electric, and Wisconsin Public Service. PSE has recently started a pilot large commercial DLC program with has one participating customer.

Although the program history is limited, this study estimates potential for large commercial customers, requiring a size threshold of 500 kW to increase likelihood of EMS systems already existing in the customer facility. The following end uses are assessed by customer segment: cooling, hot water, lighting, plug loads, space heating, and refrigeration. It is assumed this program option would be called at similar frequency to the residential DLC program: approximately 20 hours per winter and 20 hours per summer.

Technically, only a small portion of the total end-use loads could be curtailed. To estimate the achievable technical potential, the most uncertain factor is program participation. Findings from the IEA survey indicated nonresidential DLC program participation rates are generally quite low (less than 1% of load), excepting Xcel Energy and Otter Tail Power, which achieved participation rates greater than 10% at a cost of about $250/kW. This study assumes a program participation rate of 15%. Event participation is assumed at 90% based on other national programs. As shown in Table 37, although approximately 83 MW and 53 MW at $126/kW and $95/kW are technically available for the winter and summer seasons, respectively, there is essentially no achievable technical potential for this program option due to a lack of interest among customers.

Table 37. DLC Large Commercial: Technical and Achievable Technical Potential (MW in 2029)

Sector	Winter			Summer		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	24	3	<1%	23	3	<1%
Commercial	---	---	---	---	---	---
Industrial	---	---	---	---	---	---
Total	**24**	**3**	**<1%**	**23**	**3**	**<1%**

In terms of costs, the analysis estimates interfacing with existing EMS controls for each end use, reflecting a hierarchy of measures: (1) cooling; (2) lighting; (3) hot water; (4) process; and (5) plug loads. Controls are assumed to last 10 years. Customer incentives are assumed at $6/kW per month ($72/kW-year), based on the need to pay customers relatively high incentives to have direct control over loads.

Detailed assumptions providing values and sources that derived potential and levelized costs are shown in Table 38.

Table 38. Assumptions for DLC Large Commercial Potential

Program Concept	Assumptions
Customer Sectors Eligible	All Commercial subsectors
End Uses Eligible for Program	Cooling, hot water, lighting, plug load, refrigeration
Customer Size Requirements, if any	Loads greater than $500 kW due to EMS system requirements
Summer Load Basis	Top 20 Summer
Winter Load Basis	Top 20 Winter

Inputs	Model Values	Model Assumptions
Annual Attrition (%)	2%	Based on rate of electric turnover.
Per Customer Impacts (kW)	Varies by Sector	This value is a product of technical potential and average kW of eligible customers.
Total kW reduction per program	N/A	PSE does not currently offer this program.
Annual Administrative Costs	$50,000	Due to smaller number of customers, annual administration costs reduced from $60,000 to $50,000 for the commercial and industrial sector.
Technology Cost	Varies by Sector	Cost estimates assume the sites have centralized EMS systems and are based on costs for participants in PG&E's Auto Critical Peak Pricing Program. These costs reflect a hierarchy of DR measures that goes: (1) Cooling; (2) Lighting; (3) Hot Water; (4) Process; and (5) Plug load. DLC projects require a costly interface with existing EMS controls. It is assumed these controls will be linked to facilitate cooling DR measures initially with additional measures, most often lighting, added on once the system is connected (i.e., lighting measures cannot be implemented at the lower cost without first incurring the costs associated with cooling measures).
Marketing Cost (per new participant)	$500	$500 per customer for marketing (based upon 10 hours of effort by program staff at $50/hr).
Incentive (annual cost per participant)	$72/kW annually	We have observed $6/kW per month based upon other studies. We arrive at $72/kW annually through multiplying the $6/kW assumption by 12 months.
Communication Costs (per Customer Per Year)	N/A	
Overhead: First Costs	$200,000	We assume $200,000 overhead as a standard program development assumption for commercial programs, which includes costs for internal labor, research, and IT/billing system changes ($100,000 for labor and $100,000 for IT). This cost is only included in the winter portion.
Per Customer First Cost	Varies by Sector	Our cost estimate assumes each site has a centralized EMS system and is based on costs for participants in PG&E's Auto Critical Peak Pricing Program. These costs reflect a hierarchy of DR measures that goes: (1) Cooling; (2) Lighting; (3) Hot Water; (4) Process; and (5) Plug load. DLC projects require a costly interface with existing EMS controls. It is assumed these controls will be linked to facilitate Cooling DR measures initially with additional measures, most often lighting, added on once the system is connected (i.e., lighting measures cannot be implemented at the lower cost without first incurring the costs associated with cooling measures).

Per Customer Ongoing	Varies	Ongoing costs are calculated from summing annual customer incentives and 5% of technology costs for repair and/or replacement of equipment.
Eligible Load (%)	Varies by Sector	We assume full eligibility of loads greater than 200 kW.
Technical Potential (as % of Load Basis)	Varies by Sector	These assumptions are based on detailed engineering audits of DR potential of nonresidential customers throughout California, with third-party verification of results. Findings are amalgamated by sector and end-use category and supported by senior engineering analysis.
Program Participation (%)	15%	Survey results indicate zero achievable potential when combined with other programs (10% is the high stand-alone potential). We assume participation is more likely 15% (a range of participation levels are observed nationally (0.1% to 30.5% - Xcel, Otter Tail Power).
Event Participation (%)	90%	This assumption is based on Xcel Energy Peak Controlled Rates and is consistent with similar programs.

Interruptible Loads

Interruptible programs refer to contractual arrangements between the utility and its customers, typically nonresidential customers who agree to curtail or interrupt their operations, in whole or part, for a predetermined period when requested by the utility. In most cases, mandatory participation or liquidated damage agreements are required once the customer enrolls in the program; however, the number of curtailment requests, both in total and on a daily basis, is limited by the terms of the contracts.

Customers are generally not paid for individual events, but they are compensated in the form of a fixed monthly amount (per kW) of pledged interruptible load or through a rate discount. Typically, contracts require customers to curtail their connected load by a set percentage (e.g., 15%–20%) or a predetermined level (e.g., 100 kW), whichever is greater. These programs often involve long-term contracts and have penalties for non-compliance, which range from simply dropping the customer from the program to more punitive actions, such as requiring the customer to repay the utility for the committed (but not curtailed) energy at market rates.

The IEA survey of 40 utilities' DR programs revealed slightly more than half of utilities surveyed offer curtailable or interruptible rate programs to their nonresidential customers. Utilities offering programs included almost all the major utilities in California, Illinois, Indiana, Iowa, Minnesota, and Wisconsin as well as a variety of other utilities, including Allegheny Energy, Colorado Springs Utilities, Hydro Quebec, and Kansas City Power and Light. Most utilities require minimum demand reductions for customers to be eligible for the programs, ranging from 50 kW for Xcel Energy, up to the more typical level of 250 kW for MidAmerican.

In this study, it is assumed nonresidential customers with a monthly demand of at least 500 kW would be eligible for such a program. Technical potential is estimated by customer segment. One key aspect to the potential savings associated with the interruptible program is backup generation. Since these participants can turn on a backup generator during these critical peak times, the burden on a customer with a backup generator is minimal. In many utility programs (excluding those in California), customers are allowed to use backup generators to meet curtailment requirements.

Table 39 shows 70 MW (winter) and 71 MW (summer) of technical potential for nonresidential customers and 14 MW (winter) and 15 MW (summer) of achievable technical potential, totaling <1% of PSE's 2029 peak load.

Table 39. Interruptible Program: Technical and Achievable Technical Potential (MW in 2029)

Sector	Winter			Summer		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	- - -	- - -	- - -	- - -	- - -	- - -
Commercial	47	10	<1%	48	10	<1%
Industrial	23	5	<1%	23	5	<1%
Total	**70**	**14**	**<1%**	**71**	**15**	**<1%**

Detailed assumptions providing values and sources that derived potential and levelized costs are shown in Table 40.

Table 40. Assumptions for Interruptible Nonresidential Potential

Program Name	Assumptions
Customer Sectors Eligible	Nonresidential (Large C/I)
End Uses Eligible for Program	N/A
Customer Size Requirements, if any	Customers >200kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Inputs	Model Value	Model Assumption
Annual Attrition (%)	2%	Based on rate of electric turnover.
Per Customer Impacts (kW)	Varies by Sector	This value is a product of technical potential and average kW of eligible customers.
Total kW reduction per program	N/A	
Annual Administrative Costs	$50,000	Due to the smaller number of customers, annual administration costs reduced from $60,000 to $50,000 for the commercial and industrial sector.
Technology Cost	$150	Cost to convert AMR to AMI meter.
Marketing Cost	$500	Reports indicate $500 per customer for marketing (based on 10 hours of effort by program staff at $50/hr).
Incentive	$48/kW	Cost estimated as an average of values of several utilities.
Communication Costs (per Customer Per Year)	N/A	

Overhead: First Costs	$200,000	We assume $200,000 overhead as a standard program development assumption for commercial programs, which includes costs for internal labor, research, and IT/billing system changes ($100,000 for labor and $100,000 for IT). This cost is only included in the winter portion.
Per Customer First Cost	$650	Sum of technology costs and marketing cost.
Per Customer Ongoing	$430	Sum of Repair (technology cost times (1/20)), ongoing customer contractors ($400), communication charge ($7), and data collection charge ($15).
Per KW Ongoing	$48	Incentive.
Eligible Load (%)	Varies by Sector	We assume full eligibility of loads greater than 500 kW.
Technical Potential (as % of Gross)	25% commercial	These assumptions are based on detailed engineering audits of DR potential of nonresidential customers throughout California, with third-party verification of results.
Program Participation (%)	25%	These assumptions are based on information available from the utilities.
Event Participation (%)	90%	Assumed one summer and one winter event can be opted out of.

Demand Buyback

Under demand buyback (DBB) or demand bidding arrangements, the utility offers payments to customers for reducing demand when requested by the utility. Under these programs, customers remain on a standard rate, but they are presented with options to bid or propose load reductions in response to utility requests. The buyback amount generally depends on market prices published by the utility ahead of the curtailment event, and the reduction level is verified against an agreed-upon baseline usage level.

DBB is a mechanism enabling consumers to actively participate in electricity trading by offering to undertake changes in their normal consumption patterns. Participation requires the flexibility to make changes to their normal electricity demand profile, install the necessary control and monitoring technology to execute the bids, and demonstrate bid delivery. One of several Internet-based programs is generally used to disseminate information on buyback rates to potential customers, who can then take the appropriate actions to manage their peak loads during requested events. The program option in this analysis targets large, nonresidential customers (>200kW), consistent with national programs.

Unlike curtailment programs, customers have the option to curtail power requirements on an event-by-event basis. Incentives are paid to participants for energy reduced during each event, based primarily on the difference between market prices and utility rates. DBB products are common in the United States and are being offered by many major utilities. Using DBB offerings to mitigate price volatility in power markets is especially common among independent system operators (ISOs), including ISOs in California (CAISO), New York (NYISO), and New England

(ISO-NE). However, DBB options currently are not being exercised regularly due to relatively low power prices. The IEA survey of 40 utilities' DR programs revealed about half of the utilities surveyed offered DBB programs to their nonresidential customers. Investor-owned utilities offering programs include almost all of the major utilities in California, Illinois, Indiana, Minnesota, and Wisconsin as well as a variety of other utilities, including Allegheny Energy, KCP&L, and Portland General Electric.

Six utilities were interviewed that reported larger DBB program impacts as part of the previous IEA survey. Utilities generally restrict eligibility for DBB programs to large customers who can reduce their loads by at least 500 kW–1,000 kW during peak periods. Of the six utilities interviewed, only Commonwealth Edison has a low minimum load reduction criterion of 10 kW. Program participation has also been significantly influenced by the minimum load reduction required; Commonwealth Edison consequently has 3,700 participants.

Some utilities, however, have captured significant demand reduction potential from just a few program participants. Minnesota Power estimates it could realize about 100 MW of demand reduction—about 9% of its nonresidential peak demand—from its five participants in this program if spot market prices again reach the heights of 1999–2000. Commonwealth Edison claims the second largest peak reduction potential of the utilities interviewed, at about 5% of its nonresidential peak demand. The other utilities estimated their potential peak demand reduction impacts from this program at 0%–2% of nonresidential peak demands. These programs have not resulted in large peak demand impacts for utilities in the past five years due to the relatively low level of spot market prices during this period.

Table 41 shows that in the winter season, of more than 84 MW of technical potential, an average of 1 MW can be expected during any one event. In the summer season, 85 MW technical potential results in an average of 1 MW expected during any one event.

Table 41. Demand Buyback: Technical and Achievable Technical Potential (MW in 2029)

Sector	Winter			Summer		
	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2029 Peak	Technical Potential	Achievable Technical Potential	Achievable Technical as % of 2029 Peak
Residential	---	---	---	---	---	---
Commercial	64	1	<1%	65	1	<1%
Industrial	20	<1	<1%	20	<1	<1%
Total	**84**	**1**	**<1%**	**85**	**1**	**<1%**

Because participants are paid based on market energy rates, this program's cost is relatively low, at levelized costs of $83/kW-year and $11/kW-year in the winter and summer seasons, respectively. New customer costs include hardware ($150 for any necessary metering), marketing ($500), and program development ($200,000, winter only). New participant costs must be reinvested due to a 2% annual attrition rates and a hardware life of 20 years.

Detailed assumptions providing values and sources that derived the potential and levelized costs are shown in Table 42.

Table 42. Assumptions for DBB Potential

Program Name	Assumptions
Customer Sectors Eligible	All Non-Residential Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Customers >200kW
Summer Load Basis	Top 20 Summer Hours
Winter Load Basis	Top 20 Winter Hours

Inputs	Model Value	Model Assumptions
Annual Attrition (%)	2%	Based on the rate of electric turnover.
Per Customer Impacts (kW)	Varies by Sector	This value is a product of technical potential and the average kW of eligible customers.
Total kW reduction per program	N/A	PSE does not currently offer this program.
Annual Administrative Costs	$50,000	Due to smaller number of customers, annual administration costs reduced from $60,000 to $50,000 for the commercial and industrial sector.
Technology Cost	$150	Cost to convert AMR to AMI meter.
Marketing Cost	$500	Reports indicate $500 per customer for marketing (based upon 10 hours of effort by program staff at $50/hr).
Incentive	$10/kW	We assume an estimate of $10 per kW, which is taken from 2000–2002 Demand Exchange Program, based on average market prices of $100/MWh.
Communication Costs (per Customer Per Year)	N/A	
Overhead: First Costs	$200,000	We assume $200,000 overhead as a standard program development assumption for commercial programs, which includes costs for internal labor, research, and IT/billing system changes ($100,000 for labor and $100,000 for IT). This cost is only included in the winter portion.
Per Customer First Cost	$650	Sum of technology costs and marketing costs.
Per Customer Ongoing	$10/kW + $15	Ongoing costs are calculated from summing annual customer incentives and 5% of technology costs for repair and/or replacement of equipment.
Eligible Load (%)	Varies by Sector	We assume full eligibility of loads greater than 200 kW.
Technical Potential (as % of Gross)	20%	These assumptions are based on detailed engineering audits of DR potential of nonresidential customers throughout California, with third-party verification of results.
Program Participation (%)	Varies by Sector	This assumption is based on internal survey results, with an average of 20% participation.
Event Participation (%)	19%	Event participation is based on 2006 PacifiCorp results of 19% event participation (based on an average price of $130/MWh at 12 MW per event).

Critical Peak Pricing

Under a CPP program, customers receive a discount on their normal retail rates during off-peak periods in exchange for paying premium prices during critical peak events. However, the peak price is determined in advance, providing customers with some degree of certainty about participation costs. The basic rate structure is a TOU tariff where the rate has fixed prices for usage during different blocks of time (typically on- and off-peak prices by season, occasionally including a mid-peak price). During CPP events, the normal peak price under the TOU rate structure is replaced with a much higher one to reflect the utility's power cost during peak periods.

CPP rates only take effect a limited number of times during the year, with a cap typically set on the number of CPP event hours that can be implemented. In times of emergency or high market prices, the utility can invoke a critical peak event, where customers are notified and rates become much higher than normal, encouraging customers to reduce or shift loads. Most CPP programs provide advance notice along with event criteria, such as a threshold for forecasted weather temperatures, to help customers plan their operations. One of the attractive features of the CPP program is the absence of a mandatory curtailment requirement; however, both incentives and penalties lie within the pricing structure.

The benefit of a CPP rate over a standard TOU rate is an extreme price signal can be sent to customers for a limited number of events. Utilities have found demand reductions during these events are typically greater than those during TOU peak periods. This occurs for several reasons:

1. Customers under CPP rates are often equipped with automated controls triggered by a signal from the utility.

2. The higher CPP rate serves as an incentive for customers to shift load away from the CPP event period.

3. The relative rarity of CPP events may encourage short-term behavioral changes, resulting in reduced consumption during the events.

Since the CPP rate only applies on select days, it raises a number of questions about when a utility can call an event, for how long, and how often. The rules governing utility dispatch of CPP events varies widely by utility and by program, with some utilities reserving the right to call an event any time, and others providing notice one day prior to the event.

Currently, peak pricing is being offered through experimental pilots or full-scale programs by several organizations in the United States, notably Southern Company (Georgia Power), Gulf Power, Niagara Mohawk, California utilities (SCE, PG&E, SDG&E), PJM Interconnection, and New York ISO (NYISO). Adoption of CPP has not been as widespread in western states as it has been in eastern states.

Residential CPP. The most common national CPP programs are offered to the residential customer class. Recently, significant literature has shown the value of a technology-enabled CPP program, which essentially provides customers with smart thermostats. These can be programmed to change temperature settings and even control other end uses, such as lighting and water heating, depending on the pricing period (e.g., critical peak period, on-peak, or off-peak). This combination of pricing and technology has shown to be an effective combination in improving per-customer load impacts.

More recently, process-oriented appliances, such as dishwashers and washing machines, have incorporated technologies to respond to external CPP signals. During critical events when a rate increase occurs, these "energy-managed appliances" receive notification on the appliance interface, giving customers direct notification and the option of delaying use of the appliance. These appliances also have the capability to temporarily reduce their energy consumption during moments of grid instability. For example, a clothes dryer with this technology will reduce power upon receipt of a remote signal from the utility, then correct for the momentary reduction through extending the drying time. In both situations of signal response, the customer has the ability to override the signaled reduction.

Technically, national studies have shown that 13%–40%[7] of peak demand can be reduced for participating customers; this study assumes a 27% reduction based on the California pricing pilot.[8] In 2006, Gulf Power's CPP program had 2.5% of customers and a goal of reaching 10% penetration. Event participation is estimated to be 90%, based on opt-outs being typically less than 5% now that utilities require customers to use the Internet or the call center to opt out of a CPP event.

Table 43 shows that 762 MW and 44 MW are technically available for the winter and summer periods, respectively. These figures are reduced by the program and event participation rates, resulting in 69 MW (winter) and 40 MW (summer) of achievable technical potential.

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7 Charles River Associates (CRA), Impact Evaluation of the California Statewide Pricing Pilot, March 16, 2005. California Energy Commission (CEC), Statewide Pricing Pilot load reduction data for Zone 4 (desert and inland climate), provided in MS Excel by Pat McAuliffe, CEC staff, via e-mail November 3, 2006. Demand Response Research Center (DRRC), Ameren Critical Peak Pricing Pilot, Presentation by Rick Voytas, Manager of Corporate Analysis at Ameren Services, at the Demand Response Town Hall Meeting, Berkeley, CA, June 26, 2006. International Energy Agency, Demand-Side Management Programme, Task XI: Time of Use Pricing and Energy Use for Demand Management Delivery, Subtask 2: Time of Use Pricing for Demand Management Delivery, April 2005. Rocky Mountain Institute, Automated Demand Response System Pilot, Final Report Volume 1: Introduction and Executive Summary, March 2006. Summit Blue Consulting, Interim Report for the myPower Pricing Segment Evaluation, prepared for PSEG, December 27, 2006. University of California Energy Institute (UCEI), Dynamic Pricing, Advanced Metering and Demand Response in Electricity Markets, S. Borenstein et al., October 2002.

8 See Charles River Associates, 2005.

Table 43. Residential CPP : Technical and Achievable Technical Potential (MW in 2029)

Sector	Technical Potential	Winter Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak	Technical Potential	Summer Achievable Technical Potential	Achievable Technical Potential as % of 2029 Sector Peak
Residential	762	69	2%	444	40	2%
Commercial	---	---	---	---	---	---
Industrial	---	---	---	---	---	---
Total	**762**	**69**	**<1%**	**444**	**40**	**<1%**

The levelized cost of this program is $83/kW and $138/kW for winter and summer, respectively. Detailed assumptions providing values and sources that derived the potential and levelized costs are shown in Table 44.

Table 44. Assumptions for Residential CPP Potential

Program Name	Assumptions
Customer Sectors Eligible	All Residential Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	All
Summer Load Basis	Top 20 Summer Hours

Inputs	Model Value	Model Assumptions
Annual Attrition (%)	7%	Studies have found 7% (composed of 5% change of service and 2% removals) from utilities, including RMP, Xcel, Eon US, SMUD, FP&L (removals range from 1%–3%).
Per Customer Impacts (kW)	Varies by sector	This value is a product of technical potential and average kW of eligible customers.
Total kW reduction per program	N/A	PSE does not currently offer this program
Annual Administrative Costs	$60,000	An administrative adder of 15% was typically assumed for all residential program strategies (assuming that since 15% will be taken from a first cost of $400,000, the annual administrative cost will be $60,000).
Technology Cost	$150	$150 is indicated in the CEC report from 2004 (for the installed cost of ratio frequency load control devices). WH controls will require another switch and result in doubling this cost.
Marketing Cost	$35	This cost assumes an increase from the TOU marketing cost.
Incentive (annual costs)	N/A	
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a one-way transmission system.
Overhead: First Costs	$400,000	$200k for labor and $200k for IT.
Per Customer First Cost	$185	This value is calculated from the technology cost and the marketing cost per new participant.
Per Customer Ongoing	$34	Ongoing costs are calculated from summing annual customer incentives and 7% (1/15) of technology costs for repair and/or replacement of equipment.
Eligible Load (%)	100%	All residential customers are eligible.

Technical Potential (as % of Gross)	27%	The assumption is based on results from California residential pilot CPP programs for statewide average (Charles River Associates, 2005).
Program Participation (%)	10%	Gulf Power has the only full-scale residential CPP program. The company reported 8,500 participants as of October 2006, out of 350,000 residential customers (2.4%). (Sources: Jim Thompson presentation to PURC Energy Policy Roundtable, October 31, 2006; and FERC Form 861 data, 2005.) They expect to reach at least 10% penetration. (Source: Dynamic Pricing, Advanced Metering and Demand Response in Electricity Markets, Severin Borenstein, Michael Jaske, and Arthur Rosenfeld, October 2002.)
Event Participation (%)	90%	Opt-outs are typically less than 5% now that utilities are requiring customers to use the Internet or call center to opt out of a CPP event. (Source: Conversation with Tom Van Denover, VP Comverge March 2007.) With 2-way communications (through AMI or ZigBee gateway, for example) utilities can identify and replace malfunctioning thermostats, so event participation is much higher than in older one-way, switch-based DLC programs.

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5. Distributed Generation Potentials

Scope of Analysis

In addition to traditional energy-efficiency technologies, this report includes an analysis of distributed generation (DG) resources. These resources are used to produce electricity and offset utility electric loads. They are divided into two broad categories: non-renewable and renewable resources. Non-renewable resources include on-site generation using a combined heat and power (CHP) unit that consumes natural gas. Renewable resources include energy-based resources of biomass and three "clean generation" (non-combustion) resources: building photovoltaics (on-site solar), small hydro, and small wind. This study only considers on-site generation primarily used for a building's energy and heat needs. Large "central-station" generation facilities that operate to sell the majority (or all) of their power to the grid are outside the scope of this work.

The analysis specifically examined five DG resources:

- *Non-renewable CHP* includes all generators that produce energy by burning a fossil fuel, such as natural gas or diesel. In this study, only natural gas is considered because it is readily available and environmentally cleaner-burning than diesel. This category includes CHP used in cooling applications, sometimes referred to as CCHP (combined cooling heating and power), where the generator unit is coupled with an absorption chiller.
- *Renewable CHP* refers to energy generated from any plant- or animal-based (biomass) material. Biomass can be directly combusted (i.e., industrial biomass) or fed into an anaerobic digester to produce biogas, which can then be combusted to produce electricity. Although biomass energy is based on a renewable resource, this combustion process is not considered "clean" as it does produce emission products (e.g., carbon dioxide, NOx, etc.).
- *Building Photovoltaics* are rooftop-based photovoltaic (PV) panels that convert sunlight to electricity.
- *Small Hydro* is sometimes known as run-of-river hydroelectric power generation, as dams need not be built to regulate water flow. Four basic types of hydro installations are included in this study: small, micro, low-power conventional, and low-power unconventional.
- *Small Wind* encompasses small, electricity-generating wind turbines installed at a customer's site.

Methodology

The overall methodology used to calculate the potential from distributed generation resources includes three key steps:

- ***Technical potential*** was calculated separately for each resource categories, using the following key data inputs:

- Non-renewable CHP: PSE's non-residential customer database for "typical" building energy loads used to determine feasibility by market segment.
- Renewable CHP: PSE's industrial customer database for size and count of biomass-producing industrial facilities and service territory demographics for biogas-producing (anaerobic digester) facilities.
- Building PV: PSE customer counts and building square footage assumptions.
- Small Hydro: potential river sites for turbines from Idaho National Laboratory's Virtual Hydropower Prospector (VHP)[9] by county and installation type, and USGS stream flow data from representative streams to determine capacity factors.
- Small Wind: energy output estimated using power curves for sample turbines and available TMY2 wind data,[10] in addition, population density, proximity to airports, and sensitive land areas are considered.

- ***Various technology costs*** were calculated based on literature searches, available databases, and other states' programs. Installed costs included capital costs, planning, installation, and other adders.
- ***Achievable technical potential*** was determined for each resource class based on other programmatic successes, including within PSE's territory. Note that not all achievable technical potential will be cost-effective.

Summary of Findings

This section presents a summary of the key findings for distributed generation potentials. More detail regarding each resource follows these highlights.

Resource Potential

To accurately estimate the quantity of market potential, it is essential to know the current penetration of DG technologies currently found in the marketplace. The installed nameplate capacity, presented in Table 45, was obtained from existing databases,[11,12,13] and PSE data. This capacity excluded large "central-station" generation facilities and large, utility-owned generation facilities (e.g., wind farms, CHP facilities greater than 30 MW).

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9 http://hydropower.id.doe.gov/prospector/index.shtml

10 TMY2 or Typical Meteorological Year, includes wind speed data compiled by the National Renewable Energy Laboratory for cities across the country.

11 http://www.eea-inc.com/chpdata/index.html

12 http://www.epa.gov/lmop/proj/index.htm gives waste-in-place data for eligible landfills. If waste-in-place is not specified, a 500 kW generation potential is assumed.

13 http://www.small-hydro.com/index.cfm?fuseaction=countries.sites&country_ID=82

Table 45. Installed DG Capacity by Resource (2008)

Resource	Capacity (MW)
Non-Renewable CHP	40
Renewable CHP	52
Building Photovoltaics	0.9
Small Hydro	0.01
Small Wind	0.02
Total	**93**

Technical Potential

The total technical potential from DG resources, excluding existing capacity, is 3,493 aMW in 2029 (Table 46). More than half of the technical potential for DG comes from PV (51%), followed by non-renewable CHP (28%), small hydro (14%), renewable CHP (5%), and small wind (2%). It should be recognized that technical potential for the DG resources is significantly higher than what can be achieved, primarily due to high upfront costs required for these resources and feasibility constraints, particularly for small wind and hydro.

Table 46. Technical Potential for DG Renewable Resources (2029)

Resource	aMW	Percent
Non-Renewable CHP	1,039	28%
Renewable CHP	211	5%
Building Photovoltaics	1,912	51%
Small Hydro	265	14%
Small Wind	66	2%
Total	**3,493**	**100%**

Achievable Technical Potential

For DG resources, achievable technical potential represents the portion of technical potential that might actually be installed. It should be realized that not all these resources are cost-effective, but, nonetheless, may be installed by customers willing to accept long payback times.

Note that the achievable technical potential also considers current incentives for these resources. Currently, customers can receive the Washington Renewable Energy Production Incentive[14] for anaerobic digesters, wind, and PV. In addition, the Federal Production Tax Credit[15] is currently

[14] Currently available through 6/30/2014, the incentive offers $0.12 – $0.54/kWh, depending on technology and where equipment was manufactured, with a maximum incentive of $2,000/year.

[15] Production Tax Credit is 1.9 cents/kWh available through December 31, 2008, and applies to the first 10 years of production (http://www.dsireusa.org).

available to commercial and industrial projects, and the Federal Renewable Energy Production Incentive[16] is available to non-taxable entities (e.g., municipal projects) for clean energy options.

The achievable technical potential for all DG resources is shown in Table 47. Compared to the technical potential of DG resources (Table 47), this potential is significantly less due to economic considerations, low awareness of technologies, and other permitting or interconnection concerns (details are provided in the results sections, below). Among the DG resources, non-renewable CHP composes the largest percentage of achievable technical potential (34 aMW), followed by photovoltaics (21 aMW), renewable CHP (8.7 aMW), small hydro (0.12 aMW) and small wind (0.04 aMW).

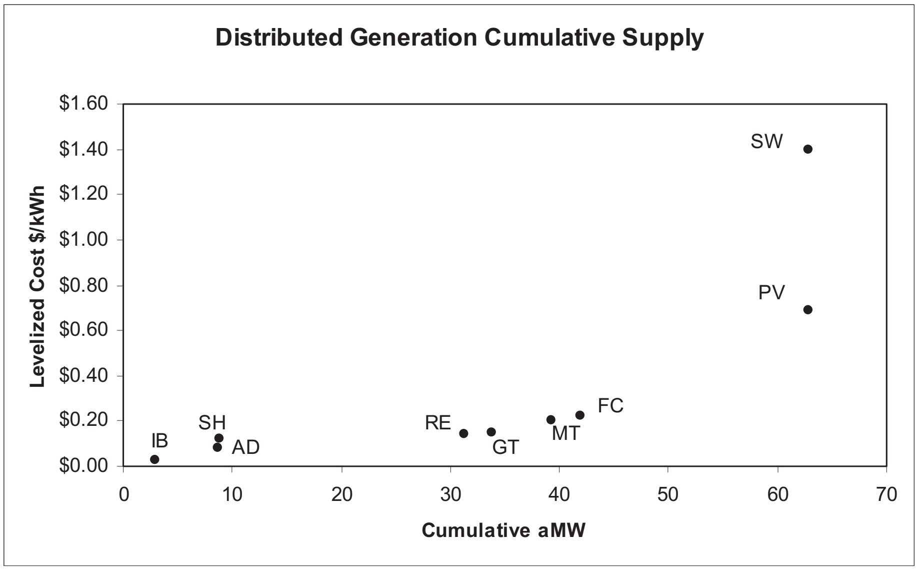
Table 47. Achievable Technical Potential for DG Resources (2029)

Resource	aMW	Percent
Non-Renewable CHP	34.0	53%
Renewable CHP	8.7	14%
Building Photovoltaics	21.0	33%
Small Hydro	0.12	0%
Small Wind	0.04	0%
Total	**66.4**	**100%**

Figure 27 presents the cumulative supply curve for all DG resources. Biomass Energy is split into Industrial Biomass (direct combustion) and Anaerobic Digesters (biogas combustion). Non-renewable CHP is divided into each generation technology. Further details on these and all renewable potentials are discussed below.

16 Renewable Energy Production Incentive is 1.5 cents per kWh (indexed for inflation) with a 10-year term. (http://www.dsireusa.org).

Figure 27. Cumulative Supply Curve for Dispersed Generation Renewable Resources (2029)



RE: reciprocating engine, MT: Microturbine, FC: Fuel Cell, GT: Gas turbine, IB: Industrial Biomass, AD: Anaerobic digester, PV: Building photovoltaics, SH: Small hydro, SW: Small wind.

Combined Heat and Power

CHP encompasses all technologies that generate electricity while heating and/or cooling a customer's facility. Generally, the power generated through these technologies is expected to contribute to the utility's base load resources, rather than to peak load requirements. Peak load reduction with an on-site generator or dispatchable standby generation is treated as part of the Demand Response potential (Section 4). CHP has traditionally been installed in hospitals, schools, and manufacturing facilities, but it can be used across nearly all facilities that have a fairly coincident electric and thermal load and an average annual energy load greater than about 30 kW. CHP used to offset cooling loads is most applicable for building segments with large cooling requirements, such as retail, grocery, and hotel/motel. CHP is broadly divided into non-renewable and renewable subcategories based on the fuel used.

CHP includes a standard electrical generator, but total energy needs of the business are also reduced by capturing the generator's waste heat and using it for other processes. For example, a typical spark-ignition engine has an electrical efficiency of only about 35%. The "lost" energy is primarily waste heat. A CHP unit will capture much of this waste heat and use it for space heating, water heating, or to power an absorption chiller, achieving an overall efficiency of up to 80%. Thus, savings become available by offsetting boiler or air conditioning usage in addition to electricity being generated.

The three primary generator technologies available in the market are: 1) reciprocating engines (either spark-ignition or compression-ignition); 2) turbines (gas or steam for larger capacity [>1 MW] or microturbines for smaller capacity [<1 MW]); and 3) fuel cells, primarily those using phosphoric acid (PAFC) or molten carbonate (MCFC) as the electrolyte, although other types of fuel cells are now becoming commercially viable.[17]

As described earlier, CHP is divided into two broad categories, depending on the fuel source-renewable or non-renewable. The same generators described above can be used with either fuel type. Note that biomass fuels from the agricultural sector (e.g., crop waste such as bagasse—from sugar, rice hulls, or rice straw) are not considered in this study. Due to high moisture content and varying ability, crop residues are not a viable fuel alternative for most CHP applications.[18] In addition, the prime energy producing crops (sugar cane and rice) are largely not present in PSE territory.

Background information on costs, operating parameters, measure life, etc., for each technology are given in Volume II, Appendix F.

CHP Technical Potential

The technical potential for CHP assumes all technologies will be adopted in all available customer sites to meet their average annual electric demand, regardless of cost or other market barriers. This applies to all non-residential building types, large industrial biomass-producing facilities, and sites that may use anaerobic digesters. These three sectors, however, need to be treated separately. To derive this potential, PSE's 2007 customer database was used; as such, the technical potential given is ramped up from the first-year load. Details on the resources used are given in Volume II, Appendix F. The technical potential by resource category is provided in Table 48.

Renewable: Anaerobic Digesters. Anaerobic digesters create methane gas (biogas fuel) by breaking down liquid or solid biological waste. The captured waste heat of the CHP unit is, in large part, used to maintain the high temperature required of the digesters themselves. The digesters are grouped into two bins: small and large. The small anaerobic digesters are coupled with smaller-scale generators, such as reciprocating engines, microturbines, or fuel cells, while large anaerobic digesters use generators such as steam or gas turbines with a capacity greater than 1,000 kW. The best candidates for anaerobic digesters include animal farms (dairy or swine), landfills, and wastewater treatment facilities.

For farms, the amount of biogas that can be generated is directly related to the number and type of animals on site. Based on typical collection systems, a study by the EPA assumes that one cow will generate 2.5 kWh/day and one pig will generate 0.25 kWh/day.[19] Given size constraints, it is likely only dairy farms with more than 500 head of cattle or 2,000 head of swine will install a generator. Based on the number and average size of farms across the state (by zip code) within PSE territory,[20,21] an overall potential is calculated.

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17 Note that not all types of fuel cells available operate at a high enough temperature to be applicable for CHP-configuration. Only viable types are considered here.

18 "Combined Heat & Power Market for Opportunity Fuels," Resource Dynamics Corp, 2004.

19 "Market Opportunities for Biogas Recovery," EPA-430-8-06-004, http://www.epa.gov/agstar

20 http://www.nass.usda.gov/Census_of_Agriculture/index.asp

Wastewater treatment facilities are similar to farms; the population served by a particular facility will determine the expected generation output. A study by the Federal Energy Management Program assumes 10,000 people will generate approximately 1 million gallons of waste per day (1 MGD). Each MGD of waste can produce about 35 kW of energy; as such, generally 3 MGD is the minimum waste flow before an anaerobic digester will be installed.[22] Thus, only population centers with 30,000 people or greater are considered for wastewater generation. Finally, for landfills, the U.S. EPA Landfill Methane Outreach Program (LMOP) encourages the implementation of generators at landfills. As part of this program, a database of participating and candidate landfills, based on waste-in-place and throughput, is available by state (with zip code resolution).[12]

Renewable: Industrial Biomass. Industrial biomass includes the waste product from industries that is combusted in place of natural gas or other fuel. For solid industrial biomass, the heat produced from combustion is often used to run a steam turbine.[23] The industrial biomass potential is based on customers with an average annual electric load greater than 1 aMW in the four key biomass-producing industries: lumber, food, pulp and paper, and chemical manufacturing. The PSE customer database is used to determine the overall load associated with these industries. For buildings with a load between 1 aMW and 5 aMW, an average load of 2.5 aMW is assumed; for those with a larger than 5 aMW annual load, the actual customer load was taken from PSE's nonresidential customer database. All industrial biomass facilities within this size range are considered CHP-eligible.

Non-Renewable Generation. For all other nonresidential facilities (excluding renewable-generation facilities), the only constraint on the technical potential is the applicability of a CHP unit within a particular building. For a building to be eligible for CHP, two key conditions need to be met: the ratio of thermal to electric loads should be within 0.5–2.5 (the range over which most CHP technologies operate), with a high coincidence between these two loads, and the overall loads should be fairly constant throughout the year. The overall percentage of buildings by market sector that are CHP-eligible, based on these ratio and load requirements, was obtained from Energy Insights™. Energy Insights has determined these consumption parameters from secondary sources, including the Energy Information Administration Commercial Buildings Energy Consumption Survey (CBECS), the Manufacturing Energy Consumption Survey (MECS) as well as market summaries developed by their own surveys, the Gas Technology Institute, and the American Gas Association. Using the PSE customer database, the number of CHP-eligible establishments within a load bundle, (e.g., 200 akW–499 akW or 500 akW–999 akW average annual electric load), together with an average load based on bundle size, is used to calculate the potential in aMW. For buildings with an annual load larger than 5 aMW, the actual customer load is taken from the customer database. The cooling potential is based on

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21 "Sizing and Characterizing the Market for Oregon Biopower Projects," CH2MHill for Energy Trust of Oregon, 2005.

22 http://www1.eere.energy.gov/femp/pdfs/bamf_wastewater.pdf

23 This is commonly referred to as *cogeneration*.

building segments that have fairly constant cooling loads: Dry Good Retail, Grocery, Hospital, and Hotel/Motel.[24]

Table 48. CHP Technical Potential by Resource Category (aMW in 2029)

Technical Potential	Total
Small Anaerobic Digesters	120
Large Anaerobic Digesters	0
Industrial Biomass	90
Non-Renewable Heating	992
Non-Renewable Cooling	46
Total	**1,249**
Note: Results may not sum to total due to rounding	

CHP Achievable Technical Potential

The first step in the analysis is an examination of what the market may accept, not all of which is necessarily cost-effective. The achievable technical potential is based on adoption rates within other programs (primarily SGIP in California). This analysis is fairly independent of the technical potential, but it provides reasonable results based on adoption rates through other programs.

Non-Renewable Generation. The achievable technical potential for non-renewable CHP is based on California's success of implementing CHP installations within SGIP. The results of SGIP were used as an expected generation outcome for PSE, normalized by the PSE load compared to the load of the participating SGIP utilities. The SGIP was in effect for six years and provides incentives that cover approximately 50% of the system cost. With slow initial growth for program implementation and greater expected barriers (e.g., longer payback periods, potentially less statewide support, insufficient interconnection standards, etc.), this generation is targeted for PSE after 10 years of program implementation. The four primary generator technologies (reciprocating engines, microturbines, fuel cells, and gas turbines) were all included in SGIP and treated distinctly in this analysis. It is assumed across all non-renewable CHP (except gas turbines) that 75% of the installations will go in the commercial sector, and 25% will be installed in the industrial sector. No residential sector penetration is assumed as residential CHP technologies are still nascent. Gas turbines, being generally quite large and generally better suited to the industrial sector, are assumed to penetrate 50% in each the commercial and industrial sector. The overall achievable technical potential in 2029 is 36 aMW for non-renewable CHP, 28 aMW of which for heating-based applications, and 8 aMW for cooling-based applications.

Renewable: Anaerobic Digesters. The availability of potential sites for anaerobic digesters (farms, landfills, wastewater treatment facilities) is area-specific; therefore, the adoption rate from other states' programs may not be representative for PSE territory. Instead, the potential

[24] "Market Potential for Advanced Thermally Activated BCHP in Five National Account Sectors", Energy and Environmental Analysis, Inc., May 2003.

was based on PSE's experience and a similar adoption percentage of technical potential as non-renewable CHP (3% in the first five years of program implementation and doubling within the next five years). All anaerobic digesters are installed in the commercial sector, and the achievable potential is about 6 aMW for smaller systems and effectively zero for larger systems in 2029.

Renewable: Industrial Biomass. Very few programs currently exist to promote industrial biomass adoption. Given the lack of data, the achievable technical potential is based on internal PSE knowledge, coupled with the adoption percentage of non-renewable resources. As the name indicates, all penetration is in the industrial sector and is about 3 aMW in 2029.

Resource Potential

The results of this analysis indicate a cumulative achievable technical potential of 45 aMW from all CHP technologies by 2029 (Table 49). As with all other resources, this potential is measured at the meter. The largest potential is from non-renewable reciprocating engine applications (24 aMW), followed by anaerobic digester (6.1 aMW).

Table 49. Achievable Technical Potential for CHP (aMW in 2029)

Sector	Industrial Biomass	Small Anaerobic Digesters	Large Anaerobic Digesters	Non-Renewable				Total
				Recip. Engine	Gas Turbine	Micro-turbine	Fuel Cell	
Industrial	3.0	0.0	0.0	5.6	1.3	0.7	0.5	11.1
Commercial	0.0	5.7	0.0	16.9	1.3	2.3	5.2	31.4
Total	3.0	5.7	0.0	22.4	2.5	2.9	5.8	42.5
% of 2029 System Sales	0.08%	0.16%	0.00%	0.63%	0.07%	0.08%	0.15%	1.13%
Levelized Cost ($/kWh)	$0.03	$0.08	$0.04	$0.13	$0.14	$0.19	$0.21	

Levelized costs ($/kWh) are shown in Table 49 for each technology, calculated using costs given in Volume II, Appendix F, along with the levelized fuel price and a nominal discount rate of 8.25%. Levelized costs for non-renewable CHP are based on heating-only applications. For cooling applications, costs average slightly higher.

Clean Energy

Clean energy consists of energy generation options that do not consume a hydrocarbon-based fuel; these are namely photovoltaics, small hydro, and small wind. Each resource is unique and, consequently, the technical and achievable technical potentials are calculated differently. Background information on costs, operating parameters, measure life, etc., for each technology are provided in Volume II, Appendix F.

Clean Energy Technical Potential

The technical potential for all clean energy resources is shown in Table 50. Below are details on the derivation of the technical potential for each of these technologies.

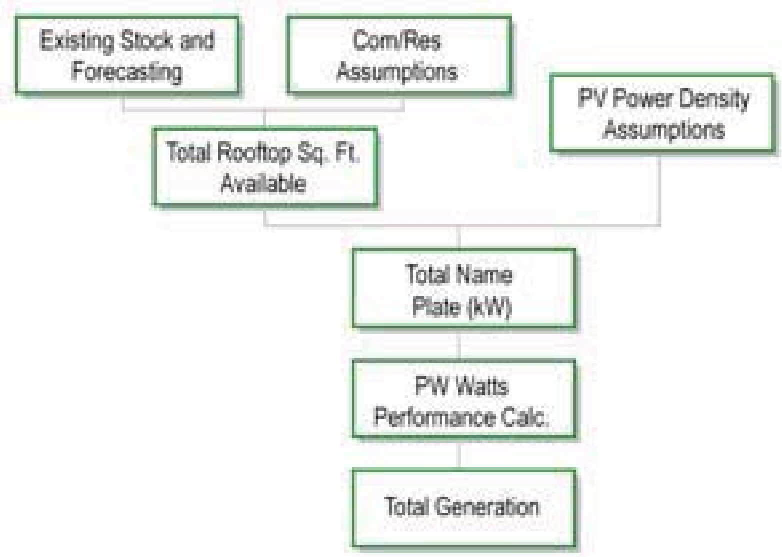
Table 50. Technical Potential of Clean Energy Resources by Technology (aMW in 2029)

Technology	Potential (aMW)
Building PV	1,912
Small Hydro	265
Small Wind	66
Total	**2,243**

Building PV

Analysis of this technical potential is based solely on rooftop applications. This provides a conservative estimate as other applications, such as ground or pole-mounted PV, awnings, and car ports, are not considered. This estimate of technical potential considers the physical limitations due to roof area, shading, orientation, and expected building growth. The PV methodology is diagrammatically displayed in Figure 28, showing how different inputs are used to estimate technical potential. Each input will be described in detail below, with further details available in Volume II, Appendix F.

Figure 28. Methodology for Calculating PV Potential



Existing Stock and Forecasting. Estimates of available square footage of roof area are based on site visits, surveys, and data mining results performed as part of this study for commercial and residential buildings in PSE territory. The load forecast is used to estimate the growth in building stock.

PV Commercial Assumptions. The following assumptions are comparable to and consistent with other studies:

- All commercial rooftops are considered flat (0° pitch).

- 35% of all roofs are unavailable (10% due to obstructions and equipment, 5% space lost due shading from equipment, and 15% from surrounding building shading and other technical restrictions).

- All building types are equally distributed across all zip codes.

PV Residential Assumptions. The following assumptions are based on field experience and remain consistent with other studies:

- Single-family and manufactured households typically have 4/12 (18.5o) pitch roofs.

- Multifamily structures have flat roofs (0o pitch).

- 83% of 4/12 pitch roof areas and 65% of flat roofs are unavailable due to shading and other obstructions.

- All building types are equally distributed across all zip codes.

PV Power Density Assumptions. PV cell technology evolves over time and efficiency continually improves. According to the DOE, cell efficiency is projected to improve at an average rate of roughly 2.1% a year across all three classes of technologies. This assumption is comparable with other studies. Conversely, there is also a performance degradation of 1% efficiency per year. Both of these assumptions are included in this analysis.

This analysis also takes into account market shares of competing solar cell technologies: mono-crystalline, poly-crystalline, and amorphous 'thin-film,' from which a weighted average is calculated to determine an overall efficiency. In addition, it is important to account for the space between modules needed for racking materials and installation requirements for the entire array, increasing the overall footprint. To adjust for this, the power density (W/sq.ft.) is reduced by 20% to give the total system array efficiency. This result is applied to the projected increase in cell efficiency to determine the annual power density.

The system power density multiplied by the useable square footage for each building type results in the total name plate capacity (kW) or the total DC kW installed.

PV Watts Performance Calculator. As noted earlier, the PV Watts performance calculator is used to determine the capacity factor.[25] The amount of solar insulation available is based on Seattle's weather station, which is equivalent to that used in the energy-efficiency building simulation models. The technical potential is based on the maximum roof area coverage of commercial and residential building types, verses the achievable technical potential based on optimum system design. The resulting weighted average capacity factor of commercial and residential buildings for the technical potential is 0.10, while, for the achievable technical potential, it was calculated as 0.12.

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[25] Developed by the National Renewable Energy Laboratory, the PV Watts Performance Calculator uses hourly Typical Meteorological Year (TMY) weather data and a PV performance model based on Sandia National Laboratories' PVFORM to estimate monthly and annual AC energy production (kWh).

Small Hydro

The technical potential for small hydro was calculated based on the sites listed in the Virtual Hydro Prospector (VHP). Data were downloaded for all suitable potential small hydro sites in PSE's territory. These data included capacity, county, and other information, such as head and stream flow. They were then analyzed to derive hydro potential by county, adding up the potential for all four installation types (i.e., small hydro, micro hydro, low-power conventional and low-power unconventional).

The potential hydro sites listed in the VHP were screened for feasibility based on the following criteria:

- Hydropower potential ≥10 kW.
- Not in a zone in which development was excluded by federal law or policy.
- Not in a zone making development highly unlikely because of land-use designations.
- Not coinciding with an existing hydroelectric plant.
- Located within 1 mile of a road.
- Located within 1 mile of part of the power infrastructure (power plant, power line, or substation) ***or*** within a typical distance from a populated area for plants of the same power class in the region.

After screening for feasibility criteria, the VHP calculates potential power output for each site using the following assumptions:

- ***Project location***: optimal, based on hydraulic head capture.
- ***Penstock length***: optimal, based on capturing 90% of hydraulic head with the longest, typical penstock length, and based on existing low-power or small hydro plants in the region.
- ***Flow rate***: lesser of either half the stream reach flow rate ***or*** no more than the flow rate required to produce 30 aMW of annual average energy.

Some of the VHPs assumptions result in a conservative potential estimate. The following assumptions indicate the actual potential may be higher than what is reported in the VHP:

- The VHP assumes 50% of the stream reach is available for hydro system use. Other studies indicate this estimate is conservative. For example, a small hydro potential study produced for BC Hydro estimates 90% of stream flow is useable, deeming only 10% of flow needs to be retained to protect fish. Therefore, the actual potential at each site could be as much as 80% higher than the potential indicated in the VHP.[26]

- The study did not include potential for hydrokinetic technologies in cases where little head is available but there is sufficient velocity and stream depth to support such hydrokinetic technologies.

Potential from Hydro Prospector

The data for all potential projects in PSE territory were obtained from the VHP online tool. Though this study limited project size to 500 kW—generally the maximum allowable size for a behind-the-meter system—sites were included that had more potential, as we assumed part of the potential could be utilized. Table 51 shows the number of sites by county.

Table 51. Count of Potential Hydro Sites by County and Size Class

Size Class	<20 kW	20-30 kW	30-40 kW	40-60 kW	60-80 kW	80-100 kW	100-300 kW	300-500 kW	Total
Whatcom	19	12	4	11	5	4	49	75	179
Skagit	10	13	9	11	5	4	26	66	144
Jefferson	6	1	1	2	3	2	6	6	27
King	21	25	18	19	16	14	90	191	394
Pierce	3	7	4	7	1	5	25	61	113
Thurston	23	19	11	15	6	13	14	15	116
Kitsap	14	8	7	4	1	1	0	0	35
Kittitas	25	12	9	13	9	5	48	88	209
Island	0	0	0	0	0	0	0	0	0
Total	**121**	**97**	**63**	**82**	**46**	**48**	**258**	**502**	**1,217**

The total amount of technical potential by size range is shown in Table 52.

Table 52. Technical Potential by Site Size Class (aMW in 2029)

Size Class	<20 kW	20-30 kW	30-40 kW	40-60 kW	60-80 kW	80-100 kW	100-300 kW	300-500 kW	Total
Potential (aMW)	1.46	2.02	1.81	3.43	2.76	3.55	42.98	207.21	265.21

Note that these values may not agree with the distribution of potential hydro sites within a county; the exact location of the utility's operating areas within each county were not known. Based on available geographical data, sites outside PSE's electric territory were excluded.

To calculate generation per month, stream flow data were taken from the USGS Website.[27] These data, which show the stream flow for each month for different streams in each county,

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26 Details of Idaho National Laboratory's identification and analysis of potential hydro sites listed in the VHP are given in the report: *Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants*, January 2006, Prepared for the DOE, Office of Energy Efficiency and Renewable Energy by Idaho National Laboratory.

27 http://waterdata.usgs.gov/ia

were used to estimate the proportion of total annual generation in each month by first calculating the percentage of annual stream flow (in each month) for the sample streams in that county, then applying that percentage to annual generation for the whole county.[28]

This analysis showed the share of annual generation is distributed differently, depending on the part of the state in which the county is located. In addition, the total potential is much lower in summer than in winter, with the September flow only 34% of the peak flow in January. Further details are provided in Volume II, Appendix F.

Small Wind

The technical potential for small wind assumes all technologies will be installed by all customers living at available sites, regardless of cost or other market barriers. We began with PSE's customer forecast, weighted by zip code based on the 2000 Census. Then, for reasons described in-depth below, we applied the following conditions:

- Eliminated customers renting their homes;
- Excluded 95% of the urban population; and
- Excluded customers living close to an airport.

Population Density. Small wind turbines are currently less viable options for heavily populated regions due to the lack of land available for turbines and the interruption of air flow by tall buildings.[29] We determined population density at the zip code level using 2000 Census data; because of urban population density, we excluded 95% of residential customers. However, as some urban lots may be suitable for small wind, we kept 5%of the urban population in the technical potential. Census data also provided an estimate of renter-occupied versus owner-occupied homes by zip code. Renter-occupied homes are not expected to install turbines as renters will not be inclined to invest in such a location-specific measure.

Proximity to Airports. Wind turbines within 2 miles of an airport may be subject to tower height regulations by the Federal Aviation Administration (FAA).[30] Small wind turbines are unlikely to be affected by these height restrictions, but this assumption has been made to ensure a conservative resource estimate. Therefore, we excluded a portion of customers located near an airport.

After applying these screening criteria, it was determined it technically may be feasible to install a wind turbine at 134,384 PSE residential customer sites.

In addition to customer availability, the quantity of the wind resource is a major component to technical potential**.** Wind speeds are based on TMY2 data, which include wind speeds for three

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28 The calculation can be represented as: Monthly generation (kWh) = kW potential x 8760 hours/year x the percentage of annual stream flow in the month.

29 Building integrated turbines are gaining greater acceptance in Europe and, in the future, may be deemed a viable option in the U.S. However, they have not been included in the analysis here due to insufficient acceptance levels in the U.S. and insufficient data availability.

30 AWEA. http://www.awea.org/smallwind/toolbox2/factsheet_visual_impact.html

cities within or near PSE electric territory: Seattle, Yakima, and Olympia. We then assigned each zip code within PSE territory to one of these wind profiles, based on geographic proximity.

Clean Energy Achievable Technical Potential

Achievable technical potential by technology is provided in Table 53. The industrial sector was not considered a market likely to install clean energy options. The total potential from all resources across PSE territory is 21 aMW. Note that none of the clean energy options are likely to be cost-effective, and the current achievable technical potential derives purely from customers willing to accept long payback periods. Details on derivation of this achievable technical potential are given below for each technology.

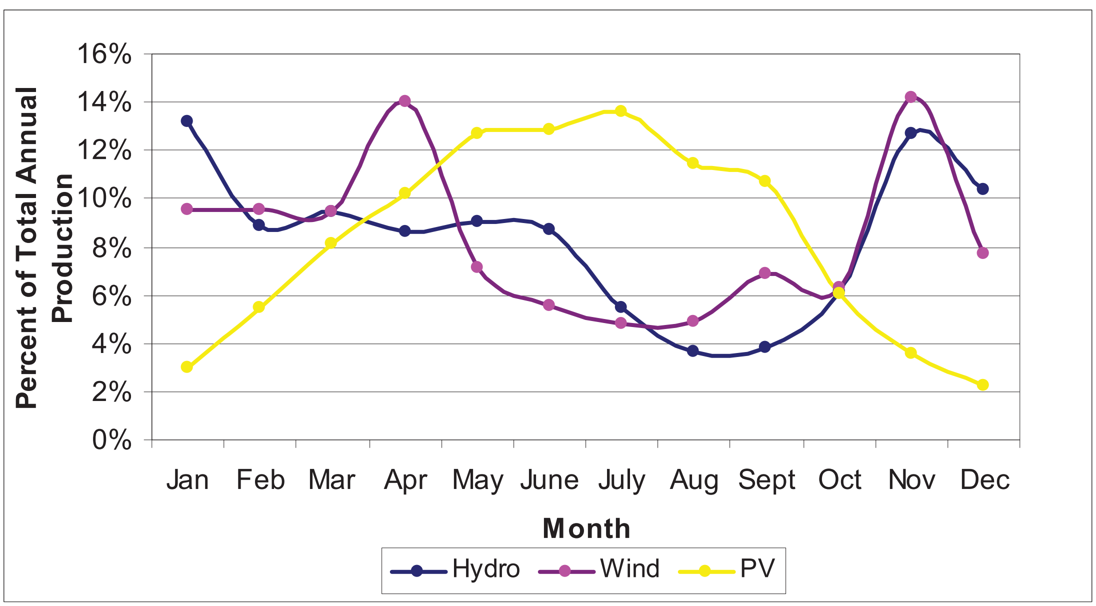
Table 53. Clean Energy Achievable Technical Potential (aMW) by Sector in 2029

Sector	Building PV	Small Hydro	Small Wind	Total
Residential	3.6	0.08	0.04	3.7
Commercial	17.3	0.04	0	17.3
Total	**20.9**	**0.12**	**0.04**	**21.1**
Levelized Cost ($/kWh)	$0.6	$0.1	$1.40	

Individual results may not sum to total due to rounding.

All clean energy options are intermittent resources. For small hydro and wind, peak power generation occurs in winter; PV peaks in the summer. The variations in achievable technical potentials over the year for each technology are shown in Figure 29.

Figure 29. Clean Energy Average Monthly Achievable Technical Potential (2029)



Although none of the clean energy resources are likely to be considered cost-effective, changes from other factors may affect the payback period. These factors may include government incentives, technological breakthroughs that reduce costs, and future energy costs. It is difficult to quantify the payback period's affect on adoption, but decreasing the payback period to less than 10 years can have as much as a two- to three-fold increase in achievable technical potential.

Building PV

Achievable technical potential for PV is primarily based on the recent success of PV installations in PSE's service territory and knowledge of PSE's internal staff as well as on existing programs across the country. A program's success is, in part, dependent on the current incentives available. Incentives can be provided by one or more of the following: federal tax incentives, state tax incentives, utility buy-downs, production-based incentives, and other rebates. Volume II, Appendix F lists several state programs from around the country that offer PV incentives.[31] Incentives have become critical in promoting and creating a successful PV program. Depending on the type and size of the incentive, it can affect the adoption rate. In most instances, the total incentive is roughly 50% of the installed cost for the residential market and 75% for the commercial sector. The achievable technical potential is based on existing successful programs implementing these incentive levels, and is calculated from their adoption rates. The resulting achievable technical potential is less than 1% of the technical potential.

The resulting achievable technical potential is 21 aMW. The levelized cost for PV is $0.69 /kWh. If current federal tax credits and the production subsidy incentives remain, the levelized cost falls to $0.60/kWh.[32]

Small Hydro

Achievable technical potential for small hydro is difficult to analyze because very few utility or state programs promote hydro as a customer-based renewable resource. Currently in North America, the Energy Trust of Oregon, BC Hydro, and Holy Cross Energy (Colorado) all have some form of incentive program promoting small hydro. However, data available on program installations and potential are sparse, and thus could not be used for this assessment. Instead, it is assumed, based on discussions with PSE staff, that over the 20-year horizon, small hydro units would be installed at 10 residential sites (approximately 10 kW each) and one commercial site (approximately 50 kW).

Small Wind

The achievable technical potential estimates were based primarily on discussions with PSE staff and historical program activity. Based on this, it was assumed two to three 10 kW turbines will be installed per year, along with one 1.9 kW turbine. This leads to an overall installed nameplate capacity of 610 kW, or 0.04 aMW of energy generated from small wind in 2029. This value is an overall figure, as we assumed no achievable technical potential in the Yakima region, and most market penetration occurs near Seattle and Olympia, where wind conditions are most favorable.

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31 Database of State Incentives for Renewables and Energy Efficiency (DSIRE); www.dsireusa.org.

32 Washington's production subsidy remains in effect until December 31, 2014, and the expanded Federal tax credits remain until December 31, 2016, after which point they are scheduled to revert to enacted EPAct 2005 incentive levels.

quantec

THE CADMUS GROUP, INC.

Comprehensive Assessment of Demand-Side Resource Potentials (2010-2029): Appendices

Volume II

July 10, 2009

FINAL REPORT

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Table of Contents

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Appendix A: Data Collection

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Appendix A.1: Residential End Use Survey

A.1.1 – Summary of Findings

One of the key tasks in helping PSE develop its 2010 IRP was cataloging the assumptions from previous IRPs and looking for opportunities to update the data. One such identified area was customer characteristics and energy consumption patterns in the residential sector. As PSE had not conducted a Residential Appliance Saturation Survey (RASS) since 2003, it was determined that an update would be a worthwhile endeavor. An updated RASS was planned for late 2008, but these results would not be available in time for inclusion in the 2010 IRP, so a smaller-scale Residential End Use Survey (REUS) was designed and implemented by The Cadmus Group (formerly Quantec, LLC).

The main tasks in the design, implementation, and analysis of this survey were:

- Designing the survey instrument
- Creating the sample
- Conducting surveys
- Analyzing survey responses

Designing the Survey Instrument

To ensure that all necessary information was gathered, Cadmus worked closely with PSE staff on survey and question design. Questions were intended to gather information on:

- End uses present in homes
- Fuels used to run these end uses
- Building characteristics
- Energy efficiency measures already installed
- End use consumption estimates based on participant billing data

The final survey instrument is included in section A.1.2.

Creating the Sample

The sample frame used is this survey, as shown in Table 1, was intended to reflect the composition of PSE's residential sector, based on dwelling type (single family, multifamily, and manufactured homes) as well as on service type (electricity only, natural gas only, and combination customers).

Table 1. Population Distribution Across Service and Dwelling Type

Service Type	Single Family		Multifamily		Manufactured		*Total*	
	Count	% of Population	Count	% of Population	Count	% of Population	Count	% of Population
Combo - Electric and Gas	316,788	25%	20,853	2%	2,686	0%	340,327	27%
Electric Only	308,338	25%	203,811	16%	65,881	5%	578,030	46%
Gas Only	305,024	24%	29,685	2%	673	0%	335,382	27%
Total	**930,150**	**74%**	**254,349**	**20%**	**69,240**	**6%**	**1,253,739**	**100%**

To obtain enough data points in each segment to attain statistically representative results, it was determined that 600 surveys would be completed, spread across the segments proportionally based on PSE's customer population. Some segments, such as manufactured combo homes, were over-sampled in an effort to obtain a large enough sample to be statistically significant. Table 2 presents the sample distribution used for the survey quotas.

Table 2. Quota Distribution Across Service and Dwelling Type

Service Type	Single Family	Multifamily	Manufactured	*Total*
Combo - Electric and Gas	195	84	25	*304*
Electric Only	105	30	25	*160*
Gas Only	124	12	0	*136*
Total	**424**	**126**	**50**	***600***

A sample of 13,000 records, shown in Table 3, was drawn by PSE and provided to the professional survey firm contracted to administer the survey.

Table 3. Distribution of Survey Sample

Service Type	Single Family	Multifamily	Manufactured	Total
Combo - Electric and Gas	1,906	2,459	2,761	*7,126*
Electric Only	1,104	298	196	*1,598*
Gas Only	2,604	1,670	2	*4,276*
Total	**5,614**	**4,427**	**2,959**	***13,000***

Conducting the Survey

To administer the surveys, Cadmus contracted with Market Strategies. Of the 13,000 records provided, 3,171 were determined to be unusable prior to the fielding of the survey. This included: 2,741 cell phones, 285 "bad" numbers, 64 duplicates, and 81 records that were registered on the "do not call" list. Table 4 shows the sample attrition and final disposition for this study.

Table 4. Final Sample Disposition

	Record Disposition	Removed from Sample	Remaining
	Original Sample	-	**13,000**
Pre-call screen	Pre-Field Cleaning	3,171	9,829
	Quota Full	3,941	5,888
Unreachable	No Answer	1,911	3,977
	Out of Service/Wrong Number	775	3,202
	Answering Mach/Voice Mail	645	2,557
	Busy	201	2,356
	Business	86	2,270
Survey Not Completed	Refusal	1,604	666
	Screened Out	75	591
	Language Issues	74	517
	Completed Interview		**517**

Table 5 shows the distribution of the 517 surveys by service and dwelling types. As demonstrated, the number of customers in manufactured homes with gas service was very low, but this was to be expected, based on the population distribution (Table 1).

Table 5. Completed Survey Distribution Across Service and Dwelling Type

Service Type	Single Family		Multifamily		Manufactured		*Total*	
	Count	% of Completes	Count	% of Completes	Count	% of Completes	Count	% of Completes
Combo - Electric and Gas	145	28%	10	2%	2	0%	157	30%
Electric Only	99	19%	40	8%	38	7%	177	34%
Gas Only	169	33%	14	3%	0	0%	183	35%
Total	**413**	**80%**	**64**	**12%**	**40**	**8%**	**517**	**100%**

Analyzing Survey Responses

Upon survey completion, each question was analyzed for each segment and in aggregate. Frequency tables are provided in the appendices:

- A.1.3 – Survey Results by Service Type
- A.1.4 – Survey Results by Dwelling Type

Appendix A.1.2: Residential End Use Survey

February 2008
Closed-ended:
Other-Specifieds:

QAX. MOVE IN **FUEL** FROM SAMPLE

1 Puget Sound Energy (PSE)

QAY. MOVE IN **SERVTYPE** FROM SAMPLE

1 Electricity
2 Natural Gas
3 Electricity and Natural Gas

Hello, my name is _____, from Market Strategies and I'm calling on behalf of **Puget Sound Energy** We are conducting a study about household energy use in Washington, and I'd like to ask you a few questions about the home at [address from sample]. I'm not selling anything, and your participation will help with future decisions regarding energy efficiency programs for consumers. [If necessary, refer customer to Bob Yetter, Market Research, at PSE. Dial 888-225-5773, select option 5, then dial ext. 81-3194.]

QA. First, can you verify that you are the person in your household who would be most likely to make decisions concerning your electric and gas utilities for the home at [Address from Sample]?

1 Yes {CONTINUE}
2 No {ASK TO SPEAK TO THIS PERSON; ARRANGE CALLBACK IF NECESSARY}
DK {TERMINATE}
REF {TERMINATE}

QB. Can you verify that PSE currently provides your [From Sample: Gas, Electricity, Gas AND Electricity] service?

1 Yes
2 No
a. If no, ask: What service is PSE providing to your home?

QC. Thank you. Do you own, rent, or lease this property?

1 Own
2 Rent
3 Lease
4 Other, Record
5 DK

QD. Which of the following best describes how the residence is occupied? [Prompt]

1 Year-round, full-time
2 Seasonal or part-time use – [Terminate]
3 Landlord of vacant unit– [Terminate]
4 Other [Specify]
5 Don't know – [Terminate]

NOTE: Residence Description

Q1. Which of the following best describes your home? *(READ CODES 1-4 AS NECESSARY)*

1 Single family **detached** house (on a separate lot) not connected to other living units
2 Single family **attached**, such as a duplex, **row- or townhouse** *(TECH NOTE: If necessary say: "It has adjacent walls to another residence with no units above or below.")*
3 A unit in a **condominium** or **apartment** building *(TECH NOTE: If necessary say: "The building has 4 or more attached units.")*
4 Manufactured home or house trailer, or
5 Something else [SPECIFY]
DK {TERMINATE}
REF {TERMINATE}

{IF Q1=2 OR 3 ASK Q2, OTHERWISE GO TO Q3}

Q2. How many living units or apartments are in the building where this residence is located? Please answer only for the building that contains this residence; do not consider other buildings that may exist in the complex.

[RECORD NUMBER 2-96]

DK
REF

Q3. How many levels or stories are there in this residence? Please do not include an unfinished attic, unfinished basement, garage, or other floors that are never heated and are not used for living space. [Do not prompt] *(IF Q1=2 OR 3, DISPLAY: "Please answer only for the portion of the building where your unit is located.")*

1 One story
2 One and a half stories
3 Split level or two stories
4 Two and a half stories
5 Tri level or three stories
6 More than three stories
4 Other [SPECIFY]
DK
REF

NOTE: Home Characteristics/Weatherization / Efficient Equipment

Q4. Is your home built on top of a foundation (a slab, with no basement), above a crawl space, above a unfinished basement, or above an finished basement? If different portions of your house have different configurations, please answer based on **the largest** portion of your home's footprint. *(READ CODES 1-4 AS NECESSARY)*

1 On a concrete slab or foundation
2 Above a crawl space
3 Above an unfinished basement
4 Above a finished basement
DK
REF

Q5. Approximately what percentage of this residence's windows are **double or triple-pane**?

[RECORD NUMBER 0-100]%

DK
REF

Q6. Approximately what percentage of your home's windows are equipped with **storm windows**? [Tech Note: If asked, A storm window is a secondary window, or perhaps a plastic sheet, that you place inside or outside your regular window to protect against the wind and cold. Storm windows are typically put on or pulled down before the winter, and removed or pulled up after the weather warms up each year.)

[RECORD NUMBER 0-100]%

DK
REF

Q7. What is the approximate square footage of **heated floor space** in this residence? [If necessary, prompt with "Make a guess if you can"] *(IF Q1=2 OR 3, DISPLAY: "Please indicate the number of square feet that pertains to your unit only.")*

[RECORD NUMBER OF SQUARE FEET 0-6000]

3001 More than 6,000 square feet
DK
REF

{IF Q7=DK ASK Q8, OTHERWISE GO TO Q9}

Q8. Although you aren't sure about the actual **heated floor space**, can you estimate the square footage of your home using these categories? *(IF Q1=2 OR 3, DISPLAY: "Please indicate the category that pertains to your unit only.") (READ CODES 1-7 AS NECESSARY)*

1 Less than 500 square feet
2 501 to 1,000 square feet
3 1,001 to 1,500 square feet
4 1,501 to 2,000 square feet
5 2,001 to 2,500 square feet
6 2,501 to 3,000 square feet
7 3,001 to 4,000 square feet
8 4,001 to 5,000 square feet
9 5,001 to 6,000 square feet
More than 6,001 square feet
DK
REF

Q9. How many heated rooms are in this residence? (Please include all heated areas. Do not include halls or foyers, bathrooms, closets, unheated porches, unheated garages, or unheated basement areas and rooms.)

[RECORD NUMBER]
DK
REF

Q10. How many bathrooms are in this home? [If necessary: A full bath has a bathtub, toilet, and a sink; a ¾ bathroom has a toilet, shower, and sink; a half bath has a toilet and a sink; a ¼ bathroom has a toilet only.]?

1 None
2 One
3 1.25
4 1.5
5 1.75

6	2
7	2.25
8	2.5
9	2.75
10	3
11	3.25
12	3.5
13	3.75
14	4
15	More than 4
16	Other, record
17	DK
	REF

Q11. In what year was this residence built [If necessary, prompt with “Make a guess if you can”] *(IF Q1=2 OR 3, DISPLAY: “Answer only for the building in which you live .”)*

[RECORD NUMBER 1800 - 2008]
DK
REF

{IF Q1 1=DK ASK Q11A, OTHERWISE GO TO INTRO BEFORE Q12}

Q11A. Although you aren’t sure about the actual **year your home was built**, can you identify which from this list the closest general time frame? *(IF Q1=2 OR 3, DISPLAY: “Answer only for the building in which you live .”)* Was it…. *(READ CODES 1-3 AS NECESSARY)*

1	Before 1940
2	1940 to 1959
3	1960 to 1979
4	1980 to 1985
5	1986 to 1990
6	1991 to 1995
7	1996 to 2000
8	2001 to 2002
9	2003 to 2004
10	2005
11	2006
12	2007
13	2008
DK	
REF	

NOTE: Home Heating Systems

In the next series of questions I'll be asking you about the **main heating system** in your home. Please answer the questions about the heating system that is used most.

{IF Q1=2 OR 3 ASK Q12, OTHERWISE GO TO FILTER BEFORE Q13}

Q12. Does the main heating system serve only this residence or does it serve more than one residence?

1 Only this residence
2 More than one residence
DK
REF

{IF Q1=1, 4, 5 OR Q12=1 ASK Q13, OTHERWISE GO TO INTRO BEFORE Q20}

Q13. What is the type of system that is used to heat the majority of your home? *(ASK AS OPEN END; ACCEPT ONE MENTION) (PROBE FOR SPECIFICS: For example, there are 2 different types of heat pumps.)*

1 Natural gas central forced air furnace
2 Natural gas hot water boiler (with radiators, baseboards or in the floor); also called natural gas hydronic heating
3 Electric hot water boiler (with radiators, baseboards or in the floor); also called electric hydronic heating
4 Natural gas steam boiler (with radiators)
5 Natural gas radiant floor heating
6 Natural gas fireplace or stove
7 Electric Baseboard, wall heaters (without fans), ceiling cables, or floor cables
8 Electric wall heaters with fans
9 Electric central forced air furnace
10 Air-source Heat pump (ELEC)
11 Ground-source heat pump (ELEC)
12 Portable heaters (ELEC)
13 Oil central forced air furnace
14 Oil hot water boiler (with radiators, baseboards, or in floor); also called oil hydronic heating)
15 Oil steam boiler (with radiators)
16 Bottled gas central forced air (propane, butane, or kerosene)
17 Bottled gas portable heaters (propane, butane, or kerosene)
18 Wood or pellet stove – Skip to Q20
19 Wood fireplace – Skip to Q20
20 Solar
21 Other System & Fuel [SPECIFY]
22 None (No heating system) Skip to Q20
DK
REF

Q14. What type of temperature control is on the **main** heating system? *(TECH NOTE: If necessary say: "The one used most often.") (READ CODES 1-5 AS NECESSARY)*

1 Regular thermostat(s) with temperature settings
2 Clock or programmable thermostat(s)
3 Dial control **without** temperature settings
4 Simple on/off switch or no temperature control, or
5 Something else [SPECIFY]
DK
REF

Q15. Which of the following statements best describes how the main **heating** system is used? [NOTE: Select all that apply] *(If necessary, READ CODES 1-4)*

1 The thermostat(s) is kept at a constant setting or temperature
2 The thermostat is adjusted when occupants are sleeping
3 The thermostat is adjusted when occupants leave the house
4 The heater is turned on only when someone is cold
DK
REF

{IF Q15=1, 4, DK, REF ASK Q16, OTHERWISE GO TO FILTER BEFORE Q17}

Q16. When you are **heating** your house, at what temperature do you normally keep your thermostat? (ASK AS OPEN END, ACCEPT ONE MENTION)

[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

{IF Q15=2 OR 3 ASK Q17-Q19, OTHERWISE GO TO Q20}

When you are **heating** your house, at what **temperature** do you normally keep your thermostat set during these different periods of time?-

Q17. When one or more people in your household are at home and awake?

[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

Q18. When one or more people in your household are at home and everyone is sleeping?
[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

Q19. When no one is at home?
[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

NOTE: Home Cooling Systems

Now, moving on to your home's cooling system…

{IF Q1=2 OR 3 ASK Q20, OTHERWISE GO TO FILTER BEFORE Q21}

Q20. Does the main **cooling** system serve only this residence or does it serve more than one residence?

1 Only this residence
2 More than one residence
3 Residence has no cooling system [VOL] [Go to Q30]
DK
REF

{IF Q1=1, 4, 5 OR Q20=1 ASK Q21-Q24, OTHERWISE GO TO FILTER BEFORE Q29}

Q21. Which of the following is the type of cooling system that is used to cool the majority of home? *(READ CODES 1-9 AS NECESSARY-select all that apply)*

1 Central air conditioner
2 Air-source heat pump
3 Ground-source heat pump
4 Room air conditioners
5 Ductless mini-split air conditioner
6 Evaporative cooler (Swamp cooler)
7 Portable fans
8 Whole-house fan, or
9 Ceiling fans
10 Something else [SPECIFY]
DK
REF

{IF Q21=1-6, ASK Q22, OTHERWISE GO TO FILTER BEFORE Q29}

Q22. What type of temperature control is on the main cooling system? *(TECH NOTE: If necessary say: "The one used most often.") (If necessary READ CODES 1-4)*

1 Regular thermostat(s) with temperature settings
2 Clock or programmable thermostat(s)
3 Dial control **without** temperature settings
4 Simple on/off switch or no temperature control
5 Other [SPECIFY]
DK
REF

Q23. Which of the following statements best describes how the main **cooling** system is used? [NOTE: Select all that apply] *(READ CODES 1-5)*

1 The thermostat(s) is kept at a constant setting or temperature
2 The thermostat is adjusted when occupants are sleeping
3 The thermostat is adjusted when occupants leave the house
4 The cooling system is turned on only when someone is warm
5 We rarely use this cooling system
DK
REF

{IF Q23=1, 4, 5, DK, REF ASK Q24, OTHERWISE GO TO FILTER BEFORE Q25}

Q24. When you are **cooling** your house, at what temperature do you normally keep your thermostat? (ASK AS OPEN END, ACCEPT ONE MENTION)

[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

{IF Q23=2, 3 ASK Q25-Q28, OTHERWISE GO TO Q29}

Q25. When you are **cooling** your house, at what **temperature** do you normally keep your thermostat set during these different periods of time? –

Q26. When one or more people in your household are at home and awake?

[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

Q27. When one or more people in your household are at home and everyone is sleeping?
[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

Q28. When no one is at home?
[RECORD NUMBER OF DEGREES FAHRENHEIT 0-96]

97 97 degrees F or more
DK
REF

NOTE: Water Heating

I'd like to now ask you some questions about the water heater that you use to heat water for dish-washing, bathing, etc.

{IF Q1=2 OR 3 ASK Q29, OTHERWISE GO TO FILTER BEFORE Q30}

Q29. Does the water heater, or the source of the hot water, serve only this residence or does it serve more than one residence?

1 Only this residence
2 Central water heating or tank for more than one residence
3 This residence has no hot water (Skip to Intro for Q38)
DK
REF

{IF Q1=1, 4, 5 OR Q29=1 ASK Q30, OTHERWISE GO TO INTRO BEFORE Q38}

Q30. How many water heaters are at this residence?

1 One
2 Two
3 Three or more
DK
REF

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*(IF Q30=2 OR 3, RESTORE: "In the next series of questions I'll be asking you about the **primary** or **main** water heater for your house. Please answer these questions about the water heater that is used the most.")*

Q31. What type of water heater do you have? *(READ CODES 1-5 AS NECESSARY)*

1 Tank-type water heater. This is **the most common** type of water heater.
2 Heat pump water heater
3 Indirect water heater that uses the home's boiler as the heat source or an integrated water heater that is also used to heat the home.
4 Solar water heater
5 Tankless hotwater heater, also called Demand or instantaneous water heaters
DK
REF

{IF Q31=4, ASK Q32-Q32A, OTHERWISE GO TO Q33}

Q32. What type of system is used in conjunction with your solar water heater? *(READ CODES 1-2)*

1 Tank-type water heater (this is the "standard" type, with a water storage tank)
2 Tankless hotwater heater, also called Demand or Instantaneous water heaters
DK
REF

Q32A. What is the secondary or back-up type of fuel you use to heat water at this residence? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane), or
4 Something else [SPECIFY]
DK
REF

{IF Q31=4, GO TO Q34}

Q33. What type of fuel or energy is used to heat the water used in this residence? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane), or
4 Something else [SPECIFY]
DK
REF

Q34. At what **specific temperature** is your water heater thermostat set? *(ASK AS OPEN END, ACCEPT ONE MENTION)*

[RECORD NUMBER OF DEGREES FAHRENHEIT 0-200]

DK
REF

{IF Q34=DK ASK Q34A, OTHERWISE GO TO INTRO BEFORE Q35}

Q34A. If not set at a specific temperature, then which of these statements best describes where your water heater thermostat is set? *(READ CODES 1-5 AS NECESSARY)*

1 On the "low" setting
2 Between the "low" and "medium" settings
3 On the "medium" setting
4 Between the "medium" and "high" settings
5 On the "high" setting
DK
REF

Which of the following items do you have for your **main** water heater? Do you have …

Q35. A water heater tank wrap

1 Yes
2 No
DK
REF

Q36. Pipe insulation

1 Yes
2 No
DK
REF

Q37. A water heater timer

1 Yes
2 No
DK
REF

NOTE: Appliances & Other Equipment

In this section I will be asking about the appliances and other equipment you have in your home.

Now, about your refrigerator(s)…

Q38. How many refrigerators are in your home?

[RECORD NUMBER 0-10]
DK
REF

{IF Q38 > 0, ASK Q39, OTHERWISE GO TO INTRO BEFORE Q40}

Q39. How many years old is your *(IF Q38>1 RESTORE: "primary")* refrigerator? ? *(READ CODES 1-3)*

1 6 or less years old
2 7 to 14 years old
3 15 or more years old
DK
REF

Now, about your freezer(s)…

Q40. How many stand-alone freezers are in your home?

[RECORD NUMBER 0-10]

DK
REF

{IF Q40 > 0, ASK Q41, OTHERWISE GO TO Q42}

Q41. How many years old is your *(IF Q40>1 RESTORE: "primary")* stand-alone freezer? *(READ CODES 1-3)*

1 6 or less years old
2 7 to 14 years old
3 15 or more years old
DK
REF

Q42. How many dishwashers are in your home?

[RECORD NUMBER 0-10]
DK
REF

Now, about your clothes washer…

Q43. Do you have a private clothes washer that is used just by the people in your household?

1 Yes
2 No
DK
REF

{IF Q43=1 ASK Q44, OTHERWISE GO TO Q45}

Q44 Which of the following best describes the type of clothes washer in your home? *(READ CODES 1-2)*

1 Front Load Washing Machine
2 Top Load Washing Machine
3 Other: Specify
DK
REF

Q45. Do you have a clothes dryer that is used just by the people in your household?

1 Yes
2 No
DK
REF

{IF Q45=1 ASK Q46, OTHERWISE GO TO Q47}

Q46. What fuel or energy source do you use for your clothes dryer? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane)
4 Something else [SPECIFY]
DK
REF

Q47. Do you have your own swimming pool? *(If necessary, clarify: A private pool that only your household has access to.)*

1 Yes
2 No
DK
REF

{IF Q47=1 ASK Q48-48B, OTHERWISE GO TO Q49}

Q48. You probably use one fuel to "**run**" your pool and another to **heat** the water. What fuel or energy source do you use to **heat** your swimming pool? *(READ CODES 1-5 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Solar
4 Propane or bottled gas (LP, propane, butane)
5 Not heated
6 Something else [SPECIFY]
DK
REF

Q48A. How often do you operate your pool pump and filtration system? *(READ CODES 1-2 AS NECESSARY)*

1 All day and all night?
2 Turned off at night? or
3 Something else [SPECIFY]
DK
REF

Q48B. Do you own an insulating cover for your pool?
1 Yes
2 No
DK
REF

Q49. Do you have your own hot tub or spa? *(If necessary, clarify: A private hot tub or spa that only your household has access to.)*

1 Yes
2 No
DK
REF

{IF Q49=1 ASK Q50, OTHERWISE GO TO Q51}

Q50. What fuel or energy source do you use for your hot tub or spa? *(READ CODES 1-3 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane)
4 Something else [SPECIFY]
DK
REF

Q50A. Do you have your own sauna? *(If necessary, clarify: A private sauna that only your household has access to.)*

1 Yes
2 No
DK
REF

{IF Q50A=1 ASK Q50B, OTHERWISE GO TO Q51}

Q50B. What fuel or energy source do you use for sauna? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane)
4 Something else [SPECIFY]
DK
REF

Next, I'd like to ask about your cooking equipment. Some people have cook-tops that are separate from their ovens. Others have a range where the cook-top and oven are contained in one appliance. For the next few questions, please think of your cook-top and oven as two separate items

Q51. How many cook-top units do you have.

[RECORD NUMBER 0-2] {If more than two: "Note that you may have multiple burners in your cook-top, but only one unit" – recode as necessary}

DK
REF

{IF Q51>0 ASK Q52, OTHERWISE GO TO Q53}

Q52. What fuel or energy source do you use for your cook-top(s)? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane)
4 Something else [SPECIFY]
DK
REF

Q53. How many ovens do you have?

[RECORD NUMBER 0-10]
DK
REF

{IF Q53>0 ASK Q54, OTHERWISE GO TO Q55}

Q54. What fuel or energy source do you use for your oven(s)? *(READ CODES 1-4 AS NECESSARY)*

1 Electricity
2 Natural gas
3 Propane or bottled gas (LP, propane, butane)
4 Something else [SPECIFY]
DK
REF

Q55. How many microwave ovens do you have?

[RECORD NUMBER 0-10]

DK
REF

NOTE: Audio Visual Equipment

SCREEN DESIGN: RANDOMIZE QUESTIONS Q56–Q69

PROG. NOTE: BLOCK Q56-Q62, BLOCK Q56-Q57

PROG. NOTE: BLOCK Q64-Q69

Now, in order to get an idea of the way your home is using energy, I'd like to find out about your audio/video equipment and your home office equipment. For each piece of equipment I mention, please tell me how many of each you have in your home. What is the total number of …

[RECORD NUMBER 0-96]

DK
REF

Q56. Televisions, **of all types**, in your home?

{IF Q56=1-96 ASK Q57, OTHERWISE CONTINUE}

PROG. NOTE: IF Q57>Q56 DISPLAY: *"You have reported having a greater number of Flat Screen tvs than the total number of televisions of all types in your home."*

Q57. Large flat screen tvs (over 32 inches)?

Q58. Game console (Playstation, Wii, Nintendo, xbox, xCube, etc)

Q59. VCRs or DVD players (not a combo unit)

Q60 Combination VCR and DVD unit

Q61. Stand-alone DVR (not TIVO)

Q62. TIVO, Cable or satellite TV set-top boxes or receivers in your home ?

Q63. Stereo systems in your home?

Q64. Personal computers, including laptops, in your home?

{IF Q64=1-96 ASK Q65, OTHERWISE GO TO Q66}

Q65. Computer monitors in your home?

Q66. Combination printer / fax / copiers in your home?

Q67. Standalone Printers in your home?

Q68. Standalone Fax machines in your home?

Q69. Standalone Copiers in your home?

{ASK Q70 LAST}

Q70. Surge protector strips for any of the audio/video or home office equipment mentioned above?

Q71. Which, if any, of the appliances in your home are ENERGYSTAR rated? [RECORD APPLIANCE AND VERIFY COUNT]

NOTE: Occupancy Characteristics

Q72. Including yourself, how many people usually live in this residence at least six months of the year? Please include all members of your household whether or not they are related to you, but do not include anyone who is just visiting or children who may be away at college or in the military.

[RECORD NUMBER 1-96]
DK
REF

We'd like to ask a few more questions to get a feel for your energy usage patterns: [If the respondent hesitates to answer Q73 or Q74: Your answers to these questions are kept anonymous, and will be handled with strict confidentiality. If you have any concerns, Bob Yetter at PSE can ran be reached using a toll free number. {Refer contact if requested - Dial 888-225-5773, select option 5, then dial ext. 81-3194}]

Q73. On a typical weekday, for what average length of time is your home occupied by at least one person [Do not read. If necessary, prompt with randomized option from list]?

1 23-24 hrs/day
2 21-22 hrs/day
3 19-20 hrs/day
4 17-18 hrs/day
5 15-16 hrs/day
6 13-14 hrs/day
7 11-12 hrs/day
8 9-10 hrs/day
9 7-8 hrs/day
10 5-6 hrs/day
11 3-4 hrs/day
12 1-2 hrs/day

Q74. On a typical weekend, for what average length of time is your home occupied by at least one person [Do not read. If necessary, prompt with randomized option from list]?

1 23-24 hrs/day
2 21-22 hrs/day
3 19-20 hrs/day
4 17-18 hrs/day
5 15-16 hrs/day
6 13-14 hrs/day
7 11-12 hrs/day
8 9-10 hrs/day
9 7-8 hrs/day
10 5-6 hrs/day
11 3-4 hrs/day
12 1-2 hrs/day

"Thank you very much for your cooperation and assistance!"

Appendix A.1.3 Survey Results by Service Type

The following tables present the results of the survey by service type. The actual number of responses in each customer segment have been extrapolated to the population to provide an estimate of the results across PSE's entire service territory.

Table B.1

Question ax. Service type from sample	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electric and Gas (combo)	341,000	0	0	341,000
	27.2%	0	0	27.2%
Electric only	0	578,030	0	578,030
	0	46.1%	0	46.1%
Gas only	0	0	334,709	334,709
	0	0	26.7%	26.7%

Table B.2

Question c. Do you own or rent or lease this property?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Own	307,625	392,820	294,761	995,206
	24.5%	31.3%	23.5%	79.4%
Rent	28,528	160,794	38,164	227,486
	2.3%	12.8%	3.0%	18.1%
Lease	4,847	21,293	1,785	27,924
	0.4%	1.7%	0.1%	2.2%
Refused	0	3,123	0	3,123
	0	0.2%	0	0.2%

Table B.3

Question d. Which of the following best describes how the residence is occupied?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Year-round, full-time	341,000	578,030	334,709	1,253,739
	27.2%	46.1%	26.7%	100.0%

Table B.4

Question 1. Which of the following best describes your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Single family detached home	296,117	320,013	287,179	903,308
	23.6%	25.5%	22.9%	72.0%
Duplex, row- or townhouse	19,838	33,694	21,309	74,841
	1.6%	2.7%	1.7%	6.0%
Apartment or condo	21,687	171,267	24,437	217,390
	1.7%	13.7%	1.9%	17.3%
Manufactured home	3,359	53,056	1,785	58,199
	0.3%	4.2%	0.1%	4.6%

Table B.5

Question 1c. Which of the following best describes your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Single family	296,117	320,013	287,179	903,308
	23.6%	25.5%	22.9%	72.0%
Multi-family	41,524	204,961	45,746	292,232
	3.3%	16.3%	3.6%	23.3%
Manufactured home	3,359	53,056	1,785	58,199
	0.3%	4.2%	0.1%	4.6%

Table B.6

Question 2c. How many living units or apartments are in the building where this residence is located?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
2 units	9,254	5,095	17,068	31,417
	0.7%	0.4%	1.4%	2.5%
3 units	2,085	10,191	0	12,276
	0.2%	0.8%	0	1.0%
4 units	13,267	25,476	4,241	42,984
	1.1%	2.0%	0.3%	3.4%
5 or more units	12,670	159,104	24,437	196,210
	1.0%	12.7%	1.9%	15.7%
Don't know	4,249	5,095	0	9,345
	0.3%	0.4%	0	0.7%
Not applicable	299,476	373,069	288,963	961,507
	23.9%	29.8%	23.0%	76.7%

Table B.7

Question 3. How many levels or stories are there in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
One story	106,787	264,413	114,014	485,213
	8.5%	21.1%	9.1%	38.7%
One and a half stories	8,657	11,102	5,354	25,112
	0.7%	0.9%	0.4%	2.0%
Split level or two stories	178,340	199,625	155,763	533,727
	14.2%	15.9%	12.4%	42.6%
Two and a half stories	15,149	34,023	12,828	62,000
	1.2%	2.7%	1.0%	4.9%
Tri level or three stories	27,819	55,554	38,941	122,314
	2.2%	4.4%	3.1%	9.8%
More than three stories	4,249	13,313	7,810	25,373
	0.3%	1.1%	0.6%	2.0%

Table B.8

Question 4. On which of the following is your home built?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Concrete slab or foundation	89,937	254,691	101,310	445,938
	7.2%	20.3%	8.1%	35.6%
Above a crawl space	185,260	174,979	122,479	482,718
	14.8%	14.0%	9.8%	38.5%
Above an unfinished basement	16,343	28,928	51,555	96,826
	1.3%	2.3%	4.1%	7.7%
Above a finished basement	41,040	57,033	55,460	153,533
	3.3%	4.5%	4.4%	12.2%
Don't know	6,335	47,352	3,905	57,592
	0.5%	3.8%	0.3%	4.6%
Refused	2,085	15,047	0	17,132
	0.2%	1.2%	0	1.4%

Table B.9

Question 5c. Approximately what percentage of this residence's windows are double or triple-pane?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
25% or less	34,175	115,132	42,526	191,833
	2.7%	9.2%	3.4%	15.3%
26% - 50%	17,234	20,709	16,061	54,005
	1.4%	1.7%	1.3%	4.3%
51% - 75%	4,328	11,102	7,367	22,798
	0.3%	0.9%	0.6%	1.8%
76% - 100%	266,912	407,821	250,238	924,971
	21.3%	32.5%	20.0%	73.8%
Don't know	15,588	23,265	18,517	57,371
	1.2%	1.9%	1.5%	4.6%
Refused	2,761	0	0	2,761
	0.2%	0	0	0.2%

Table B.10

Question 6c. Approximately what percentage of your home's windows are equipped with storm windows?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
25% or less	279,366	441,621	254,159	975,146
	22.3%	35.2%	20.3%	77.8%
26% - 50%	4,328	13,313	18,075	35,716
	0.3%	1.1%	1.4%	2.8%
51% - 75%	3,844	6,246	0	10,089
	0.3%	0.5%	0	0.8%
76% - 100%	29,735	74,026	43,959	147,719
	2.4%	5.9%	3.5%	11.8%
Don't know	23,727	42,824	18,517	85,068
	1.9%	3.4%	1.5%	6.8%

Table B.11

Question 7c. What is the approximate square footage of heated floor space in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Less than 500 square feet	0	37,490	0	37,490
	0	3.0%	0	3.0%
501 to 1,000 square feet	26,849	136,485	31,467	194,800
	2.1%	10.9%	2.5%	15.5%
1,001 to 1,500 square feet	40,589	126,218	77,317	244,124
	3.2%	10.1%	6.2%	19.5%
1,501 to 2,000 square feet	110,732	123,858	69,049	303,640
	8.8%	9.9%	5.5%	24.2%
2,001 to 2,500 square feet	51,940	54,822	63,146	169,908
	4.1%	4.4%	5.0%	13.6%
2,501 to 3,000 square feet	46,044	17,348	41,732	105,124
	3.7%	1.4%	3.3%	8.4%
3,001 to 4,000 square feet	47,611	15,614	16,397	79,622
	3.8%	1.2%	1.3%	6.4%
4,001 to 5,000 square feet	4,328	6,246	1,785	12,359
	0.3%	0.5%	0.1%	1.0%
More than 6,000 square feet	2,164	0	0	2,164
	0.2%	0	0	0.2%
Don't know	10,742	59,950	33,816	104,508
	0.9%	4.8%	2.7%	8.3%

Table B.12

Question 8. Although you aren't sure about the actual heated floor space can you estimate the square footage of your home using these categories?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Less than 500 square feet	0	13,658	0	13,658
	0	1.1%	0	1.1%
501 to 1,000 square feet	2,085	28,360	11,944	42,390
	0.2%	2.3%	1.0%	3.4%
1,001 to 1,500 square feet	2,164	7,979	7,138	17,282
	0.2%	0.6%	0.6%	1.4%
1,501 to 2,000 square feet	2,164	0	3,798	5,962
	0.2%	0	0.3%	0.5%
2,001 to 2,500 square feet	2,164	0	0	2,164
	0.2%	0	0	0.2%
Don't know	2,164	9,952	9,152	21,268
	0.2%	0.8%	0.7%	1.7%
Refused	0	0	1,785	1,785
	0	0	0.1%	0.1%
Not applicable	330,258	518,080	300,893	1,149,231
	26.3%	41.3%	24.0%	91.7%

Table B.13

Question 9. How many heated rooms are in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	0	8,218	3,798	12,016
	0	0.7%	0.3%	1.0%

Question 9. How many heated rooms are in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
2	2,164	54,420	3,905	60,489
	0.2%	4.3%	0.3%	4.8%
3	8,420	43,169	15,955	67,544
	0.7%	3.4%	1.3%	5.4%
4	27,413	125,472	36,592	189,476
	2.2%	10.0%	2.9%	15.1%
5	27,603	98,919	47,864	174,386
	2.2%	7.9%	3.8%	13.9%
6	65,443	73,771	58,235	197,449
	5.2%	5.9%	4.6%	15.7%
7	43,801	87,323	56,237	187,361
	3.5%	7.0%	4.5%	14.9%
8	60,112	33,307	47,085	140,504
	4.8%	2.7%	3.8%	11.2%
9	45,447	21,860	20,195	87,502
	3.6%	1.7%	1.6%	7.0%
10	28,134	11,102	18,075	57,311
	2.2%	0.9%	1.4%	4.6%
11	8,657	11,102	8,923	28,682
	0.7%	0.9%	0.7%	2.3%
12	8,657	3,123	7,138	18,918
	0.7%	0.2%	0.6%	1.5%
13	2,164	3,123	5,354	10,641
	0.2%	0.2%	0.4%	0.8%

Question 9. How many heated rooms are in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
14	6,492	0	0	6,492
	0.5%	0	0	0.5%
15	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
16	0	3,123	1,785	4,907
	0	0.2%	0.1%	0.4%
Don't know	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%

Table B.14

Question 9c. How many heated rooms are in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	0	8,218	3,798	12,016
	0	0.7%	0.3%	1.0%
2	2,164	54,420	3,905	60,489
	0.2%	4.3%	0.3%	4.8%
3	8,420	43,169	15,955	67,544
	0.7%	3.4%	1.3%	5.4%
4	27,413	125,472	36,592	189,476
	2.2%	10.0%	2.9%	15.1%
5	27,603	98,919	47,864	174,386
	2.2%	7.9%	3.8%	13.9%
6	65,443	73,771	58,235	197,449
	5.2%	5.9%	4.6%	15.7%
7	43,801	87,323	56,237	187,361
	3.5%	7.0%	4.5%	14.9%
8	60,112	33,307	47,085	140,504
	4.8%	2.7%	3.8%	11.2%
9	45,447	21,860	20,195	87,502
	3.6%	1.7%	1.6%	7.0%
10	28,134	11,102	18,075	57,311
	2.2%	0.9%	1.4%	4.6%
More than 10 rooms	28,134	20,471	24,984	73,588
	2.2%	1.6%	2.0%	5.9%

Question 9c. How many heated rooms are in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Don't know	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%

Table B.15

Question 10. How many bathrooms are in this home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
None	0	13,313	5,354	18,667
	0	1.1%	0.4%	1.5%
1	38,266	202,335	88,589	329,191
	3.1%	16.1%	7.1%	26.3%
1.25	4,328	6,246	0	10,574
	0.3%	0.5%	0	0.8%
1.5	17,910	32,395	18,533	68,838
	1.4%	2.6%	1.5%	5.5%
1.75	10,821	19,082	9,488	39,390
	0.9%	1.5%	0.8%	3.1%
2	78,947	196,166	85,461	360,574
	6.3%	15.6%	6.8%	28.8%
2.25	63,121	42,569	58,571	164,261
	5.0%	3.4%	4.7%	13.1%
2.5	0	3,123	7,138	10,261
	0	0.2%	0.6%	0.8%
2.75	108,129	53,433	52,317	213,878
	8.6%	4.3%	4.2%	17.1%
3	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
3.5	6,492	3,123	2,120	11,736
	0.5%	0.2%	0.2%	0.9%

Question 10. How many bathrooms are in this home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
4	10,821	6,246	5,354	22,420
	0.9%	0.5%	0.4%	1.8%

Table B.16

Question 11c. In what year was this residence built?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Before 1940	6,492	33,201	87,385	127,078
	0.5%	2.6%	7.0%	10.1%
1940 to 1959	33,059	29,839	73,624	136,523
	2.6%	2.4%	5.9%	10.9%
1960 to 1979	132,081	206,294	50,654	389,029
	10.5%	16.5%	4.0%	31.0%
1980 to 1985	23,806	50,432	8,923	83,160
	1.9%	4.0%	0.7%	6.6%
1986 to 1990	32,383	60,278	12,492	105,153
	2.6%	4.8%	1.0%	8.4%
1991 to 1995	28,055	39,208	27,104	94,367
	2.2%	3.1%	2.2%	7.5%
1996 to 2000	34,548	37,490	42,953	114,991
	2.8%	3.0%	3.4%	9.2%
2001 to 2002	15,746	9,952	6,254	31,952
	1.3%	0.8%	0.5%	2.5%
2003 to 2004	17,077	9,713	1,785	28,574
	1.4%	0.8%	0.1%	2.3%
2005	2,164	5,095	3,569	10,829
	0.2%	0.4%	0.3%	0.9%
2006	2,164	4,035	5,689	11,888
	0.2%	0.3%	0.5%	0.9%

Question 11c. In what year was this residence built?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
2007	4,328	0	3,569	7,897
	0.3%	0	0.3%	0.6%
2008	0	3,467	0	3,467
	0	0.3%	0	0.3%
Don't know	9,096	89,026	10,707	108,830
	0.7%	7.1%	0.9%	8.7%

Table B.17

Question 11a. Although you aren't sure about the actual year your home was built can you identify which from this list is the closest general time frame?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Before 1940	2,761	0	1,785	4,546
	0.2%	0	0.1%	0.4%
1940 to 1959	0	3,123	1,785	4,907
	0	0.2%	0.1%	0.4%
1960 to 1979	2,085	40,523	3,569	46,178
	0.2%	3.2%	0.3%	3.7%
1980 to 1985	0	5,095	0	5,095
	0	0.4%	0	0.4%
1986 to 1990	0	1,734	1,785	3,518
	0	0.1%	0.1%	0.3%
1991 to 1995	0	1,734	1,785	3,518
	0	0.1%	0.1%	0.3%
1996 to 2000	2,085	10,191	0	12,276
	0.2%	0.8%	0	1.0%
Don't know	2,164	26,627	0	28,791
	0.2%	2.1%	0	2.3%
Not applicable	331,904	489,004	324,002	1,144,909
	26.5%	39.0%	25.8%	91.3%

Table B.18

Question 12. Does the main heating system serve only this residence or does it serve more than one residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Only this residence	41,524	186,553	35,480	263,557
	3.3%	14.9%	2.8%	21.0%
More than one residence	0	13,313	8,146	21,459
	0	1.1%	0.6%	1.7%
Don't know	0	5,095	2,120	7,216
	0	0.4%	0.2%	0.6%
Not applicable	299,476	373,069	288,963	961,507
	23.9%	29.8%	23.0%	76.7%

Table B.19

Question 13. What is the type of system that is used to heat the majority of your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Natural Gas: Central forced air furnace	285,611	98,647	265,429	649,688
	22.8%	7.9%	21.2%	51.8%
Natural Gas: Hot water boiler	8,172	1,734	7,474	17,380
	0.7%	0.1%	0.6%	1.4%
Electric: Hot water boiler	0	26,494	0	26,494
	0	2.1%	0	2.1%
Natural Gas: Steam boiler	0	0	3,569	3,569
	0	0	0.3%	0.3%
Natural Gas: Radiant floor heating	0	0	1,785	1,785
	0	0	0.1%	0.1%
Natural Gas: Fireplace or stove	4,249	13,313	14,841	32,404
	0.3%	1.1%	1.2%	2.6%
Electric: Baseboard, wall heaters, ceiling cables, or floor cables	8,420	172,941	11,043	192,404
	0.7%	13.8%	0.9%	15.3%
Electric: Wall heaters with fans	2,085	20,709	1,785	24,579
	0.2%	1.7%	0.1%	2.0%
Electric: Central forced air furnace	8,657	42,903	2,120	53,680
	0.7%	3.4%	0.2%	4.3%
Electric: Air-source heat pump	4,328	25,672	0	30,000
	0.3%	2.0%	0	2.4%
Electric: Ground-source heat pump	2,164	4,857	0	7,021
	0.2%	0.4%	0	0.6%

Question 13. What is the type of system that is used to heat the majority of your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electric: Portable heaters	0	7,979	0	7,979
	0	0.6%	0	0.6%
Oil: Central forced air furnace	0	23,593	0	23,593
	0	1.9%	0	1.9%
Oil: Hot water boiler (with radiators, baseboards, or in floor)	0	3,123	0	3,123
	0	0.2%	0	0.2%
Bottled Gas: Central forced air (propane, butane, kerosene)	0	12,836	1,785	14,620
	0	1.0%	0.1%	1.2%
Bottled Gas: Portable heaters (propane, butane, kerosene)	0	6,246	0	6,246
	0	0.5%	0	0.5%
Wood: Wood stove or pellet stove	6,492	22,443	1,785	30,720
	0.5%	1.8%	0.1%	2.5%
Wood: Fireplace	2,164	7,979	0	10,144
	0.2%	0.6%	0	0.8%
Other system and fuel	2,164	22,443	1,785	26,392
	0.2%	1.8%	0.1%	2.1%
None (No heating system)	0	0	1,785	1,785
	0	0	0.1%	0.1%
Don't know	6,492	42,585	9,259	58,336
	0.5%	3.4%	0.7%	4.7%
Refused	0	3,123	0	3,123
	0	0.2%	0	0.2%
Not applicable	0	18,409	10,266	28,675
	0	1.5%	0.8%	2.3%

Table B.20

Question 14. What type of temperature control is on the main heating system?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Regular thermostat(s) with temperature settings	109,829	291,932	98,625	500,386
	8.8%	23.3%	7.9%	39.9%
Clock or programmable thermostat(s)	213,936	136,572	194,809	545,317
	17.1%	10.9%	15.5%	43.5%
Dial control without temperature settings	2,085	44,797	14,276	61,158
	0.2%	3.6%	1.1%	4.9%
Simple on/off switch or no temperature control	2,164	10,191	3,905	16,260
	0.2%	0.8%	0.3%	1.3%
No response	0	33,800	3,905	37,705
	0	2.7%	0.3%	3.0%
Not applicable	12,985	60,739	19,189	92,913
	1.0%	4.8%	1.5%	7.4%

Table B.21

Question 15. Which of the following describes how the main heating system is used?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
The thermostat(s) is kept at a constant setting or temperature	68,046	128,997	87,017	284,060
	6.1%	11.6%	7.8%	25.5%
The thermostat is adjusted when occupants are sleeping	236,242	248,836	167,034	652,111
	21.2%	22.4%	15.0%	58.6%

The thermostat is adjusted when occupants leave the house	167,473	180,028	142,370	489,872
	15.0%	16.2%	12.8%	44.0%
The heater is turned on only when someone is cold	47,002	156,461	55,109	258,572
	4.2%	14.1%	5.0%	23.2%

Table B.22

Question 16. Home heating - at what temperature do you normally keep your thermostat?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	0	5,095	0	5,095
	0	0.4%	0	0.4%
50	0	8,218	0	8,218
	0	0.7%	0	0.7%
55	2,164	6,829	1,785	10,778
	0.2%	0.5%	0.1%	0.9%
58	2,164	5,095	3,569	10,829
	0.2%	0.4%	0.3%	0.9%
59	0	0	1,785	1,785
	0	0	0.1%	0.1%
60	8,578	26,388	3,569	38,535
	0.7%	2.1%	0.3%	3.1%
62	0	0	5,354	5,354
	0	0	0.4%	0.4%
63	2,085	6,246	1,785	10,115
	0.2%	0.5%	0.1%	0.8%
64	0	8,547	1,785	10,331
	0	0.7%	0.1%	0.8%
65	10,742	40,958	15,177	66,877
	0.9%	3.3%	1.2%	5.3%
66	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%

Question 16. Home heating - at what temperature do you normally keep your thermostat?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
67	6,492	8,218	12,492	27,202
	0.5%	0.7%	1.0%	2.2%
68	33,499	37,835	36,927	108,261
	2.7%	3.0%	2.9%	8.6%
69	6,492	6,246	7,138	19,876
	0.5%	0.5%	0.6%	1.6%
70	22,239	54,032	32,580	108,851
	1.8%	4.3%	2.6%	8.7%
71	2,164	5,095	5,354	12,613
	0.2%	0.4%	0.4%	1.0%
72	0	24,416	3,569	27,985
	0	1.9%	0.3%	2.2%
73	0	3,123	0	3,123
	0	0.2%	0	0.2%
75	2,761	9,368	1,785	13,914
	0.2%	0.7%	0.1%	1.1%
76	2,164	0	2,120	4,285
	0.2%	0	0.2%	0.3%
Don't know	0	10,191	0	10,191
	0	0.8%	0	0.8%
Refused	2,164	8,218	0	10,382
	0.2%	0.7%	0	0.8%
Not applicable	235,127	303,913	196,152	735,192
	18.8%	24.2%	15.6%	58.6%

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Table B.23

Question 17. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	0	10,191	0	10,191
	0	0.8%	0	0.8%
54	0	0	1,785	1,785
	0	0	0.1%	0.1%
55	0	5,095	0	5,095
	0	0.4%	0	0.4%
59	0	0	1,785	1,785
	0	0	0.1%	0.1%
60	4,249	3,123	1,785	9,157
	0.3%	0.2%	0.1%	0.7%
62	0	14,464	0	14,464
	0	1.2%	0	1.2%
63	0	0	3,798	3,798
	0	0	0.3%	0.3%
64	8,657	3,123	1,785	13,564
	0.7%	0.2%	0.1%	1.1%
65	21,484	33,784	11,379	66,647
	1.7%	2.7%	0.9%	5.3%
66	10,336	3,123	3,569	17,028
	0.8%	0.2%	0.3%	1.4%
67	21,642	23,593	28,143	73,378
	1.7%	1.9%	2.2%	5.9%

Question 17. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
68	81,110	72,875	61,133	215,118
	6.5%	5.8%	4.9%	17.2%
69	25,970	9,368	21,873	57,211
	2.1%	0.7%	1.7%	4.6%
70	57,948	55,766	51,752	165,465
	4.6%	4.4%	4.1%	13.2%
71	13,424	8,324	3,569	25,317
	1.1%	0.7%	0.3%	2.0%
72	8,657	19,665	3,905	32,226
	0.7%	1.6%	0.3%	2.6%
73	2,164	0	0	2,164
	0.2%	0	0	0.2%
75	0	11,341	2,120	13,461
	0	0.9%	0.2%	1.1%
Don't know	0	1,734	3,569	5,303
	0	0.1%	0.3%	0.4%
Not applicable	85,360	302,461	132,762	520,583
	6.8%	24.1%	10.6%	41.5%

Table B.24

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	10,663	23,265	5,354	39,282
	0.9%	1.9%	0.4%	3.1%
37	0	0	1,785	1,785
	0	0	0.1%	0.1%
40	0	5,095	0	5,095
	0	0.4%	0	0.4%
45	2,164	5,095	1,785	9,044
	0.2%	0.4%	0.1%	0.7%
50	6,492	9,368	1,785	17,645
	0.5%	0.7%	0.1%	1.4%
52	2,164	0	0	2,164
	0.2%	0	0	0.2%
53	2,164	0	0	2,164
	0.2%	0	0	0.2%
55	21,078	22,788	16,519	60,385
	1.7%	1.8%	1.3%	4.8%
56	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%
57	2,164	6,246	0	8,410
	0.2%	0.5%	0	0.7%
58	12,985	9,952	1,785	24,721
	1.0%	0.8%	0.1%	2.0%

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
59	4,328	6,246	0	10,574
	0.3%	0.5%	0	0.8%
60	43,722	43,603	32,580	119,905
	3.5%	3.5%	2.6%	9.6%
61	4,328	4,857	5,354	14,538
	0.3%	0.4%	0.4%	1.2%
62	23,806	14,225	32,687	70,717
	1.9%	1.1%	2.6%	5.6%
63	15,149	4,857	9,381	29,386
	1.2%	0.4%	0.7%	2.3%
64	10,336	12,491	7,367	30,195
	0.8%	1.0%	0.6%	2.4%
65	42,313	58,305	34,471	135,090
	3.4%	4.7%	2.7%	10.8%
66	15,070	4,857	11,272	31,199
	1.2%	0.4%	0.9%	2.5%
67	10,821	4,857	7,367	23,045
	0.9%	0.4%	0.6%	1.8%
68	17,234	11,102	23,199	51,536
	1.4%	0.9%	1.9%	4.1%
69	2,164	0	0	2,164
	0.2%	0	0	0.2%

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
70	2,164	13,313	5,689	21,167
	0.2%	1.1%	0.5%	1.7%
Don't know	0	11,924	1,785	13,709
	0	1.0%	0.1%	1.1%
Refused	0	3,123	0	3,123
	0	0.2%	0	0.2%
Not applicable	85,360	302,461	132,762	520,583
	6.8%	24.1%	10.6%	41.5%

Table B.25

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	19,241	41,435	16,061	76,737
	1.5%	3.3%	1.3%	6.1%
40	0	1,734	0	1,734
	0	0.1%	0	0.1%
45	2,164	8,218	1,785	12,167
	0.2%	0.7%	0.1%	1.0%
50	12,906	14,225	3,569	30,700
	1.0%	1.1%	0.3%	2.4%
52	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
53	0	0	2,014	2,014
	0	0	0.2%	0.2%
54	0	3,123	0	3,123
	0	0.2%	0	0.2%
55	25,485	26,149	7,138	58,773
	2.0%	2.1%	0.6%	4.7%
56	4,328	8,218	1,785	14,331
	0.3%	0.7%	0.1%	1.1%
57	2,164	3,123	2,014	7,301
	0.2%	0.2%	0.2%	0.6%
58	11,418	8,218	5,583	25,219
	0.9%	0.7%	0.4%	2.0%

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
59	0	3,123	0	3,123
	0	0.2%	0	0.2%
60	60,033	49,265	42,068	151,366
	4.8%	3.9%	3.4%	12.1%
61	2,164	0	0	2,164
	0.2%	0	0	0.2%
62	12,985	9,713	29,118	51,816
	1.0%	0.8%	2.3%	4.1%
63	10,821	6,829	7,367	25,017
	0.9%	0.5%	0.6%	2.0%
64	8,657	3,123	12,721	24,500
	0.7%	0.2%	1.0%	2.0%
65	22,757	42,108	26,768	91,633
	1.8%	3.4%	2.1%	7.3%
66	10,742	4,857	11,272	26,871
	0.9%	0.4%	0.9%	2.1%
67	6,492	4,857	0	11,349
	0.5%	0.4%	0	0.9%
68	21,642	1,734	8,923	32,298
	1.7%	0.1%	0.7%	2.6%
69	2,164	0	2,014	4,178
	0.2%	0	0.2%	0.3%
70	0	0	8,923	8,923
	0	0	0.7%	0.7%

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
71	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%
72	0	3,123	0	3,123
	0	0.2%	0	0.2%
Don't know	10,821	24,416	7,474	42,710
	0.9%	1.9%	0.6%	3.4%
Refused	2,164	7,979	1,785	11,928
	0.2%	0.6%	0.1%	1.0%
Not applicable	85,360	302,461	132,762	520,583
	6.8%	24.1%	10.6%	41.5%

Table B.26

Question 20. Does the main cooling system serve only this residence or does it serve more than one residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Only this residence	17,674	10,191	11,715	39,579
	1.4%	0.8%	0.9%	3.2%
More than one residence	0	10,191	1,785	11,975
	0	0.8%	0.1%	1.0%
Residence has more than one cooling system	21,765	179,485	32,247	233,497
	1.7%	14.3%	2.6%	18.6%
Don't know	2,085	0	0	2,085
	0.2%	0	0	0.2%
Refused	0	5,095	0	5,095
	0	0.4%	0	0.4%
Not applicable	299,476	373,069	288,963	961,507
	23.9%	29.8%	23.0%	76.7%

Table B.27

Question 21. Which of the following is the type of cooling system that is used to cool the majority of home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Central air conditioner	71,338	26,955	23,535	121,828
	10.0%	3.8%	3.3%	17.0%
Air-source heat pump	6,492	43,020	7,138	56,650
	0.9%	6.0%	1.0%	7.9%
Ground-source heat pump	2,164	14,570	2,014	18,747
	0.3%	2.0%	0.3%	2.6%
Room air conditioners	19,399	26,255	21,873	67,526
	2.7%	3.7%	3.1%	9.4%
Ductless mini-split air conditioner	0	0	0	0
	0%	0%	0%	0%
Evaporative cooler (swamp cooler)	0	7,979	1,785	9,764
	0	1.1%	0.2%	1.4%
Portable fans	139,621	114,834	111,255	365,710
	19.5%	16.1%	15.6%	51.1%
Whole-house fan	6,492	20,815	12,721	40,029
	0.9%	2.9%	1.8%	5.6%
Ceiling fans	74,178	82,439	65,389	222,007
	10.4%	11.5%	9.1%	31.0%
Something else (specify)	2,164	0	0	2,164
	0.3%	0	0	0.3%

Table B.28

Question 22. What type of temperature control is on the main cooling system?	**Service Type**			**Total**
	Electric and Gas (combo)	Electric only	Gas only	
Regular thermostat(s) with temperature settings	19,477	36,774	17,845	74,097
	1.6%	2.9%	1.4%	5.9%
Clock or programmable thermostat(s)	73,424	52,627	20,195	146,245
	5.9%	4.2%	1.6%	11.7%
Dial control without temperature settings	2,164	19,665	3,569	25,398
	0.2%	1.6%	0.3%	2.0%
Simple on/off switch or no temperature control	4,328	6,590	9,381	20,299
	0.3%	0.5%	0.7%	1.6%
Don't know	0	0	3,569	3,569
	0	0	0.3%	0.3%
Not applicable	241,606	462,374	280,150	984,130
	19.3%	36.9%	22.3%	78.5%

Table B.29

Question 23. Which of the following statements best describes how the main cooling system is used?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
The thermostat(s) is kept at a constant setting or temperature	10,742	26,255	3,569	40,566
	4.0%	9.9%	1.3%	15.3%
The thermostat is adjusted when occupants are sleeping	12,985	19,665	3,569	36,219
	4.9%	7.4%	1.3%	13.6%
The thermostat is adjusted when occupants leave the house	8,657	11,686	1,785	22,127
	3.3%	4.4%	0.7%	8.3%
The cooling system is turned on only when someone is warm	41,040	37,357	30,673	109,071
	15.4%	14.1%	11.5%	41.0%
We rarely use this cooling system	32,462	52,733	20,088	105,283
	30.8%	50.1%	19.1%	100.0%

Table B.30

Question 24. Home cooling - at what temperature do you normally keep your thermostat?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
50	4,328	0	0	4,328
	0.3%	0	0	0.3%
55	0	3,123	0	3,123
	0	0.2%	0	0.2%
60	0	6,829	5,354	12,183
	0	0.5%	0.4%	1.0%
62	2,164	0	0	2,164
	0.2%	0	0	0.2%
64	2,164	0	2,014	4,178
	0.2%	0	0.2%	0.3%
65	8,578	0	1,785	10,362
	0.7%	0	0.1%	0.8%
67	4,328	1,734	1,785	7,847
	0.3%	0.1%	0.1%	0.6%
68	2,164	6,246	7,138	15,548
	0.2%	0.5%	0.6%	1.2%
69	2,164	3,123	0	5,287
	0.2%	0.2%	0	0.4%
70	12,985	17,931	8,923	39,839
	1.0%	1.4%	0.7%	3.2%
71	2,164	1,734	0	3,898
	0.2%	0.1%	0	0.3%

Question 24. Home cooling - at what temperature do you normally keep your thermostat?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
72	8,657	12,491	5,354	26,502
	0.7%	1.0%	0.4%	2.1%
73	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
74	10,821	3,123	1,785	15,728
	0.9%	0.2%	0.1%	1.3%
75	8,578	8,324	3,569	20,471
	0.7%	0.7%	0.3%	1.6%
78	2,164	1,734	3,905	7,803
	0.2%	0.1%	0.3%	0.6%
80	0	6,246	0	6,246
	0	0.5%	0	0.5%
82	0	3,123	0	3,123
	0	0.2%	0	0.2%
85	0	3,123	0	3,123
	0	0.2%	0	0.2%
87	0	3,123	0	3,123
	0	0.2%	0	0.2%
Don't know	10,821	24,283	7,596	42,700
	0.9%	1.9%	0.6%	3.4%
Refused	0	3,123	1,785	4,907
	0	0.2%	0.1%	0.4%
Not applicable	256,756	468,620	281,934	1,007,309
	20.5%	37.4%	22.5%	80.3%

Table B.31

Question 26. Home cooling - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
67	0	0	1,785	1,785
	0	0	4.6%	4.6%
68	2,164	0	0	2,164
	5.6%	0	0	5.6%
70	2,164	14,808	1,785	18,757
	5.6%	38.6%	4.6%	48.9%
71	2,164	0	0	2,164
	5.6%	0	0	5.6%
72	0	3,123	0	3,123
	0	8.1%	0	8.1%
73	2,164	0	0	2,164
	5.6%	0	0	5.6%
74	2,164	0	0	2,164
	5.6%	0	0	5.6%
75	0	1,734	0	1,734
	0	4.5%	0	4.5%
78	2,164	0	0	2,164
	5.6%	0	0	5.6%
Don't know	2,164	0	0	2,164
	5.6%	0	0	5.6%

Table B.32

Question 27. Home cooling - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	4,328	6,829	1,785	12,942
	0.3%	0.5%	0.1%	1.0%
60	0	1,734	0	1,734
	0	0.1%	0	0.1%
65	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
68	0	3,123	0	3,123
	0	0.2%	0	0.2%
70	2,164	3,123	0	5,287
	0.2%	0.2%	0	0.4%
72	0	3,123	0	3,123
	0	0.2%	0	0.2%
73	2,164	0	0	2,164
	0.2%	0	0	0.2%
75	2,164	0	0	2,164
	0.2%	0	0	0.2%
82	2,164	0	0	2,164
	0.2%	0	0	0.2%
Refused	0	1,734	0	1,734
	0	0.1%	0	0.1%
Not applicable	325,851	558,365	331,140	1,215,356
	26.0%	44.5%	26.4%	96.9%

Table B.33

Question 28. Home cooling - at what temperature do you normally keep your thermostat set when no one is at home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	4,328	9,952	0	14,280
	0.3%	0.8%	0	1.1%
60	0	1,734	0	1,734
	0	0.1%	0	0.1%
66	2,164	0	0	2,164
	0.2%	0	0	0.2%
67	0	0	1,785	1,785
	0	0	0.1%	0.1%
68	2,164	0	0	2,164
	0.2%	0	0	0.2%
70	0	0	1,785	1,785
	0	0	0.1%	0.1%
72	0	3,123	0	3,123
	0	0.2%	0	0.2%
73	2,164	0	0	2,164
	0.2%	0	0	0.2%
75	2,164	3,123	0	5,287
	0.2%	0.2%	0	0.4%
78	2,164	0	0	2,164
	0.2%	0	0	0.2%
Refused	0	1,734	0	1,734
	0	0.1%	0	0.1%

Question 28. Home cooling - at what temperature do you normally keep your thermostat set when no one is at home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Not applicable	325,851	558,365	331,140	1,215,356
	26.0%	44.5%	26.4%	96.9%

Table B.34

Question 29. Does the water heater or the source of the hot water serve only this residence or does it serve more than one residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Only this residence	39,360	186,553	35,480	261,393
	3.1%	14.9%	2.8%	20.8%
Central water heating or tank for more than one residence	2,164	13,313	8,481	23,959
	0.2%	1.1%	0.7%	1.9%
This residence has no hot water	0	5,095	0	5,095
	0	0.4%	0	0.4%
Don't know	0	0	1,785	1,785
	0	0	0.1%	0.1%
Not applicable	299,476	373,069	288,963	961,507
	23.9%	29.8%	23.0%	76.7%

Table B.35

Question 30. How many water heaters are at this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
One	312,269	525,837	311,615	1,149,722
	24.9%	41.9%	24.9%	91.7%
Two	22,239	28,689	11,043	61,970
	1.8%	2.3%	0.9%	4.9%
Three or more	2,164	5,095	0	7,259
	0.2%	0.4%	0	0.6%
Don't know	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.36

Question 31. What type of water heater do you have?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Tank-type water heater	323,766	520,159	306,598	1,150,522
	25.8%	41.5%	24.5%	91.8%
Indirect water heater or integrated water heater	2,085	6,246	5,354	13,685
	0.2%	0.5%	0.4%	1.1%
Tankless hotwater heater aka demand or instantaneous water heater	10,821	13,075	8,923	32,818
	0.9%	1.0%	0.7%	2.6%
Don't know	2,164	20,142	3,569	25,876
	0.2%	1.6%	0.3%	2.1%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.37

Question 32. What type of system is used in conjunction with your solar water heater?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Not applicable	341,000	578,030	334,709	1,253,739
	27.2%	46.1%	26.7%	100.0%

Table B.38

Question 32a. What is the secondary or back-up type of fuel you use to heat water at this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Not applicable	341,000	578,030	334,709	1,253,739
	27.2%	46.1%	26.7%	100.0%

Table B.39

Question 33. What type of fuel or energy is used to heat the water used in this residence?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	46,890	426,023	50,883	523,797
	3.7%	34.0%	4.1%	41.8%
Natural gas	285,532	88,129	266,086	639,746
	22.8%	7.0%	21.2%	51.0%
Propane or bottled gas (LP, propane, butane)	0	25,327	0	25,327
	0	2.0%	0	2.0%
Don't know	4,249	0	3,905	8,154
	0.3%	0	0.3%	0.7%
Not applicable	4,328	38,551	13,835	56,714
	0.3%	3.1%	1.1%	4.5%

Table B.40

Question 34. At what specific temperature is your water heater thermostat set?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
69	2,164	0	0	2,164
	0.2%	0	0	0.2%
70	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
72	0	5,095	0	5,095
	0	0.4%	0	0.4%
75	0	0	1,785	1,785
	0	0	0.1%	0.1%
80	0	3,123	0	3,123
	0	0.2%	0	0.2%
85	0	3,123	0	3,123
	0	0.2%	0	0.2%
90	4,328	0	0	4,328
	0.3%	0	0	0.3%
98	0	0	3,569	3,569
	0	0	0.3%	0.3%
100	8,657	14,464	5,354	28,474
	0.7%	1.2%	0.4%	2.3%
102	4,328	3,123	1,785	9,236
	0.3%	0.2%	0.1%	0.7%
105	0	3,123	0	3,123
	0	0.2%	0	0.2%

Question 34. At what specific temperature is your water heater thermostat set?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
109	0	0	1,785	1,785
	0	0	0.1%	0.1%
110	8,657	27,867	7,138	43,662
	0.7%	2.2%	0.6%	3.5%
114	0	0	1,785	1,785
	0	0	0.1%	0.1%
115	10,742	11,102	5,354	27,198
	0.9%	0.9%	0.4%	2.2%
118	0	1,734	0	1,734
	0	0.1%	0	0.1%
120	43,317	81,316	64,383	189,015
	3.5%	6.5%	5.1%	15.1%
125	10,821	9,368	11,165	31,355
	0.9%	0.7%	0.9%	2.5%
130	10,742	11,102	7,138	28,982
	0.9%	0.9%	0.6%	2.3%
135	0	4,857	1,785	6,641
	0	0.4%	0.1%	0.5%
140	17,313	27,061	3,798	48,172
	1.4%	2.2%	0.3%	3.8%
145	2,164	0	0	2,164
	0.2%	0	0	0.2%

Question 34. At what specific temperature is your water heater thermostat set?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
150	2,761	0	1,785	4,546
	0.2%	0	0.1%	0.4%
155	0	0	1,785	1,785
	0	0	0.1%	0.1%
160	2,164	1,734	0	3,898
	0.2%	0.1%	0	0.3%
165	2,164	6,246	0	8,410
	0.2%	0.5%	0	0.7%
170	0	4,857	0	4,857
	0	0.4%	0	0.4%
180	2,164	3,123	1,785	7,072
	0.2%	0.2%	0.1%	0.6%
185	0	1,734	0	1,734
	0	0.1%	0	0.1%
190	2,085	0	0	2,085
	0.2%	0	0	0.2%
Don't know	202,100	335,472	200,483	738,055
	16.1%	26.8%	16.0%	58.9%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.41

Question 34a. If not set at a specific temperature then which of these statements best describes where your water heater thermostat is set?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
On the 'low' setting	4,328	21,876	9,610	35,814
	0.3%	1.7%	0.8%	2.9%
Between the 'low' and 'medium' settings	12,500	36,340	18,304	67,144
	1.0%	2.9%	1.5%	5.4%
On the 'medium' setting	87,006	122,767	83,661	293,434
	6.9%	9.8%	6.7%	23.4%
Between the 'medium' and 'high' setting	58,714	52,882	59,455	171,051
	4.7%	4.2%	4.7%	13.6%
On the 'high' setting	15,746	6,246	1,785	23,776
	1.3%	0.5%	0.1%	1.9%
Don't know	23,806	95,362	27,669	146,836
	1.9%	7.6%	2.2%	11.7%
Not applicable	138,900	242,558	134,226	515,684
	11.1%	19.3%	10.7%	41.1%

Table B.42

Question 35. Which of the following items do you have for your main water heater? Do you have a water heater tank wrap?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	127,234	189,364	87,475	404,073
	10.1%	15.1%	7.0%	32.2%
No	193,770	329,628	209,742	733,140
	15.5%	26.3%	16.7%	58.5%
Don't know	17,831	40,629	27,226	85,687
	1.4%	3.2%	2.2%	6.8%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.43

Question 36. Which of the following items do you have for your main water heater? Do you have pipe insulation?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	207,038	284,099	150,957	642,094
	16.5%	22.7%	12.0%	51.2%
No	96,135	211,522	138,572	446,229
	7.7%	16.9%	11.1%	35.6%
Don't know	35,663	64,000	34,914	134,577
	2.8%	5.1%	2.8%	10.7%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.44

Question 37. Which of the following items do you have for your main water heater? Do you have a water heater timer?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	34,548	58,528	21,415	114,490
	2.8%	4.7%	1.7%	9.1%
No	276,154	408,166	250,605	934,925
	22.0%	32.6%	20.0%	74.6%
Don't know	28,134	92,928	52,423	173,485
	2.2%	7.4%	4.2%	13.8%
Not applicable	2,164	18,409	10,266	30,839
	0.2%	1.5%	0.8%	2.5%

Table B.45

Question 38. How many refrigerators are in your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	229,513	442,937	251,032	923,482
	18.3%	35.3%	20.0%	73.7%
2	104,995	131,970	80,108	317,073
	8.4%	10.5%	6.4%	25.3%
3	4,328	3,123	3,569	11,020
	0.3%	0.2%	0.3%	0.9%
4	2,164	0	0	2,164
	0.2%	0	0	0.2%

Table B.46

Question 39. How many years old is your primary refrigerator?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
6 or less years old	204,670	310,530	175,729	690,929
	16.3%	24.8%	14.0%	55.1%
7 to 14 years old	106,032	150,872	98,625	355,529
	8.5%	12.0%	7.9%	28.4%
15 or more years old	28,134	72,875	56,786	157,796
	2.2%	5.8%	4.5%	12.6%
Don't know	2,164	43,752	3,569	49,485
	0.2%	3.5%	0.3%	3.9%

Table B.47

Question 40. How many stand-alone freezers are in your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	174,699	308,544	211,421	694,664
	13.9%	24.6%	16.9%	55.4%
1	152,719	250,404	114,366	517,488
	12.2%	20.0%	9.1%	41.3%
2	13,582	19,082	8,923	41,586
	1.1%	1.5%	0.7%	3.3%

Table B.48

Question 41. How many years old is your 'primary' stand-alone freezer?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
6 or less years old	49,697	82,811	39,718	172,225
	4.0%	6.6%	3.2%	13.7%
7 to 14 years old	41,716	82,705	34,471	158,892
	3.3%	6.6%	2.7%	12.7%
15 or more years old	72,724	89,162	49,099	210,985
	5.8%	7.1%	3.9%	16.8%
Don't know	2,164	14,808	0	16,973
	0.2%	1.2%	0	1.4%
Not applicable	174,699	308,544	211,421	694,664
	13.9%	24.6%	16.9%	55.4%

Table B.49

Question 42. How many dishwashers are in your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	19,996	67,451	46,415	133,862
	1.6%	5.4%	3.7%	10.7%
1	321,004	507,456	280,820	1,109,280
	25.6%	40.5%	22.4%	88.5%
2	0	3,123	7,474	10,597
	0	0.2%	0.6%	0.8%

Table B.50

Question 43. Do you have a private clothes washer that is used just by the people in your household?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	341,000	498,611	320,874	1,160,485
	27.2%	39.8%	25.6%	92.6%
No	0	79,419	13,835	93,254
	0	6.3%	1.1%	7.4%

Table B.51

Question 44. Which of the following best describes the type of clothes washer in your home?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Front load washing machine	120,956	93,807	118,606	333,370
	9.6%	7.5%	9.5%	26.6%
Top load washing machine	217,880	404,804	200,483	823,166
	17.4%	32.3%	16.0%	65.7%
Don't know	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
Not applicable	0	79,419	13,835	93,254
	0	6.3%	1.1%	7.4%

Table B.52

Question 45. Do you have a clothes dryer that is used just by the people in your household?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	336,075	498,611	319,089	1,153,775
	26.8%	39.8%	25.5%	92.0%
No	4,925	79,419	15,620	99,964
	0.4%	6.3%	1.2%	8.0%

Table B.53

Question 46. What fuel or energy source do you use for your clothes dryer?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	262,054	444,595	254,052	960,701
	22.7%	38.5%	22.0%	83.3%
Natural gas	71,935	34,351	60,904	167,190
	6.2%	3.0%	5.3%	14.5%
Propane or bottled gas (LP, propane, butane)	0	12,836	0	12,836
	0	1.1%	0	1.1%
Something else (specify)	0	1,734	0	1,734
	0	0.2%	0	0.2%
Don't know	2,085	5,095	4,134	11,315
	0.2%	0.4%	0.4%	1.0%

Table B.54

Question 47. Do you have your own swimming pool?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	8,172	11,102	9,152	28,426
	0.7%	0.9%	0.7%	2.3%
No	332,828	566,928	325,557	1,225,313
	26.5%	45.2%	26.0%	97.7%

Table B.55

Question 48. What fuel or energy source do you use to heat your swimming pool?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	0	1,734	3,569	5,303
	0	0.1%	0.3%	0.4%
Natural gas	6,492	0	5,583	12,075
	0.5%	0	0.4%	1.0%
Solar	0	6,246	0	6,246
	0	0.5%	0	0.5%
Not heated	0	3,123	0	3,123
	0	0.2%	0	0.2%
Don't know	1,680	0	0	1,680
	0.1%	0	0	0.1%
Not applicable	332,828	566,928	325,557	1,225,313
	26.5%	45.2%	26.0%	97.7%

Table B.56

Question 48a. How often do you operate your pool pump and filtration system?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
All day and all night	0	0	1,785	1,785
	0	0	0.1%	0.1%
Turned off at night	2,164	0	5,583	7,747
	0.2%	0	0.4%	0.6%
Something else (specify)	4,328	7,979	1,785	14,092
	0.3%	0.6%	0.1%	1.1%
Don't know	1,680	3,123	0	4,802
	0.1%	0.2%	0	0.4%
Not applicable	332,828	566,928	325,557	1,225,313
	26.5%	45.2%	26.0%	97.7%

Table B.57

Question 48b. Do you own an insulating cover for your pool?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	0	7,979	5,583	13,562
	0	0.6%	0.4%	1.1%
No	8,172	3,123	3,569	14,864
	0.7%	0.2%	0.3%	1.2%
Not applicable	332,828	566,928	325,557	1,225,313
	26.5%	45.2%	26.0%	97.7%

Table B.58

Question 49. Do you have your own hot tub or spa?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	38,955	28,795	32,580	100,329
	3.1%	2.3%	2.6%	8.0%
No	302,045	549,235	302,129	1,153,410
	24.1%	43.8%	24.1%	92.0%

Table B.59

Question 50. What fuel or energy source do you use for your hot tub or spa?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	32,462	25,672	25,213	83,347
	2.6%	2.0%	2.0%	6.6%
Natural gas	6,492	3,123	7,367	16,983
	0.5%	0.2%	0.6%	1.4%
Not applicable	302,045	549,235	302,129	1,153,410
	24.1%	43.8%	24.1%	92.0%

Table B.60

Question 50a. Do you have your own sauna?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Yes	4,328	17,587	3,569	25,484
	0.3%	1.4%	0.3%	2.0%
No	336,672	558,710	331,140	1,226,521
	26.9%	44.6%	26.4%	97.8%
Don't know	0	1,734	0	1,734
	0	0.1%	0	0.1%

Table B.61

Question 50b. What fuel or energy source do you use for your sauna?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	4,328	17,587	3,569	25,484
	0.3%	1.4%	0.3%	2.0%
Not applicable	336,672	560,443	331,140	1,228,255
	26.9%	44.7%	26.4%	98.0%

Table B.62

Question 51. How many cook-top units do you have?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	19,320	42,585	14,276	76,182
	1.5%	3.4%	1.1%	6.1%
1	315,672	501,077	306,156	1,122,906
	25.2%	40.0%	24.4%	89.6%
2	6,008	29,272	14,276	49,556
	0.5%	2.3%	1.1%	4.0%
Don't know	0	5,095	0	5,095
	0	0.4%	0	0.4%

Table B.63

Question 52. What fuel or energy source do you use for your cook-top(s)?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	195,720	436,781	180,975	813,476
	15.6%	34.8%	14.4%	64.9%
Natural gas	125,960	64,774	137,337	328,071
	10.0%	5.2%	11.0%	26.2%
Propane or bottled gas (LP, propane, butane)	0	28,795	0	28,795
	0	2.3%	0	2.3%
Don't know	0	0	2,120	2,120
	0	0	0.2%	0.2%
No response	0	5,095	0	5,095
	0	0.4%	0	0.4%

Not applicable	19,320	42,585	14,276	76,182
	1.5%	3.4%	1.1%	6.1%

Table B.64

Question 53. How many ovens do you have?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	0	6,246	0	6,246
	0	0.5%	0	0.5%
1	273,990	514,646	305,927	1,094,563
	21.9%	41.0%	24.4%	87.3%
2	67,010	45,798	28,782	141,590
	5.3%	3.7%	2.3%	11.3%
3	0	11,341	0	11,341
	0	0.9%	0	0.9%

Table B.65

Question 54. What fuel or energy source do you use for your oven(s)?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
Electricity	282,050	507,488	249,811	1,039,349
	22.5%	40.5%	19.9%	82.9%
Natural gas	56,786	48,338	82,778	187,901
	4.5%	3.9%	6.6%	15.0%
Propane or bottled gas (LP, propane, butane)	0	15,959	0	15,959
	0	1.3%	0	1.3%
Don't know	2,164	0	2,120	4,285
	0.2%	0	0.2%	0.3%
Not applicable	0	6,246	0	6,246
	0	0.5%	0	0.5%

Table B.66

Question 55. How many microwave ovens do you have?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	2,085	23,265	11,272	36,623
	0.2%	1.9%	0.9%	2.9%
1	317,352	532,560	305,591	1,155,504
	25.3%	42.5%	24.4%	92.2%
2	21,563	19,082	17,845	58,490
	1.7%	1.5%	1.4%	4.7%
3	0	3,123	0	3,123
	0	0.2%	0	0.2%

Table B.67

Question 56. Number of televisions of all types in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	4,328	16,436	7,474	28,239
	0.3%	1.3%	0.6%	2.3%
1	47,408	156,329	91,823	295,560
	3.8%	12.5%	7.3%	23.6%
2	108,005	209,672	106,573	424,249
	8.6%	16.7%	8.5%	33.8%
3	82,080	121,912	76,416	280,409
	6.5%	9.7%	6.1%	22.4%
4	56,268	44,409	29,224	129,901
	4.5%	3.5%	2.3%	10.4%
5	25,000	21,293	14,276	60,569
	2.0%	1.7%	1.1%	4.8%
6	4,328	7,979	3,569	15,877
	0.3%	0.6%	0.3%	1.3%
7	2,761	0	1,785	4,546
	0.2%	0	0.1%	0.4%
8	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
Refused	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.8%

Table B.68

Question 57. Number of large flat-screen tvs (over 32 inches) in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	190,197	420,106	192,812	803,116
	15.5%	34.3%	15.7%	65.5%
1	109,684	115,338	116,577	341,599
	9.0%	9.4%	9.5%	27.9%
2	23,806	17,931	14,276	56,013
	1.9%	1.5%	1.2%	4.6%
3	0	3,123	1,785	4,907
	0	0.3%	0.1%	0.4%
4	2,164	0	0	2,164
	0.2%	0	0	0.2%
5	0	5,095	0	5,095
	0	0.4%	0	0.4%
Refused	2,164	0	0	2,164
	0.2%	0	0	0.2%
Not applicable	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.9%

Table B.69

Question 58. Number of game consoles (Playstation Wii Nintendo xbox xCube etc) in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	204,671	443,938	206,844	855,453
	16.3%	35.4%	16.5%	68.2%
1	75,215	70,363	80,108	225,685
	6.0%	5.6%	6.4%	18.0%
2	32,981	36,430	30,902	100,312
	2.6%	2.9%	2.5%	8.0%
3	8,657	11,102	9,488	29,246
	0.7%	0.9%	0.8%	2.3%
4	4,328	8,218	0	12,546
	0.3%	0.7%	0	1.0%
5	0	7,979	3,569	11,548
	0	0.6%	0.3%	0.9%
6	4,328	0	0	4,328
	0.3%	0	0	0.3%
Don't know	2,164	0	0	2,164
	0.2%	0	0	0.2%
Refused	8,657	0	3,798	12,455
	0.7%	0	0.3%	1.0%

Table B.70

Question 59. Number of VCRs or DVD players (not a combo unit) in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	70,808	147,272	86,469	304,549
	5.6%	11.7%	6.9%	24.3%
1	124,236	234,044	126,080	484,361
	9.9%	18.7%	10.1%	38.6%
2	68,046	133,419	89,244	290,709
	5.4%	10.6%	7.1%	23.2%
3	38,955	43,736	21,979	104,670
	3.1%	3.5%	1.8%	8.3%
4	15,149	13,313	5,583	34,045
	1.2%	1.1%	0.4%	2.7%
5	4,328	3,123	1,785	9,236
	0.3%	0.2%	0.1%	0.7%
6	2,164	0	0	2,164
	0.2%	0	0	0.2%
7	2,164	0	0	2,164
	0.2%	0	0	0.2%
9	2,164	0	0	2,164
	0.2%	0	0	0.2%
Don't know	2,164	3,123	1,785	7,072
	0.2%	0.2%	0.1%	0.6%
Refused	10,821	0	1,785	12,605
	0.9%	0	0.1%	1.0%

Table B.71

Question 60. Number of combination VCR and DVD units in your home.	**Service Type**			**Total**
	Electric and Gas (combo)	Electric only	Gas only	
0	181,574	309,979	170,268	661,821
	14.5%	24.7%	13.6%	52.8%
1	107,487	191,936	117,249	416,671
	8.6%	15.3%	9.4%	33.2%
2	38,955	52,283	30,902	122,139
	3.1%	4.2%	2.5%	9.7%
3	6,492	20,709	9,152	36,354
	0.5%	1.7%	0.7%	2.9%
4	0	0	1,785	1,785
	0	0	0.1%	0.1%
5	0	0	1,785	1,785
	0	0	0.1%	0.1%
23	0	3,123	0	3,123
	0	0.2%	0	0.2%
Don't know	0	0	1,785	1,785
	0	0	0.1%	0.1%
Refused	6,492	0	1,785	8,277
	0.5%	0	0.1%	0.7%

Table B.72

Question 61. Number of stand-alone DVR units (not TIVO) in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	247,063	421,028	239,317	907,408
	19.7%	33.6%	19.1%	72.4%
1	61,036	109,798	71,857	242,691
	4.9%	8.8%	5.7%	19.4%
2	15,746	39,224	12,828	67,798
	1.3%	3.1%	1.0%	5.4%
3	2,085	1,734	5,354	9,173
	0.2%	0.1%	0.4%	0.7%
Don't know	6,414	6,246	3,569	16,228
	0.5%	0.5%	0.3%	1.3%
Refused	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.8%

Table B.73

Question 62. Number of TIVO or cable or satellite TV set-top boxes or receivers in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	121,745	243,201	121,169	486,115
	9.7%	19.4%	9.7%	38.8%
1	117,698	193,803	121,398	432,899
	9.4%	15.5%	9.7%	34.5%
2	43,204	89,311	58,235	190,751
	3.4%	7.1%	4.6%	15.2%
3	36,712	33,545	24,984	95,241
	2.9%	2.7%	2.0%	7.6%
4	4,328	18,170	5,354	27,852
	0.3%	1.4%	0.4%	2.2%
5	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%
Don't know	4,328	0	1,785	6,113
	0.3%	0	0.1%	0.5%
Refused	8,657	0	0	8,657
	0.7%	0	0	0.7%

Table B.74

Question 63. Number of stereo systems in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	68,238	190,219	99,877	358,333
	5.4%	15.2%	8.0%	28.6%

Question 63. Number of stereo systems in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	188,360	324,066	182,515	694,942
	15.0%	25.8%	14.6%	55.4%
2	47,611	46,859	35,920	130,390
	3.8%	3.7%	2.9%	10.4%
3	19,477	11,686	10,707	41,870
	1.6%	0.9%	0.9%	3.3%
4	4,328	3,467	1,785	9,580
	0.3%	0.3%	0.1%	0.8%
6	0	1,734	0	1,734
	0	0.1%	0	0.1%
13	0	0	2,120	2,120
	0	0	0.2%	0.2%
Refused	12,985	0	1,785	14,769
	1.0%	0	0.1%	1.2%

Table B.75

Question 64. Number of personal computers - including laptops - in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	28,010	96,501	29,011	153,522
	2.2%	7.7%	2.3%	12.2%
1	128,000	283,247	147,939	559,186
	10.2%	22.6%	11.8%	44.6%

Question 64. Number of personal computers - including laptops - in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
2	97,905	108,287	82,350	288,543
	7.8%	8.6%	6.6%	23.0%
3	45,965	63,862	46,856	156,684
	3.7%	5.1%	3.7%	12.5%
4	17,313	14,792	17,845	49,951
	1.4%	1.2%	1.4%	4.0%
5	6,492	6,246	7,138	19,876
	0.5%	0.5%	0.6%	1.6%
7	2,164	0	0	2,164
	0.2%	0	0	0.2%
8	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
Don't know	0	5,095	0	5,095
	0	0.4%	0	0.4%
Refused	12,985	0	1,785	14,769
	1.0%	0	0.1%	1.2%

Table B.76

Question 65. Number of computer monitors in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	23,727	59,605	42,510	125,842
	2.2%	5.4%	3.9%	11.4%

Question 65. Number of computer monitors in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	176,209	313,325	183,981	673,514
	16.0%	28.5%	16.7%	61.2%
2	69,174	69,391	45,301	183,866
	6.3%	6.3%	4.1%	16.7%
3	22,239	27,867	24,984	75,089
	2.0%	2.5%	2.3%	6.8%
4	4,328	6,246	5,354	15,928
	0.4%	0.6%	0.5%	1.4%
5	2,164	0	0	2,164
	0.2%	0	0	0.2%
6	0	0	1,785	1,785
	0	0	0.2%	0.2%
Don't know	2,164	0	0	2,164
	0.2%	0	0	0.2%
Not applicable	12,985	5,095	1,785	19,865
	1.2%	0.5%	0.2%	1.8%

Table B.77

Question 66. Number of combination printer / fax / copiers in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	133,523	309,863	172,266	615,652
	10.6%	24.7%	13.7%	49.1%

1	181,507	226,642	142,813	550,962
	14.5%	18.1%	11.4%	43.9%
2	15,149	31,573	16,061	62,783
	1.2%	2.5%	1.3%	5.0%
3	2,164	3,123	1,785	7,072
	0.2%	0.2%	0.1%	0.6%
Don't know	0	6,829	0	6,829
	0	0.5%	0	0.5%
Refused	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.8%

Table B.78

Question 67. Number of stand-alone printers in your home.	Service Type: Electric and Gas (combo)	Service Type: Electric only	Service Type: Gas only	Total
0	138,855	293,199	142,265	574,318
	11.1%	23.4%	11.3%	45.8%
1	153,937	246,429	158,309	558,675
	12.3%	19.7%	12.6%	44.6%
2	37,388	36,668	26,997	101,053
	3.0%	2.9%	2.2%	8.1%
3	0	1,734	1,785	3,518
	0	0.1%	0.1%	0.3%
4	0	0	1,785	1,785
	0	0	0.1%	0.1%
10	0	0	1,785	1,785
	0	0	0.1%	0.1%
Don't know	2,164	0	0	2,164
	0.2%	0	0	0.2%
Refused	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.8%

Table B.79

Question 68. Number of stand-alone fax machines in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	282,568	502,483	293,329	1,078,379
	22.5%	40.1%	23.4%	86.0%
1	47,611	67,329	36,027	150,968
	3.8%	5.4%	2.9%	12.0%
2	2,164	8,218	3,569	13,951
	0.2%	0.7%	0.3%	1.1%
Refused	8,657	0	1,785	10,441
	0.7%	0	0.1%	0.8%

Table B.80

Question 69. Number of stand-alone copiers in your home.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	264,894	458,985	283,841	1,007,721
	21.1%	36.6%	22.6%	80.4%
1	62,524	94,629	45,514	202,667
	5.0%	7.5%	3.6%	16.2%
2	7,090	19,559	1,785	28,433
	0.6%	1.6%	0.1%	2.3%
11	0	0	1,785	1,785
	0	0	0.1%	0.1%
Don't know	0	4,857	0	4,857
	0	0.4%	0	0.4%
Refused	6,492	0	1,785	8,277
	0.5%	0	0.1%	0.7%

Table B.81

Question 70. Number of surge protector strips in your home for any of the audio/video or home office mentioned above.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
0	32,823	81,454	42,403	156,680
	2.6%	6.5%	3.4%	12.5%
1	64,879	125,201	73,748	263,828
	5.2%	10.0%	5.9%	21.0%
2	65,882	145,104	80,673	291,659
	5.3%	11.6%	6.4%	23.3%
3	81,596	75,547	65,816	222,959
	6.5%	6.0%	5.2%	17.8%
4	21,642	65,612	32,351	119,604
	1.7%	5.2%	2.6%	9.5%
5	21,642	34,113	14,505	70,260
	1.7%	2.7%	1.2%	5.6%
6	20,074	30,184	7,367	57,625
	1.6%	2.4%	0.6%	4.6%
7	10,821	3,123	3,569	17,513
	0.9%	0.2%	0.3%	1.4%
8	4,328	7,979	0	12,308
	0.3%	0.6%	0	1.0%
9	2,164	1,734	1,785	5,682
	0.2%	0.1%	0.1%	0.5%
10	4,328	3,123	3,569	11,020
	0.3%	0.2%	0.3%	0.9%

Question 70. Number of surge protector strips in your home for any of the audio/video or home office mentioned above.	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
12	0	0	1,785	1,785
	0	0	0.1%	0.1%
20	2,164	0	0	2,164
	0.2%	0	0	0.2%
Don't know	2,164	3,123	5,354	10,641
	0.2%	0.2%	0.4%	0.8%
Refused	6,492	1,734	1,785	10,011
	0.5%	0.1%	0.1%	0.8%

Table B.82

Question 71. Which, if any, of the appliances in your home are Energy Star rated?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
all of them/everything	10,821	30,078	8,923	49,821
	1.5%	4.1%	1.2%	6.8%
air conditioning	0	0	5,354	5,354
	0	0	0.7%	0.7%
computer monitor	6,414	0	7,138	13,552
	0.9%	0	1.0%	1.9%
computer	12,985	36,579	10,707	60,271
	1.8%	5.0%	1.5%	8.3%
dishwasher	83,872	85,006	68,746	237,624
	11.5%	11.6%	9.4%	32.6%
dryer	104,916	79,343	94,310	278,569
	14.4%	10.9%	12.9%	38.2%
freezer	34,627	17,931	12,492	65,050
	4.7%	2.5%	1.7%	8.9%
furnace	6,492	3,123	12,721	22,336
	0.9%	0.4%	1.7%	3.1%
microwave	21,157	30,422	12,828	64,407
	2.9%	4.2%	1.8%	8.8%
oven	25,485	14,225	9,381	49,091
	3.5%	1.9%	1.3%	6.7%
refrigerator	144,953	181,623	121,398	447,975
	19.9%	24.9%	16.6%	61.4%

Question 71. Which, if any, of the appliances in your home are Energy Star rated?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
stove	47,533	69,063	35,036	151,632
	6.5%	9.5%	4.8%	20.8%
television	19,477	30,094	18,075	67,646
	2.7%	4.1%	2.5%	9.3%
washing machine	122,150	93,568	105,017	320,736
	16.7%	12.8%	14.4%	44.0%
water heater	19,477	75,892	47,986	143,355
	2.7%	10.4%	6.6%	19.6%
asked/answered	293,546	468,905	276,474	1,038,925
	23.4%	37.4%	22.1%	82.9%
Don't know	47,454	109,125	56,451	213,030
	3.8%	8.7%	4.5%	17.0%
Refused	0	0	1,785	1,785
	0	0	0.1%	0.1%

Table B.83

Question 72. How many people - including yourself - usually live in this residence at least six months of the year?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1	45,244	185,644	57,353	288,241
	3.6%	14.8%	4.6%	23.0%
2	123,233	235,867	112,001	471,101
	9.8%	18.8%	8.9%	37.6%
3	67,528	65,357	76,890	209,775
	5.4%	5.2%	6.1%	16.7%
4	51,861	55,988	57,899	165,749
	4.1%	4.5%	4.6%	13.2%
5	27,164	32,050	18,075	77,289
	2.2%	2.6%	1.4%	6.2%
6	8,657	0	8,923	17,579
	0.7%	0	0.7%	1.4%
7	2,164	0	1,785	3,949
	0.2%	0	0.1%	0.3%
8	4,328	3,123	0	7,451
	0.3%	0.2%	0	0.6%
Refused	10,821	0	1,785	12,605
	0.9%	0	0.1%	1.0%

Table B.84

Question 73. For what average length of time is your home occupied by at least one person on a typical weekday ?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
23-24 hrs/day	137,412	243,831	116,928	498,171
	11.0%	19.4%	9.3%	39.7%
21-22 hrs/day	15,746	42,930	21,750	80,427
	1.3%	3.4%	1.7%	6.4%
19-20 hrs/day	39,394	40,613	26,768	106,775
	3.1%	3.2%	2.1%	8.5%
17-18 hrs/day	30,298	42,824	40,512	113,634
	2.4%	3.4%	3.2%	9.1%
15-16 hrs/day	28,055	70,363	38,605	137,023
	2.2%	5.6%	3.1%	10.9%
13-14 hrs/day	32,305	26,255	28,005	86,564
	2.6%	2.1%	2.2%	6.9%
11-12 hrs/day	30,219	60,650	24,100	114,969
	2.4%	4.8%	1.9%	9.2%
9-10 hrs/day	4,249	4,857	5,354	14,460
	0.3%	0.4%	0.4%	1.2%
7-8 hrs/day	2,164	27,777	13,057	42,998
	0.2%	2.2%	1.0%	3.4%
5-6 hrs/day	4,328	1,734	7,138	13,200
	0.3%	0.1%	0.6%	1.1%
3-4 hrs/day	2,164	3,123	0	5,287
	0.2%	0.2%	0	0.4%

Question 73. For what average length of time is your home occupied by at least one person on a typical weekday ?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1-2 hrs/day	0	0	3,569	3,569
	0	0	0.3%	0.3%
Don't know	3,844	4,857	3,569	12,269
	0.3%	0.4%	0.3%	1.0%
Refused	10,821	8,218	5,354	24,393
	0.9%	0.7%	0.4%	1.9%

Table B.85

Question 74. For what average length of time is your home occupied by at least one person on a typical weekend?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
23-24 hrs/day	182,780	303,674	162,565	649,020
	14.6%	24.2%	13.0%	51.8%
21-22 hrs/day	17,910	39,807	9,152	66,869
	1.4%	3.2%	0.7%	5.3%
19-20 hrs/day	54,137	68,496	52,882	175,515
	4.3%	5.5%	4.2%	14.0%
17-18 hrs/day	27,897	39,701	25,319	92,918
	2.2%	3.2%	2.0%	7.4%
15-16 hrs/day	12,985	41,435	31,467	85,887
	1.0%	3.3%	2.5%	6.9%
13-14 hrs/day	10,742	15,047	11,272	37,061
	0.9%	1.2%	0.9%	3.0%
11-12 hrs/day	8,657	25,805	16,733	51,194
	0.7%	2.1%	1.3%	4.1%
9-10 hrs/day	4,328	20,471	7,138	31,937
	0.3%	1.6%	0.6%	2.5%
7-8 hrs/day	0	9,368	7,474	16,842
	0	0.7%	0.6%	1.3%
5-6 hrs/day	6,492	0	3,569	10,062
	0.5%	0	0.3%	0.8%
3-4 hrs/day	2,085	0	0	2,085
	0.2%	0	0	0.2%

Question 74. For what average length of time is your home occupied by at least one person on a typical weekend?	Service Type			Total
	Electric and Gas (combo)	Electric only	Gas only	
1-2 hrs/day	0	0	1,785	1,785
	0	0	0.1%	0.1%
Don't know	8,657	11,102	1,785	21,543
	0.7%	0.9%	0.1%	1.7%
Refused	4,328	3,123	3,569	11,020
	0.3%	0.2%	0.3%	0.9%

Appendix A.1.4 Survey Results by Dwelling Type

The following tables present the results of the survey by dwelling type. The actual number of responses in each customer segment have been extrapolated to the population to provide an estimate of the results across PSE's entire service territory.

Table C.1

Question ax. Service type from sample	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electric and Gas (combo)	296,117	19,838	21,687	3,359	341,000
	23.6%	1.6%	1.7%	0.3%	27.2%
Electric only	320,013	33,694	171,267	53,056	578,030
	25.5%	2.7%	13.7%	4.2%	46.1%
Gas only	287,179	21,309	24,437	1,785	334,709
	22.9%	1.7%	1.9%	0.1%	26.7%

Table C.2

Question c. Do you own or rent or lease this property?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Own	832,148	49,387	67,553	46,118	995,206
	66.4%	3.9%	5.4%	3.7%	79.4%
Rent	56,884	22,693	137,561	10,348	227,486
	4.5%	1.8%	11.0%	0.8%	18.1%
Lease	11,153	2,761	12,276	1,734	27,924
	0.9%	0.2%	1.0%	0.1%	2.2%
Refused	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%

Table C.3

Question d. Which of the following best describes how the residence is occupied?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Year-round, full-time	903,308	74,841	217,390	58,199	1,253,739
	72.0%	6.0%	17.3%	4.6%	100.0%

Table C.4

Question 1. Which of the following best describes your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Single family detached home	903,308	0	0	0	903,308
	72.0%	0	0	0	72.0%
Duplex, row- or townhouse	0	74,841	0	0	74,841
	0	6.0%	0	0	6.0%
Apartment or condo	0	0	217,390	0	217,390
	0	0	17.3%	0	17.3%
Manufactured home	0	0	0	58,199	58,199
	0	0	0	4.6%	4.6%

Table C.5

Question1c. Which of the following best describes your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Single family	903,308	0	0	0	903,308
	72.0%	0	0	0	72.0%
Multi-family	0	74,841	217,390	0	292,232
	0	6.0%	17.3%	0	23.3%
Manufactured home	0	0	0	58,199	58,199
	0	0	0	4.6%	4.6%

Table C.6

Question 2c. How many living units or apartments are in the building where this residence is located?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
2 units	0	31,417	0	0	31,417
	0	2.5%	0	0	2.5%
3 units	0	2,085	10,191	0	12,276
	0	0.2%	0.8%	0	1.0%
4 units	0	11,465	31,519	0	42,984
	0	0.9%	2.5%	0	3.4%
5 or more units	0	27,710	168,501	0	196,210
	0	2.2%	13.4%	0	15.7%
Don't know	0	2,164	7,181	0	9,345
	0	0.2%	0.6%	0	0.7%
Not applicable	903,308	0	0	58,199	961,507
	72.0%	0	0	4.6%	76.7%

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Table C.7

Question 3. How many levels or stories are there in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
One story	345,487	15,754	65,773	58,199	485,213
	27.6%	1.3%	5.2%	4.6%	38.7%
One and a half stories	22,948	0	2,164	0	25,112
	1.8%	0	0.2%	0	2.0%
Split level or two stories	409,291	44,691	79,745	0	533,727
	32.6%	3.6%	6.4%	0	42.6%
Two and a half stories	44,593	5,095	12,311	0	62,000
	3.6%	0.4%	1.0%	0	4.9%
Tri level or three stories	77,040	7,216	38,058	0	122,314
	6.1%	0.6%	3.0%	0	9.8%
More than three stories	3,949	2,085	19,339	0	25,373
	0.3%	0.2%	1.5%	0	2.0%

Table C.8

Question 4. On which of the following is your home built?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Concrete slab or foundation	272,838	48,966	100,210	23,924	445,938
	21.8%	3.9%	8.0%	1.9%	35.6%
Above a crawl space	404,961	23,755	24,927	29,074	482,718
	32.3%	1.9%	2.0%	2.3%	38.5%
Above an unfinished basement	82,395	0	14,431	0	96,826
	6.6%	0	1.2%	0	7.7%
Above a finished basement	132,920	0	20,613	0	153,533
	10.6%	0	1.6%	0	12.2%
Don't know	7,072	2,120	44,933	3,467	57,592
	0.6%	0.2%	3.6%	0.3%	4.6%
Refused	3,123	0	12,276	1,734	17,132
	0.2%	0	1.0%	0.1%	1.4%

Table C.9

Question 5c. Approximately what percentage of this residence's windows are double or triple-pane?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
25% or less	108,856	17,450	46,564	18,962	191,833
	8.7%	1.4%	3.7%	1.5%	15.3%
26% - 50%	42,496	6,414	5,095	0	54,005
	3.4%	0.5%	0.4%	0	4.3%
51% - 75%	21,064	0	0	1,734	22,798
	1.7%	0	0	0.1%	1.8%
76% - 100%	707,877	42,148	139,228	35,719	924,971
	56.5%	3.4%	11.1%	2.8%	73.8%
Don't know	23,015	8,830	23,741	1,785	57,371
	1.8%	0.7%	1.9%	0.1%	4.6%
Refused	0	0	2,761	0	2,761
	0	0	0.2%	0	0.2%

Table C.10

Question 6c. Approximately what percentage of your home's windows are equipped with storm windows?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
25% or less	719,551	45,712	170,302	39,582	975,146
	57.4%	3.6%	13.6%	3.2%	77.8%
26% - 50%	25,526	0	10,191	0	35,716
	2.0%	0	0.8%	0	2.8%
51% - 75%	8,410	0	0	1,680	10,089
	0.7%	0	0	0.1%	0.8%
76% - 100%	102,238	15,880	14,396	15,205	147,719
	8.2%	1.3%	1.1%	1.2%	11.8%
Don't know	47,583	13,250	22,501	1,734	85,068
	3.8%	1.1%	1.8%	0.1%	6.8%

Table C.11

Question 7c. What is the approximate square footage of heated floor space in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Less than 500 square feet	15,614	0	18,409	3,467	37,490
	1.2%	0	1.5%	0.3%	3.0%
501 to 1,000 square feet	56,170	23,290	104,938	10,402	194,800
	4.5%	1.9%	8.4%	0.8%	15.5%
1,001 to 1,500 square feet	161,437	13,285	49,001	20,402	244,124
	12.9%	1.1%	3.9%	1.6%	19.5%
1,501 to 2,000 square feet	248,045	31,387	7,216	16,993	303,640
	19.8%	2.5%	0.6%	1.4%	24.2%
2,001 to 2,500 square feet	169,908	0	0	0	169,908
	13.6%	0	0	0	13.6%
2,501 to 3,000 square feet	105,124	0	0	0	105,124
	8.4%	0	0	0	8.4%
3,001 to 4,000 square feet	77,502	0	2,120	0	79,622
	6.2%	0	0.2%	0	6.4%
4,001 to 5,000 square feet	12,359	0	0	0	12,359
	1.0%	0	0	0	1.0%
More than 6,000 square feet	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Don't know	54,986	6,880	35,707	6,935	104,508
	4.4%	0.5%	2.8%	0.6%	8.3%

Table C.12

Question 8. Although you aren't sure about the actual heated floor space can you estimate the square footage of your home using these categories?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Less than 500 square feet	0	0	10,191	3,467	13,658
	0	0	0.8%	0.3%	1.1%
501 to 1,000 square feet	10,044	5,095	25,517	1,734	42,390
	0.8%	0.4%	2.0%	0.1%	3.4%
1,001 to 1,500 square feet	17,282	0	0	0	17,282
	1.4%	0	0	0	1.4%
1,501 to 2,000 square feet	5,962	0	0	0	5,962
	0.5%	0	0	0	0.5%
2,001 to 2,500 square feet	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Don't know	17,749	1,785	0	1,734	21,268
	1.4%	0.1%	0	0.1%	1.7%
Refused	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Not applicable	848,322	67,962	181,683	51,265	1,149,231
	67.7%	5.4%	14.5%	4.1%	91.7%

Table C.13

Question 9. How many heated rooms are in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1	5,136	0	6,880	0	12,016
	0.4%	0	0.5%	0	1.0%

Question 9. How many heated rooms are in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
2	9,044	5,095	42,883	3,467	60,489
	0.7%	0.4%	3.4%	0.3%	4.8%
3	19,958	3,905	40,214	3,467	67,544
	1.6%	0.3%	3.2%	0.3%	5.4%
4	66,186	20,573	88,902	13,815	189,476
	5.3%	1.6%	7.1%	1.1%	15.1%
5	104,897	26,796	29,512	13,180	174,386
	8.4%	2.1%	2.4%	1.1%	13.9%
6	174,177	14,603	0	8,669	197,449
	13.9%	1.2%	0	0.7%	15.7%
7	169,676	2,085	6,880	8,719	187,361
	13.5%	0.2%	0.5%	0.7%	14.9%
8	133,572	1,785	0	5,147	140,504
	10.7%	0.1%	0	0.4%	11.2%
9	85,382	0	2,120	0	87,502
	6.8%	0	0.2%	0	7.0%
10	55,577	0	0	1,734	57,311
	4.4%	0	0	0.1%	4.6%
11	28,682	0	0	0	28,682
	2.3%	0	0	0	2.3%
12	18,918	0	0	0	18,918
	1.5%	0	0	0	1.5%
13	10,641	0	0	0	10,641
	0.8%	0	0	0	0.8%

Question 9. How many heated rooms are in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
14	6,492	0	0	0	6,492
	0.5%	0	0	0	0.5%
15	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
16	4,907	0	0	0	4,907
	0.4%	0	0	0	0.4%
Don't know	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%

Table C.14

Question 9c. How many heated rooms are in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1	5,136	0	6,880	0	12,016
	0.4%	0	0.5%	0	1.0%
2	9,044	5,095	42,883	3,467	60,489
	0.7%	0.4%	3.4%	0.3%	4.8%
3	19,958	3,905	40,214	3,467	67,544
	1.6%	0.3%	3.2%	0.3%	5.4%
4	66,186	20,573	88,902	13,815	189,476
	5.3%	1.6%	7.1%	1.1%	15.1%
5	104,897	26,796	29,512	13,180	174,386
	8.4%	2.1%	2.4%	1.1%	13.9%
6	174,177	14,603	0	8,669	197,449
	13.9%	1.2%	0	0.7%	15.7%
7	169,676	2,085	6,880	8,719	187,361
	13.5%	0.2%	0.5%	0.7%	14.9%
8	133,572	1,785	0	5,147	140,504
	10.7%	0.1%	0	0.4%	11.2%
9	85,382	0	2,120	0	87,502
	6.8%	0	0.2%	0	7.0%
10	55,577	0	0	1,734	57,311
	4.4%	0	0	0.1%	4.6%
More than 10 rooms	73,588	0	0	0	73,588
	5.9%	0	0	0	5.9%

Question 9c. How many heated rooms are in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Don't know	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%

Table C.15

Question 10. How many bathrooms are in this home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
None	6,692	6,880	5,095	0	18,667
	0.5%	0.5%	0.4%	0	1.5%
1	136,885	10,191	162,994	19,122	329,191
	10.9%	0.8%	13.0%	1.5%	26.3%
1.25	10,574	0	0	0	10,574
	0.8%	0	0	0	0.8%
1.5	54,152	7,856	5,095	1,734	68,838
	4.3%	0.6%	0.4%	0.1%	5.5%
1.75	33,802	2,120	0	3,467	39,390
	2.7%	0.2%	0	0.3%	3.1%
2	268,038	18,659	40,001	33,877	360,574
	21.4%	1.5%	3.2%	2.7%	28.8%
2.25	140,816	21,360	2,085	0	164,261
	11.2%	1.7%	0.2%	0	13.1%
2.5	10,261	0	0	0	10,261
	0.8%	0	0	0	0.8%
2.75	206,104	7,775	0	0	213,878
	16.4%	0.6%	0	0	17.1%
3	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
3.5	9,615	0	2,120	0	11,736
	0.8%	0	0.2%	0	0.9%

Question 10. How many bathrooms are in this home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
4	22,420	0	0	0	22,420
	1.8%	0	0	0	1.8%

Table C.16

Question 11c. In what year was this residence built?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Before 1940	106,474	0	20,604	0	127,078
	8.5%	0	1.6%	0	10.1%
1940 to 1959	126,295	2,164	4,546	3,518	136,523
	10.1%	0.2%	0.4%	0.3%	10.9%
1960 to 1979	285,927	29,368	53,038	20,696	389,029
	22.8%	2.3%	4.2%	1.7%	31.0%
1980 to 1985	64,301	0	10,191	8,669	83,160
	5.1%	0	0.8%	0.7%	6.6%
1986 to 1990	70,414	3,949	22,466	8,324	105,153
	5.6%	0.3%	1.8%	0.7%	8.4%
1991 to 1995	84,874	4,206	2,164	3,123	94,367
	6.8%	0.3%	0.2%	0.2%	7.5%
1996 to 2000	79,551	9,974	23,732	1,734	114,991
	6.3%	0.8%	1.9%	0.1%	9.2%
2001 to 2002	20,883	2,120	7,216	1,734	31,952
	1.7%	0.2%	0.6%	0.1%	2.5%
2003 to 2004	16,687	2,085	6,335	3,467	28,574
	1.3%	0.2%	0.5%	0.3%	2.3%

Question 11c. In what year was this residence built?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
2005	5,733	0	5,095	0	10,829
	0.5%	0	0.4%	0	0.9%
2006	7,983	3,905	0	0	11,888
	0.6%	0.3%	0	0	0.9%
2007	6,113	1,785	0	0	7,897
	0.5%	0.1%	0	0	0.6%
2008	1,734	0	0	1,734	3,467
	0.1%	0	0	0.1%	0.3%
Don't know	26,339	15,286	62,003	5,201	108,830
	2.1%	1.2%	4.9%	0.4%	8.7%

Table C.17

Question 11a. Although you aren't sure about the actual year your home was built can you identify which from this list is the closest general time frame?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Before 1940	4,546	0	0	0	4,546
	0.4%	0	0	0	0.4%
1940 to 1959	4,907	0	0	0	4,907
	0.4%	0	0	0	0.4%
1960 to 1979	6,692	10,191	27,562	1,734	46,178
	0.5%	0.8%	2.2%	0.1%	3.7%
1980 to 1985	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
1986 to 1990	0	0	1,785	1,734	3,518
	0	0	0.1%	0.1%	0.3%
1991 to 1995	1,785	0	0	1,734	3,518
	0.1%	0	0	0.1%	0.3%
1996 to 2000	0	0	12,276	0	12,276
	0	0	1.0%	0	1.0%
Don't know	8,410	5,095	15,286	0	28,791
	0.7%	0.4%	1.2%	0	2.3%
Not applicable	876,968	59,556	155,387	52,998	1,144,909
	69.9%	4.8%	12.4%	4.2%	91.3%

Table C.18

Question 12. Does the main heating system serve only this residence or does it serve more than one residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Only this residence	0	74,841	188,716	0	263,557
	0	6.0%	15.1%	0	21.0%
More than one residence	0	0	21,459	0	21,459
	0	0	1.7%	0	1.7%
Don't know	0	0	7,216	0	7,216
	0	0	0.6%	0	0.6%
Not applicable	903,308	0	0	58,199	961,507
	72.0%	0	0	4.6%	76.7%

Table C.19

Question 13. What is the type of system that is used to heat the majority of your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Natural Gas: Central forced air furnace	587,469	29,167	24,387	8,665	649,688
	46.9%	2.3%	1.9%	0.7%	51.8%
Natural Gas: Hot water boiler	11,846	0	2,120	3,413	17,380
	0.9%	0	0.2%	0.3%	1.4%
Electric: Hot water boiler	12,836	0	10,191	3,467	26,494
	1.0%	0	0.8%	0.3%	2.1%
Natural Gas: Steam boiler	3,569	0	0	0	3,569
	0.3%	0	0	0	0.3%
Natural Gas: Radiant floor heating	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%

Question 13. What is the type of system that is used to heat the majority of your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Natural Gas: Fireplace or stove	18,008	0	14,396	0	32,404
	1.4%	0	1.1%	0	2.6%
Electric: Baseboard, wall heaters, ceiling cables, or floor cables	51,046	22,278	112,145	6,935	192,404
	4.1%	1.8%	8.9%	0.6%	15.3%
Electric: Wall heaters with fans	17,399	2,085	5,095	0	24,579
	1.4%	0.2%	0.4%	0	2.0%
Electric: Central forced air furnace	29,127	7,216	0	17,337	53,680
	2.3%	0.6%	0	1.4%	4.3%
Electric: Air-source heat pump	21,676	0	0	8,324	30,000
	1.7%	0	0	0.7%	2.4%
Electric: Ground-source heat pump	7,021	0	0	0	7,021
	0.6%	0	0	0	0.6%
Electric: Portable heaters	6,246	0	0	1,734	7,979
	0.5%	0	0	0.1%	0.6%
Oil: Central forced air furnace	23,593	0	0	0	23,593
	1.9%	0	0	0	1.9%
Oil: Hot water boiler (with radiators, baseboards, or in floor)	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Bottled Gas: Central forced air (propane, butane, kerosene)	14,620	0	0	0	14,620
	1.2%	0	0	0	1.2%
Bottled Gas: Portable heaters (propane, butane, kerosene)	6,246	0	0	0	6,246
	0.5%	0	0	0	0.5%
Wood: Wood stove or pellet stove	22,502	5,095	0	3,123	30,720
	1.8%	0.4%	0	0.2%	2.5%

Question 13. What is the type of system that is used to heat the majority of your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Wood: Fireplace	8,410	0	0	1,734	10,144
	0.7%	0	0	0.1%	0.8%
Other system and fuel	21,297	0	5,095	0	26,392
	1.7%	0	0.4%	0	2.1%
None (No heating system)	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Don't know	30,583	9,000	15,286	3,467	58,336
	2.4%	0.7%	1.2%	0.3%	4.7%
Refused	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Not applicable	0	0	28,675	0	28,675
	0	0	2.3%	0	2.3%

Table C.20

Question 14. What type of temperature control is on the main heating system?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Regular thermostat(s) with temperature settings	305,281	37,178	123,361	34,566	500,386
	24.3%	3.0%	9.8%	2.8%	39.9%
Clock or programmable thermostat(s)	503,072	18,473	10,196	13,576	545,317
	40.1%	1.5%	0.8%	1.1%	43.5%
Dial control without temperature settings	26,768	5,095	27,562	1,734	61,158
	2.1%	0.4%	2.2%	0.1%	4.9%
Simple on/off switch or no temperature control	3,949	0	12,311	0	16,260
	0.3%	0	1.0%	0	1.3%
No response	0	14,095	15,286	8,324	37,705
	0	1.1%	1.2%	0.7%	3.0%
Not applicable	64,238	0	28,675	0	92,913
	5.1%	0	2.3%	0	7.4%

Question 15. Which of the following describes how the main heating system is used?	**Dwelling Type**				**Total**
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
The thermostat(s) is kept at a constant setting or temperature	209,189	22,847	39,838	12,187	284,060
	18.8%	2.1%	3.6%	1.1%	25.5%
The thermostat is adjusted when occupants are sleeping	536,186	28,328	60,312	27,286	652,111
	48.2%	2.5%	5.4%	2.5%	58.6%
The thermostat is adjusted when occupants leave the house	367,194	29,130	64,473	29,074	489,872
	33.0%	2.6%	5.8%	2.6%	44.0%
The heater is turned on only when someone is cold	145,437	11,578	89,421	12,136	258,572
	13.1%	1.0%	8.0%	1.1%	23.2%

Table C.21

Question 16. Home heating - at what temperature do you normally keep your thermostat?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
50	3,123	0	5,095	0	8,218
	0.2%	0	0.4%	0	0.7%
55	3,949	0	5,095	1,734	10,778
	0.3%	0	0.4%	0.1%	0.9%
58	5,733	0	5,095	0	10,829
	0.5%	0	0.4%	0	0.9%
59	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
60	17,645	0	19,156	1,734	38,535
	1.4%	0	1.5%	0.1%	3.1%
62	5,354	0	0	0	5,354
	0.4%	0	0	0	0.4%
63	8,030	2,085	0	0	10,115
	0.6%	0.2%	0	0	0.8%
64	10,331	0	0	0	10,331
	0.8%	0	0	0	0.8%
65	38,279	11,085	12,311	5,201	66,877
	3.1%	0.9%	1.0%	0.4%	5.3%
66	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%

Question 16. Home heating - at what temperature do you normally keep your thermostat?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
67	22,107	0	5,095	0	27,202
	1.8%	0	0.4%	0	2.2%
68	76,812	6,405	21,577	3,467	108,261
	6.1%	0.5%	1.7%	0.3%	8.6%
69	19,876	0	0	0	19,876
	1.6%	0	0	0	1.6%
70	78,566	6,880	12,952	10,453	108,851
	6.3%	0.5%	1.0%	0.8%	8.7%
71	5,354	2,164	5,095	0	12,613
	0.4%	0.2%	0.4%	0	1.0%
72	16,060	0	10,191	1,734	27,985
	1.3%	0	0.8%	0.1%	2.2%
73	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
75	8,030	5,884	0	0	13,914
	0.6%	0.5%	0	0	1.1%
76	2,164	0	2,120	0	4,285
	0.2%	0	0.2%	0	0.3%
Don't know	0	0	10,191	0	10,191
	0	0	0.8%	0	0.8%
Refused	5,287	0	5,095	0	10,382
	0.4%	0	0.4%	0	0.8%
Not applicable	567,751	40,338	93,227	33,877	735,192
	45.3%	3.2%	7.4%	2.7%	58.6%

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Table C.22

Question 17. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	0	0	10,191	0	10,191
	0	0	0.8%	0	0.8%
54	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
55	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
59	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
60	7,072	0	2,085	0	9,157
	0.6%	0	0.2%	0	0.7%
62	9,368	5,095	0	0	14,464
	0.7%	0.4%	0	0	1.2%
63	3,798	0	0	0	3,798
	0.3%	0	0	0	0.3%
64	13,564	0	0	0	13,564
	1.1%	0	0	0	1.1%
65	46,311	16,517	2,085	1,734	66,647
	3.7%	1.3%	0.2%	0.1%	5.3%
66	13,184	2,164	0	1,680	17,028
	1.1%	0.2%	0	0.1%	1.4%

Question 17. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
67	71,593	1,785	0	0	73,378
	5.7%	0.1%	0	0	5.9%
68	183,475	1,785	19,456	10,402	215,118
	14.6%	0.1%	1.6%	0.8%	17.2%
69	53,262	3,949	0	0	57,211
	4.2%	0.3%	0	0	4.6%
70	133,288	2,164	21,399	8,614	165,465
	10.6%	0.2%	1.7%	0.7%	13.2%
71	19,413	2,085	2,085	1,734	25,317
	1.5%	0.2%	0.2%	0.1%	2.0%
72	18,421	0	7,216	6,590	32,226
	1.5%	0	0.6%	0.5%	2.6%
73	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
75	6,246	0	7,216	0	13,461
	0.5%	0	0.6%	0	1.1%
Don't know	3,569	0	0	1,734	5,303
	0.3%	0	0	0.1%	0.4%
Not applicable	315,010	39,298	140,562	25,712	520,583
	25.1%	3.1%	11.2%	2.1%	41.5%

Table C.23

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	18,092	5,095	14,361	1,734	39,282
	1.4%	0.4%	1.1%	0.1%	3.1%
37	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
40	5,095	0	0	0	5,095
	0.4%	0	0	0	0.4%
45	1,785	2,164	5,095	0	9,044
	0.1%	0.2%	0.4%	0	0.7%
50	17,645	0	0	0	17,645
	1.4%	0	0	0	1.4%
52	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
53	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
55	48,057	0	7,181	5,147	60,385
	3.8%	0	0.6%	0.4%	4.8%
56	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%
57	8,410	0	0	0	8,410
	0.7%	0	0	0	0.7%

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
58	17,892	5,095	0	1,734	24,721
	1.4%	0.4%	0	0.1%	2.0%
59	10,574	0	0	0	10,574
	0.8%	0	0	0	0.8%
60	100,136	8,965	3,870	6,935	119,905
	8.0%	0.7%	0.3%	0.6%	9.6%
61	12,805	0	0	1,734	14,538
	1.0%	0	0	0.1%	1.2%
62	66,863	2,120	0	1,734	70,717
	5.3%	0.2%	0	0.1%	5.6%
63	27,653	0	0	1,734	29,386
	2.2%	0	0	0.1%	2.3%
64	28,515	0	0	1,680	30,195
	2.3%	0	0	0.1%	2.4%
65	107,145	6,069	15,286	6,590	135,090
	8.5%	0.5%	1.2%	0.5%	10.8%
66	20,931	4,249	4,285	1,734	31,199
	1.7%	0.3%	0.3%	0.1%	2.5%
67	23,045	0	0	0	23,045
	1.8%	0	0	0	1.8%
68	45,932	1,785	2,085	1,734	51,536
	3.7%	0.1%	0.2%	0.1%	4.1%

Question 18. Home heating - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
69	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
70	6,692	0	14,475	0	21,167
	0.5%	0	1.2%	0	1.7%
Don't know	3,518	0	10,191	0	13,709
	0.3%	0	0.8%	0	1.1%
Refused	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Not applicable	315,010	39,298	140,562	25,712	520,583
	25.1%	3.1%	11.2%	2.1%	41.5%

Table C.24

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	44,468	5,095	23,706	3,467	76,737
	3.5%	0.4%	1.9%	0.3%	6.1%
40	1,734	0	0	0	1,734
	0.1%	0	0	0	0.1%
45	4,907	2,164	5,095	0	12,167
	0.4%	0.2%	0.4%	0	1.0%

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
50	26,881	0	2,085	1,734	30,700
	2.1%	0	0.2%	0.1%	2.4%
52	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
53	2,014	0	0	0	2,014
	0.2%	0	0	0	0.2%
54	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
55	43,435	0	10,191	5,147	58,773
	3.5%	0	0.8%	0.4%	4.7%
56	9,236	5,095	0	0	14,331
	0.7%	0.4%	0	0	1.1%
57	7,301	0	0	0	7,301
	0.6%	0	0	0	0.6%
58	20,123	5,095	0	0	25,219
	1.6%	0.4%	0	0	2.0%
59	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
60	132,382	3,949	8,154	6,881	151,366
	10.6%	0.3%	0.7%	0.5%	12.1%
61	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
62	47,962	2,120	0	1,734	51,816
	3.8%	0.2%	0	0.1%	4.1%
63	18,188	0	5,095	1,734	25,017
	1.5%	0	0.4%	0.1%	2.0%
64	24,500	0	0	0	24,500
	2.0%	0	0	0	2.0%
65	70,982	3,870	10,191	6,590	91,633
	5.7%	0.3%	0.8%	0.5%	7.3%
66	18,767	4,249	2,120	1,734	26,871
	1.5%	0.3%	0.2%	0.1%	2.1%
67	9,615	0	0	1,734	11,349
	0.8%	0	0	0.1%	0.9%
68	30,513	1,785	0	0	32,298
	2.4%	0.1%	0	0	2.6%
69	4,178	0	0	0	4,178
	0.3%	0	0	0	0.3%
70	8,923	0	0	0	8,923
	0.7%	0	0	0	0.7%
71	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%
72	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%

Question 19. Home heating - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Don't know	30,399	2,120	10,191	0	42,710
	2.4%	0.2%	0.8%	0	3.4%
Refused	10,194	0	0	1,734	11,928
	0.8%	0	0	0.1%	1.0%
Not applicable	315,010	39,298	140,562	25,712	520,583
	25.1%	3.1%	11.2%	2.1%	41.5%

Table C.25

Question 20. Does the main cooling system serve only this residence or does it serve more than one residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Only this residence	0	28,114	11,465	0	39,579
	0	2.2%	0.9%	0	3.2%
More than one residence	0	0	11,975	0	11,975
	0	0	1.0%	0	1.0%
Residence has more than one cooling system	0	46,728	186,770	0	233,497
	0	3.7%	14.9%	0	18.6%
Don't know	0	0	2,085	0	2,085
	0	0	0.2%	0	0.2%
Refused	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%

Not applicable	903,308	0	0	58,199	961,507
	72.0%	0	0	4.6%	76.7%

Table C.26

Question 21. Which of the following is the type of cooling system that is used to cool the majority of home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Central air conditioner	102,466	12,147	7,216	0	121,828
	14.3%	1.7%	1.0%	0	17.0%
Air-source heat pump	46,593	0	0	10,058	56,650
	6.5%	0	0	1.4%	7.9%
Ground-source heat pump	17,014	0	0	1,734	18,747
	2.4%	0	0	0.2%	2.6%
Room air conditioners	51,626	7,181	0	8,719	67,526
	7.2%	1.0%	0	1.2%	9.4%
Ductless mini-split air conditioner	0	0	0	0	0
	0	0	0	0	0
Evaporative cooler (swamp cooler)	4,907	0	0	4,857	9,764
	0.7%	0	0	0.7%	1.4%
Portable fans	336,802	4,206	2,164	22,538	365,710
	47.1%	0.6%	0.3%	3.2%	51.1%
Whole-house fan	34,827	0	0	5,201	40,029
	4.9%	0	0	0.7%	5.6%
Ceiling fans	204,619	1,785	0	15,603	222,007
	28.6%	0.2%	0	2.2%	31.0%
Something else (specify)	2,164	0	0	0	2,164
	0.3%	0	0	0	0.3%

Table C.27

Question 22. What type of temperature control is on the main cooling system?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Regular thermostat(s) with temperature settings	62,783	6,113	0	5,201	74,097
	5.0%	0.5%	0	0.4%	5.9%
Clock or programmable thermostat(s)	122,586	8,119	7,216	8,324	146,245
	9.8%	0.6%	0.6%	0.7%	11.7%
Dial control without temperature settings	15,102	5,095	0	5,201	25,398
	1.2%	0.4%	0	0.4%	2.0%
Simple on/off switch or no temperature control	15,443	0	0	4,857	20,299
	1.2%	0	0	0.4%	1.6%
Don't know	1,785	0	0	1,785	3,569
	0.1%	0	0	0.1%	0.3%
Not applicable	685,609	55,514	210,175	32,832	984,130
	54.7%	4.4%	16.8%	2.6%	78.5%

Table C.28

Question 23. Which of the following statements best describes how the main cooling system is used?	**Dwelling Type**				**Total**
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
The thermostat(s) is kept at a constant setting or temperature	28,184	7,181	0	5,201	40,566
	10.6%	2.7%	0	2.0%	15.3%
The thermostat is adjusted when occupants are sleeping	24,138	0	5,095	6,986	36,219
	9.1%	0	1.9%	2.6%	13.6%
The thermostat is adjusted when occupants leave the house	11,400	2,164	5,095	3,467	22,127
	4.3%	0.8%	1.9%	1.3%	8.3%
The cooling system is turned on only when someone is warm	87,927	3,870	7,216	10,058	109,071
	33.1%	1.5%	2.7%	3.8%	41.0%
We rarely use this cooling system	87,379	6,113	0	11,791	105,283
	83.0%	5.8%	0	11.2%	100.0%

Table C.29

Question 24. Home cooling - at what temperature do you normally keep your thermostat?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
50	4,328	0	0	0	4,328
	0.3%	0	0	0	0.3%
55	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
60	5,354	5,095	0	1,734	12,183
	0.4%	0.4%	0	0.1%	1.0%
62	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
64	4,178	0	0	0	4,178
	0.3%	0	0	0	0.3%
65	6,492	3,870	0	0	10,362
	0.5%	0.3%	0	0	0.8%
67	5,682	2,164	0	0	7,847
	0.5%	0.2%	0	0	0.6%
68	15,548	0	0	0	15,548
	1.2%	0	0	0	1.2%
69	5,287	0	0	0	5,287
	0.4%	0	0	0	0.4%
70	31,276	0	5,095	3,467	39,839
	2.5%	0	0.4%	0.3%	3.2%
71	3,898	0	0	0	3,898
	0.3%	0	0	0	0.3%

Question 24. Home cooling - at what temperature do you normally keep your thermostat?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
72	26,502	0	0	0	26,502
	2.1%	0	0	0	2.1%
73	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
74	13,564	2,164	0	0	15,728
	1.1%	0.2%	0	0	1.3%
75	13,184	2,085	0	5,201	20,471
	1.1%	0.2%	0	0.4%	1.6%
78	3,949	0	2,120	1,734	7,803
	0.3%	0	0.2%	0.1%	0.6%
80	6,246	0	0	0	6,246
	0.5%	0	0	0	0.5%
82	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
85	0	0	0	3,123	3,123
	0	0	0	0.2%	0.2%
87	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Don't know	32,591	1,785	0	8,324	42,700
	2.6%	0.1%	0	0.7%	3.4%
Refused	4,907	0	0	0	4,907
	0.4%	0	0	0	0.4%
Not applicable	704,840	57,678	210,175	34,617	1,007,309
	56.2%	4.6%	16.8%	2.8%	80.3%

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Table C.30

Question 26. Home cooling - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and awake?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
67	1,785	0	0	0	1,785
	4.6%	0	0	0	4.6%
68	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%
70	6,246	2,164	5,095	5,252	18,757
	16.3%	5.6%	13.3%	13.7%	48.9%
71	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%
72	3,123	0	0	0	3,123
	8.1%	0	0	0	8.1%
73	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%
74	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%
75	0	0	0	1,734	1,734
	0	0	0	4.5%	4.5%
78	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%
Don't know	2,164	0	0	0	2,164
	5.6%	0	0	0	5.6%

Table C.31

Question 27. Home cooling - at what temperature do you normally keep your thermostat set when one or more people in your household are at home and everyone is sleeping?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	6,113	0	5,095	1,734	12,942
	0.5%	0	0.4%	0.1%	1.0%
60	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
65	2,164	0	0	1,785	3,949
	0.2%	0	0	0.1%	0.3%
68	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
70	3,123	2,164	0	0	5,287
	0.2%	0.2%	0	0	0.4%
72	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
73	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
75	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
82	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Refused	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
Not applicable	879,170	72,677	212,295	51,214	1,215,356
	70.1%	5.8%	16.9%	4.1%	96.9%

Table C.32

Question 28. Home cooling - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	7,451	0	5,095	1,734	14,280
	0.6%	0	0.4%	0.1%	1.1%
60	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
66	0	2,164	0	0	2,164
	0	0.2%	0	0	0.2%
67	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
68	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
70	0	0	0	1,785	1,785
	0	0	0	0.1%	0.1%
72	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
73	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
75	5,287	0	0	0	5,287
	0.4%	0	0	0	0.4%
78	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Refused	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%

Question 28. Home cooling - at what temperature do you normally keep your thermostat set when no one is at home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Not applicable	879,170	72,677	212,295	51,214	1,215,356
	70.1%	5.8%	16.9%	4.1%	96.9%

Table C.33

Question29. Does the water heater or the source of the hot water serve only this residence or does it serve more than one residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Only this residence	0	74,841	186,552	0	261,393
	0	6.0%	14.9%	0	20.8%
Central water heating or tank for more than one residence	0	0	23,959	0	23,959
	0	0	1.9%	0	1.9%
This residence has no hot water	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
Don't know	0	0	1,785	0	1,785
	0	0	0.1%	0	0.1%
Not applicable	903,308	0	0	58,199	961,507
	72.0%	0	0	4.6%	76.7%

Table C.34

Question30. How many water heaters are at this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
One	837,345	74,841	179,336	58,199	1,149,722
	66.8%	6.0%	14.3%	4.6%	91.7%
Two	59,850	0	2,120	0	61,970
	4.8%	0	0.2%	0	4.9%
Three or more	2,164	0	5,095	0	7,259
	0.2%	0	0.4%	0	0.6%
Don't know	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

Table C.35

Question 31. What type of water heater do you have?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Tank-type water heater	858,648	67,962	169,180	54,732	1,150,522
	68.5%	5.4%	13.5%	4.4%	91.8%
Indirect water heater or integrated water heater	11,599	0	2,085	0	13,685
	0.9%	0	0.2%	0	1.1%
Tankless hotwater heater aka demand or instantaneous water heater	25,989	0	5,095	1,734	32,818
	2.1%	0	0.4%	0.1%	2.6%
Don't know	7,072	6,880	10,191	1,734	25,876
	0.6%	0.5%	0.8%	0.1%	2.1%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

Table C.36

Question 32. What type of system is used in conjunction with your solar water heater?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Not applicable	903,308	74,841	217,390	58,199	1,253,739
	72.0%	6.0%	17.3%	4.6%	100.0%

Table C.37

Question 32a. What is the secondary or back-up type of fuel you use to heat water at this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Not applicable	903,308	74,841	217,390	58,199	1,253,739
	72.0%	6.0%	17.3%	4.6%	100.0%

Table C.38

Question 33. What type of fuel or energy is used to heat the water used in this residence?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	304,336	30,763	140,897	47,800	523,797
	24.3%	2.5%	11.2%	3.8%	41.8%
Natural gas	564,409	35,113	31,559	8,665	639,746
	45.0%	2.8%	2.5%	0.7%	51.0%
Propane or bottled gas (LP, propane, butane)	25,327	0	0	0	25,327
	2.0%	0	0	0	2.0%
Don't know	2,164	2,085	3,905	0	8,154
	0.2%	0.2%	0.3%	0	0.7%
Not applicable	7,072	6,880	41,029	1,734	56,714
	0.6%	0.5%	3.3%	0.1%	4.5%

Table C.39

Question 34. At what specific temperature is your water heater thermostat set?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
69	0	2,164	0	0	2,164
	0	0.2%	0	0	0.2%
70	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
72	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
75	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
80	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
85	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
90	4,328	0	0	0	4,328
	0.3%	0	0	0	0.3%
98	3,569	0	0	0	3,569
	0.3%	0	0	0	0.3%
100	20,256	0	5,095	3,123	28,474
	1.6%	0	0.4%	0.2%	2.3%
102	9,236	0	0	0	9,236
	0.7%	0	0	0	0.7%

Question 34. At what specific temperature is your water heater thermostat set?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
105	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
109	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
110	38,566	0	5,095	0	43,662
	3.1%	0	0.4%	0	3.5%
114	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
115	25,112	2,085	0	0	27,198
	2.0%	0.2%	0	0	2.2%
118	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
120	158,641	11,569	10,191	8,614	189,015
	12.7%	0.9%	0.8%	0.7%	15.1%
125	29,190	2,164	0	0	31,355
	2.3%	0.2%	0	0	2.5%
130	25,163	0	2,085	1,734	28,982
	2.0%	0	0.2%	0.1%	2.3%
135	4,907	0	0	1,734	6,641
	0.4%	0	0	0.1%	0.5%
140	43,316	0	0	4,857	48,172
	3.5%	0	0	0.4%	3.8%

Question 34. At what specific temperature is your water heater thermostat set?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
145	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
150	4,546	0	0	0	4,546
	0.4%	0	0	0	0.4%
155	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
160	2,164	0	0	1,734	3,898
	0.2%	0	0	0.1%	0.3%
165	8,410	0	0	0	8,410
	0.7%	0	0	0	0.7%
170	3,123	0	0	1,734	4,857
	0.2%	0	0	0.1%	0.4%
180	7,072	0	0	0	7,072
	0.6%	0	0	0	0.6%
185	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
190	0	0	2,085	0	2,085
	0	0	0.2%	0	0.2%
Don't know	493,088	56,859	156,905	31,203	738,055
	39.3%	4.5%	12.5%	2.5%	58.9%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

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Table C.40

Question 34a. If not set at a specific temperature then which of these statements best describes where your water heater thermostat is set?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
On the 'low' setting	15,276	1,785	15,286	3,467	35,814
	1.2%	0.1%	1.2%	0.3%	2.9%
Between the 'low' and 'medium' settings	41,565	15,286	6,880	3,413	67,144
	3.3%	1.2%	0.5%	0.3%	5.4%
On the 'medium' setting	211,363	7,216	60,935	13,921	293,434
	16.9%	0.6%	4.9%	1.1%	23.4%
Between the 'medium' and 'high' setting	116,661	13,172	36,017	5,201	171,051
	9.3%	1.1%	2.9%	0.4%	13.6%
On the 'high' setting	18,851	4,925	0	0	23,776
	1.5%	0.4%	0	0	1.9%
Don't know	89,373	14,475	37,787	5,201	146,836
	7.1%	1.2%	3.0%	0.4%	11.7%
Not applicable	410,219	17,983	60,486	26,996	515,684
	32.7%	1.4%	4.8%	2.2%	41.1%

Table C.41

Question 35. Which of the following items do you have for your main water heater? Do you have a water heater tank wrap?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	325,856	14,139	41,993	22,085	404,073
	26.0%	1.1%	3.3%	1.8%	32.2%
No	537,090	51,737	115,134	29,179	733,140
	42.8%	4.1%	9.2%	2.3%	58.5%
Don't know	40,362	8,965	29,425	6,935	85,687
	3.2%	0.7%	2.3%	0.6%	6.8%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

Table C.42

Question 36. Which of the following items do you have for your main water heater? Do you have pipe insulation?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	526,110	31,294	52,148	32,542	642,094
	42.0%	2.5%	4.2%	2.6%	51.2%
No	313,408	29,701	87,864	15,255	446,229
	25.0%	2.4%	7.0%	1.2%	35.6%
Don't know	63,789	13,847	46,539	10,402	134,577
	5.1%	1.1%	3.7%	0.8%	10.7%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

Table C.43

Question 37. Which of the following items do you have for your main water heater? Do you have a water heater timer?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	101,248	4,328	7,181	1,734	114,490
	8.1%	0.3%	0.6%	0.1%	9.1%
No	701,360	54,633	132,919	46,013	934,925
	55.9%	4.4%	10.6%	3.7%	74.6%
Don't know	100,701	15,880	46,452	10,453	173,485
	8.0%	1.3%	3.7%	0.8%	13.8%
Not applicable	0	0	30,839	0	30,839
	0	0	2.5%	0	2.5%

Table C.44

Question 38. How many refrigerators are in your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1	604,450	57,643	208,390	52,998	923,482
	48.2%	4.6%	16.6%	4.2%	73.7%
2	285,673	17,198	9,000	5,201	317,073
	22.8%	1.4%	0.7%	0.4%	25.3%
3	11,020	0	0	0	11,020
	0.9%	0	0	0	0.9%
4	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%

Table C.45

Question 39. How many years old is your primary refrigerator?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
6 or less years old	515,265	42,357	112,451	20,855	690,929
	41.1%	3.4%	9.0%	1.7%	55.1%
7 to 14 years old	260,132	20,509	58,004	16,884	355,529
	20.7%	1.6%	4.6%	1.3%	28.4%
15 or more years old	119,054	6,880	21,459	10,402	157,796
	9.5%	0.5%	1.7%	0.8%	12.6%
Don't know	8,856	5,095	25,476	10,058	49,485
	0.7%	0.4%	2.0%	0.8%	3.9%

Table C.46

Question 40. How many stand-alone freezers are in your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	403,027	58,831	207,200	25,607	694,664
	32.1%	4.7%	16.5%	2.0%	55.4%
1	460,428	16,011	10,191	30,859	517,488
	36.7%	1.3%	0.8%	2.5%	41.3%
2	39,853	0	0	1,734	41,586
	3.2%	0	0	0.1%	3.3%

Table C.47

Question 41. How many years old is your 'primary' stand-alone freezer?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
6 or less years old	152,428	9,345	0	10,453	172,225
	12.2%	0.7%	0	0.8%	13.7%
7 to 14 years old	140,196	6,666	5,095	6,935	158,892
	11.2%	0.5%	0.4%	0.6%	12.7%
15 or more years old	197,514	0	0	13,471	210,985
	15.8%	0	0	1.1%	16.8%
Don't know	10,144	0	5,095	1,734	16,973
	0.8%	0	0.4%	0.1%	1.4%
Not applicable	403,027	58,831	207,200	25,607	694,664
	32.1%	4.7%	16.5%	2.0%	55.4%

Table C.48

Question 42. How many dishwashers are in your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	74,117	2,164	43,712	13,870	133,862
	5.9%	0.2%	3.5%	1.1%	10.7%
1	820,715	72,677	171,558	44,330	1,109,280
	65.5%	5.8%	13.7%	3.5%	88.5%
2	8,476	0	2,120	0	10,597
	0.7%	0	0.2%	0	0.8%

Table C.49

Question 43. Do you have a private clothes washer that is used just by the people in your household?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	901,523	71,719	135,978	51,265	1,160,485
	71.9%	5.7%	10.8%	4.1%	92.6%
No	1,785	3,123	81,412	6,935	93,254
	0.1%	0.2%	6.5%	0.6%	7.4%

Table C.50

Question 44. Which of the following best describes the type of clothes washer in your home?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Front load washing machine	289,782	12,024	26,707	4,857	333,370
	23.1%	1.0%	2.1%	0.4%	26.6%
Top load washing machine	607,793	59,694	109,271	46,408	823,166
	48.5%	4.8%	8.7%	3.7%	65.7%
Don't know	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
Not applicable	1,785	3,123	81,412	6,935	93,254
	0.1%	0.2%	6.5%	0.6%	7.4%

Table C.51

Question 45. Do you have a clothes dryer that is used just by the people in your household?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	897,575	68,957	135,978	51,265	1,153,775
	71.6%	5.5%	10.8%	4.1%	92.0%
No	5,733	5,884	81,412	6,935	99,964
	0.5%	0.5%	6.5%	0.6%	8.0%

Table C.52

Question 46. What fuel or energy source do you use for your clothes dryer?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	721,949	57,413	131,808	49,531	960,701
	62.6%	5.0%	11.4%	4.3%	83.3%
Natural gas	160,776	4,328	2,085	0	167,190
	13.9%	0.4%	0.2%	0	14.5%
Propane or bottled gas (LP, propane, butane)	11,102	0	0	1,734	12,836
	1.0%	0	0	0.2%	1.1%
Something else (specify)	1,734	0	0	0	1,734
	0.2%	0	0	0	0.2%
Don't know	2,014	7,216	2,085	0	11,315
	0.2%	0.6%	0.2%	0	1.0%

Table C.53

Question 47. Do you have your own swimming pool?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	26,746	0	0	1,680	28,426
	2.1%	0	0	0.1%	2.3%
No	876,561	74,841	217,390	56,520	1,225,313
	69.9%	6.0%	17.3%	4.5%	97.7%

Table C.54

Question 48. What fuel or energy source do you use to heat your swimming pool?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	5,303	0	0	0	5,303
	0.4%	0	0	0	0.4%
Natural gas	12,075	0	0	0	12,075
	1.0%	0	0	0	1.0%
Solar	6,246	0	0	0	6,246
	0.5%	0	0	0	0.5%
Not heated	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Don't know	0	0	0	1,680	1,680
	0	0	0	0.1%	0.1%
Not applicable	876,561	74,841	217,390	56,520	1,225,313
	69.9%	6.0%	17.3%	4.5%	97.7%

Table C.55

Question 48a. How often do you operate your pool pump and filtration system?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
All day and all night	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Turned off at night	7,747	0	0	0	7,747
	0.6%	0	0	0	0.6%
Something else (specify)	14,092	0	0	0	14,092
	1.1%	0	0	0	1.1%
Don't know	3,123	0	0	1,680	4,802
	0.2%	0	0	0.1%	0.4%
Not applicable	876,561	74,841	217,390	56,520	1,225,313
	69.9%	6.0%	17.3%	4.5%	97.7%

Table C.56

Question 48b. Do you own an insulating cover for your pool?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	13,562	0	0	0	13,562
	1.1%	0	0	0	1.1%
No	13,184	0	0	1,680	14,864
	1.1%	0	0	0.1%	1.2%
Not applicable	876,561	74,841	217,390	56,520	1,225,313
	69.9%	6.0%	17.3%	4.5%	97.7%

Table C.57

Question 49. Do you have your own hot tub or spa?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	94,698	2,164	0	3,467	100,329
	7.6%	0.2%	0	0.3%	8.0%
No	808,610	72,677	217,390	54,732	1,153,410
	64.5%	5.8%	17.3%	4.4%	92.0%

Table C.58

Question 50. What fuel or energy source do you use for your hot tub or spa?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	77,715	2,164	0	3,467	83,347
	6.2%	0.2%	0	0.3%	6.6%
Natural gas	16,983	0	0	0	16,983
	1.4%	0	0	0	1.4%
Not applicable	808,610	72,677	217,390	54,732	1,153,410
	64.5%	5.8%	17.3%	4.4%	92.0%

Table C.59

Question 50a. Do you have your own sauna?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Yes	20,389	0	5,095	0	25,484
	1.6%	0	0.4%	0	2.0%
No	882,919	74,841	212,295	56,466	1,226,521
	70.4%	6.0%	16.9%	4.5%	97.8%
Don't know	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%

Table C.60

Question 50b. What fuel or energy source do you use for your sauna?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	20,389	0	5,095	0	25,484
	1.6%	0	0.4%	0	2.0%
Not applicable	882,919	74,841	212,295	58,199	1,228,255
	70.4%	6.0%	16.9%	4.6%	98.0%

Table C.61

Question 51. How many cook-top units do you have?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	48,162	5,095	19,456	3,467	76,182
	3.8%	0.4%	1.6%	0.3%	6.1%
1	817,616	69,746	187,743	47,800	1,122,906
	65.2%	5.6%	15.0%	3.8%	89.6%
2	32,434	0	10,191	6,931	49,556
	2.6%	0	0.8%	0.6%	4.0%
Don't know	5,095	0	0	0	5,095
	0.4%	0	0	0	0.4%

Table C.62

Question 52. What fuel or energy source do you use for your cook-top(s)?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	536,684	59,136	166,392	51,265	813,476
	42.8%	4.7%	13.3%	4.1%	64.9%
Natural gas	286,305	8,490	31,542	1,734	328,071
	22.8%	0.7%	2.5%	0.1%	26.2%
Propane or bottled gas (LP, propane, butane)	27,061	0	0	1,734	28,795
	2.2%	0	0	0.1%	2.3%
Don't know	0	2,120	0	0	2,120
	0	0.2%	0	0	0.2%
No response	5,095	0	0	0	5,095
	0.4%	0	0	0	0.4%

Not applicable	48,162	5,095	19,456	3,467	76,182
	3.8%	0.4%	1.6%	0.3%	6.1%

Table C.63

Question 53. How many ovens do you have?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	6,246	0	0	0	6,246
	0.5%	0	0	0	0.5%
1	756,995	72,677	210,210	54,681	1,094,563
	60.4%	5.8%	16.8%	4.4%	87.3%
2	133,822	2,164	2,085	3,518	141,590
	10.7%	0.2%	0.2%	0.3%	11.3%
3	6,246	0	5,095	0	11,341
	0.5%	0	0.4%	0	0.9%

Table C.64

Question 54. What fuel or energy source do you use for your oven(s)?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
Electricity	716,243	68,480	198,159	56,466	1,039,349
	57.1%	5.5%	15.8%	4.5%	82.9%
Natural gas	162,696	4,241	19,231	1,734	187,901
	13.0%	0.3%	1.5%	0.1%	15.0%
Propane or bottled gas (LP, propane, butane)	15,959	0	0	0	15,959
	1.3%	0	0	0	1.3%
Don't know	2,164	2,120	0	0	4,285
	0.2%	0.2%	0	0	0.3%
Not applicable	6,246	0	0	0	6,246
	0.5%	0	0	0	0.5%

Table C.65

Question 55. How many microwave ovens do you have?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	17,131	0	19,491	0	36,623
	1.4%	0	1.6%	0	2.9%
1	830,547	70,592	197,899	56,466	1,155,504
	66.2%	5.6%	15.8%	4.5%	92.2%
2	52,507	4,249	0	1,734	58,490
	4.2%	0.3%	0	0.1%	4.7%
3	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%

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Table C.66

Question 56. Number of televisions of all types in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	15,928	0	12,311	0	28,239
	1.3%	0	1.0%	0	2.3%
1	172,072	10,829	89,130	23,529	295,560
	13.7%	0.9%	7.1%	1.9%	23.6%
2	287,041	35,899	78,825	22,484	424,249
	22.9%	2.9%	6.3%	1.8%	33.8%
3	243,947	10,240	17,554	8,669	280,409
	19.5%	0.8%	1.4%	0.7%	22.4%
4	105,788	10,018	12,311	1,785	129,901
	8.4%	0.8%	1.0%	0.1%	10.4%
5	45,883	7,856	5,095	1,734	60,569
	3.7%	0.6%	0.4%	0.1%	4.8%
6	15,877	0	0	0	15,877
	1.3%	0	0	0	1.3%
7	4,546	0	0	0	4,546
	0.4%	0	0	0	0.4%
8	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
Refused	8,277	0	2,164	0	10,441
	0.7%	0	0.2%	0	0.8%

Table C.67

Question 57. Number of large flat-screen tvs (over 32 inches) in your home.	**Dwelling Type**				**Total**
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	550,928	39,970	169,328	42,890	803,116
	45.0%	3.3%	13.8%	3.5%	65.5%
1	273,704	32,707	23,396	11,791	341,599
	22.3%	2.7%	1.9%	1.0%	27.9%
2	45,236	2,164	5,095	3,518	56,013
	3.7%	0.2%	0.4%	0.3%	4.6%
3	4,907	0	0	0	4,907
	0.4%	0	0	0	0.4%
4	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
5	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
Refused	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Not applicable	8,277	0	2,164	0	10,441
	0.7%	0	0.2%	0	0.9%

Table C.68

Question 58. Number of game consoles (Playstation Wii Nintendo xbox xCube etc) in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	592,634	44,312	167,243	51,265	855,453
	47.3%	3.5%	13.3%	4.1%	68.2%
1	173,760	21,699	28,492	1,734	225,685
	13.9%	1.7%	2.3%	0.1%	18.0%
2	77,903	6,666	12,276	3,467	100,312
	6.2%	0.5%	1.0%	0.3%	8.0%
3	25,392	0	2,120	1,734	29,246
	2.0%	0	0.2%	0.1%	2.3%
4	5,287	2,164	5,095	0	12,546
	0.4%	0.2%	0.4%	0	1.0%
5	11,548	0	0	0	11,548
	0.9%	0	0	0	0.9%
6	4,328	0	0	0	4,328
	0.3%	0	0	0	0.3%
Don't know	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Refused	10,291	0	2,164	0	12,455
	0.8%	0	0.2%	0	1.0%

Table C.69

Question 59. Number of VCRs or DVD players (not a combo unit) in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	211,631	14,579	62,684	15,654	304,549
	16.9%	1.2%	5.0%	1.2%	24.3%
1	343,973	27,181	80,719	32,487	484,361
	27.4%	2.2%	6.4%	2.6%	38.6%
2	210,365	20,726	51,294	8,324	290,709
	16.8%	1.7%	4.1%	0.7%	23.2%
3	83,366	12,355	7,216	1,734	104,670
	6.6%	1.0%	0.6%	0.1%	8.3%
4	20,732	0	13,313	0	34,045
	1.7%	0	1.1%	0	2.7%
5	9,236	0	0	0	9,236
	0.7%	0	0	0	0.7%
6	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
7	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
9	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Don't know	7,072	0	0	0	7,072
	0.6%	0	0	0	0.6%
Refused	10,441	0	2,164	0	12,605
	0.8%	0	0.2%	0	1.0%

Table C.70

Question 60. Number of combination VCR and DVD units in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	467,314	46,375	117,669	30,463	661,821
	37.3%	3.7%	9.4%	2.4%	52.8%
1	296,002	17,302	79,149	24,218	416,671
	23.6%	1.4%	6.3%	1.9%	33.2%
2	95,102	6,069	17,450	3,518	122,139
	7.6%	0.5%	1.4%	0.3%	9.7%
3	28,136	5,095	3,123	0	36,354
	2.2%	0.4%	0.2%	0	2.9%
4	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
5	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
23	3,123	0	0	0	3,123
	0.2%	0	0	0	0.2%
Don't know	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Refused	8,277	0	0	0	8,277
	0.7%	0	0	0	0.7%

Table C.71

Question 61. Number of stand-alone DVR units (not TIVO) in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	663,946	37,824	163,043	42,596	907,408
	53.0%	3.0%	13.0%	3.4%	72.4%
1	166,500	29,278	34,777	12,136	242,691
	13.3%	2.3%	2.8%	1.0%	19.4%
2	46,873	1,785	17,406	1,734	67,798
	3.7%	0.1%	1.4%	0.1%	5.4%
3	5,354	2,085	0	1,734	9,173
	0.4%	0.2%	0	0.1%	0.7%
Don't know	12,359	3,870	0	0	16,228
	1.0%	0.3%	0	0	1.3%
Refused	8,277	0	2,164	0	10,441
	0.7%	0	0.2%	0	0.8%

Table C.72

Question 62. Number of TIVO or cable or satellite TV set-top boxes or receivers in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	342,204	16,595	100,319	26,996	486,115
	27.3%	1.3%	8.0%	2.2%	38.8%
1	299,964	24,823	87,311	20,801	432,899
	23.9%	2.0%	7.0%	1.7%	34.5%
2	144,496	19,750	19,570	6,935	190,751
	11.5%	1.6%	1.6%	0.6%	15.2%
3	79,834	8,578	5,095	1,734	95,241
	6.4%	0.7%	0.4%	0.1%	7.6%
4	15,928	5,095	5,095	1,734	27,852
	1.3%	0.4%	0.4%	0.1%	2.2%
5	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%
Don't know	6,113	0	0	0	6,113
	0.5%	0	0	0	0.5%
Refused	8,657	0	0	0	8,657
	0.7%	0	0	0	0.7%

Table C.73

Question 63. Number of stereo systems in your home.	**Dwelling Type**				**Total**
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	219,457	20,374	94,629	23,873	358,333
	17.5%	1.6%	7.5%	1.9%	28.6%
1	514,988	42,156	110,406	27,391	694,942
	41.1%	3.4%	8.8%	2.2%	55.4%
2	113,371	10,191	5,095	1,734	130,390
	9.0%	0.8%	0.4%	0.1%	10.4%
3	35,041	0	5,095	1,734	41,870
	2.8%	0	0.4%	0.1%	3.3%
4	7,847	0	0	1,734	9,580
	0.6%	0	0	0.1%	0.8%
6	0	0	0	1,734	1,734
	0	0	0	0.1%	0.1%
13	0	2,120	0	0	2,120
	0	0.2%	0	0	0.2%
Refused	12,605	0	2,164	0	14,769
	1.0%	0	0.2%	0	1.2%

Table C.74

Question 64. Number of personal computers - including laptops - in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	68,990	6,034	57,697	20,801	153,522
	5.5%	0.5%	4.6%	1.7%	12.2%
1	374,073	48,678	112,562	23,873	559,186
	29.8%	3.9%	9.0%	1.9%	44.6%
2	235,905	18,345	22,501	11,791	288,543
	18.8%	1.5%	1.8%	0.9%	23.0%
3	135,794	1,785	17,371	1,734	156,684
	10.8%	0.1%	1.4%	0.1%	12.5%
4	49,951	0	0	0	49,951
	4.0%	0	0	0	4.0%
5	19,876	0	0	0	19,876
	1.6%	0	0	0	1.6%
7	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
8	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
Don't know	0	0	5,095	0	5,095
	0	0	0.4%	0	0.4%
Refused	12,605	0	2,164	0	14,769
	1.0%	0	0.2%	0	1.2%

Table C.75

Question 65. Number of computer monitors in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	71,620	14,579	34,441	5,201	125,842
	6.5%	1.3%	3.1%	0.5%	11.4%
1	486,765	52,064	110,812	23,873	673,514
	44.2%	4.7%	10.1%	2.2%	61.2%
2	173,027	2,164	2,085	6,590	183,866
	15.7%	0.2%	0.2%	0.6%	16.7%
3	68,260	0	5,095	1,734	75,089
	6.2%	0	0.5%	0.2%	6.8%
4	15,928	0	0	0	15,928
	1.4%	0	0	0	1.4%
5	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
6	1,785	0	0	0	1,785
	0.2%	0	0	0	0.2%
Don't know	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Not applicable	12,605	0	7,259	0	19,865
	1.1%	0	0.7%	0	1.8%

Table C.76

Question 66. Number of combination printer / fax / copiers in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	399,793	31,460	146,605	37,794	615,652
	31.9%	2.5%	11.7%	3.0%	49.1%
1	435,143	33,191	65,690	16,938	550,962
	34.7%	2.6%	5.2%	1.4%	43.9%
2	50,859	5,095	5,095	1,734	62,783
	4.1%	0.4%	0.4%	0.1%	5.0%
3	7,072	0	0	0	7,072
	0.6%	0	0	0	0.6%
Don't know	0	5,095	0	1,734	6,829
	0	0.4%	0	0.1%	0.5%
Refused	10,441	0	0	0	10,441
	0.8%	0	0	0	0.8%

Table C.77

Question 67. Number of stand-alone printers in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	369,469	29,408	149,492	25,948	574,318
	29.5%	2.3%	11.9%	2.1%	45.8%
1	425,553	40,338	65,734	27,050	558,675
	33.9%	3.2%	5.2%	2.2%	44.6%
2	92,490	5,095	0	3,467	101,053
	7.4%	0.4%	0	0.3%	8.1%
3	1,785	0	0	1,734	3,518
	0.1%	0	0	0.1%	0.3%
4	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
10	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Don't know	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Refused	8,277	0	2,164	0	10,441
	0.7%	0	0.2%	0	0.8%

Table C.78

Question 68. Number of stand-alone fax machines in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	758,057	63,633	205,079	51,609	1,078,379
	60.5%	5.1%	16.4%	4.1%	86.0%
1	128,118	9,044	7,216	6,590	150,968
	10.2%	0.7%	0.6%	0.5%	12.0%
2	6,692	2,164	5,095	0	13,951
	0.5%	0.2%	0.4%	0	1.1%
Refused	10,441	0	0	0	10,441
	0.8%	0	0	0	0.8%

Table C.79

Question 69. Number of stand-alone copiers in your home.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	711,934	58,360	191,019	46,408	1,007,721
	56.8%	4.7%	15.2%	3.7%	80.4%
1	159,947	11,386	21,276	10,058	202,667
	12.8%	0.9%	1.7%	0.8%	16.2%
2	18,243	5,095	5,095	0	28,433
	1.5%	0.4%	0.4%	0	2.3%
11	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
Don't know	3,123	0	0	1,734	4,857
	0.2%	0	0	0.1%	0.4%
Refused	8,277	0	0	0	8,277
	0.7%	0	0	0	0.7%

Table C.80

Question 70. Number of surge protector strips in your home for any of the audio/video or home office mentioned above.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
0	82,470	10,283	46,539	17,388	156,680
	6.6%	0.8%	3.7%	1.4%	12.5%
1	184,462	10,571	63,649	5,147	263,828
	14.7%	0.8%	5.1%	0.4%	21.0%
2	193,972	35,598	43,707	18,382	291,659
	15.5%	2.8%	3.5%	1.5%	23.3%
3	182,564	4,249	32,732	3,413	222,959
	14.6%	0.3%	2.6%	0.3%	17.8%
4	85,565	10,191	20,381	3,467	119,604
	6.8%	0.8%	1.6%	0.3%	9.5%
5	61,266	2,164	5,095	1,734	70,260
	4.9%	0.2%	0.4%	0.1%	5.6%
6	47,137	0	5,287	5,201	57,625
	3.8%	0	0.4%	0.4%	4.6%
7	17,513	0	0	0	17,513
	1.4%	0	0	0	1.4%
8	10,574	0	0	1,734	12,308
	0.8%	0	0	0.1%	1.0%
9	5,682	0	0	0	5,682
	0.5%	0	0	0	0.5%
10	11,020	0	0	0	11,020
	0.9%	0	0	0	0.9%

Question 70. Number of surge protector strips in your home for any of the audio/video or home office mentioned above.	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
12	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%
20	2,164	0	0	0	2,164
	0.2%	0	0	0	0.2%
Don't know	8,856	1,785	0	0	10,641
	0.7%	0.1%	0	0	0.8%
Refused	8,277	0	0	1,734	10,011
	0.7%	0	0	0.1%	0.8%

Table C.81

Question 71. Energy Star equipment	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
all of them/everything	39,819	1,785	5,095	3,123	49,821
	5.5%	0.2%	0.7%	0.4%	6.8%
air conditioning	5,354	0	0	0	5,354
	0.7%	0	0	0	0.7%
computer monitor	11,466	0	2,085	0	13,552
	1.6%	0	0.3%	0	1.9%
computer	34,794	0	25,476	0	60,271
	4.8%	0	3.5%	0	8.3%
dishwasher	201,893	19,990	7,181	8,560	237,624
	27.7%	2.7%	1.0%	1.2%	32.6%
dryer	250,651	17,621	5,095	5,201	278,569
	34.3%	2.4%	0.7%	0.7%	38.2%
freezer	56,436	5,095	0	3,518	65,050
	7.7%	0.7%	0	0.5%	8.9%
furnace	22,336	0	0	0	22,336
	3.1%	0	0	0	3.1%
microwave	51,614	4,285	5,095	3,413	64,407
	7.1%	0.6%	0.7%	0.5%	8.8%
oven	47,412	0	0	1,680	49,091
	6.5%	0	0	0.2%	6.7%
refrigerator	355,294	35,088	41,993	15,600	447,975
	48.7%	4.8%	5.8%	2.1%	61.4%

Question 71. Energy Star equipment	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
stove	117,368	14,667	14,396	5,201	151,632
	16.1%	2.0%	2.0%	0.7%	20.8%
television	41,583	9,044	15,286	1,734	67,646
	5.7%	1.2%	2.1%	0.2%	9.3%
washing machine	290,682	19,406	7,181	3,467	320,736
	39.8%	2.7%	1.0%	0.5%	44.0%
water heater	106,841	19,003	12,311	5,201	143,355
	14.6%	2.6%	1.7%	0.7%	19.6%
asked/answered	776,935	63,633	152,293	46,063	1,038,925
	62.0%	5.1%	12.1%	3.7%	82.9%
Don't know	124,588	11,208	65,097	12,136	213,030
	9.9%	0.9%	5.2%	1.0%	17.0%
Refused	1,785	0	0	0	1,785
	0.1%	0	0	0	0.1%

Table C.82

Question 72. How many people - including yourself - usually live in this residence at least six months of the year?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1	109,701	28,018	136,706	13,815	288,241
	8.7%	2.2%	10.9%	1.1%	23.0%
2	366,864	29,839	38,682	35,715	471,101
	29.3%	2.4%	3.1%	2.8%	37.6%
3	181,213	5,990	17,371	5,201	209,775
	14.5%	0.5%	1.4%	0.4%	16.7%
4	143,936	6,069	12,276	3,467	165,749
	11.5%	0.5%	1.0%	0.3%	13.2%
5	62,173	4,925	10,191	0	77,289
	5.0%	0.4%	0.8%	0	6.2%
6	17,579	0	0	0	17,579
	1.4%	0	0	0	1.4%
7	3,949	0	0	0	3,949
	0.3%	0	0	0	0.3%
8	7,451	0	0	0	7,451
	0.6%	0	0	0	0.6%
Refused	10,441	0	2,164	0	12,605
	0.8%	0	0.2%	0	1.0%

Table C.83

Question 73. For what average length of time is your home occupied by at least one person on a typical weekday ?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
23-24 hrs/day	400,195	23,928	43,189	30,859	498,171
	31.9%	1.9%	3.4%	2.5%	39.7%
21-22 hrs/day	44,676	5,095	25,454	5,201	80,427
	3.6%	0.4%	2.0%	0.4%	6.4%
19-20 hrs/day	76,400	4,249	19,535	6,590	106,775
	6.1%	0.3%	1.6%	0.5%	8.5%
17-18 hrs/day	78,950	9,000	23,950	1,734	113,634
	6.3%	0.7%	1.9%	0.1%	9.1%
15-16 hrs/day	91,512	1,785	41,993	1,734	137,023
	7.3%	0.1%	3.3%	0.1%	10.9%
13-14 hrs/day	59,674	10,654	9,301	6,935	86,564
	4.8%	0.8%	0.7%	0.6%	6.9%
11-12 hrs/day	71,191	11,085	32,692	0	114,969
	5.7%	0.9%	2.6%	0	9.2%
9-10 hrs/day	10,641	0	2,085	1,734	14,460
	0.8%	0	0.2%	0.1%	1.2%
7-8 hrs/day	23,807	5,095	14,095	0	42,998
	1.9%	0.4%	1.1%	0	3.4%
5-6 hrs/day	9,302	2,164	0	1,734	13,200
	0.7%	0.2%	0	0.1%	1.1%
3-4 hrs/day	5,287	0	0	0	5,287
	0.4%	0	0	0	0.4%

Question 73. For what average length of time is your home occupied by at least one person on a typical weekday ?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1-2 hrs/day	1,785	1,785	0	0	3,569
	0.1%	0.1%	0	0	0.3%
Don't know	10,590	0	0	1,680	12,269
	0.8%	0	0	0.1%	1.0%
Refused	19,297	0	5,095	0	24,393
	1.5%	0	0.4%	0	1.9%

Table C.84

Question 74. For what average length of time is your home occupied by at least one person on a typical weekend?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
23-24 hrs/day	497,885	34,945	80,130	36,060	649,020
	39.7%	2.8%	6.4%	2.9%	51.8%
21-22 hrs/day	40,260	0	23,142	3,467	66,869
	3.2%	0	1.8%	0.3%	5.3%
19-20 hrs/day	126,688	9,449	27,641	11,737	175,515
	10.1%	0.8%	2.2%	0.9%	14.0%
17-18 hrs/day	50,260	8,455	32,469	1,734	92,918
	4.0%	0.7%	2.6%	0.1%	7.4%
15-16 hrs/day	48,703	10,829	24,622	1,734	85,887
	3.9%	0.9%	2.0%	0.1%	6.9%
13-14 hrs/day	20,931	5,095	9,301	1,734	37,061
	1.7%	0.4%	0.7%	0.1%	3.0%
11-12 hrs/day	34,978	2,120	14,095	0	51,194
	2.8%	0.2%	1.1%	0	4.1%
9-10 hrs/day	30,203	0	0	1,734	31,937
	2.4%	0	0	0.1%	2.5%
7-8 hrs/day	14,722	0	2,120	0	16,842
	1.2%	0	0.2%	0	1.3%
5-6 hrs/day	6,113	2,164	1,785	0	10,062
	0.5%	0.2%	0.1%	0	0.8%
3-4 hrs/day	0	0	2,085	0	2,085
	0	0	0.2%	0	0.2%

Question 74. For what average length of time is your home occupied by at least one person on a typical weekend?	Dwelling Type				Total
	Single family detached home	Duplex, row- or townhouse	Apartment or condo	Manufactured home	
1-2 hrs/day	0	1,785	0	0	1,785
	0	0.1%	0	0	0.1%
Don't know	21,543	0	0	0	21,543
	1.7%	0	0	0	1.7%
Refused	11,020	0	0	0	11,020
	0.9%	0	0	0	0.9%

Appendix A.2 – Commercial Building Stock Assessment

Background and Objectives

This report characterizes the 2008 commercial building stock in Puget Sound Energy's (PSE) service territory. The study is intended to:

1. Augment and update the results of 2003 Commercial Building Stock Assessment (CBSA) conducted for the Pacific Northwest, and

2. Develop energy-use intensity (EUI) values, fuel shares, and penetration of energy-efficient technologies and practices for use in the Comprehensive Assessment of Demand-Side Resource Potentials (2010-2029).

The results of this study are expected to serve as a basis for current planning, forecasting, and program development initiatives by PSE. Site information from the 2003 CBSA was updated during Winter 2009 and is currently being processed; these results will be incorporated into the database during May/June 2009.

Study Approach

Sample Development

This study augments commercial building data collected during the 2003 CBSA study. Because auxiliary data collection activities such as the new construction study and supplemental site visits for the 1998-2000 cohort provided adequate data for newer buildings, only buildings constructed before 1995 were included in this study. PSE provided a database of all current commercial accounts. To build a sample frame, Cadmus classified accounts into building type categories (see Table 1) by NAICS code, and screened for vintage (pre-1995). The building type sample distribution was determined according to the building type percentage kWh usage for PSE. Offices make up the largest part of the commercial electricity load and thus, had the highest site visit target. Within each building type, buildings were sorted into quartiles based on the annual electricity (kWh) consumption, and site visit targets were evenly distributed across the quartiles, shown in Table 1. Buildings were randomly selected from the screened customer database for each quartile.

Table 1. Initial Sample Frame, Oversample

Building Type	Q1 sample	Q2 Sample	Q3 Sample	Q4 Sample	Desired Sample
Dry Goods Retail	5	5	6	6	22
Grocery	1	2	2	2	7
Office	10	10	11	11	42
Restaurant	1	2	3	3	9
Warehouse	-	-	-	1	1
Health	1	1	2	2	6
Hotel/Motel	-	1	1	1	3
Schools	2	2	3	3	10
Total	20	23	28	29	100

To preemptively address sample attrition during the recruitment and auditing process, the initial sample frame targeted 100 buildings, with the goal of completing a minimum of 80 audits at the conclusion of field work. The actual sample of site visits conducted by building segmentation is shown in Table 2. Buildings classified as "Health" were harder to recruit due to privacy and timing issues.

Table 2. Actual Building Sample

Building Type	Q1	Q2	Q3	Q4	Total
Dry Goods Retail	5	4	5	6	20
Grocery	1	-	3	5	9
Office	1	6	11	10	28
Restaurant	1	3	4	4	12
Warehouse	-	-	-	1	1
Health	1	1	-	-	2
Hotel/Motel	1	1	-	1	3
Schools	1	1	3	3	8
Total	11	16	26	30	83

Sample Recruitment and Data Collection

Given the dated and often incorrect contact information in the sample frame, it was necessary to design recruitment and scheduling procedures which would result in reaching as many sites as possible. Project staff called contacts at the commercial buildings listed in the sample frame to recruit buildings for in-person audits. In cases where contact information was wrong or unavailable, staff performed Internet research to determine the correct information. Once the targeted number of site visits for a given quartile and building type were recruited, the callers moved forward with recruitment of other quartiles or building types.

After a building had committed to participate, an auditor followed up and scheduled an on-site audit. During the walk-through, the auditor collected information on square footage, building use and general characteristics, HVAC systems, lighting, envelope, and refrigeration (if applicable). The site visit data collection instrument is located in Appendix A.2.2.

Recruited contacts were uploaded into a Web interface designed for organizing and tracking data collection from site visits. The web database mirrored the field data collection instrument and auditors could access the database in the field and input information. Recruitment began in May 2008 and concluded in July 2008. Auditors conducted site visits from June 2008 through August 2008.

Data Analysis

Case weights for the PSE sample were defined as the PSE population floor space divided by the sample floor space. The weighting was performed at the following levels: building type, four cohorts (pre 1988, 1988-1994, 1995-2001, 2002-2007), and three building size bins (<20,000, 20,000-100,000, >100,000). Population floor space totals were obtained from PNNRES for pre-1988 cohorts and Dodge for post-1988 cohorts.

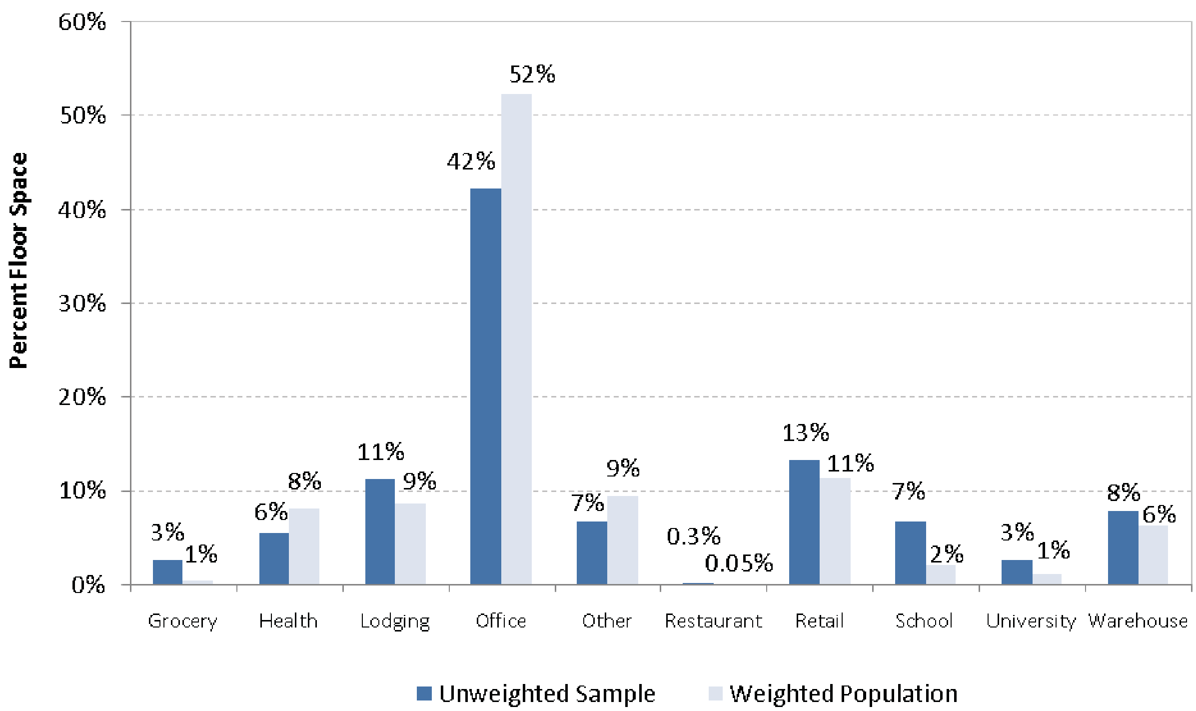
Information on how this data was used in the potential study is included in Appendix C. A summary of basic characteristics is provided in the next section. The potential study data inputs and summarization may differ from the general summary of data, as the inputs took into account the differences among gas only, electricity only, and duel fuel customers.

Appendix A.2.2 – CBSA Key Findings

Building Type

Floor space by building type is shown in Figure 1. The un-weighted totals show the actual floor space distribution based on the sample. The weighted totals show the floor space in the population weighted by each building type's usage distribution.

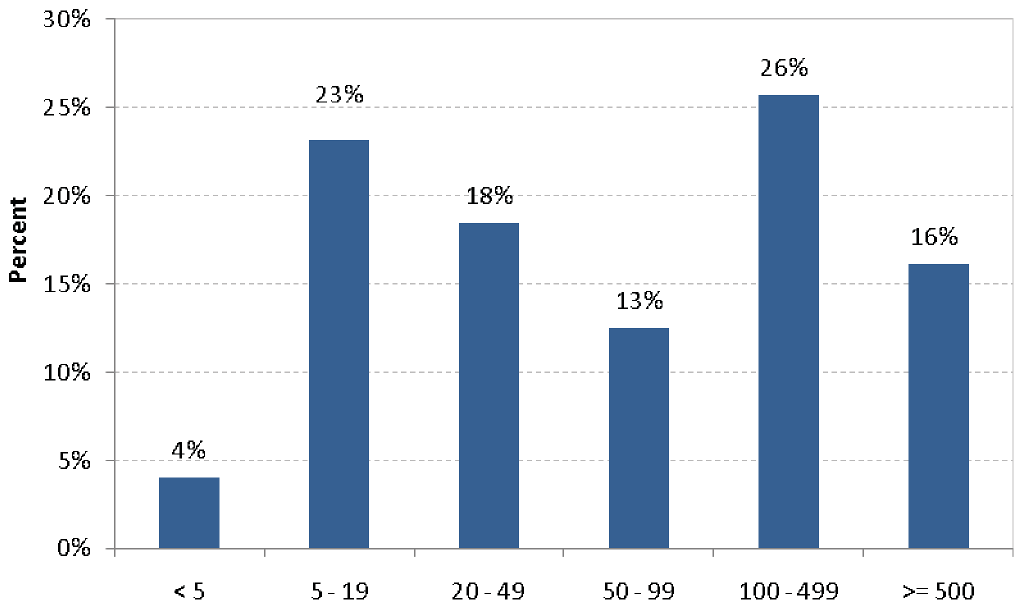
Figure 1. Building Type by Percentage Floor Space



Building Size

Commercial building size is split fairly evenly at 50,000 square feet; approximately half of the buildings are larger than 50,000 (55%) and half are smaller than 50,000 square feet. Most buildings fall under the 100,000-499,000 square feet category (26%) or the 5,000-19,000 square feet category (23%). buildings smaller than 5,000 square feet make up only 4% of the commercial floor space.

Figure 2. Building Size Distribution (1000 sq.ft.)



Heating and Cooling

Natural gas is the primary heating fuel for about 51% of commercial building floor space; electricity is the primary heating source for about 38% of building floor, as shown in Figure 3. Other commercial building heating sources are wood stoves and waste oil burners.

Figure 4 and Figure 5 show the distribution of primary heating and cooling system types; the data indicate that the majority of buildings are served by packaged (rooftop) HVAC units. Boilers and chillers serve approximately a quarter of the heated/cooled commercial floor space while heat pumps serve 13% of the building population.

Figure 3. Predominant Fuel Type

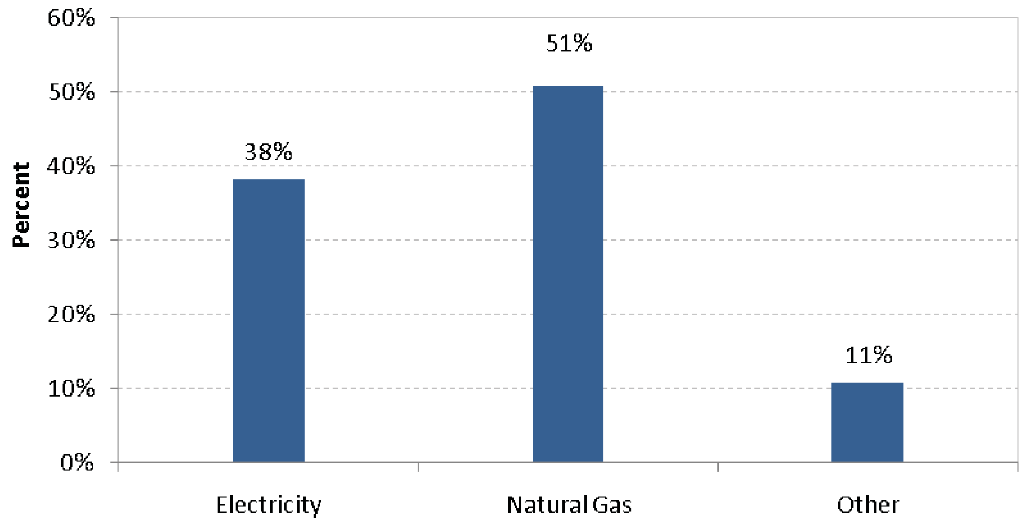


Figure 4. Primary Heating Equipment

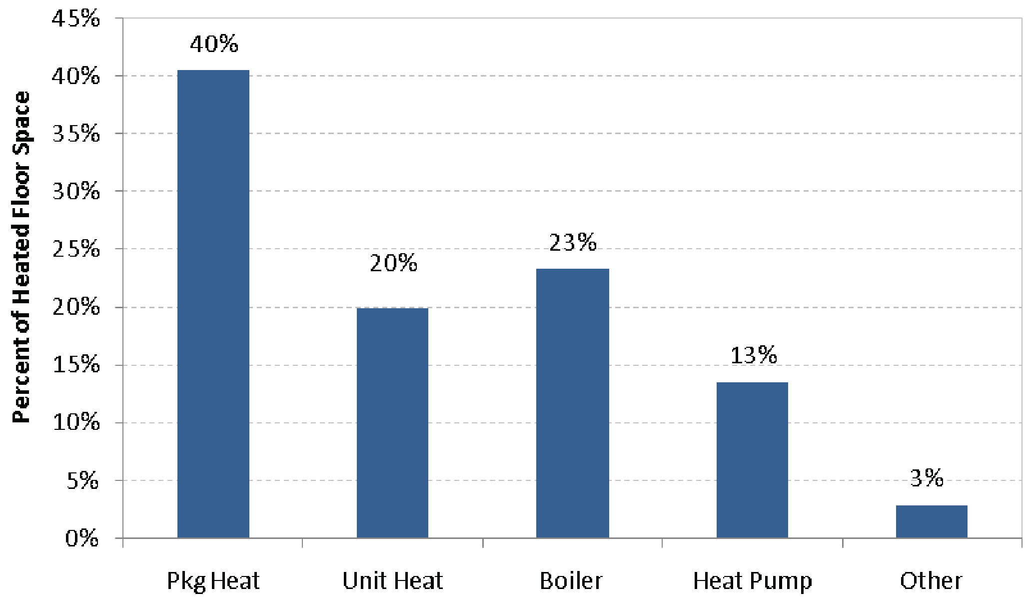
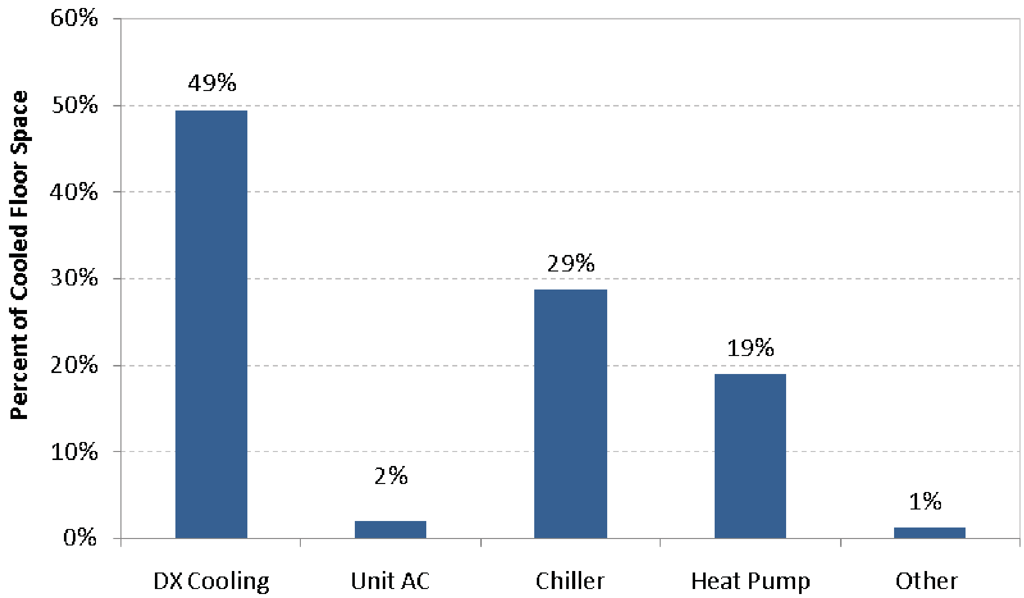


Figure 5. Primary Cooling Equipment



Lighting

The overall indoor lighting power density (LPD) for all commercial floor space is 1.06 W/sf. Figure 6 shows the LPD for each building type as well as the overall commercial building LPD.

The majority of commercial lighting wattage is in fluorescent lamps (62%). The fluorescent category includes T-12, T-8, T-5, and compact fluorescent lamps. As shown in Figure 7, T-8 fluorescent lamps account for nearly 40% of the installed lighting wattage, and T-12 lamps account for about 11%. HID lights make up 25% of the indoor lighting wattages.

Figure 6. Interior Lighting Power Density

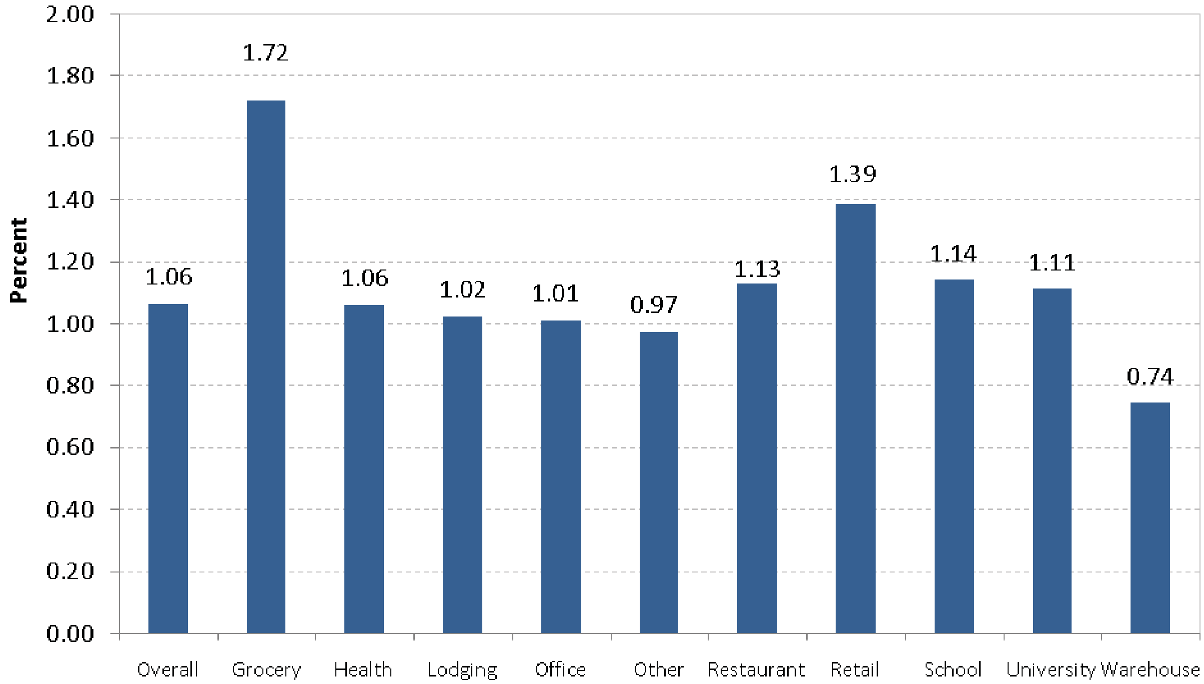
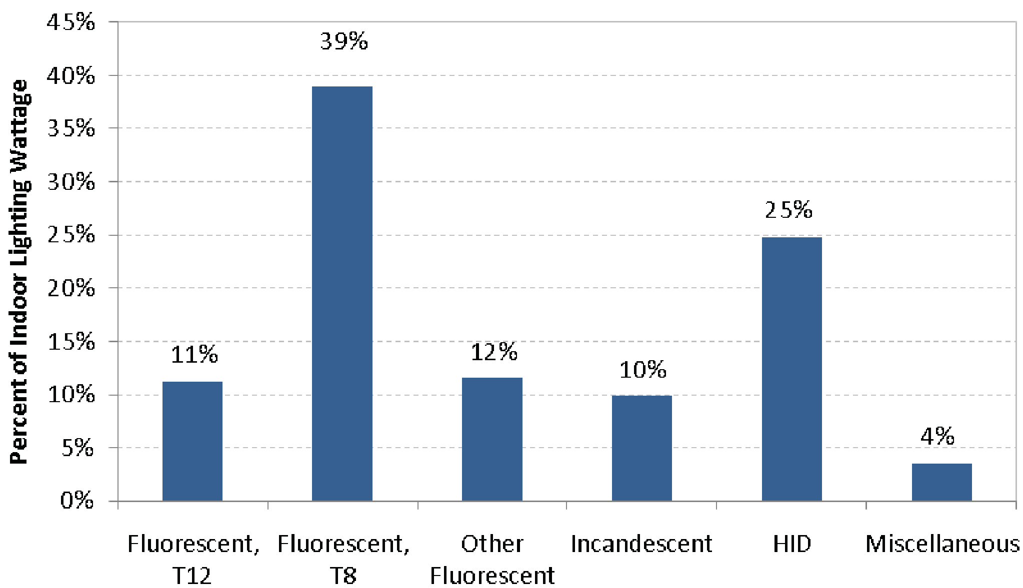


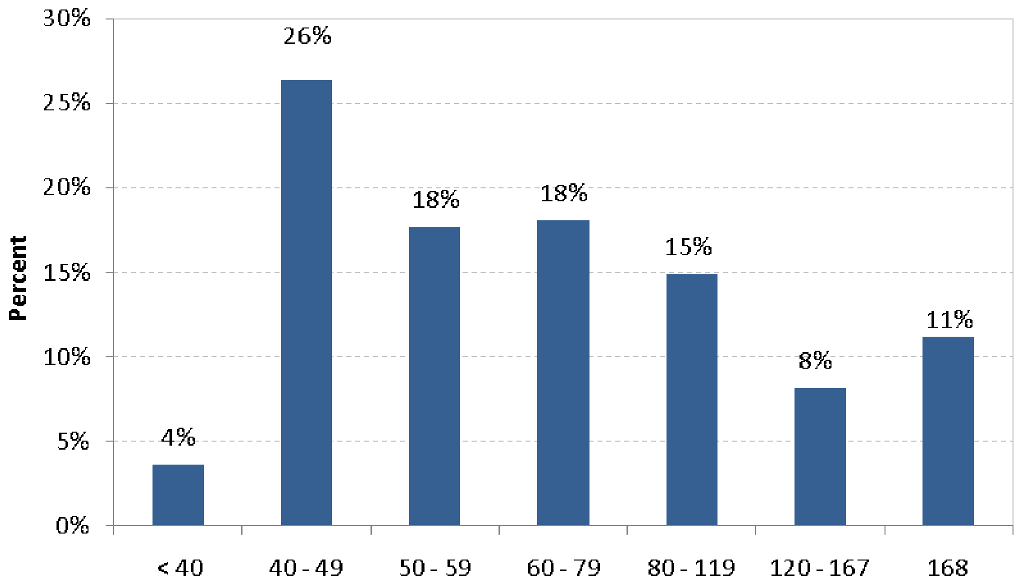
Figure 7. Percent Wattage by Indoor Lamp Type



Operating Hours

Most commercial buildings (62%) operate between 40 to 80 hours per week, shown in Figure 8. Approximately 11% of commercial buildings are on a continuous operation schedule and only 4% operate less than 40 hours a week.

Figure 8. Building Hours of Operation



Appendix A.2.3 – Data Collection Instrument

Site Visit Data Collection Instrument

2008 Commercial Building Stock Assessment

****Confidential: All data collected on this form is confidential and may only be used for this study.*

1. General Building Information

Site Name			
Site Address			
City/State/Zip			

Primary Contact for Site Visit

Contact 1		Title					
Address		City		State		Zip	
Phone 1a		Phone 1b		Email			

Alternate Contact for Site Visit

Contact 2		Title					
Address		City		State		Zip	
Phone 2a		Phone 2b		Email			

General Building/Complex Information

Is the site building: **F**unctional, **D**emolished, **V**acant, or **I**naccessible?		F D V I
Is this site a **S**ingle building or a **M**ultiple building complex?		S M
What best describes the economic use of the building/complex?	(table below)	
Total Bldg. Floor Area (SQFT) including enclosed parking (exclude residential)		
Primary Heating Fuel	(table below)	
Primary Cooling Fuel	(table below)	
No. of Floors above grade		
No. of Floors below grade		
Are there areas within bldg. with high concentration of computers/servers? (If Yes, see page 15)		Y N

Economic Use Codes

1	Retail	6	Health
2	Grocery	7	Hotel/Motel
3	Office	8	School
4	Restaurant	9	Other
5	Warehouse	10	Vacant

Fuel Type Codes

1	Electricity
2	Natural Gas
3	Fuel Oil
4	Propane
5	Other

Comments:

Building Occupancy & Management

What percentage of the building/complex is occupied by the Owner and/or Tenants?		%owner	%tenant
Original Construction	Original Total Floor Area		
Is a renovation/upgrade planned in the next 2 years?			
If yes, which systems? **L**ighting, **H**VAC, HVAC **C**ontrols, **R**efrigeration, **W**indows		L H C R W Ro	
Is a staff person whose duties include energy conservation and/or management?			
Is maintenance/repair work done **I**n-house, or by an **O**utside party?			

General O&M	I O	HVAC Controls	I O	Refrigeration	I O
Lighting	I O	HVAC Equipment	I O		

General Space Information

	Primary Space	Secondary Space	Tertiary Space	Common Space	Indoor Parking
	Space ID: 1	Space ID: 2	Space ID: 3	Space ID: C	Space ID: P
Functional Use (table below)					
% Of Total Building SQFT					
Space Cooled?	Y N	Y N	Y N	Y N	
After Hours Shutoff/Setup?	Y N	Y N	Y N	Y N	Y N
Space Heated?	Y N	Y N	Y N	Y N	
After Hours Shutoff/Setback?	Y N	Y N	Y N	Y N	Y N

Functional Use Codes (Space Type)	
1 Assembly / Recreation	7 Office
2 Classroom	8 Sales
3 Dining	9 Storage – Low bay
4 Guest room	10 Vacant
5 Kitchen	11 Warehouse – High bay
6 Laundry / Housekeeping	

Utility Information

Electric Accounts ID:	**E1**	**E2**	**E3**
Electric Utility Name:			
Meter #			

Gas Accounts ID:	**G1**	**G2**	**G3**
Gas Utility Name:			
Meter #			

2a. Business Schedules

Primary Schedule For Space ID 1

Day Type	Business Hours (1-24)	Closed All Day?	Open 24 Hours?
Weekday	from ________ To ________	☐	☐
Saturday	from ________ To ________	☐	☐
Sunday	from ________ To ________	☐	☐

Primary Schedule For Space ID 2

Day Type	Business Hours (1-24)	Closed All Day?	Open 24 Hours?
Weekday	from ________ To ________	☐	☐
Saturday	from ________ To ________	☐	☐
Sunday	from ________ To ________	☐	☐

Primary Schedule For Space ID 3

Day Type	Business Hours (1-24)	Closed All Day?	Open 24 Hours?
Weekday	from ________ To ________	☐	☐
Saturday	from ________ To ________	☐	☐
Sunday	from ________ To ________	☐	☐

Primary Schedule For Space ID Common

Day Type	Business Hours (1-24)	Closed All Day?	Open 24 Hours?
Weekday	from ________ To ________	☐	☐
Saturday	from ________ To ________	☐	☐
Sunday	from ________ To ________	☐	☐

Primary Schedule For Space ID Indoor Parking

Day Type	Business Hours (1-24)	Closed All Day?	Open 24 Hours?
Weekday	from ________ To ________	☐	☐
Saturday	from ________ To ________	☐	☐
Sunday	from ________ To ________	☐	☐

3. Building Envelope

WALLS		Space 1	Space 2	Space 3	Space C
Surface Type:	**B** = Brick **C** = Concrete **CB** = Concrete Block **F** = Wood **M** = Metal	B C CB F M	B C CB F M	B C CB F M	B C CB F M
Framing Type:	**M** = Metal **W** = Wood	M W	M W	M W	M W

WINDOWS		Space 1	Space 2	Space 3	Space C
% of Wall Area					
Layers of Glazing		1 2 3	1 2 3	1 2 3	1 2 3
Glazing Material:	**C** = Clear **O** = Opaque **R** = Reflective **T** = Tinted	C O R T	C O R T	C O R T	C O R T
Frame Type:	**M** = Metal **V** = Vinyl **W** = Wood	M V W	M V W	M V W	M V W
Window Type:	**F** = Fixed **O** = Operable	F O	F O	F O	F O

ROOFS		Space 1	Space 2	Space 3	Space C
Roof Type:	**F** = Flat **P** = Pitched	F P	F P	F P	F P
Surface Material:	**B** = Built-up **C** = Cool Roof **E** = Membrane **M** = Metal **S** = Shingles/Felt	B C E M S	B C E M S	B C E M S	B C E M S
Deck Material:	**C** = Concrete **M** = Metal **W** = Wood	C M W	C M W	C M W	C M W
Roof Area (SF): [Flat Roof Only]					

FLOORS		Space 1	Space 2	Space 3	Space C
Floor Type:	**B** = Basement **C** = Crawl **S** = Slab **U** = Unconditioned	B C S U	B C S U	B C S U	B C S U

SKYLIGHTS	Space 1	Space 2	Space 3	Space C
Skylights?	Y N	Y N	Y N	Y N
Skylight Area (SF):				
Lighting Dimming Control?	Y N	Y N	Y N	Y N

4. Unitary HVAC System

Packaged System ID:	PS1	PS2	PS3
Space ID (s) Served	C 1 2 3	C 1 2 3	C 1 2 3
Packaged HVAC System Type (Table below)			
Number of Identical Units			
Age of Units (Years)			
Manufacturer			
Model Name/Number			
Rated Cooling Capacity (Tons)			
Performance Rating (Circle one)	*EER SEER*	*EER SEER*	*EER SEER*
Performance Rating Value			
Temperature Control Type (Table below)			
Supply Fans: Volume Control: [VAV systems only] **D**ischarge Damper **I**nlet Vane **V**FD	D I V	D I V	D I V
Return Fans?	Y N	Y N	Y N
Economizer: **A**ir **W**ater **N**one	A W N	A W N	A W N
Primary Heat: Fuel Type (Table below)			
Heating Type (Table below)			
Rated Efficiency (%) (may be > 100)			
Supp. Heat Fuel Type (Table below)			
Heating Type (Table below)			
Rated Efficiency (%) (may be > 100)			

Packaged HVAC System Type Codes

0	Packaged Single Zone – HEAT only	7	Heat Pump, ground source
1	Packaged Single Zone – A/C only	8	Heat pump, water source
2	Packaged Single Zone – A/C w/ heat	9	Split System
3	Packaged Multi Zone	10	Unit Heater
4	Packaged VAV	11	Unit Ventilator
5	Evaporative Cooler	12	Window / Wall A/C unit
6	Heat Pump, air source	13	Window / Wall Heat Pump

Temperature Control Type Codes

1	Thermostat – Programmable
2	Thermostat - Manual
3	EMS
4	Always On
5	Manual on/off
6	Time clock

Fuel Type Codes

1	Electricity
2	Natural Gas
3	Fuel Oil
4	Propane
5	Other

Heating Type Codes

1	Forced Air Furnace
2	Resistance
3	Central Boiler
4	Other

5a. Central HVAC System - Boiler

Boiler ID:	**B1**	**B2**	**B3**
Boiler Service: **S**team **H**ot Water	S H	S H	S H
Fuel Type (Table below)			
Number of Identical Boilers			
Number of Units on Standby			
Age of Boiler(s) (years)			
Manufacturer			
Model Name/Number			
Input Capacity (kBtu/hr)			
Efficiency *(Nominal %)*			
EMS Control?	Y N	Y N	Y N

HOT WATER PUMPS

Quantity			
Motor HP			
Motor Efficiency (% or S, H, P)			
Capacity Control: **1** speed **2** speed **V**ariable	1 2 V	1 2 V	1 2 V
EMS Control?	Y N	Y N	Y N

Fuel Type Codes	
1	Electricity
2	Natural Gas
3	Fuel Oil
4	Propane
5	Other

5b. Central HVAC System - Chiller

Chiller ID:	**C1**	**C2**	**C3**
Chiller Type (Table below)			
Number of Identical Chillers			
Age of Chiller(s) (Years)			
Manufacturer			
Model Name/Number			
Rated Cooling Capacity (Tons)			
Compressor: Design Full Load kW			
EMS Control?	Y N	Y N	Y N

HEAT REJECTION SYSTEM

Condenser Type (Table below)			
Fan Control: **CO**nstant **CY**cle **P**ony motor **T**wo-Speed **V**ariable Speed	CO CY P T V	CO CY P T V	CO CY P T V
Condenser Fans: Quantity			
HP			
EMS Control?	Y N	Y N	Y N

CHILLED WATER PUMPS

Pump Use: **P**rimary **S**econdary	P S	P S	P S
Quantity			
Motor HP			
Motor Efficiency (% or S, H, P)			
Capacity Control: **1** speed **2** speed **V**ariable	1 2 V	1 2 V	1 2 V
EMS Control?	Y N	Y N	Y N

CONDENSER WATER PUMPS

Quantity			
Motor HP			
Motor Efficiency (% or S, H, P)			
Capacity Control: **1** speed **2** speed **V**ariable	1 2 V	1 2 V	1 2 V
EMS Control?	Y N	Y N	Y N

Chiller Type Codes		**Condenser Type Codes**
1 Centrifugal	4 Absorption, hot water	1 Air Cooled Condenser
2 Reciprocating	5 Absorption, natural gas	2 Cooling Tower
3 Rotary	6 Absorption, steam	3 Evaporative Cooler
		4 Other

5c. Central HVAC System – Air Handler

Air Handler ID:	AH1	AH2	AH3
Air Distribution System Type (Table below)			
Temperature Control Type (Table below)			
Age of Air Handler (Years)			
Supply Fans: Volume Control: None **I**nlet Vane **V**FD	N I V	N I V	N I V
Motor HP			
Motor Efficiency (% or S, H, P)			
Return Fans?	Y N	Y N	Y N
Motor HP			
Motor Efficiency (% or S, H, P)	/ /	/ /	/ /
Economizer?	Y N	Y N	Y N
Terminal Reheat: **E**lectric **W**ater **S**team **N**one	E S W N	E S W N	E S W N

Air Distribution System Type Codes			
1	CV - Single Zone	8	VAV – Terminal Reheat
2	CV - Multi Zone	9	VAV – Dual Duct
3	CV - Dual Duct	10	Fan Coil
4	CV - Terminal Reheat	11	Baseboard
5	FPS – Fan Powered VAV - Series	12	Heat & Vent
6	FPP – Fan Powered VAV - Parallel	13	Hydronic Heat Pump
7	VAV – Cooling Only	14	Induction

Temperature Control Type Codes	
1	Thermostat – Programmable
2	Thermostat - Manual
3	EMS
4	Always On
5	Manual on/off
6	Time clock

6. Domestic Water Heating

Water Heater ID:		WH1	WH2	WH3	WH4
Water Heater Type	(Table below)				
Fuel Type	(Table below)				
Number of Identical Units					
Age Of Water Heater	(years)				
Tank Capacity	(Gallons)				
Input Capacity	(kW or kBtu/hr)				
Tank Wrap?		Y N	Y N	Y N	Y N
Recirculation Pump?		Y N	Y N	Y N	Y N

Water Heater Type Codes	
1	Heat Pump
2	Heat Recovery
3	Instantaneous (tankless)
4	Self-Contained
5	Storage Tank (Central Boiler)
6	Other

Fuel Type Codes	
1	Electricity
2	Natural Gas
3	Fuel Oil
4	Propane
5	Other

8a. Indoor Lighting

Lighting Group ID# (multiple pages OK)	IL-_____	IL-_____	IL-_____	IL-_____	IL-_____	IL-_____
Usage: General Area **R**etail Display **T**ask	G R T	G R T	G R T	G R T	G R T	G R T
FLUORESCENT						
F = Standard Tube	F	F	F	F	F	F
U = U-tube	U	U	U	U	U	U
Length (1.5′ 2′ 3′ 4′ 6′ 8′)						
Diameter (T5 T8 T10 T12)						
CF = Compact Fluorescent	CF	CF	CF	CF	CF	CF
CIR = Circline Fluorescent	CIR	CIR	CIR	CIR	CIR	CIR
HID						
MH = Metal Halide	MH	MH	MH	MH	MH	MH
H = High Pressure Sodium	H	H	H	H	H	H
MISC.						
I = Incandescent	I	I	I	I	I	I
Q = Quartz/Halogen	Q	Q	Q	Q	Q	Q
XI = Exit Incandescent	XI	XI	XI	XI	XI	XI
XCF = Exit CF	XCF	XCF	XCF	XCF	XCF	XCF
LED = Exit LED	LED	LED	LED	LED	LED	LED

Watts per lamp:						
Number of lamps per fixture:						
Total number of fixtures:						
Ballast Type: **ES** = ES Magnetic	ES	ES	ES	ES	ES	ES
E = Electronic	E	E	E	E	E	E
Control Type: **E** = EMS	E	E	E	E	E	E
DC = Daylighting - Continuous dimming	DC	DC	DC	DC	DC	DC
DS = Daylighting - Step dimming	DS	DS	DS	DS	DS	DS
MB = Manual – circuit breaker	MB	MB	MB	MB	MB	MB
MS = Manual – wall switch	MS	MS	MS	MS	MS	MS
OS = Occupancy sensor	OS	OS	OS	OS	OS	OS
P = Photocell	P	P	P	P	P	P
T = Timeclock	T	T	T	T	T	T
N = None (continuous)	N	N	N	N	N	N
% of Lighting load controlled:						
Are controls functional and used?	Y N	Y N	Y N	Y N	Y N	Y N

8b. Indoor Lighting – Overview

Lighting Group ID (unique entries)	Description	Space ID (select one)	Area Surveyed (SF)	Total Area Represented (SF)
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
IL-_____		C P 1 2 3		
		Total		

9. Outdoor Lighting

Outdoor Lighting ID#	OL-_____	OL-_____	OL-_____	OL-_____	OL-_____	OL-_____
Use type: **A**dvertising, **P**arking Lot, Bldg **F**açade, **D**isplay, **O**ther, **S**afety/Security	A P F D G S	A P F D G S	A P F D G S	A P F D G S	A P F D G S	A P F D G S
FLUORESCENT						
F = Standard Tube	F	F	F	F	F	F
U = U-tube	U	U	U	U	U	U
Length (1.5′ 2′ 3′ 4′ 6′ 8′)						
Diameter (T5 T8 T10 T12)						
CF = Compact Fluorescent	CF	CF	CF	CF	CF	CF
CIR = Circline Fluorescent	CIR	CIR	CIR	CIR	CIR	CIR
HID						
MH = Metal Halide	MH	MH	MH	MH	MH	MH
H = High Pressure Sodium	H	H	H	H	H	H
N = Neon	N	N	N	N	N	N
MISC.						
Q = Quartz/Halogen	Q	Q	Q	Q	Q	Q
I = Incandescent	I	I	I	I	I	I

Watts per lamp (Enter 10 if Neon)						
-- Check if lamp watts were estimated?	☐	☐	☐	☐	☐	☐
Number of lamps per fixture (Enter 1 if Neon)						
Total number of fixtures (Total length if Neon)						
Ballast Type: **ES** = ES Magnetic	ES	ES	ES	ES	ES	ES
E = Electronic	E	E	E	E	E	E
Control Type: **E** = EMS	E	E	E	E	E	E
MB = Manual – circuit breaker	MB	MB	MB	MB	MB	MB
MS = Manual on/off switch	MS	MS	MS	MS	MS	MS
OS = Occupancy sensor	OS	OS	OS	OS	OS	OS
P = Photocell	P	P	P	P	P	P
PT = Photocell/Timeclock	PT	PT	PT	PT	PT	PT
T = Timeclock	T	T	T	T	T	T
N = None (continuous)	N	N	N	N	N	N
Are controls functional and used?	Y N	Y N	Y N	Y N	Y N	Y N

10. Miscellaneous Equipment

Economic Use Type	Equipment		
Grocery	Point-of-use terminals	(#)	
	Food Prep – Meat Dept.	(1=Yes, 0=No)	
	Food Prep – Deli	(1=Yes, 0=No)	
Hotel/Motel	Rooms	(#)	
	Annual Average occupancy	(%)	
	Kitchen – Full Service (below)	(1=Yes, 0=No)	
	Kitchen – Warming	(1=Yes, 0=No)	
	Laundry Facility (see below)	(1=Yes, 0=No)	
Office	PCs	(#)	
Other Health	Beds	(#)	
	Laundry Facility (see below)	(1=Yes, 0=No)	
Restaurant	Meals per day	(#)	
	Kitchen – Full Service (below)	(1=Yes, 0=No)	
	Kitchen – Warming	(1=Yes, 0=No)	
Retail	Point-of-use terminals	(#)	
School	Classrooms	(#)	
	Kitchen – Full Service (below)	(1=Yes, 0=No)	
	Kitchen – Warming	(1=Yes, 0=No)	
	Laundry Facility (see below)	(1=Yes, 0=No)	
Warehouse	Forklifts (electric only)	(#)	

Food Service Equipment		Electric / Gas
If Kitchen–Full Service	Broilers / Fryers	E G
	Griddle / Grill	E G
	Oven	E G
	Range	E G
	Dishwasher Booster	E G
If Laundry	Clothes Dryer – Commercial	E G
	Clothes Dryer – Residential	E G

Packaged Refrigeration Equipment	Count
Vending Machines	
Beverage Merchandizers	
Ice Machines	
Refrigerators	
Freezers	

11. Refrigeration Equipment

	Space ID:	C 1 2 3	C 1 2 3	C 1 2 3	C 1 2 3	C 1 2 3
Compressors	ID #:	**Cp-1**	**Cp-2**	**Cp-3**	**Cp-4**	**Cp-5**
Type:	**R**eciprocating, **S**crew, **T**wo-stage multiplex, **M**ultiplex, **O**ther	R S T M O	R S T M O	R S T M O	R S T M O	R S T M O
Temp:	**L**ow (0 to -10 °F) **M**edium (30 to 40 °F) **H**igh (50 to 55 °F)	L M H	L M H	L M H	L M H	L M H
Total HP:						
Quantity:						
Unloaders or VSD compressors?		U V NA	U V NA	U V NA	U V NA	U V NA
Heat Recovery Type:	**N**one **S**pace Heating/Reheat **W**ater heating **O**ther	N S W O	N S W O	N S W O	N S W O	N S W O

Condensers	ID #:	**Cn-1**	**Cn-2**	**Cn-3**	**Cn-4**	**Cn-5**
Type:	**A**ir-cooled, Air-cooled w/**P**re-cooler, **C**lose-approach, **E**vap-cooled, **W**ater-cooled	A P C E W	A P C E W	A P C E W	A P C E W	A P C E W
Total Fan HP:	(all types)					
Fan VSD?		Y N	Y N	Y N	Y N	Y N
Pump Motor HP	(water-cooled units only)					
Pump VSD?		Y N	Y N	Y N	Y N	Y N

Display Cases	ID #:	**DC-1**	**DC-2**	**DC-3**	**DC-4**	**DC-5**
Case Length:	(LF)					
Do the cases have doors?		Y N	Y N	Y N	Y N	Y N
Anti-sweat heater control?		Y N	Y N	Y N	Y N	Y N
Lighting Type:		T12 T8 T5 LED	T12 T8 T5 LED	T12 T8 T5 LED	T12 T8 T5 LED	T12 T8 T5 LED
Watts per lamp:						
Total number of lamps:						

12. Server Rooms

Number of Hardware in Use:	Less than 3 years old	4-10 years old	11-15 years old
Servers			
Storage Devices			
Backup Devices			
Routers, switches			

Total Floor Area:	
Separate electric meter:	[Y] [N] [?]
Total electrical load: (kW)	
Number of servers with power management system installed:	
Is power management system activated:	[Y] [N] [?]
Does space have it's own conditioning:	[Y] [N] [?]
Cooling capacity: (tons)	
Lighting power density: (W/sf)	
UPS Electrical capacity:	
UPS Current load:	
Size of Backup generator on site: (MW)	

Appendix A.3: Fuel Conversion Survey

Appendix A.3-1 Summary of Results

Fuel conversion, from electricity to natural gas, is a potential option for managing energy demand within Puget Sound Energy's service territory. To examine the viability of this management strategy, The Cadmus Group conducted a survey among PSE's residential customers to determine how receptive households are to converting from electric to gas home heating at different incentive levels. Other information collected in the survey included: home size, perceptions of natural gas, likelihood of switching to a gas water heater, and a battery of segmentation questions which touched on environmental values, energy product purchasing decisions, utility service expectations, and energy use. A copy of the survey instrument is located in Appendix A.3-2.

Consumer Contact administered the survey via telephone on June 20 through July 7, 2008. The sample frame consisted of PSE residential customers that receive electricity service only. Some PSE electricity customers overlap with Cascade Natural or other natural gas provider territory, and those respondents were screened out at the beginning of the survey. A total of 1,932 households were successfully contacted and 317 responded to the full survey, yielding a response rate of 16.4 percent. Of the 1,932 contacted households, 421 (21.8 percent) were ineligible for the survey because they receive natural gas from an alternate provider. A summary of responses for each question is located in Appendix A.3-3. Basic analysis on fuel conversion potential is presented in this memo; however, the analysis can be expanded to other items as needed.

Fuel Conversion Market Potential Assessment

Before responding to questions about fuel conversion, each respondent was informed that it will cost the average homeowner $6000 to convert their heating system from electricity to gas and that it will save them approximately $600 annually on their energy bill. Respondents then answered the following question:

> "Given the cost of converting, how likely would you be to convert to [a gas heating system] for your home in the next five years?"

Response categories were based on a 5-point Likert scale, including "very likely" (5), "somewhat likely" (4), "neutral" (3), "somewhat unlikely" (2), and "very unlikely" (1). Respondents who answered 1, 2, 3, or 4, were also asked how likely they would be to switch if they were offered an incentive of $1500, $3000, $4500, or $6000 (equivalents of 25, 50, 75, and 100 percent of total conversion cost, respectively). Each respondent answered for one randomly drawn incentive level. If a respondent indicated that s/he was "highly likely" to switch without an incentive, it was assumed s/he would also switch at any incentive level.

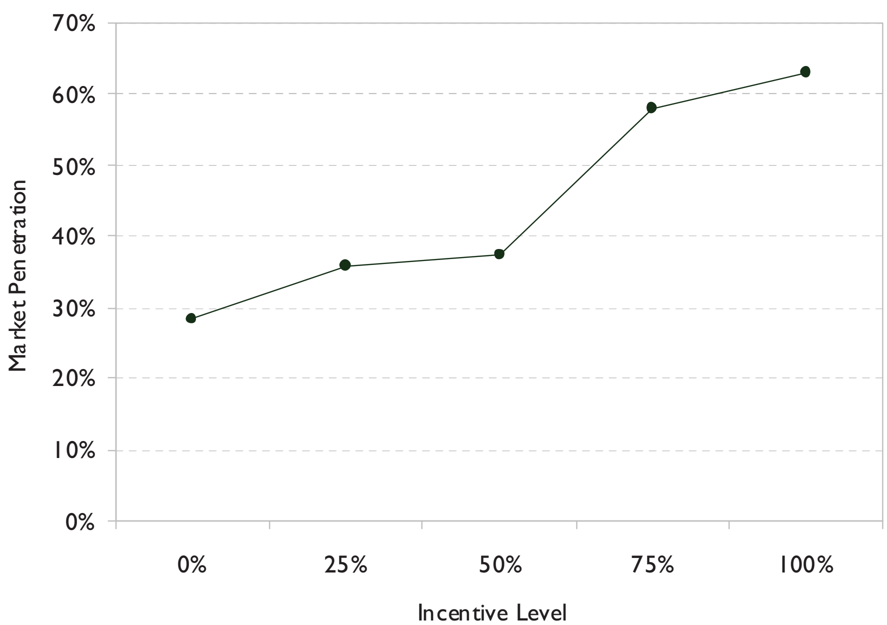
Data for the fuel conversion questions are shown in Table 1. In order to calculate the market penetration for fuel conversion, each point on the 5-point scale was assigned a probability of switching, see row 2, Table 1.

Table 1. Fuel Switching Responses At Different Incentive Levels

	5-Point Scale (Probability of Switching)						
Incentive Level	*1 (0.0)*	*2 (0.25)*	*3 (0.50)*	*4 (0.75)*	*5 (1.0)*	*Total Responses*	*Market Penetration*
None	133	47	42	25	26	273	28%
25%	23	6	11	12	4	56	36%
50%	26	12	7	14	8	67	37%
75%	13	6	15	16	19	69	58%
100%	10	7	4	11	22	54	63%

We calculated market potential by taking the weighted average of the conversion probability at each incentive level. The probability of switching is markedly higher at the 100 percent subsidy (63%) compared to no subsidy (28%). Figure 1 displays the market penetration at each incentive level.

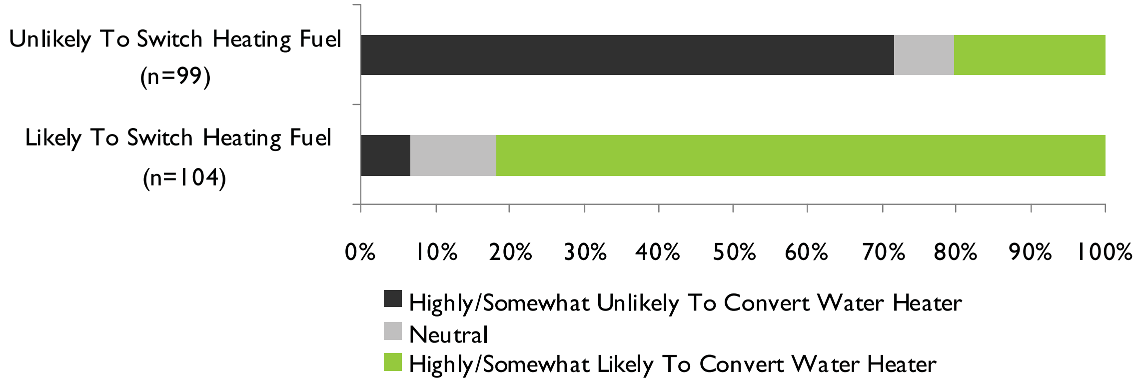
Figure 1. Market Penetration of Fuel Conversion At Different Incentive Levels



Water Heater Replacement

Homeowners who said they were highly or somewhat likely to convert their heating system indicated they would also be likely to change their hot water heater at the same time. The majority of respondents that said they were highly or somewhat unlikely to convert their heating system also indicated they would be unlikely to change their hot water heater at the same time. Figure 2 shows the likelihood of switching a gas water heat at the same time as a heating system.

Figure 2. Likeliness To Convert Water Heater At Same Time As Heating Source



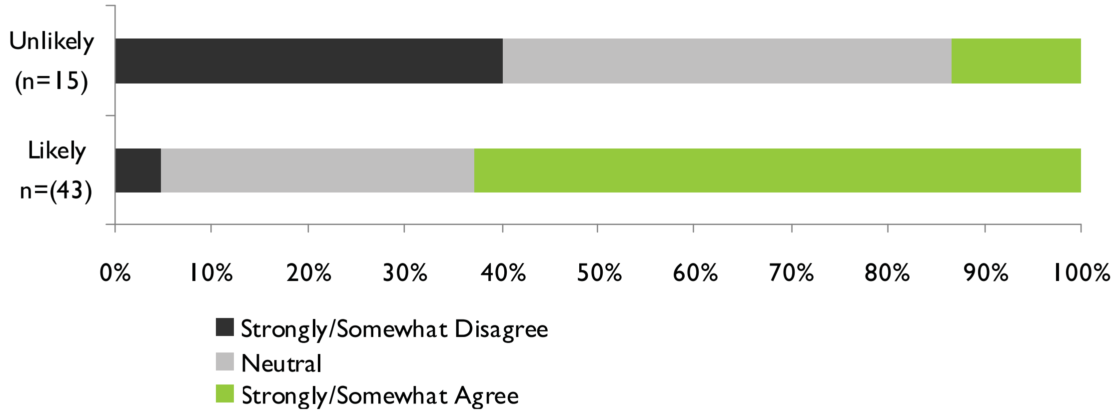
Perceptions Regarding Natural Gas

In order to examine the motivating reasons for willingness to convert fuel sources, we compared two types of respondents: those that were somewhat likely or highly likely to switch without an incentive (“Likely” group) and those that were highly unlikely or somewhat unlikely to switch with a 100 percent incentive (“Unlikely” group).

In particular, we compared the two groups’ natural gas awareness. Survey respondents were asked to rate their level of agreement with seven statements about natural gas, and the responses between the “Likely” and “Unlikely” groups were significantly different for all seven statements, as indicated by χ^2, a statistical measure of correspondence between the two groups’ responses.[1] One of the most notable differences between the two groups’ perception of natural gas was whether or not they thought it was a more economical energy source. As shown in Figure 3, the “Likely” group generally agreed that natural gas is more economical, while the “Unlikely” group disagreed or indicated neutrality.

[1] The chi-squared value and probability (p-value) is given for each statement. A p-value <0.05 is significant at the 95% confidence level. Q12_1 (χ^2 = 21.41, p=0.0003); Q12_2 (χ^2 = 26.59, p=<0.0001); Q12_3 (χ^2= 18.27, p=0.0011); Q12_4 (χ^2= 17.59, p=0.0015); Q12_5 (χ^2 = 23.34, p=0.001); Q12_6 (χ^2 = 16.68, p=0.0022); Q12_7 (χ^2 = 15.65, p=0.0035)

Figure 3. Agreement With the Statement "Natural Gas is more economical than other fuel sources."



Note: Unlikely "n" is smaller because only a quarter of the respondents were asked if they would switch with a 100 percent incentive; every respondent was asked if they would be willing to switch without an incentive.

Appendix A.3-2 Survey Instrument

Puget Sound Energy Residential Fuel Conversion Survey
June 18, 2008 FINAL

Introduction/Screening
com:[REVISED 06/18/08]

My name is ______________, and I am from Consumer Contact, calling on behalf of Puget (PEW-JIT) Sound Energy, your electricity provider. We are conducting a study to better understand whether our customers would consider switching to gas appliances when appropriate. This survey is for research purposes only and is not a marketing call. All survey results will be aggregated and only used by your utility in their planning efforts.

(Q1.) First of all, do you own your home?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

1 YES
2 NO

com:[IF Q1=1 CONTINUE,OTHERWISE TERMINATE]

~

(Q2.) Which of the following best describes your home?
(READ LIST IF NECESSARY) **com:[SINGLE MENTION]**

1 Single family detached (on a separate lot) not connected to other living units
2 Duplex or Triplex with 2 or 3 total living units (IF NECESSARY SAY "It has one adjacent wall to another residence with no units above or below")
3 Unit in Condominium or Apartment building with 4 or more attached units
4 Manufactured or mobile home

com:[IF Q2=3,4,? OR ! TERMINATE, OTHERWISE CONTINUE]

~

(Q3.) Can you verify that you are the person in your household who would be most likely to make decisions concerning appliance purchases for the home at **com:[ADDRESS FROM SAMPLE]**? (IF RESPONDENT NEEDS CLARIFICATION: "For example, if your water heater were to break down today, would you be the person who decides how to replace it?")

1 YES
2 NO (ASK TO SPEAK TO THIS PERSON OR ARRANGE CALLBACK IF NECESSARY)

com:[IF Q3=? OR ! TERMINATE, OTHERWISE CONTINUE]

~

(Q4.) Who provides your electricity service?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

(INTERVIEWER NOTE: IF RESPONDENT IS UNSURE, OFFER SUGGESTIONS SUCH AS: SNOHOMISH PUD, SEATTLE CITY LIGHT, TACOMA POWER. IF ANSWER IS GIVEN RECORD UNDER 'OTHER PLEASE SPECIFY')

1 PUGET SOUND ENERGY (PSE OR PUGET POWER)
2 OTHER (PLEASE SPECIFY): _________________

com:[IF Q4=! TERMINATE, OTHERWISE CONTINUE]

~
com:[REVISED 06/18/08]
(Q5.) What is your primary source of heating fuel?
(DO NOT READ LIST) **com:[SINGLE MENTION]**
(INTERVIEWER NOTE: READ IF NECESSARY "What fuel is used most to heat your home?")

1 NATURAL GAS
2 ELECTRIC
3 PROPANE
4 OIL
91 OTHER (PLEASE SPECIFY): _________________

com:[IF Q5=1 CONTINUE, OTHERWISE SKIP TO Q7]

~
com:[REVISED 06/18/08]

(Q6.) Who provides your natural gas service?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

1 PUGET SOUND ENERGY/WASHINGTON NATURAL GAS
2 CASCADE NATURAL GAS
3 AMERIGAS
4 FERRELLGAS
5 NORTH WEST PROPANE
6 PERMAGAS
7 SUBURBAN PROPANE
91 OTHER (PLEASE SPECIFY): _________________

com:[IF Q6=1 OR 2 OR 91 TERMINATE, OTHERWISE CONTINUE TO Q6A]

~
com:[REVISED 06/18/08]

(Q6a.) It is to my understanding that **com:[INSERT ANSWER FROM Q6]** is a propane company. Do you buy or fill a tank for fuel?

1 YES
2 NO

com:[IF YES AUTO RECODE Q5 WITH CODE 3 AND CONTINUE WITH SURVEY, OTHERWISE TERMINATE]

~
This call may be monitored or recorded for quality control purposes.
com:[REVISED 06/18/08]

(Q7.) What type of heating system does your home have?
(READ LIST) **com:[SINGLE MENTION]**

1 Central forced air heating [IF RESPONDENT IS UNSURE ASK: "Do you have a central heating unit that circulates hot air through a duct system?] **com:[INSERT HEATING TYPE "A GAS FURNACE" IN Q16-Q18]**
2 Resistance heating, such as baseboard, ceiling, floor, zone, or wall heaters **com:[INSERT HEATING TYPE "GAS WALL HEATERS" IN Q16]**
3 Portable heaters **com:[INSERT HEATING TYPE "GAS WALL HEATERS" IN Q16-Q18]**
4 Heat pump
? DON'T KNOW **com:[INSERT HEATING TYPE "A GAS HEATING SYSTEM" IN Q16-Q18]**
! REFUSED **com:[INSERT HEATING TYPE "A GAS HEATING SYSTEM" IN Q16-Q18]**

com:[IF Q7=4 SKIP TO Q19, OTHERWISE CONTINUE]
~
(Q8.) Do any of your close neighbors have gas heating and/or appliances?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

1 YES
2 NO
~
com:[REVISED 06/18/08]
(Q9.) What is the square footage of your home?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

__________(RECORD SQUARE FOOTAGE)

com:[IF ? OR ! CONTINUE, OTHERWISE SKIP TO Q11]
com:[INSERT CHECK RANGE OF MIN 300 AND MAX 8000 SQUARE FOOTAGE; ALLOW SPECIAL INPUT]

~
(Q10.) Which of the following categories do you feel best describes the square footage of your home? Your best guess is fine.
(READ LIST) **com:[SINGLE MENTION]**

1 1000 or less
2 1001-1500
3 1501-2000

4 2001-2500
5 More than 2500

~

(Q11.) How many bedrooms are there in your home?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE OR MORE

~

NG AWARENESS QUESTIONS

(Q12.) Please rate your level of agreement with the following statements about natural gas using a 5-point scale where "1" is strongly disagree and "5" is strongly agree?
(READ LIST) **com:[SINGLE MENTION FOR EACH STATEMENT]**

1	2	3	4	5	?
STRONGLY DIASAGREE				STRONGLY AGREE	DON'T KNOW

com:[RANDOMIZE]

1 Natural gas is more economical than other energy sources.
2 Natural gas heats your residence more comfortably than other heat sources.
3 Natural gas has remained more stable in price than other sources of energy over the last 3 years.
4 Natural gas is cleaner for the environment than other energy sources.
5 Natural gas improves the value of your residence.
6 Natural gas is a safe product to use for heating your residence.
7 Natural gas will be a plentiful energy source for years to come.

~

(Q13.) Have you ever considered converting your home to natural gas heating?
(DO NOT READ LIST) **com:[SINGLE MENTION]**

1 YES
2 NO

com:[IF Q13=1 CONTINUE,OTHERWISE SKIP TO Q15]

~

(Q14.) In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is "not important at all" and 5 is "extremely important", how important are the following considerations. **com:[SINGLE MENTION FOR EACH CONSIDERATION]**

(INTERVIEWER NOTE: IF NEEDED, REREAD "Please give me a number between 1 and 5 where 1 is not important at all and 5 is extremely important,")

Not important at all				Extremely Important	Don't Know
1	2	3	4	5	?

com:[RANDOMIZE]

1 Effect on the value of your home
2 Environmental friendliness
3 Effect on monthly energy bill
4 Investment to purchase new gas equipment/appliances
5 Level of comfort

~

(Q15.) What are some of the reasons that would prevent you from converting to natural gas?
(DO NOT READ) **com:[MULTIPLE MENTIONS]**

01 COST TO PURCHASE NEW GAS EQUIPMENT/APPLIANCES
02 EXPENSE OF SETTING UP NATURAL GAS SERVICE (GETTING GAS TO YOUR RESIDENCE)
03 MONTHLY ENERGY EXPENSE
04 SATISFIED WITH MY CURRENT HEAT SOURCE
05 SAFETY CONCERNS ABOUT NATURAL GAS
06 LIMITATIONS OF BUILDING STRUCTURE
07 PLAN TO MOVE SOON
91 OTHER (PLEASE SPECIFY): _________________

~

FUEL SWITCH QUESTIONS`

Assuming that it will cost the average homeowner $6000 to convert their heating system from electricity to gas and that it will save them approximately **com:[REVISED 06/19]** $600 annually on their energy bill, we would like to learn about your willingness to convert to **com:[INSERT HEATING TYPE FROM Q7]** even while your current heating system is fully operational.

(Q16.) Given the cost of converting, how likely would you be to convert to **com:[INSERT HEATING TYPE FROM Q7]** for your home in the next

five years? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.
(DO NOT READ LIST) **com:[SINGLE MENTION]**

5 HIGHLY LIKELY
4 SOMEWHAT LIKELY
3 LIKELY
2 SOMEWHAT UNLIKELY
1 VERY UNLIKELY

com:[IF Q16=5 SKIP TO Q18, OTHERWISE CONTINUE]

~
com:[REVISED 06/18/08]

(Q17.) If your utility paid **com:[RANDOM BID VALUE]** of the $6,000 cost to switch to **com:[INSERT HEATING TYPE FROM Q7]** for your home, how likely would you be to convert in the next five years? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.
(DO NOT READ LIST) **com:[SINGLE MENTION]**

5 HIGHLY LIKELY
4 SOMEWHAT LIKELY
3 LIKELY
2 SOMEWHAT UNLIKELY
1 VERY UNLIKELY

com: [INSERT RANDOM BID VALUES OF $1500, $3000, $4500, $6000]

~
com:[FOR THESE INSERTS REMOVE "A" FROM HEATING TYPE]
(Q18.) How likely would you be to convert to a gas water heater at the same time as your **com:[INSERT HEATING TYPE FROM Q7]**? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.
(DO NOT READ LIST) **com:[SINGLE MENTION]**

5 HIGHLY LIKELY
4 SOMEWHAT LIKELY
3 LIKELY
2 SOMEWHAT UNLIKELY
1 VERY UNLIKELY
0 ALREADY HAVE A GAS WATER HEATER

~

SEGMENTATION QUESTIONS

Finally, we would like to ask you some general questions that will help us in overall policy decisions. All questions need to be answered on a 10-point scale. This data will be used to compare with results we have from other surveys.

(Q19.) Now we'd like to understand how you think about using energy at your home. Using a 10-point scale where '1' means you strongly disagree, and '10' means you strongly agree, please indicate how much you agree or disagree with each of the following statements.

How much do you agree that………(READ LIST)

(INTERVIEWER: REPEAT THE SCALE AS NECESSARY.)

(INTERVIEWER: IT IS VERY IMPORTANT THAT EACH RESPONDENT PROVIDE A 1-10 RATING FOR EVERY ITEM. IF THE RESPONDENT SAYS "DON'T KNOW", PROMPT AGAIN FOR A 1-10 RATING, REPEATING SCALE AND/OR ITEM AS NECESSARY.)
com:[SINGLE MENTION FOR EACH STATEMENT]

1 STRONGLY DISAGREE	2	3	4	5	6	7	8	9	10 STRONGLY AGREE	? DK

com:[RANDOMIZE]

1 It is very important for you to find ways to control your energy costs.
2 You believe it is socially responsible to limit your use of electricity.
3 You are very concerned about the environmental effects of electricity generating plants.
4 You regularly review your home's energy usage, and constantly look for ways to save on energy costs.
5 It is just as important to conserve natural gas as it is to conserve electricity.
6 Of all the things you could do to help protect the environment, energy conservation is definitely the most important.
7 You pay a lot of attention to energy-related issues because they affect both your home and the country as a whole
8 The long-term threat from global warming and climate change is real, and potentially catastrophic

~

(Q20.) Now, I'd like to ask you how important some different factors are when you shop for energy-related products and services for your home.
Please use a scale of 1 to 10, where '1' means that factor is not at all important and '10' means that factor is extremely important when you are selecting which appliance, electronic device, or other energy-related product or service to purchase for your home.

How important......(READ LIST)

(INTERVIEWER: REPEAT THE SCALE AS NECESSARY)

(INTERVIEWER: IT IS VERY IMPORTANT THAT EACH RESPONDENT PROVIDE A 1-10 RATING FOR EVERY ITEM. IF THE RESPONDENT SAYS "DON'T KNOW", PROMPT AGAIN FOR A 1-10 RATING, REPEATING SCALE AND/OR ITEM AS NECESSARY.)

com: [SINGLE MENTION FOR EACH FACTOR]

1	2	3	4	5	6	7	8	9	10	?
NOT AT ALL IMPORTANT									EXTREMELY IMPORTANT	DK

com: [RANDOMIZE]

1 are any cost savings you might get from reduced electricity usage?
2 are any positive effects on the environment that might result from reduced energy usage?
3 are any purchase discounts that might be offered for purchasing energy efficient devices?

~

(Q21.) I'm going to read a list of different actions that people can take. Using a 10 point scale, where '1' means that action makes no contribution toward protecting the environment at all and '10' means that action makes a major contribution toward protecting the environment please tell me how much impact you think each action has.

How much of a contribution does (INSERT ITEM) make toward protecting the environment?

(INTERVIEWER: REPEAT THE SCALE AS NECESSARY.)

(INTERVIEWER: IT IS VERY IMPORTANT THAT EACH RESPONDENT PROVIDE A 1-10 RATING FOR EVERY ITEM. IF THE RESPONDENT SAYS "DON'T KNOW", PROMPT AGAIN FOR A 1-10 RATING, REPEATING SCALE AND/OR ITEM AS NECESSARY.)

(READ LIST) **com: [SINGLE MENTION FOR EACH ACTION]**

1	2	3	4	5	6	7	8	9	10	?
MAKES NO CONTRIBUTION									MAJOR CONTRIBUTION	DK

com: [RANDOMIZE]

1 Using mass transit instead of driving
2 Recycling paper, cans, bottles and plastics
3 Setting heating or cooling thermostats to use less energy
4 Driving an electric or hybrid gas-electric vehicle

5 Participating in a Green Power rates program to buy renewable energy
6 Replacing major appliances with more energy efficient ones
7 Replacing regular light bulbs and fixtures with energy efficient ones
8 Installing additional or upgraded insulation or windows

~

Finally, let's turn to the question of what you want from an energy utility company.

(Q22.) Using a 10-point scale, where '1' means not at all important, and '10' means extremely important, please indicate how important it is to you that your energy utility company do the following things, even if that meant that you had to pay a little more in order for the company to pursue these types of initiatives?

(INTERVIEWER: REPEAT THE SCALE AS NECESSARY.)

(INTERVIEWER: IT IS VERY IMPORTANT THAT EACH RESPONDENT PROVIDE A 1-10 RATING FOR EVERY ITEM. IF THE RESPONDENT SAYS "DON'T KNOW", PROMPT AGAIN FOR A 1-10 RATING, REPEATING SCALE AND/OR ITEM AS NECESSARY.)

(READ LIST) **com: [SINGLE MENTION FOR EACH ACTION]**

1	2	3	4	5	6	7	8	9	10	?
NOT AT ALL IMPORTANT									EXTREMELY IMPORTANT	DK

com: [RANDOMIZE]

1 Actively encourage its customers to participate in energy and cost saving programs.
2 Do everything possible to supply renewable, clean energy
3 Operate its business in a completely environmentally friendly manner.

~
com: [INSERT STANDARD TERMINATION PAGE]

Appendix A.3-3 Summary of Survey Responses

Table 1 - First of all, do you own your home?

Q1	Frequency	Percent
Yes	318	100.00

Table 2 - Which of the following best describes your home?

Q2	Frequency	Percent
Single family detached (on a separate lot) not connected to other living units	311	97.80
Duplex or Triplex with 2 or 3 total living units	7	2.20

Table 3 - Can you verify that you are the person in your household who would be most likely to make decisions concerning appliance purchases for the home

Q3	Frequency	Percent
Yes	318	100.00

Table 4 - Who provides your electricity service?

Q4	Frequency	Percent
Puget Sound Energy	315	99.06
Other	3	0.94

Table 5 - What is your primary source of heating fuel?

Q5	Frequency	Percent
Electric	203	27.47
Propane	10	1.35

Oil	78	10.55
Natural Gas	421	56.97
Other (Please specify)	27	3.65

If already have Natural Gas:

If Q5 = Natural Gas	Frequency	Percent
Puget Sound Energy/Washington Natural Gas	47	11.06
Cascade Natural Gas	355	83.53
Amerigas	0	0.00
Ferrellgas	1	0.24
North West Propane	0	0.00
Permagas	0	0.00
Suburban Propane	0	0.00
Other	5	1.18
Don't Know	17	4.00

Table 6 - What type of heating system does your home have?

Q7	Frequency	Percent
Central forced air heating	138	43.40
Resistance heating, such as baseboard, ceiling, floor, zone, or wall heaters	121	38.05
Portable heaters	3	0.94
Heat pump	42	13.21
Refused	1	0.31
Don't Know	13	4.09

Table 7 - Do any of your close neighbors have gas heating and/or appliances?

Q8	Frequency	Percent
Yes	147	53.26
No/None	69	25.00
Refused	2	0.72
Don't Know	58	21.01

Table 8 - What is the square footage of your home?

Q9	Frequency	Percent
Don’t Know	42	13.21
1000 or less	30	9.43
1001-1500	78	24.53
1501-2000	64	20.13
2001-2500	32	10.06
More than 2500	72	22.64

Table 9 – (If previous question “Don’t Know) Which of the following categories do you feel best describes the square footage of your home? Your best guess is fine.

Q10	Frequency	Percent
1000 or less	3	10.00
1001-1500	8	26.67
1501-2000	5	16.67
2001-2500	6	20.00
More than 2500	2	6.67
Don't Know	6	20.00

Table 10 - How many bedrooms are there in your home?

Q11	Frequency	Percent
One	6	2.17
Two	33	11.96
Three	156	56.52
Four	61	22.10
Five or More	20	7.25

Table 11 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas is more economical than other energy sources.

Q12_1	Frequency	Percent
One-Strongly Disagree	29	10.51
Two	27	9.78
Three	70	25.36
Four	51	18.48
Five-Strongly Agree	39	14.13
Refused	2	0.72
Don't Know	58	21.01

Table 12 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas heats your residence more comfortably than other heat sources.

Q12_2	Frequency	Percent
One-Strongly Disagree	33	11.96
Two	17	6.16
Three	72	26.09
Four	43	15.58
Five-Strongly Agree	37	13.41
Refused	5	1.81
Don't Know	69	25.00

Table 13 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas has remained more stable in price than other sources of energy over the last 3 years.

Q12_3	Frequency	Percent
One-Strongly Disagree	32	11.59
Two	25	9.06
Three	65	23.55
Four	33	11.96
Five-Strongly Agree	30	10.87
Refused	3	1.09
Don't Know	88	31.88

Table 14 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas is cleaner for the environment than other energy sources.

Q12_4	Frequency	Percent
One-Strongly Disagree	21	7.61
Two	30	10.87
Three	69	25.00
Four	53	19.20
Five-Strongly Agree	52	18.84
Refused	2	0.72
Don't Know	49	17.75

Table 15 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas improves the value of your residence.

Q12_5	Frequency	Percent
One-Strongly Disagree	21	7.61
Two	17	6.16
Three	71	25.72
Four	57	20.65
Five-Strongly Agree	56	20.29
Refused	5	1.81
Don't Know	49	17.75

Table 16 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas is a safe product to use for heating your residence.

Q12_6	Frequency	Percent
One-Strongly Disagree	26	9.42
Two	15	5.43
Three	43	15.58
Four	64	23.19
Five-Strongly Agree	95	34.42
Refused	3	1.09
Don't Know	30	10.87

Table 17 - Rate the following statements about natural gas using a 5-point scale where 1 is strongly disagree and 5 is strongly agree: Natural gas will be a plentiful energy source for years to come.

Q12_7	Frequency	Percent
One-Strongly Disagree	26	9.42
Two	31	11.23
Three	71	25.72
Four	39	14.13
Five-Strongly Agree	46	16.67
Refused	3	1.09
Don't Know	60	21.74

Table 18 - Have you ever considered converting your home to natural gas heating?

Q13	Frequency	Percent
Yes	149	53.99
No/None	127	46.01

Table 19 - In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is not important at all and 5 is extremely important , how important are the following considerations. Effect on the value of your home

Q14_1	Frequency	Percent
Not important at all	10	6.71
Somewhat important	10	6.71
Neutral	33	22.15
Very important	42	28.19
Extremely important	46	30.87
Don't Know	8	5.37

Table 20 - In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is not important at all and 5 is extremely important , how important are the following considerations. Environmental friendliness

Q14_2	Frequency	Percent
Not important at all	10	6.71
Somewhat important	9	6.04
Neutral	33	22.15
Very important	49	32.89
Extremely important	43	28.86
Refused	1	0.67
Don't Know	4	2.68

Table 21 - In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is not important at all and 5 is extremely important , how important are the following considerations. Effect on monthly energy bill

Q14_3	Frequency	Percent
Not important at all	5	3.36
Somewhat important	8	5.37
Neutral	25	16.78
Very important	34	22.82
Extremely important	65	43.62
Refused	1	0.67
Don't Know	11	7.38

Table 22 - In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is not important at all and 5 is extremely important , how important are the following considerations. Investment to purchase new gas equipment/appliances

Q14_4	Frequency	Percent
Not important at all	16	10.74
Somewhat important	13	8.72
Neutral	28	18.79
Very important	34	22.82
Extremely important	53	35.57
Don't Know	5	3.36

Table 23 - In deciding whether or not to switch to natural gas on a scale from 1 to 5 where 1 is not important at all and 5 is extremely important , how important are the following considerations. Level of comfort

Q14_5	Frequency	Percent
Not important at all	10	6.71
Somewhat important	5	3.36
Neutral	36	24.16
Very important	45	30.20
Extremely important	45	30.20
Refused	1	0.67
Don't Know	7	4.70

Table 24 - What are some of the reasons that would prevent you from converting to natural gas?

Q15_1	Frequency	Percent
Cost to purchase new gas equipment/appliances	112	40.58
Expense of setting up natural gas service	40	14.49
Monthly energy expense	1	0.36
Satisfied with my current heat source	13	4.71
Safety concerns about natural gas	16	5.80
Limitations of building structure	11	3.99
Plan to move soon	4	1.45
Other	76	27.54
Don't Know	3	1.09

Table 25 - What are some of the reasons that would prevent you from converting to natural gas?

Q15_2	Frequency	Percent
Cost to purchase new gas equipment/appliances	11	18.33
Expense of setting up natural gas service	24	40.00
Monthly energy expense	3	5.00
Satisfied with my current heat source	1	1.67
Safety concerns about natural gas	5	8.33
Limitations of building structure	3	5.00
Other	13	21.67

Table 26 - What are some of the reasons that would prevent you from converting to natural gas?

Q15_3	Frequency	Percent
Monthly energy expense	4	44.44
Safety concerns about natural gas	1	11.11
Limitations of building structure	1	11.11
Plan to move soon	1	11.11
Other	2	22.22

Table 27 - Given the cost of converting, how likely would you be to convert to com:[INSERT HEATING TYPE FROM Q7] for your home in the next five years? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.

Q16	Frequency	Percent
Very unlikely	133	48.19
Somewhat unlikely	47	17.03
Likely	42	15.22
Somewhat likely	25	9.06
Highly likely	26	9.42
Don't Know	3	1.09

Table 28 - If your utility paid com:[RANDOM BID VALUE] of the $6,000 cost to switch to com:[INSERT HEATING TYPE FROM Q7] for your home, how likely would you be to convert in the next five years? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.

Q17	Bid Value: $1500	Bid Value: $3000	Bid Value: $4500	Bid Value: $6000	Total
Very unlikely	23	26	13	10	72
Somewhat unlikely	6	12	6	7	31
Likely	11	7	15	4	37
Somewhat likely	12	14	16	11	53
Highly likely	4	8	19	22	53
Don't Know	1	1	2		4

Table 29 - How likely would you be to convert to a gas water heater at the same time as your com:[INSERT HEATING TYPE FROM Q7]? Please give a number between 1 to 5, where 1 is very unlikely and 5 is highly likely.

Q18	Frequency	Percent
Already have a gas heater	3	1.09
Very unlikely	70	25.36
Somewhat unlikely	15	5.43
Likely	30	10.87
Somewhat likely	41	14.86
Highly likely	111	40.22
Refused	2	0.72
Don't Know	4	1.45

Table 30 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: It is very important for you to find ways to control your energy costs.

Q19_1	Frequency	Percent
One-strongly disagree	4	1.26
Two	2	0.63
Three	5	1.57
Four	4	1.26
Five	26	8.18
Six	11	3.46
Seven	29	9.12
Eight	58	18.24
Nine	33	10.38
Ten-strongly agree	146	45.91

Table 31 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: You believe it is socially responsible to limit your use of electricity.

Q19_2	Frequency	Percent
One-strongly disagree	20	6.29
Two	7	2.20
Three	5	1.57
Four	10	3.14
Five	29	9.12
Six	13	4.09
Seven	32	10.06
Eight	58	18.24
Nine	29	9.12
Ten-strongly agree	112	35.22
Refused	1	0.31
Don't Know	2	0.63

Table 32 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: You are very concerned about the environmental effects of electricity generating plants.

Q19_3	Frequency	Percent
One-strongly disagree	35	11.01
Two	15	4.72
Three	12	3.77
Four	22	6.92
Five	51	16.04
Six	16	5.03
Seven	32	10.06
Eight	41	12.89
Nine	14	4.40
Ten-strongly agree	69	21.70
Refused	1	0.31
Don't Know	10	3.14

Table 33 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: You regularly review your home s energy usage, and constantly look for ways to save on energy costs.

Q19_4	Frequency	Percent
One-strongly disagree	9	2.83
Two	9	2.83
Three	8	2.52
Four	11	3.46
Five	38	11.95
Six	22	6.92
Seven	27	8.49
Eight	51	16.04
Nine	31	9.75
Ten-strongly agree	110	34.59
Don't Know	2	0.63

Table 34 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: It is just as important to conserve natural gas as it is to conserve electricity.

Q19_5	Frequency	Percent
One-strongly disagree	3	0.94
Two	1	0.31
Three	2	0.63
Four	5	1.57
Five	40	12.58
Six	10	3.14
Seven	28	8.81
Eight	36	11.32
Nine	25	7.86
Ten-strongly agree	158	49.69
Don't Know	10	3.14

Table 35 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: Of all the things you could do to help protect the environment, energy conservation is definitely the most important.

Q19_6	Frequency	Percent
One-strongly disagree	19	5.97
Two	4	1.26
Three	8	2.52
Four	10	3.14
Five	50	15.72
Six	24	7.55
Seven	45	14.15
Eight	60	18.87
Nine	23	7.23
Ten-strongly agree	71	22.33
Refused	1	0.31
Don't Know	3	0.94

Table 36 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: You pay a lot of attention to energy-related issues because they affect both your home and the country as a whole

Q19_7	Frequency	Percent
One-strongly disagree	3	0.94
Two	5	1.57
Three	8	2.52
Four	10	3.14
Five	33	10.38
Six	17	5.35
Seven	32	10.06
Eight	61	19.18
Nine	39	12.26
Ten-strongly agree	107	33.65
Don't Know	3	0.94

Table 37 - Where 1 means you strongly disagree, and 10 means you strongly agree, indicate how much you agree or disagree with: The long-term threat from global warming and climate change is real, and potentially catastrophic

Q19_8	Frequency	Percent
One-strongly disagree	46	14.47
Two	10	3.14
Three	14	4.40
Four	5	1.57
Five	36	11.32
Six	12	3.77
Seven	21	6.60
Eight	34	10.69
Nine	24	7.55
Ten-strongly agree	106	33.33
Refused	1	0.31
Don't Know	9	2.83

Table 38 - Use a scale of 1 to 10, where 1 means that factor is not at all important and 10 means that factor is extremely important when you are selecting which appliance, electronic device, or other energy-related product or service to purchase for your home. are any cost savings you might get from reduced electricity usage?

Q20_1	Frequency	Percent
One-not at all important	3	0.94
Two	4	1.26
Three	6	1.89
Four	5	1.57
Five	29	9.12
Six	13	4.09
Seven	32	10.06
Eight	54	16.98
Nine	36	11.32
Ten-extremely important	131	41.19
Refused	2	0.63
Don't Know	3	0.94

Table 39 - Use a scale of 1 to 10, where 1 means that factor is not at all important and 10 means that factor is extremely important when you are selecting which appliance, electronic device, or other energy-related product or service to purchase for your home. are any positive effects on the environment that might result from reduced energy usage?

Q20_2	Frequency	Percent
One-not at all important	15	4.72
Two	4	1.26
Three	10	3.14
Four	7	2.20
Five	35	11.01
Six	10	3.14
Seven	33	10.38
Eight	59	18.55
Nine	30	9.43
Ten-extremely important	106	33.33
Refused	2	0.63
Don't Know	7	2.20

Table 40 - Use a scale of 1 to 10, where 1 means that factor is not at all important and 10 means that factor is extremely important when you are selecting which appliance, electronic device, or other energy-related product or service to purchase for your home. are any purchase discounts that might be offered for purchasing energy efficient devices?

Q20_3	Frequency	Percent
One-not at all important	10	3.14
Two	4	1.26
Three	11	3.46
Four	4	1.26
Five	34	10.69
Six	16	5.03
Seven	33	10.38
Eight	59	18.55
Nine	25	7.86
Ten-extremely important	116	36.48
Refused	2	0.63
Don't Know	4	1.26

Table 41 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has:Using mass transit instead of driving

Q21_1	Frequency	Percent
One-makes no contribution	24	7.55
Two	10	3.14
Three	4	1.26
Four	8	2.52
Five	30	9.43
Six	18	5.66
Seven	29	9.12
Eight	48	15.09
Nine	37	11.64
Ten-major contribution	102	32.08
Refused	6	1.89
Don't Know	2	0.63

Table 42 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has:Recycling paper, cans, bottles and plastics

Q21_2	Frequency	Percent
One-makes no contribution	5	1.57
Two	6	1.89
Three	9	2.83
Four	1	0.31
Five	16	5.03
Six	19	5.97
Seven	25	7.86
Eight	45	14.15
Nine	38	11.95
Ten-major contribution	148	46.54
Refused	5	1.57
Don't Know	1	0.31

Table 43 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has:Setting heating or cooling thermostats to use less energy

Q21_3	Frequency	Percent
One-makes no contribution	5	1.57
Two	6	1.89
Three	2	0.63
Four	4	1.26
Five	29	9.12
Six	15	4.72
Seven	31	9.75
Eight	60	18.87
Nine	33	10.38
Ten-major contribution	120	37.74
Refused	5	1.57
Don't Know	8	2.52

Table 44 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has: Driving an electric or hybrid gas-electric vehicle

Q21_4	Frequency	Percent
One-makes no contribution	22	6.92
Two	3	0.94
Three	9	2.83
Four	5	1.57
Five	45	14.15
Six	18	5.66
Seven	41	12.89
Eight	50	15.72
Nine	33	10.38
Ten-major contribution	80	25.16
Refused	6	1.89
Don't Know	6	1.89

Table 45 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has: Participating in a Green Power rates program to buy renewable energy

Q21_5	Frequency	Percent
One-makes no contribution	18	5.66
Two	11	3.46
Three	8	2.52
Four	12	3.77
Five	38	11.95
Six	12	3.77
Seven	36	11.32
Eight	53	16.67
Nine	20	6.29
Ten-major contribution	78	24.53
Refused	6	1.89
Don't Know	26	8.18

Table 46 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has: Replacing major appliances with more energy efficient ones

Q21_6	Frequency	Percent
One-makes no contribution	5	1.57
Two	4	1.26
Three	10	3.14
Four	13	4.09
Five	40	12.58
Six	21	6.60
Seven	47	14.78
Eight	57	17.92
Nine	27	8.49
Ten-major contribution	85	26.73
Refused	5	1.57
Don't Know	4	1.26

Table 47 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has: Replacing regular light bulbs and fixtures with energy efficient ones

Q21_7	Frequency	Percent
One-makes no contribution	18	5.66
Two	6	1.89
Three	8	2.52
Four	8	2.52
Five	29	9.12
Six	24	7.55
Seven	38	11.95
Eight	62	19.50
Nine	23	7.23
Ten-major contribution	94	29.56
Refused	5	1.57
Don't Know	3	0.94

Table 48 - Where 1 means that action makes no contribution toward protecting the environment at all and 10 means that action makes a major contribution toward protecting the environment tell how much impact you think each action has: Installing additional or upgraded insulation or windows

Q21_8	Frequency	Percent
One-makes no contribution	8	2.52
Two	6	1.89
Three	8	2.52
Four	5	1.57
Five	23	7.23
Six	22	6.92
Seven	31	9.75
Eight	56	17.61
Nine	39	12.26
Ten-major contribution	110	34.59
Refused	5	1.57
Don't Know	5	1.57

Table 49 - Where 1 means not at all important, and 10 means extremely important, how important is it to you that your energy utility company do the following things, even if that meant that you had to pay a little more? Actively encourage its customers to participate in energy and cost saving programs.

Q22_1	Frequency	Percent
One-not at all important	17	5.35
Two	2	0.63
Three	6	1.89
Four	10	3.14
Five	29	9.12
Six	13	4.09
Seven	38	11.95
Eight	51	16.04
Nine	34	10.69
Ten-extremely important	110	34.59
Refused	7	2.20
Don't Know	1	0.31

Table 50 - Where 1 means not at all important, and 10 means extremely important, how important is it to you that your energy utility company do the following things, even if that meant that you had to pay a little more? Do everything possible to supply renewable, clean energy

Q22_2	Frequency	Percent
One-not at all important	14	4.40
Two	3	0.94
Three	5	1.57
Four	4	1.26
Five	28	8.81
Six	14	4.40
Seven	25	7.86
Eight	60	18.87
Nine	32	10.06
Ten-extremely important	119	37.42
Refused	7	2.20
Don't Know	7	2.20

Table 51 - Where 1 means not at all important, and 10 means extremely important, how important is it to you that your energy utility company do the following things, even if that meant that you had to pay a little more? Operate its business in a completely environmentally friendly manner.

Q22_3	Frequency	Percent
One-not at all important	15	4.72
Two	8	2.52
Three	6	1.89
Four	6	1.89
Five	39	12.26
Six	16	5.03
Seven	34	10.69
Eight	54	16.98
Nine	34	10.69
Ten-extremely important	92	28.93
Refused	7	2.20
Don't Know	7	2.20

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Appendix B: Data Development

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Appendix B.1: Commercial Measure Descriptions

Electric Non-Equipment Measures

Cooking

Convection Oven. Operates at a lower temperature and cooks more quickly than a standard oven due to fans that circulate heat evenly throughout the oven and move hot air past food. The baseline measure is a standard commercial oven.

Cooking Fryers – Commercial. Under heavy load, operates at 80% or better efficiency and, when idle, uses less than 1,000 Watts. This measure follows the 2006 CEE qualified electric deep fat fryers requirements.

Hot Food Holding Cabinets – Commercial. ENERGY STAR® hot food-holding cabinets use a maximum of 40 Watts/cubic foot less than the baseline measure, a conventional holding cabinet.[1]

Steam Cookers – Commercial. Commercial ENERGY STAR electric steam cookers have a cooking efficiency of 50%, with idle energy rates that vary depending upon pan size.[2]

HVAC Auxiliary

Automated Exhaust VFD Control – Parking Garage CO Sensor. This measure allows the ventilation system to run only when CO_2 levels are above a specified level. The ventilation system would run constantly without this measure.

Cooking Hood Controls. Utilizing sensors and two-speed or variable speed fans, hood controls reduce exhaust (and makeup) airflow when appliances are not at capacity (or have been turned off). The baseline for this measure is no hood controls.

HVAC Motors – Premium Efficiency. Premium efficiency motors are more efficient than standard efficiency motors. According to the Consortium of Energy Efficiency (CEE), premium efficiency motors are typically cost-effective in applications when they operate more then 4,000 hours a year. Payback within two years is estimated. Currently, CEE and the National Electrical Manufacturers Association (NEMA) have premium efficiency standards for manufacturers to adhere to. This measure specifically relates to HVAC motors, ranging from 1 HP to 200 HP, depending on the building size.

Motors – Pump and Fan System – Variable Speed Control. Variable speed controls allow pump and fan motors to operate at a lower speed while still maintaining the set points during partial

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1 http://www.energystar.gov/index.cfm?c=hfhc.pr_hfhc
2 http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers

load conditions. Energy is reduced when motor operation can vary with load rather than run at a constant speed.

Motors – Variable Air Volume (VAV) Box High Efficiency. High efficiency fan-powered boxes prevent hot and cold spots by maintaining room air circulation while supply-air temperature is modulated to match load. Energy is saved by re-circulating warm air from zones that have lower heating requirements to zones with greater heating requirements. An electronically commutated motor (ECM) powers the fan in each VAV box. An ECM is a brushless DC motor with all of its speed and torque controls built in electronically, which allows the motor to adjust its speed to ensure the optimal airflow at all times.[3]

Optimized Variable Volume Lab Hood Design. Allows the volumetric flow rate to vary, which causes a constant speed through the duct, regardless of sash opening. For buildings such as universities, schools, and hospitals that use lab hoods, small savings can be obtained by using a variable, rather than constant, volume lab hood. The baseline measure is a constant volume lab hood.

HVAC & Envelope

Automatic Ventilation VFD Control (occupancy/CO_2 sensors). The ventilation system automatically adjusts air flow when CO_2 levels are above a specified level. When using CO_2 control, a minimum ventilation rate is maintained at all times to control non-occupant contaminants like off-gassing from furniture, equipment, and building components. Without it, as a baseline, the ventilation system would run constantly.

Building Commissioning and Retro-Commissioning. Commissioning ensures that energy-using systems that have been installed are operating in an optimal fashion in order to maximize energy efficiency. The commissioning process can be applied to existing buildings to restore them to optimal performance. Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current operation.[4,5] The baseline measure is no commissioning. The cost for this measure is derived by taking the cost of the initial commissioning for the first year and then taking a 40% commissioning cost in each year for the life of the measure (10 years). It is feasible to only perform retro-commissioning every three years. If this step is performed the total cost of the measure would go down, which would make the measure more cost-effective than shown in this study.

Centrifugal Chiller – Variable Speed Drive (VSD) Remodel for Existing. The VSD controls the rotational speed of the chiller compressor to match the output capacity with the part load cooling while maintaining full load efficiency. Baseline for this measure is a constant speed compressor motor with inlet vane control.

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3 LEED qualified Justice Center reported by DCJ.com and Minnesota Power Incentive Program
4 http://www.green.ca.gov/CommissioningGuidelines/default.htm
5 http://cbs.lbl.gov/BPA/cct.html

Chilled Water Piping Loop with Variable speed drive (VSD) Control. A VSD controller, with two-way valves at the cooling coils, controls the chilled water pump to vary pump speed and chilled water flow to match the varying cooling load, thus reducing pumping energy requirements. The baseline is a constant speed pump with three-way valves.

Chilled Water Reset. Varies the temperature of the chilled water in a loop, allowing for an increase of water temperature as the cooling requirement decreases. The baseline measure is no chilled water reset.

Chiller Water-Side Economizer. Consists of a heat exchanger attached to a condenser water piping loop that operates when outdoor conditions can produce condenser water colder than the mixed air temperature. A water side economizer is used if an outdoor-air economizer is not practical. The baseline measure is no economizer.

Cooling DX Package Air-Side Economizer. An air-side economizer uses already cooled air (return air) mixed with a proportion of outside air to cool indoor spaces. Using the return air results in energy savings, as less air needs to be cooled.

Cooling Tower – Decrease Approach Temperature. An oversized cooling tower allows a reduced approach temperature, which saves energy. The approach temperature is the difference between the tower water leaving and the wet-bulb temperature.

Cooling Tower – Two-Speed Fan Motor. A two-speed fan cycles between off, low, and high speeds to maintain the tower set point. The low-speed setting option uses less energy than a single, high speed fan. The baseline measure is a single-speed fan motor.

Cooling Tower – VSD Fan Control. One step more sophisticated than the two-speed fan motor is the variable speed drive (VSD). A VSD modulates the air flow so the heat rejection exactly matches the load at the desired set point.

Direct Digital Control System – Install. Direct digitally controlled (DDC) systems allow for both HVAC and lighting to be controlled and monitored using an electronic or digital system. For lighting, replacing the manually operated wall switches with a digital interface allows for direct control of lights at a remote location at anytime. For HVAC, the entire system, including pumps, motors, fans, and set points, can be digitally programmed for each unit to further increase tighter control of the system.

Direct Digital Control System – Optimization. Allows for digital monitoring and control of HVAC and lighting systems. The optimization of the control system consists of upgrading a high-efficiency energy management system to a premium efficiency system.

Direct Digital Control System – Wireless Performance Monitoring. These are second-generation building automation systems that allow for wireless optimization and operation of building systems such as HVAC through computerized monitoring and control software and interfaces.

Direct/Indirect Evaporative Cooling, Pre-Cooling. A direct evaporative cooler is a low-energy system that evaporates water into the air stream, thus reducing the temperature of the air, but increasing the humidity. An indirect evaporative cooler uses a secondary air stream that is cooled by water and goes through a heat exchanger with the primary air stream, cooling the air but not affecting the humidity. A direct/indirect system cools the air stream first through an indirect cooler, and then cools it further through a direct cooler. Including an evaporative cooler before the DX system will reduce the overall cooling load.

Duct Repair and Sealing. The repair and sealing of leaky ducts creates significant energy savings by ensuring conditioned air only goes to occupied spaces, thereby reducing an excessive runtime/load on the HVAC system.

Exhaust Air to Ventilation Air Heat Recovery. Captures air that is exhausted out of a building during the heating season, which is warmer than the air outside. Transferring this heat to the incoming air lowers the overall heating load.

Exhaust Hood Makeup Air. Provides exhaust air at the hood instead of allowing the hood to exhaust the conditioned air in the room. The baseline practice is expulsion of conditioned air through exhaust hoods.

Green Roof. A green roof is a living roof that supports soil and plant growth. A series of carefully engineered layers are applied to the roof deck. These layers are watertight, lightweight, and long lasting. Green roofs can be incorporated into new buildings as long as load requirements are met. They are suited for roofs that have slopes ranging up to 20° and are most successful when sufficient attention has been paid to selecting plants that will thrive in the local climate and conditions. One of the most significant advantages is that a green roof can last up to three times longer than a standard roof. A green roof can also buffer temperature extremes, which improves a building's energy performance by dropping the temperatures on the roof 3° – 7°, resulting in approximately 12% reduction in cooling loads.

Heat Pump – Commissioning. Commissioning ensures that energy-using systems that have been installed are operating in an optimal fashion in order to maximize energy efficiency.[6] Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage.[7] The baseline measure is no commissioning. The cost for this measure is derived by taking the cost of the initial commissioning for the first year and then on a yearly basis taking a 40% commissioning cost in each year for the life of the measure (10 years). It is feasible to only perform retro-commissioning every three years and will still only involve 40% of the initial cost for commissioning. If this step is performed, the total cost of the measure would go down making the measure cost effective than it is shown in this study.

Heat Pump – Ground Source. Geothermal or ground source heat pumps (GSHP) utilize the constant temperature of the earth as the exchange medium instead of the outside air temperature that is used by Air Source Heat Pumps (ASHP). This allows higher efficiencies on the coldest

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6 http://cbs.lbl.gov/BPA/cct.html
7 http://www.green.ca.gov/CommissioningGuidelines/default.htm

nights, compared to air-source heat pumps.[8] Table B.1 shows the measure and baseline energy efficiency requirements.

Table B.1. Ground Source Heat Pump Efficiency Requirements

Measure Efficiency – GSHP	Baseline Efficiency – ASHP
COP=3.1, EER=13.4 (State Code) COP=4.0, EER=20	COP=3.2, EER=10.1

Heat Pump – Water Source. Groundwater source heat pumps use natural wells or man-made lakes to circulate water through a piping system. The water is used as a medium in the pipes to either reject or absorb heat and then is put back into the water source from which it originated.

Hotel Key Card Energy Control System. This is a key card system to control room HVAC and lighting during non-occupied periods. Occupancy is determined by the key card and/or additional sensors. The central system first sets temperature at a minimum level and turns off lighting, then gives control to the guest for temperature and lighting when the guest enters the room.

Infiltration Control (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, roof, crawlspaces, and outside walls decreases overall heating and cooling losses. Baseline and measure values are presented in Table B.2.

Table B.2. Infiltration Reduction Measures

Measure (ACH)	Baseline (ACH)
0.65	1.00

Insulation – Floor (Non-Slab). These measures represent an increase in R-value to current code levels of R-19 for the floor space (non-slab) and better. Baseline and measure values are presented in Table B.3.

Table B.3. Floor Insulation Measures

Measure	Baseline
R-10	R-0
R-19	R-10

Insulation – Ceiling. These measures represent an increase in R-value to current code values of R-21 or better. Baseline and measure values are presented in Table B.4.

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8 Description source: EERE

Table B.4. Ceiling Insulation Measures

Measure	Baseline
R-21	R-0
R-21	existing ceiling insulation
R-38	R-21
R-49	R-21

Insulation – Duct. Packaged Direct Expansion (DX) and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating the ducts reduces energy loss in the unoccupied plenum space. This measure assumes that R-0 insulation will be replaced with R-4 insulation (or that R-4 insulation will be installed), and that R-4 insulation will be replaced with R-8 (or that R-8 insulation will be installed).

Insulation – Wall. Wall insulation installed with a current code R-value of R-19 or better. Measures are based on 2x6 wall construction. Baseline and measure values are presented in Table B.5.

Table B.5. Wall Insulation Measures

Framing Type	Measure	Baseline
2x6	R-19	R-0
2x6	R-19	Existing wall insulation
2x6 Advanced	R-25	R-19

Leak Proof Duct Fittings. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time. Although the use of mastics and mechanical fasteners is becoming more widespread, a low-cost, leak-proof system will help to transform the market.

Pipe Insulation. Adding R-4 insulation around the pipes decreases temperature losses, thereby reducing demand on water heaters and chilled water systems.

Sensible and Total Heat Recovery Devices. Sensible heat recovery devices transfer energy (heat) from the return air stream back into the supply air stream, which avoids heat losses in exhausted air. This raises the incoming outdoor air temperature in the winter and cools it in the summer. Energy savings results from reduced needs for mechanical heating or cooling. Total heat devices, also called enthalpy recovery, transfer both sensible and latent heat. Latent heat significantly raises the humidity of the outdoor air in the winter and reduces it in the summer. Dehumidification in the summer can be costly and total recovery devices help reduce this.[9]

Thermostat – Programmable. A programmable thermostat controls the set point temperatures automatically, ensuring the HVAC system is not running during low-occupancy hours.

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9 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf

Turbocor Compressor. A totally oil-free compressor that incorporates leading edge thermodynamic and electronic technologies with magnetic bearing systems to achieve significantly higher efficiencies than compressors in a similar capacity range.

Windows – High-Efficiency. This measure represents an increase in building performance by reducing the U-value in existing construction and new construction windows, as shown in Table B.6.

Table B.6. High-efficiency Window Measures

Measure U-Value	Baseline U-Value
0.55	0.65
0.35	0.55

The code for either new construction or window replacement states the customer must go to code (U=0.55) at a minimum when installing new windows.

Lighting

Bi-Level Control, Stairwell Lighting. An occupancy sensor that reduces the light load by 50% when a stairwell is unoccupied for a set amount of time. The baseline is continuous operation at full power.

Daylighting Controls – Dimming-Continuous, Fluorescent Fixtures. A dimming switch allows light levels to vary from 0% – 100% brightness. A continuously dimming switch permits variation throughout the range, increasing electricity savings. The baseline measure is operating fluorescent fixtures at full power.

HE Fixtures/Design. This measure is a generic way to indicate improved lighting efficiency. The baseline lighting technology is representative of all available technologies that make up the total Watts per square foot for that particular building type. This includes all overhead lighting such as T12, T8, T5 tubes, canned CFLs, etc. The lighting reduction package measures reduce the lighting power density (W/sqft) by installing higher efficiency technologies such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc. A low reduction package results in a 15% decrease in power density and high reduction results in a 25% decrease in lighting power density. Lighting reduction packages such as T5HO (High Output) for high bay applications, in warehouse and grocery, can reduce the power density by 35%.

Hotel Key Card Energy Control System. This is a key card system to control room HVAC and lighting during non-occupied periods. Occupancy is determined by the key card and/or additional sensors. The central system first sets temperature and lighting at a minimum level then gives control to the guest for temperature and lighting when the guest enters the room.

Light-Emitting Diodes (LED) Exit Lighting. LED exit signs use a fraction of the Wattage that incandescent and compact fluorescent (CFL) signs use while lasting over 50,000 hours. The baseline measure is incandescent and CFL signs.

LED Refrigeration Case Lights. Light-emitting diodes (LEDs) are highly efficient bulbs that can be used for refrigeration case lights and exit signs, a 70% energy savings over a fluorescent bulb.

LED Solid State White Lighting Package. Light emitting diodes (LEDs) are solid-state devices that convert electricity to light, with very high efficiency and long life. Recently, lighting manufacturers have been able to produce "cool" white LED lighting indirectly, using ultraviolet LEDs to excite phosphors that emit a white-appearing light. Replacement for incandescent lamps.

Occupancy Sensor Control, Fluorescent. If a space is unoccupied for a designated amount of time, an occupancy sensor will turn off the lights. The lights will turn on again once the sensor detects a person has entered the space.

Time Clocks and Timers (Lighting). Includes an integrated time-clock that automatically switches lighting and other loads on and off on a time schedule, or in response to an occupancy sensor or a building automation system.

Lighting – Traffic

LED Pedestrian Light. Replace incandescent pedestrian light with efficient and long-lasting LED array.

LED Traffic Light. LEDs are significantly more efficient at producing light than incandescent bulbs and last for years. LED traffic lights are brighter and use significantly less energy than their incandescent counterparts.

Plug Load

Battery Charging System. Used to recharge a wide variety of cordless products, including power tools, small household appliances, and personal care products like electric shavers. An ENERGY STAR charging system uses 35% less energy than the baseline, non-ENERGY STAR battery charger.[10]

Computers. ENERGY STAR computers feature: (1) "on" mode, where the maximum allowed power varies based on the computer monitor's resolution; (2) "sleep" mode, where computer monitor models must consume 2 Watts or less; and, (3) "off" mode, where computer monitor models must consume 1 Watt or less. The baseline measure does not include these features.[11]

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10 http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers

11 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.ShowProductGroup&pgw_code=MO

Copiers. ENERGY STAR copiers deliver the same performance as conventional equipment and are, on average, 25% more efficient. They power down when not in use. The baseline measure is non-ENERGY STAR copiers.[12]

Fax. ENERGY STAR fax machines enter sleep mode after inactivity for at least 5 minutes. This reduces their total power consumption.[13]

Monitors. In "sleep" mode, the monitor consumes less than 2 Watts. The "sleep" mode needs to be enabled in order to de-energize the monitor when not in use.

Office Computer Network Energy Management. On an individual basis, the energy wasted by a computer that remains in the full-power "on" state no matter how long it remains idle is almost insignificant. But for a corporation with hundreds or thousands of workstations operating on a local area network (LAN) or a wide area network (WAN), that wasted energy can be quite significant, easily translating to tens of thousands of dollars in unnecessary electricity expenditures each year. The energy-savings potential of implementing a PC power-management policy across a LAN will vary depending on the equipment attached to the network and how that equipment is being used.

Power Supply 80+ Office Measure. Applies to the 80 PLUS performance specification requirements for power supplies in computers and servers. 80 PLUS specifies 80% or greater efficiency at 20%, 50% and 100% of rated load with a true power factor of 0.9 or greater.[14]

Printers. ENERGY STAR printers deploy a maximum time delay to sleep depending upon the size of the equipment. This reduces power consumption during periods of inactivity.[15]

Refrigerator eCube. The eCube is placed in a refrigerated area and monitors the temperature of the product and not the temperature of the air. The thermostat is connected to the compressor, which cycles on and off to maintain the set point, based on the product temperature. The cycles of the compressor are reduced because the temperature is now based on the product and not the air.[16]

Residential-Size Refrigerator/Freezer. ENERGY STAR residential grade refrigerators use at least 10% less energy than required by current federal standards and 40% less energy than conventional models sold in 2001.

Scanners. ENERGY STAR enabled scanners enter a low power "sleep" mode of less than 12 Watts within 15 minutes of inactivity.[17]

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12 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CP
13 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf
14 www.80PLUS.org
15 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf
16 http://www.senergysolution.com/sEnergySolution/eCube.aspx
17 http://www.energystar.gov.au/products/scanners.html

Vending Machines – High Efficiency. ENERGY STAR new and rebuilt refrigerated beverage vending machines are up to 40% more energy efficient than the standard model, through more efficient compressors, fan motors, lighting systems, and low-power mode options during non-use periods.[18]

Vending Miser. Senses occupancy and cycles off the cooling of the vending machine when no occupancy is detected.

Water Coolers. ENERGY STAR coolers providing only cold water consume less than 0.16 kWh per day; a unit providing both hot and cold water consumes less than 1.20 kWh per day.[19]

Refrigeration

Anti-Sweat (Humidistat) Controls. Enables the user to turn refrigeration display case anti-sweat heaters off when ambient relative humidity is low enough that sweating will not occur. Without the control, the heaters generally run continuously.

Commercial Reach-in Refrigerator (Solid Door ENERGY STAR Refrigerators/Freezers). ENERGY STAR labeled commercial solid door refrigerators and freezers are designed with high efficiency components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors. Compared to standard models, ENERGY STAR labeled commercial solid door refrigerators and freezers save energy.[20]

Compressor VSD Retrofit. Modulates motor speed in response to changes in load. When low-load conditions exist, the current to the compressor motor is decreased, slowing the compressor motor down. Baseline is a constant-speed compressor.

Custom Refrigeration System. Customized high efficiency walk-in refrigeration system combine energy efficiency measures, including: (1) a premium efficiency (EMS) system; (2) a variable speed drive (VSD) compressor; (3) a VSD condenser; (4) a VSD evaporator fan; and, (5) floating condenser head pressure controls.

Demand Control Defrost – Hot Gas. When frost collects on the evaporator, it reduces coil capacity by acting as a layer of insulation and reducing the airflow between the fins. In hot gas defrost, refrigerant vapor from either the compressor discharge or the high pressure receiver is used to warm the evaporator coil and melt the frost that has collected there.[21]

Display Cases. Refrigerated display cases achieve a higher performance efficiency and reduce overall energy consumption by incorporating hot gas defrost, anti-sweat controls, high

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18 ENERGY STAR
19 http://www.energystar.gov/index.cfm?c=water_coolers.pr_water_coolers
20 ENERGY STAR
21 Parker Refrigeration Specialists

performance evaporative fans, defrost control, improved insulation and liquid suction heat exchangers.[22]

Evaporative Condenser – High-Efficiency. In the refrigeration cycle, the condenser consumes all the input electricity to the system in order to produce cooling. A high efficiency condenser can perform the refrigeration cycle using less energy than a standard system.

Floating Head Pressure Controls. Allow more heat to be rejected through the condenser at low outside air temperatures, thereby increasing the compressor efficiency.

High Efficiency Compressors. A component of refrigeration systems, high efficiency compressors operate up to 20% more efficiently than standard-efficiency compressors.

High-Efficiency Evaporator Fans, Walk-in Refrigerators. A component of refrigeration systems, high-efficiency evaporator fan motors release less heat into the refrigerated room than conventional induction motors, reducing the energy draw by the fan motor and the compressor.

Ice Makers. High efficiency commercial ice makers use high efficiency compressors and fan motors, thicker insulation, and other measures to achieve 15% more efficiency than the baseline measure, which is a conventional automatic commercial ice maker.[23]

Motors – Case Fans with ECM Motors. The case fan is one of the components of the refrigeration system. ECM are smaller variable speed motors that operate from a single-phase power source with an electronic controller mounted in or on the motor. The baseline measure is a High-Efficiency Case Fan Motor.

Night Covers for Display Cases. Night covers help to eliminate wasted refrigeration cooling by insulating display cases. In addition, they reduce the heating load of buildings through less escaped refrigerated air needing to be reheated.

Reduced Speed or Cycling of Evaporator Fans. Allowing the evaporator fans to run less frequently or at a lower speed permits the evaporator to fit the system need, rather than run continuously at high speed. Only for new construction.

Refrigeration Commissioning or Retro-Commissioning. Commissioning ensures that refrigeration systems that have been installed are operating in an optimal fashion in order to maximize energy efficiency. Retro-commissioning is checking previously commissioned equipment to ensure that it is continuing to run efficiently. The baseline measure is no commissioning.[24] The cost for this measure is derived by taking the cost of the initial commissioning for the first year and then on a yearly basis taking a 40% commissioning cost in each year for the life of the measure (10 years). It is feasible to only perform retro-commissioning every three years and will still only involve 40% of the initial cost for

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22 OakRidge National Laboratory for the US DOE-1996

23 Consortium for Energy Efficiency (CEE)

24 http://cbs.lbl.gov/BPA/cct.html

commissioning. If this step is performed, the total cost of the measure would go down making the measure cost effective than it is shown in this study.

Refrigerator eCube. The eCube is placed in a refrigerated area and monitors the temperature of the product, not the temperature of the air. The thermostat is connected to the compressor, which cycles on and off to maintain the set point, based on the product temperature. The cycles of the compressor are reduced because the temperature is now based on the product and not the air.[25]

Special Glass Doors for Refrigerated Reach-In Cases. "Low-E," double pane thermal glass doors reduce cooling loses in refrigerated reach-in cases.

Strip Curtains for Walk-Ins. Strip curtains on walk-in refrigerators reduce the infiltration of warm air into the refrigerated space by improving the barrier between the cold space and the ambient air.

Total

Dry-Type High Efficiency Transformer. Dry type transformers have coils that are exposed to air rather than oil. Energy Star versions of these transformers offer significant savings over conventional transformers.

Water Heat

Clothes Washer – Ozonating. Disinfects water using a supply of ozone-enriched air, which suppresses subsequent biological activity and controls biological growth within the appliance, thus reducing the need to rely on hot water. The baseline measure is a standard commercial clothes washer.[26]

Clothes Washer Commercial (w/out dryer). This measure applies to laundromat type facilities where commercial grade clothes washers are used. Energy can be saved by using ENERGY STAR clothes washers.

Demand-Controlled Circulating Systems. A demand-controlled circulating system only circulates hot water when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwashing – Commercial – Chemical. Sanitizes dishes with chemicals, rather than hot water, allowing for a lower water temperature. The baseline is a standard commercial dishwasher.

Dishwashing – Commercial – High Efficiency. Dishwashers with a minimal idle rate as well as a minimal amount of water consumption per rack of loaded dishes depending upon size and type.

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[25] http://www.senergysolution.com/sEnergySolution/eCube.aspx
[26] http://www.patentstorm.us/patents/6607672-description.html

Dishwashing – Residential Sized System. Residential sized dishwashing systems are often more appropriate for smaller commercial buildings. The smaller size leads to energy savings.

Drain Water Heat Recovery (Power-Pipe) – Heat Recovery Water Heater. Drain water heat recovery devices recover heat energy from drain water and are used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the entering water temperature.[27]

Faucet Aerators. Faucet aerators, by mixing water and air, reduce the amount of water that flows through the faucet. The faucet aerator creates a fine water spray through an inserted screen in the faucet head. Flow rate requirements for this measure are presented in Table B.7.

Table B.7. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
1.5	2.5
2.5	4.0

* Gallons per minute

Heat Pump Water Heater. The water heating heat pump moves heat from a warm reservoir (such as air) and transfers this heat into the hot water system. The system employs an evaporator, compressor, condenser, expansion valve, hot water circulating pump, and controls to accomplish this function.[28]

Hot Water Supply Pipe Insulation. R-4 insulation added around hot water pipes decreases heat loss. Only for existing construction. The baseline measure is no insulation.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead. Flow rate requirements for this measure are presented in Table B.8.

Table B.8. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.0	2.5
2.5	4.5

Low-Flow Spray Heads. Low-flow spray heads mix water and air to reduce the amount of water that flows through the spray head. The spray head creates a fine water spray through an inserted screen in the spray head, achieving a flow reduction of nearly 50%, from a flow rate of 1.6 GPM to 3.0 GPM.

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27 www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

28 Description source: U.S. Department of Energy

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn on and off faucet water when motion is detected at the sink. This eliminates the water running continuously while washing hands.

Water Heater Thermostat Setback. This measure generates savings by reducing the set point temperature from 130° to 115°. Often, the set point temperature on a hot water system is set higher than necessary.

Electric Equipment Measures

Direct Expansion Packaged Air Conditioner System. Direct Expansion (DX) system use a refrigerant piping circuit, compressor, and refrigerant coils to transfer heat. All components are in a single package typically installed on the building roof. As a measurement of efficiency, commercial sized units are normally rated as Energy Efficient Ratio (EER). Table B.9 displays the different models compared in this measure.

Table B.9. DX AC Unit EER Comparisons

Measure EER	Baseline EER
11.0	10.3 (state code)
11.5	10.3 (state code)
12.0	10.3 (state code)

Heat Pump – Air Source. Air source heat pumps use a Coefficient of Performance (COP) ratio of the cooling effect produced (expressed in Btu/hr), divided by the energy input (expressed on the same basis and as an EER Ratio).[29] These units use the difference between outdoor air temperatures and indoor air temperatures to cool and heat your building. Table B.10 displays the different models compared in this measure.

Table B.10. Heat Pump COP/EER Comparisons

Measure COP & EER	Baseline COP & EER
3.5 (COP) & 11.0 (EER)	3.2 (COP) & 10.1 (EER) (code)
3.8 (COP) & 11.8 (EER) (code)	3.2 (COP) & 10.1 (EER) (code)

Water-Cooled Chiller, Screw Chiller. Screw compressors are positive displacement devices. The refrigerant chamber is actively compressed to a smaller volume by the twisting motion of two interlocking, rotating screws. Refrigerant trapped in the space enclosed between the two rotating screws is compressed as it makes its way from the inlet to the outlet of the compressor. A slide valve is used to adjust the compression effect by varying the amount of compression that occurs before the refrigerant is discharged. Screw chillers are generally used for small- to medium-sized buildings. This unit uses water to cool the refrigerant.

29 http://tristate.apogee.net/cool/cfmec.asp

Table B.11. Screw Chiller kW/ton Comparison

Measure kW/ton	Baseline kW/ton
0.461	0.634 (state code replacement)
0.507	0.634 (state code replacement)
0.574	0.634 (state code replacement)

Gas Non-Equipment Measures

Cooking

Broiler. A type of oven unit, ENERGY STAR broilers have a rigorous start-up/shutdown and turndown schedule for additional energy savings over standard units. Improved efficiency broilers have an efficiency of 34%, compared to baseline models at 15%.

Convection Oven. Operates at a lower temperatures and achieves quicker cook times than a standard oven, due to fans that circulate heat evenly throughout the oven by moving hot air past the food. The baseline measure is a standard commercial oven.

Conveyor Oven. A high efficiency conveyor oven has 23% efficiency; in comparison, a standard conveyor oven has 15% efficiency.

Fryers – Commercial Gas Cooking. ENERGY STAR-rated gas fired fryers meet at least a minimal efficiency of 50% and a maximum idle rate of no more than 9,000 Btu/hr. The ENERGY STAR model is being compared to a standard fryer with an efficiency of 35%.

Griddle. ENERGY STAR griddles are at least 40% efficient and on average use less than 0.25 therm/hour. The baseline measure is a standard grill at 32% efficiency.[30]

Power Burner Oven. Generally, the unit incorporates a larger burner and is often sold on range-oven combination units. This burners mixes a greater percentage of air to the gas to increase the overall combustion efficiency of the burner.

Steam Cooker. ENERGY STAR commercial gas steam cookers must be 38% efficient, while also meeting a maximum idle rate that is based on pan size for each unit. The baseline measure is a steam cooker at 30% efficiency.

HVAC & Envelope

Automatic Ventilation VFD Control (occupancy/CO_2 sensors). The ventilation system automatically adjust air flow when CO_2 levels are above a specified level. When using CO_2 control, a minimum ventilation rate is maintained at all times to control non-occupant

[30] www.energystar.org

contaminants like off-gassing from furniture, equipment and building components. Without it, as a baseline, the ventilation system would run constantly.

Boiler – Commissioning. Commissioning ensures that the boiler unit is properly installed, adequately sized, and operated in an optimal fashion in order to maximize energy efficiency. Some measures that are considered include turbulators, heat recovery systems, pipe insulation, out door air re-set controls, and a stack damper.[31] The baseline measure is no commissioning.

Boiler – Direct Digital Control (DDC) System-Installation. DDC controls replace manual and electromechanical controls to allow for tighter control of the boiler system. These controls include demand control ventilation, which controls air quantities based on demand, resets supply air temperature to reduce reheat energy, and employs optimal start up and setback control points.[32]

Boiler – Direct Digital Control System-Optimization. Optimizing a boiler DDC system verifies that control setpoints and general operation of the unit are working properly. This measure can be applied in both new and existing applications.

Boiler – Direct Digital Control System – Wireless Performance Monitoring. Second-generation building automation systems that allow for wireless optimization and operation of building systems such as HVAC through computerized monitoring and control software and interfaces.

Boiler – Retro-Commissioning. The commissioning process is applied to existing buildings to restore them to optimal performance. Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage.[33] The baseline measure is no commissioning on existing equipment. The cost for this measure is derived by taking the cost of the initial commissioning for the first year and then on a yearly basis taking a 40% commissioning cost in each year for the life of the measure (10 years). It is feasible to only perform retro-commissioning every three years and will still only involve 40% of the initial cost for commissioning. If this step is performed, the total cost of the measure would go down making the measure cost effective than it is shown in this study. This change could potentially make the measure pass a cost effectiveness screen and would raise the total estimate for the total economic potential.

Boiler Economizer. Recovers heat energy that would otherwise be lost out the boiler stack. This heat energy is recovered by using a heat exchanger located on the stack to heat boiler feed water.[34]

Duct Repair and Sealing. The repair and sealing of leaky ducts creates significant energy savings by ensuring that conditioned air only goes to occupied spaces, therefore reducing an

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31 http://www.pse.com/solutions/businessPDFs/08_3966_GasBoilerTuneup.pdf

32 http://www.oee.nrcan.gc.ca/publications/infosource/pub/ici/eii/pdf/m92-242-2002-3E.pdf

33 http://www.green.ca.gov/CommissioningGuidelines/default.htm

34 http://crownsolutions.com/news_september05.html

excessive runtime/load on the HVAC system. Only for existing construction, and applicable to buildings using packaged DX equipment or heat pumps.

Exhaust Air to Ventilation Air Heat Recovery. The air that is exhausted out of a building during the heating season will be warmer than the air outside. Capturing some of this heat and transferring it to the incoming air lowers the overall heating load.

Exhaust Hood Makeup Air. Provides exhaust air at the hood instead of allowing the hood to exhaust the conditioned air in the room. The baseline measure is for conditioned air to be expelled through exhaust hoods.

Existing Windows. This measure replaces an assumed existing window value for the region with a more efficient window.

Furnace – Commissioning & Retro-Commissioning. Commissioning ensures that energy-using systems that have been installed are operating in an optimal fashion in order to maximize energy efficiency. The commissioning process can be applied to existing buildings to restore them to optimal performance. Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage.[35] The baseline measure is no commissioning. The cost for this measure is derived by taking the cost of the initial commissioning for the first year and then on a yearly basis taking a 40% commissioning cost in each year for the life of the measure (10 years). It is feasible to only perform retro-commissioning every three years and will still only involve 40% of the initial cost for commissioning. If this step is performed, the total cost of the measure would go down making the measure cost effective than it is shown in this study. This change could potentially make the measure pass a cost effectiveness screen and would raise the total estimate for the total economic potential.

Infiltration Control (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, roof, crawlspaces, and outside walls decreases overall heating and cooling losses. Baseline and measure air changes/hour (ACH) values are presented in Table B.12.

Table B.12. Infiltration Reduction Measures

Measure (ACH)	Baseline (ACH)
0.65	1.00

Insulation – Floor (Non-Slab). These measures represent an increase in R-value to current code levels of R-19 for the floor space (non-slab) and better. Baseline and measure values are presented in Table B.13.

35 http://www.green.ca.gov/CommissioningGuidelines/default.htm

Table B.13. Floor Insulation Measures

Measure	Baseline
R-10	R-0
R-19	R-10

Insulation – Ceiling. These measures represent an increase in R-value to current code values of R-21 or better. Baseline and measure values are presented in Table B.14.

Table B.14. Ceiling Insulation Measures

Measure	Baseline
R-21	R-0
R-21	Existing ceiling insulation
R-38	R-21
R-49	R-21

Insulation (Duct) (Unconditioned Spaces). Packaged Direct Expansion (DX) and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating the ducts reduces energy loss in the unoccupied plenum space. This measure assumes that R-0 insulation will be replaced with R-4 insulation (or that R-4 insulation will be installed), and that R-4 insulation will be replaced with R-8 (or that R-8 insulation will be installed).

Insulation – Wall. Wall insulation installed with a current code R-value of R-19 or better. Measures are based on 2x4 or 2x6 wall construction. Baseline and measure values are presented in Table B.15.

Table B.15. Wall Insulation Measures

Framing Type	Measure	Baseline
2x6	R-19	R-0
2x6	R-19	Existing wall insulation
2x6 Advanced	R-25	R-19

Integrated Space Heating/Water Heating. Integrated hot water heating systems provide both space conditioning and hot water heating with one appliance or energy source. Water is heated directly and space heating is accomplished with a hot water heat exchanger coil piped to the forced air heating system. Thus, a combination space/water heating system can provide high efficiency hot water heating and space heating for the cost of one high efficiency appliance.

Leak Proof Duct Fittings. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time. Although the use of mastics and mechanical fasteners is becoming more widespread, a low-cost, leak-proof system will help to transform the market.

Sensible and Total Heat Recovery Devices. Sensible heat recovery devices transfer energy (heat) from the return air stream back into the supply air stream, avoiding wasting heat in exhausted air. This raises the indoor air temperature in the winter and cools it in the summer. Energy savings results from reduced needs for mechanical heating or cooling. Total heat devices, also called enthalpy recovery, transfer both sensible and latent heat. Latent heat significantly raises the humidity of the incoming outdoor air in the winter and reduces it in the summer. Dehumidification in the summer can be costly and total recovery devices help reduce this.[36]

Steam Pipe Insulation. Insulation of pipes from R-0 to R-4 prevents pipe losses from transferred heat. The size of the loss depends on the diameter of the pipe and the pressure of steam in PSI.

Steam Trap Maintenance. Prevents the dirt created from chemical treatments and or pipe scaling from plugging the trap. In most cases, plugging prevents the valve from closing, allowing live steam to escape into the condensate return line or atmosphere, wasting energy.[37]

Thermostat – Programmable. A programmable thermostat controls the set point temperatures automatically. As temperatures can be set separately for low occupancy hours, the HVAC system does not run needlessly.

Windows. Increases building performance by reducing the U-value in existing construction and new construction windows, as shown in Table B.16.

Table B.16. High-Efficiency Window Measures

Measure U-Value (SHGC)	Baseline U-Value (SHGC)
0.55	0.65
0.35	0.55

The code for either new construction or window replacement states the customer must go to code (U=0.55) at a minimum when installing new windows.

Pool Heat

Swimming Pool/Spa Covers. Covers a pool/spa to reduce evaporation, which is the largest source of pool/spa energy loss. It takes 1 Btu (British thermal unit) to raise 1 pound of water 1°, but each pound of 80ºF water that evaporates takes 1,048 Btu of heat out of the pool.[38] The baseline measure is an uncovered pool or spa.

Water Heat

Chemical Dishwashing System. Sanitizes dishes with chemicals, rather than hot water, allowing for a lower water temperature. The baseline measure is a standard commercial dishwasher.

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36 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf
37 http://www.steamtraptesting.com/
38 http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13140

Clothes Washer – Ozonating. Disinfects water using a supply of ozone-enriched air, which suppresses subsequent biological activity as well as controls biological growth within the appliance, thus reducing the need to rely on hot water. The baseline measure is a standard commercial clothes washer.[39]

Clothes Washer Commercial (without Dryer). This measure applies to laundromat-type facilities where commercial grade clothes washers are used. Energy can be saved by using ENERGY STAR clothes washers.

Demand Controlled Circulating Systems. A demand-controlled circulating system only circulates hot water when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwashing – Commercial – High Efficiency. Dishwashers with a minimal idle rate as well as a minimal amount of water consumption per rack of loaded dishes depending upon size and type.

Dishwashing – Residential-Sized System. Residential-sized dishwashing systems are often more appropriate for smaller commercial buildings. The smaller size leads to energy savings.

Drain Water Heat Recovery (Power-Pipe) – Heat Recovery Water Heater. Drain water heat recovery devices recover heat energy from drain water and are used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the entering water temperature.[40]

Faucet Aerators. Faucet aerators, by mixing water and air, reduce the amount of water that flows through the faucet. The faucet aerator creates a fine water spray with a screen that is inserted in the faucet head. Flow rate requirements for this measure are presented in Table B.17.

Table B.17. Faucet Aerator Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
1.5	2.5
2.5	4.0

Hot Water Pipe Insulation. Adding R-4 insulation around the pipes for the storage hot water system will decrease heat loss.

Integrated Space Heating/Water Heating. Integrated hot water heating systems provide both space conditioning and hot water heating with one appliance or energy source. Water is heated directly and space heating is accomplished with a hot water heat exchanger coil piped to the forced air heating system. Thus, a combination space/water heating system can provide high efficiency hot water heating and space heating for the cost of one high efficiency appliance.

[39] http://www.patentstorm.us/patents/6607672-description.html

[40] www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

Low-Flow Showerheads. Low-flow showerheads, by mixing water and air, reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead. Flow rate requirements are presented in Table B.18.

Table B.18. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.0	2.5
2.5	4.5

Low-Flow Spray Heads. Low-flow spray heads use the same principle as faucet aerators to achieve a flow reduction of nearly 50%, lowering the flow rate to 1.6 GPM from 3.0 GPM.

Refrigeration with Heat Recovery. Commercial walk-in refrigerators are normally equipped with their own compressor/condenser package, which is cooled to remove the heat generated by the vapor compression refrigeration cycle. Typically, this heat is released into the environment. Where the equipment is water-cooled, that heat can be recaptured for useful purposes like domestic water heating.[41]

Tankless Water Heater – Commercial. Tankless water heaters provide hot water at a preset temperature when needed without storage, thereby reducing or eliminating standby losses. An energy factor of 0.82 was used for the tankless system and compared to an existing tank with 80% thermal efficiency.

Tankless Water Heater – Residential. Tankless water heaters provide hot water at a preset temperature when needed without storage, thereby reducing or eliminating standby losses. An energy factor of 0.82 was used for the tankless system and compared to an energy factor of 0.59.

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn on and off faucet water when motion is detected at the sink. This eliminates the water running continuously while washing hands.

Water Heater Thermostat Setback. This measure generates savings by reducing the set point temperature from 130° to 115°. Often, the set point temperature on a hot water system is set higher than necessary.

Gas Equipment Measures

Gas Boiler – Greater than 300 kBtuh. Boilers are classified as condensing and non-condensing. Condensing boilers condense the flue gas and water vapor, extracting useful heat and improving the boiler efficiency. Boilers are also rated by their input fuel consumption, or in terms of horsepower, where 1 boiler hp = 33,520 Btuh. This measure compares several boilers with different thermal efficiencies and is applicable to both new and existing construction. The overall efficiency of the boiler is defined as the gross output energy divided by the input energy and is

[41] http://www.oee.nrcan.gc.ca/publications/infosource/pub/ici/eii/m92-242-2002-6e.cfm?attr=24

affected by combustion efficiency, standby losses, cycling losses and heat transfer. Table B.19 displays the different thermal efficiencies being compared in this measure.[42]

Table B.19. Gas Boiler Thermal-Efficiency Comparison

Measure Thermal Efficiency	Baseline Thermal Efficiency
85%	80% (state code)
90%	80% (state code)

Gas Boiler – Less than 300 kBtuh. The National Energy Policy Act of 1992 mandates that all boiler manufacturers must meet the requirements of ASHRAE Standard 90.1. Boilers less than 300 kBtuh are rated using an Annual Fuel Utilization Efficiency (AFUE). AFUE measures the amount of heat actually delivered to the amount of fuel consumed during the heating season; sometimes referred to as the seasonal efficiency. Table B.50 displays the different AFUE values compared in this measure.

Table B.20. AFUE Gas Boiler Comparison

Measure AFUE	Baseline AFUE
AFUE 85%	AFUE 80%
AFUE 90%	

Gas Furnace. Similar to the small gas boiler measure, this furnace measure also compares several different AFUE values amongst different units. Table B.21 displays the different AFUE values compared in this measure.

Table B.21. Gas Furnace AFUE Comparison

Measure AFUE	Baseline AFUE
AFUE 90%	AFUE 80% (state code)
AFUE 94% (condensing)	

Water Heaters. Gas water heaters have a range of thermal efficiencies. Table B.52 displays the different efficiencies compared and their baselines.

Table B.22. Commercial Gas Water Heater Comparison

Measure Energy Factor	Baseline Energy Factor
0.67	0.59 (state code)
0.90 (condensing)	

[42] http://www.newbuildings.org/downloads/guidelines/BoilerGuideline.pdf

Passive Renewable Measures

Smart Siting. For new construction only, this measure analyzes the optimal building orientation to minimize heating and cooling load on the HVAC system.

Solar Pool Heating. A solar pool heater is generally mounted on the roof of a building and is designed to use the sun to directly heat water rather than electricity or gas. Note that this is a passive process, not one that involves photovoltaic cells.

Solar Water Heating. A solar water heater is generally mounted on the roof of a building and is designed to use the sun indirectly to heat water through a heat exchanger, rather than electricity or gas. Note that this is a passive process, not one that involves photovoltaic cells.

Thermal (Trombe) Wall. Thermal walls slow heat movement by slowing convectional currents that occur in walls. This keeps buildings warmer in the winter and cooler in the summer.

Window Overhang. Overhangs shade windows, reducing solar heat gains and the overall cooling load on the home.

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Appendix B.2: Residential Measure Descriptions

Electric Non-Equipment Measures

Cooking

Convection Oven. Operates at lower temperatures and achieves quicker cook times than a standard oven, due to fans that circulate heat evenly throughout the oven by moving hot air past the food. The baseline is a standard commercial oven.

HVAC Aux

ECM Motor. Electronically commutated motors (ECM) consume less power than a standard motor. The cost difference for operating the ECM motor ranges from about 30% lower during high flow rate conditions to about 70% lower during turndown. For existing construction, ECM motors have a technical feasibility of 65% for cooling and varying amounts for HVAC auxiliary (gas or electric heating as the primary fuel). This 65% feasibility for cooling (Central AC) could be underestimating the total potential for this specific application. One reason for the lower feasibility for HVAC auxiliary measures is to account for the percentage of homes that currently use this type of equipment to heat their homes. Typically this is taken into account in equipment fuel shares and saturations, but because of the HVAC auxiliary end use these factors had to be taken into account in the technical feasibility.

VSD Fan. Controls the rotational speed of a piece of motor-driven equipment, through adjusting the frequency of the voltage applied to the motor. Baseline for this measure is a constant speed fan motor.

HVAC & Envelope

Advanced Cold Climate Heat Pump. Cold-climate heat pumps are air-to-air heat pumps that have been optimized for colder climates. The performance of these heat pumps is expected to be approximately the same as ground-source heat pumps (GSHP).

Blinds – Fixed Angle/Automatic. A covering for a window or door, usually attached to the interior side of a window that reduces sunlight, thus blocking unwanted heat from the summer sun and holding in heat in cold weather. Automatic blinds adjust to the appropriate angle at the appropriate time, and make hard to reach blinds accessible for adjustment. The baseline for this measure is no interior blinds.

Canned Lighting Air-Tight Sealing. Proper sealing around recessed lighting fixtures prevents unwanted heat loss through these air spaces due to air pressure differentials in conditioned and unconditioned spaces in homes. The baseline is no sealing.

Ceiling Fan. ENERGY STAR®-qualified ceiling fans use improved motors and blade designs, allowing the user to decrease the thermostat a couple of degrees yet still feel at least 5° cooler. The fans do not create cooler temperatures. The kit does not include light fixtures; all savings are associated with the improved fan design.

Check Me! O&M Tune Up. For central air conditioning systems, the Check Me! procedures for certified maintenance will improve overall efficiency. Proper system tune-up/maintenance ensures that both refrigerant charge and airflow through the evaporator coil are properly tested and correctly adjusted – two factors that affect system efficiency. Maintenance includes changing filters and cleaning coils to maintain the overall performance and efficiency of the unit.

Doors – R-5. Composite doors with a foam core increase overall insulation, which slows heat loss. This measure includes adding a thermal door with a resistance value of R-5 to houses with neither thermal nor storm doors.

Doors – R-11. A steel door with a polyurethane foam core offers an insulating value of about R-11. The steel surface holds up well to normal wear and tear, and any dents can be repaired easily with auto-body putty.

Doors – Weatherization. To minimize infiltration door sweep, weather stripping mounts to the bottom of the door. It consists of an extruded aluminum strip that holds a flexible vinyl strip to block the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Location. In many homes, ducts are run through unconditioned areas such as attics, garages, crawlspaces, and basements for convenience and practical reasons. Ducts in unconditioned areas lose energy because of large temperature differences between conditioned air in the ducts and the surrounding space. Locating ducts in conditioned spaces helps to reduce wasted heat loss.[43]

Duct Repair and Sealing. Duct sealing cost effectively saves energy, improves air and thermal distribution (comfort and ventilation), and reduces cross contamination between different zones in the building (i.e., smoking vs. non-smoking, bio-aerosols, localized indoor air pollutants).

Duct Sealing – Aerosol Based. A significant amount of energy use in residential buildings is associated with duct losses due to leakage. This is an aerosol duct-sealing technology that seals holes in ducts up to ¼" in diameter from the inside by spraying atomized latex aerosol into a pressurized duct system.

Ductless Mini-Split REM. Ductless heat pumps, similar to mini-split systems, are used to provide heating and cooling to multiple zones without duct-work. A ductless heat pump stores the compressor outside and pipes the refrigerant to the individual units located in each zone/room inside where the heating or cooling takes place. Energy is saved by eliminating duct losses.

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43 http://www.toolbase.org/pdf/techinv/ductsinconditionedspace_techspec.pdf

Evaporative Space Cooling. A direct evaporative cooler is a low-energy system that evaporates water into the air stream, thus reducing the temperature of the air, but increasing the humidity. An indirect evaporative cooler uses a secondary air stream that is cooled by water and goes through a heat exchanger with the primary air stream, cooling it but not affecting the humidity. A direct/indirect system will cool the air stream first through an indirect cooler, then cool it further through a direct cooler.

Heat Pump – Ground or Water-Source – Open Loop. Ground-source heat pumps use the natural heat storage capacity of the earth or ground water to provide energy efficient heating and cooling. In an open loop application, the system draws well water for use as the heat source or heat sink and, after use, returns the well water to a drainage field or another well. This measure compares an efficient model with a Energy Efficient Ratio (EER) of 16.2 and a Coefficient of Performance (COP) of 3.6 to the baseline model air-source heat pump with a 11.3 EER and 3.2 COP. [44]

Heat Pump – Ground or Water-Source – Closed Loop. In a closed-loop or earth-coupled loop, the system uses a water and antifreeze solution that is circulated in a ground loop of pipes to extract heat from the earth. Ground loops can be installed in a vertical well or a horizontal loop. Vertical wells are usually more expensive and used where space is limited. This measure compares several models to the baseline systems and is summarized in Table B.23.[45]

Table B.23. Closed Loop Heat Pump Comparison

Measure EER/COP	Baseline EER/COP
14.1 EER/3.3 COP	11.3 EER/3.2 COP
16.2 EER/4.1 COP	11.3 EER/3.2 COP

Heat Pump – Proper Sizing. Properly sized heat pumps operate for long periods of time (rather than frequently cycling on and off), resulting in optimum equipment operating efficiency and better control.[46]

ICF Construction. Building a concrete home with insulating concrete forms (ICFs) saves energy and money. The greater insulation, tighter construction, and temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Infiltration Control (Caulk, Weather Strip, etc.). Filling gaps in windows with synthetic filler prevents drafts and heating/cooling loss.

Insulation (Basement – Wall) 2x4. Adding insulation to the basement or crawlspace walls increases the thermal performance of the concrete foundation. Only for existing homes. Table B.24 summarizes the different resistance values compared in the measure.

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44 http://www.toolbase.org/Technology-Inventory/HVAC/geothermal-heat-pumps
45 http://www.toolbase.org/Technology-Inventory/HVAC/geothermal-heat-pumps
46 http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice

Table B.24. Wall R-Value Comparison

Measure Insulation	Baseline Insulation
R-13 (state code)	R-0
R-13 (state code)	R-7 existing wall
R-13 + R-5	R-13

Insulation (Ceiling). This measure represents an increase in R-value. Adding insulation in existing buildings increases the thermal performance and brings the resistance value up to and past code, depending on vintage. Table B.25 summarizes the different resistance values compared in the measure.

Table B.25. Ceiling R-Value Comparison

Measure Insulation	Baseline Insulation
R-38	R-9
R-38	R-19
R-49	R-38

Insulation (Duct). Adding insulation around the ducts in the heating system reduces heat loss to unconditioned spaces. Table B.26 summarizes the different resistance values compared in the measure.

Table B.26. Duct R-Value Comparison

Measure Insulation	Baseline Insulation
R-8	R-0
R-8	R-4

Insulation (Floor). Adding insulation to the floor increases the overall resistance value and slow heat transfer from the basement to the upper levels. Table B.27 summarizes the different resistance values compared in the measure.

Table B.27. Floor R-Value Comparison

Measure Insulation	Baseline Insulation
R-30	R-0
R-30	R-20 existing floor
R-38	R-30

Insulation (Rim and Band Joist). An un-insulated band joist can account for a significant portion of a building's heat loss, as the only thing separating inside from outside is 2 inches of wood and the siding material covering it. The heat loss through an un-insulated band joist increases when the basement is kept warmer, or contains heating or water heating equipment. Insulating a band joist is an easy way to improve a building's energy efficiency. The baseline is no insulation.

Insulation (Slab). A substantial amount of heat is lost through an un-insulated slab, resulting in cold, uncomfortable floors. Even if the foundation wall is insulated vertically under the slab, significant heat is still lost from the slab edge that is closest to the cold outside air. Table B.28 compares the different slab insulations for this measure.

Table B.28. Slab Insulation Measures

Measure Insulation	Baseline Insulation
R-10	R-0
R-10	Existing wall insulation R-7
R-15	R-10

Insulation (Wall) 2x4. Wall insulation can help slow the transfer of heat and reduce both the heating and cooling loads in houses. Table B.29 compares the different insulations for 2x4 framing.

Table B.29. 2x4 Wall Insulation Measures

Measure Insulation	Baseline Insulation
R-13	R-0
R-13	Existing wall insulation R-8
R-13 + R-5 Sheathing	R-13

Insulation (Wall) 2x6. Wall insulation can help slow the transfer of heat and reduce both the heating and cooling loads in houses. Table B.30 compares the different insulations for 2x6 framing.

Table B.30. 2x6 Wall Insulation Measures

Measure Insulation	Baseline Insulation
R-21	R-0
R-21	Existing wall insulation R-8
R-21 + R-5 Sheathing	R-21 (State Code)

Leak Proof Duct Fittings. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time. Although the use of mastics and mechanical fasteners is becoming more widespread, a low-cost, leak-proof system will help to transform the market.

Microchannel Heat Exchangers. A microchannel heat exchanger allows for a longer dwell time for the air passing over it, as compared to a standard fit-tube heat exchanger. This results in an increase in heat exchanger effectiveness.

Motor - ECM Motor for Heat Pump. Applicable to ENERGY STAR appliances and dryers, electronically commutated motors (ECM) provide precisely timed voltages to the coils and use rotation position sensors for timing. This results in greater efficiency than a standard motor. Applicable to any motor, particularly those used in dryers.

Outlet Gasket. Provide sealing around electrical outlets to reduce drafts and heat loss through small air spaces.

Radiant Electric Ceiling Panels. Radiant heating systems rely on infrared radiation to heat objects, people, and surfaces. The effect is that radiant energy as received by people (directly from the heater and indirectly from other surfaces) allows them to perceive a comfort condition temperature that is 4° to 5° higher than the actual air temperature. This allows a radiant heater to operate at lower air temperatures thus decreasing the use of heating fuel by reducing air stratification within the space, side-wall and ceiling as well as building heat losses.

Radiant Electric Floor Heating. Radiant heating systems rely on infra red radiation to heat objects, people, and surfaces. The effect is that radiant energy as received by people (directly from the heater and indirectly from other surfaces) allows them to perceive a comfort condition temperature that is 4° to 5° higher than the actual air temperature. This allows a radiant heater to operate at lower air temperatures thus decreasing the use of heating fuel by reducing air stratification within the space, side-wall and ceiling as well as building heat losses.

SIP Construction. Structural insulated panels use continuous foam insulation throughout the panel that provides excellent energy efficiency and low levels of air infiltration. Baseline is standard wood framing.

Solid State Refrigeration for Heat Pumps. Using thermoelectric devices to convert electricity for cooling is only starting to become economical due to advances in efficiency levels.

Spray-On Foam Insulation. Unlike traditional insulation materials like fiberglass or cellulose, spray foam insulation seals and fills tiny cracks and seams, which virtually eliminates energy-wasting air infiltration. Because it provides a higher R-value per inch, homeowners using foam insulation can use 2x4 construction on exterior walls instead of the 2x6 studs required with traditional insulation. This measure proposes to increase the resistance value to R-23, compared to the baseline of R-13.[47]

Thermostat – Clock/Programmable. A programmable thermostat controls the set point temperatures automatically, ensuring the HVAC system is not running during low-occupancy hours.

Thermostat – Multi-Zone. A multi-zone programmable thermostat controls the set point temperatures automatically for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours.

VSD Motor for Heat Pump. Controls the rotational speed of a piece of motor-driven equipment, through adjusting the frequency of the voltage applied to the motor. Baseline for this measure is a constant speed fan motor.

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47 http://www.powerhousetv.com/stellent2/groups/public/documents/pub/phtv_se_in_bu_000575.hcsp

Whole-House Dehumidifier. A high capacity whole-house dehumidifier can be run standalone in a basement or ducted into an existing central air conditioning system. These units remove moisture content from the air and prevent mold, mildew and damp conditions.

Whole-House Fan. Draws cool outdoor air inside through open windows and exhausts hot indoor air through the attic to the outside. A whole house fan is a simple and inexpensive method of cooling a house when outdoor temperatures are lower than indoor temperatures.

Windows. This measure represents an increase in building performance by reducing the U-value in existing construction and new construction windows, as shown in Table B.31. The cost for all increments of windows does not include any labor costs associated with installing the windows. If this value was included, it will only be included in the cost associated with going from Existing windows to a lower more efficiency window. Adding this additional labor for a single family home would increase the cost by approximately $2000 and would decrease the overall total resource cost effectiveness.

Table B.31. High Efficiency Window Measures

Measure U-Value	Baseline U-Value
0.30	Existing Windows 0.65
0.19	0.30

The code for either new construction or window replacement states the customer must go to code (U=0.40) at a minimum when installing new windows.

Lighting

CFL Lighting – 3-Way. Three-way lights allow for different stages of illumination using different input Wattages. This measure compares a 3-way CFL lamp with 13 Watt, 20 Watt, and 25 Watt increments to a three-way incandescent lamp using 30 Watts, 75 Watts, and 100 Watts.

Compact Fluorescent Lamps & Fixtures. Combining the energy efficiency of fluorescent lighting with the convenience and popularity of incandescent fixtures, CFLs: (1) save up to 75% of the initial lighting energy by replacing incandescent that are roughly 3 – 4 times their Wattage, and (2) create further savings by lasting 6–15 times longer (6,000–15,000 hours). A variety of CFL fixture and lamp replacement measures exist, and this particular measure examines the savings from replacing a 60 watt incandescent bulb with a 15 watt fluorescent lamp. [48]

CFL Torchieres. A compact fluorescent torchiere is a table or floor lamp designed to direct light upward for indirect illumination. Most of the light is thrown against the ceiling and reflected back. This measure compares a standard 180 Watt halogen lamp to a 55 Watt CFL.

Daylighting Controls (Photocell) – Indoor/Outdoors. Photocells are used to adjust lighting levels according to the level of daylight the room is receiving. Baseline is no daylighting controls.

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48 http://www.eere.energy.gov/consumer/your_home/lighting_daylighting/indexmytopic=12050

LED Christmas Lighting. Typical Christmas tree lighting uses incandescent bulbs that can be costly, as well as a fire hazard. LED lights use a low wattage bulb and can save up to 90% of holiday lighting costs.

LED Lamps. Light emitting diodes (LEDs) are solid-state devices that convert electricity to light, potentially with very high efficiency and long life. Recently, lighting manufacturers have been able to produce “cool” white LED lighting indirectly, using ultraviolet LEDs to excite phosphors that emit a white-appearing light. These lights are viewed as a replacement for incandescent lamps.

Occupancy Sensors. If a space is unoccupied for a designated amount of time, an occupancy sensor will turn off the lights. The lights will turn on again once the sensor detects a person has entered the space.

Time Clocks (Exterior Lighting). Allows the user to program times to automatically turn lights on and off outside the residence. Programmed exterior lighting saves energy by ensuring that lights are not accidentally left on during the daytime.

Plug Load

1-watt Standby Power. Standby power is the electricity used by electrical equipment when it is switched off, or not performing its main function. Minimizing this loss to one watt or less can reduce this standby energy consumption by more than 50%.

Battery Chargers. Battery charging systems recharge a wide variety of cordless products, including power tools, small household appliances, and personal care products like electric shavers. Conventional battery chargers — even when not actively charging a product – draw as much as 5 to 20 times more energy than actually stored in the battery. Advanced energy-saving designs are now available that, on average, use 35% less energy. The baseline is a standard battery charger.[49]

Computers. ENERGY STAR computers feature: (1) “on” mode, where the maximum allowed power varies based on the computer monitor’s resolution; (2) “sleep” mode, where computer monitor models must consume 2 Watts or less; and, (3) “off” mode, where computer monitor models must consume 1 Watt or less. The baseline equipment does not include these features.[50]

Dehumidifiers. ENERGY STAR-qualified models have more efficient refrigeration coils, compressors, and fans than conventional models, which means they use less energy to remove moisture. These qualified models remove the same amount of moisture as a similarly-sized standard unit, but uses 10% – 20% less energy. The baseline for this measure is a standard dehumidifier.[51]

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49 http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers

50 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.ShowProductGroup&pgw_code=MO

51 http://www.energystar.gov/index.cfm?c=dehumid.pr_dehumidifiers

Digital Set Top Receiver. ENERGY STAR receivers must consume less than 7 Watts for satellite and 5 Watts for Low Noise Blockers to qualify. The baseline measure is a standard receiver.

DVD System. ENERGY STAR DVD players use as little as one fourth of the energy used by standard models in the "off" mode. Baseline measure is a standard DVD player.[52]

HDTVs. Short for High-Definition Televisions, ENERGY STAR models are required to consume less than 1 Watt when switched to the off position. The baseline is a standard television, generally consuming more than 3 Watts when off.

Home Audio Systems. According to ENERGY STAR products, a 6% energy savings can be achieved over standard home audio systems.[53]

Home Office Copiers. ENERGY STAR copy machines enter sleep mode after inactivity for at least 30 minutes. This reduces their total power consumption.[54]

Home Office Monitors. When ENERGY STAR monitors enter sleep mode, the monitor must consume less than 2 Watts. The sleep mode needs to be enabled in order to de-energize the monitor when not in use.

Printers. Printers are required by ENERGY STAR standards to deploy a maximum time delay to sleep depending upon the size of the equipment. This reduces power consumption during periods of inactivity.[55]

TVs. ENERGY STAR certified televisions use approximately 30% less energy than standard models and consume less than 1 Watt when idle.

VCRs. ENERGY STAR certified VCRs use approximately 30% less energy than standard models and consume less than one Watt when idle.

Power Supply Transformer/Converter - External Power Adapters. Energy Star power adapters provide more efficient electricity conversion for a variety of devices.

Powerstrip with Occupancy Sensor. Energy-saving products such as power strips with an occupancy sensor are found in workstations where power strips are commonly used. The sensor will turn on and off the power to all devices such as computers, desk lights, and audio equipment that are plugged into the power strip based on occupancy within the work area.

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52 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DP
53 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=HA
54 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf
55 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf

Pool Pumps

Pool Pump Timers. Setting a pool pump to run during off-peak times (starting after 8 p.m. and cycling off before 10 a.m.) reduces energy costs. Cycling pumps further reduce monthly costs. Baseline is no continuous running pump.

Pool Pumps – VSD. Enables the pool pump motor to run at variable speeds as opposed to constantly running at full power.

Refrigeration / Freezer

1 kWh per day Refrigerator. Reducing the energy use of a refrigerator to less than 1 kWh/day will result in over 25% reduction in energy use from a baseline refrigerator.

Refrigerator//Freezer – Early Replacement. Replacing equipment before the end of its useful life is advantageous because of the significant inefficiencies in older refrigerator/freezers, resulting in excessive energy consumption. Existing units are replaced with standard (code) models.

Refrigerator eCube. The eCube is placed in a refrigerated area and monitors the temperature of the product and not the temperature of the air. The thermostat is connected to the compressor, which cycles on and off to maintain the set point, based on the product temperature. The cycles of the compressor are reduced because the temperature is now based on the product and not the air.[56]

Removal of Secondary Refrigerator/Freezer. This refers to the environmentally friendly disposal of unneeded appliances such as secondary refrigerators or stand-alone freezers.

Solid State Refrigerator. Using thermoelectric devices to convert electricity for cooling (refrigeration) is only starting to become economical due to advances in efficiency levels.

Stand-Alone Freezer – Removal. Removal of stand-alone freezers is beneficial due to their inefficient use of energy. Proper disposal is required, as they use hazardous materials such as Freon & CFCs.

Water Heat

Clothes Washer. Several Modified Energy Factor (MEF) models were compared in this measure, as shown in Table B.32.

[56] http://www.senergysolution.com/sEnergySolution/eCube.aspx

Table B.32. Clothes Washer Modified Energy Factor Comparisons

Measure MEF	Baseline MEF
1.26 Federal Code	1.10 Existing Unit
1.83 ENERGY STAR	1.26 Federal Code
2.01 ENERGY STAR Tier 2	1.26 Federal Code
2.2 ENERGY STAR Tier 3	1.26 Federal Code

Clothes Washer - Early Replacement. Replacing equipment before the end of its useful life is advantageous because of the significant inefficiencies in older clothes washers, resulting in excessive energy consumption. Existing units are replaced with standard (code) models.

Desuperheater for Central Air Conditioner (Ground-Source Heat Pump) System. Desuperheaters are heat recovery devices that transfer heat from the air conditioning unit to the domestic water heater, that would normally be transferred to the ground. A desuperheater provides supplemental water heating only when the heat pump operates in the cooling mode.[57]

Dishwasher. ENERGY STAR dishwashers use an estimated 41% less energy than the federal minimum standard for energy consumption. Table B.33 shows the following energy factors compared in this measure.

Table B.33. Dishwasher Energy Factor Comparisons

Measure Energy Factor	Baseline Energy Factor
0.65 Federal Code	0.46 Existing Unit
0.77	0.65 Federal Code

Drain Water Heat Recovery (Power-Pipe). Drain water heat recovery devices recover heat energy from domestic drain water and are used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the entering water temperature. This measure is intended only for new construction.

Faucet Aerators. Faucet aerators, by mixing water and air, reduce the amount of water that flows through the faucet. The faucet aerator creates a fine water spray with a screen that is inserted in the faucet head. Flow rate requirements for this measure are presented in Table B.1735.

Table B.34. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.2	3.0 (existing)
1.5	2.2
0.5	2.2

* Gallons per minute

[57] http://www1.eere.energy.gov/femp/procurement/eep_groundsource_heatpumps.html

Heat Pump Water Heater. The water-heating heat pump moves heat from a warm reservoir (such as air) into the hot water system. The system employs an evaporator, compressor, condenser, expansion valve, hot water circulating pump and controls to accomplish this function.[58]

Hot Water Pipe Insulation. Adding R-4 insulation around the pipes will decrease heat loss.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead. Flow rate requirements for this measure are presented in Table B.836.

Table B.35. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.5	3.0
1.75	2.5

Tankless Water Heater. Tankless water heaters produce the majority of energy savings by avoiding standby losses that occur when a normal storage tank is not in use. Tankless water heaters provide hot water at a preset temperature when needed without storage, thereby reducing or eliminating standby losses. An energy factor of 0.95 was used for the tankless system and compared to a standard electric water heater with an 0.92 EF.[59]

Water Heater Thermostat Setback. This measure generates savings by reducing the set point temperature from 130° to 120°. Often, the set point temperature on a hot water system is set higher than necessary.

Electric Equipment Measures

Air Conditioner – Central (2.5 ton unit). This unit has a 30,000 BTU/hr cooling capacity. This measure compares several different SEER models, which are summarized in Table B.36

Table B.36. Central AC SEER Comparison

Measure SEER	Baseline SEER
14 SEER	13 SEER (federal code)
16 SEER	
18 SEER	

Air Conditioner – Central (3.0 ton unit). This unit has a 36,000 BTU/hr cooling capacity. This measure compares several different SEER models, as summarized above in Table B.36.

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58 Description source: U.S. Department of Energy

59 http://www.toolbase.org/Technology-Inventory/Plumbing/tankless-water-heaters

Air Conditioner – Room (Individual Rooms) (10,000 BTU/HR). ENERGY STAR-qualified room air conditioners use less energy than conventional models through improved energy performance as well as timers for better temperature control. ENERGY STAR qualified room air conditioners have a 10.8 EER value compared to a standard model that has 9.8 EER.

Air Source Heat Pump. Electric air-source heat pumps use the difference between outdoor air temperatures and indoor air temperatures to cool and heat the home. Table B.1039 displays the different models compared in this measure.

Table B.37. Heat Pump SEER/HSPF Comparisons

Measure SEER & HSPF	Baseline SEER & HSPF
14 SEER, 8.5 HSPF	
16 SEER, 8.8 HSPF	13 SEER, 7.7 HSPF
18 SEER, 9.0 HSPF	

Clothes Dryer with Moisture Sensor. High efficiency dryers have a moisture sensor that stops the drying cycle when the humidity in the drum falls below a certain level. Conventional drying equipment uses thermostats or timers that do not determine when clothes are dry, thereby causing excessive energy consumption due to extended run time.

Freezer – Stand-Alone. ENERGY STAR-qualified freezer models use at least 10% less energy than required by current federal standards from the National Appliance Energy Conservation Act (NAECA).

Refrigerator/Freezer. ENERGY STAR residential grade refrigerators use at least 10% less energy than required by current federal standards and 40% less energy than conventional models sold in 2001.

Water Heater (Electric). High efficiency water heaters are more efficient than standard electric water heaters. This measure assumes an energy factor (EF) for the high efficiency water heaters of 0.95, an increase from the code minimum of 0.92.

Gas Non-Equipment Measures

Cooking

Convection Oven. Operates at a lower temperature and achieves quicker cook times than a standard oven, due to fans that circulate heat evenly throughout the oven by moving hot air past the food. The baseline measure is a standard commercial oven.

HVAC & Envelope

Canned Lighting Air-Tight Sealing. Proper sealing around recessed lighting fixtures prevents unwanted heat loss through these air spaces due to air pressure differentials in conditioned and unconditioned spaces in homes. The baseline is no sealing.

Doors – R-5. Composite doors with a foam core increase overall insulation, which slows heat loss. This measure includes adding a thermal door with a resistance value of R-5 to houses with neither thermal nor storm doors.

Doors – R-11. A steel door with a polyurethane foam core offers an insulating value of about R-11. The steel surface holds up well to normal wear and tear, and any dents can be repaired easily with auto-body putty.

Doors – Weatherization. To minimize infiltration door sweep, weather stripping mounts to the bottom of the door. It consists of an extruded aluminum strip that holds a flexible vinyl strip to block the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Location. In many homes, ducts are run through attics, garages, crawlspaces, and basements for convenience and practical reasons. However, ducts in unconditioned areas lose energy because of large temperature differences between air in the ducts and the surrounding space. Locating ducts in conditioned spaces helps to reduce wasted heat loss.[60]

Duct Repair and Sealing. Duct sealing cost effectively saves energy, improves air and thermal distribution (comfort and ventilation), and reduces cross contamination between different zones in the building (i.e., smoking vs. non-smoking, bio-aerosols, localized indoor air pollutants).

Gas Boiler – Proper Sizing. A properly sized gas boiler will operate for long periods of time (rather than frequently cycling on and off), resulting in optimum equipment operating efficiency and better control.[61]

Gas Furnace – Maintenance. This involves an overall inspection of the mechanical equipment of the furnace to ensure proper operation prior to the heating season, and also a general cleaning and replacement of the air filter. The measure does not include duct inspection.

Gas Furnace – Maintenance – New Equipment. Includes an overall equipment inspection and tune-up of a recently installed gas unit that may not have been optimized prior to manufacture.

Gas Furnace – Proper Sizing. A properly sized gas furnace will operate for long periods of time (rather than frequently cycling on and off), resulting in optimum equipment operating efficiency and better control.[62]

ICF Construction. Building a concrete home with insulating concrete forms (ICFs) saves energy and money. The greater insulation, tighter construction and temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Infiltration Control (Caulk, Weather Strip, etc.). Filling gaps in windows with synthetic filler prevents drafts and heating/cooling loss.

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60 http://www.toolbase.org/pdf/techinv/ductsinconditionedspace_techspec.pdf
61 http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice
62 http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice

Insulation (Basement – Wall) 2x4. Adding insulation to the basement or crawlspace walls increases the thermal performance of the concrete foundation. Only for existing homes. Table B.38 summarizes the different resistance values compared in the measure.

Table B.38. Wall R-Value Comparison

Measure Insulation	Baseline Insulation
R-13	R-0
R-13	R-8 existing wall
R-13 + R-5	R-13

Insulation (Ceiling). This measure represents an increase in R-value. Adding insulation in existing buildings increases the thermal performance and brings the resistance value up to and past code, depending on vintage. Table B.39 summarizes the different resistance values compared in the measure.

Table B.39. Ceiling R-Value Comparison

Measure Insulation	Baseline Insulation
R-38	Existing Value
R-38	R-19
R-49	R-38

Insulation (Duct). Adding insulation around the ducts in the heating system reduces heat loss to unconditioned spaces. Table B.40 summarizes the different thermal resistance values compared in the measure.

Table B.40 Duct R-Value Comparison

Measure Insulation	Baseline Insulation
R-8	R-0
R-8	R-4

Insulation (Floor). Adding insulation to the floor increases the overall resistance value and slow heat transfer from the basement to the upper levels. Table B.41 summarizes the different resistance values compared in the measure.

Table B.41. Floor R-Value Comparison

Measure Insulation	Baseline Insulation
R-30	R-0
R-30	R-5 existing floor
R-38	R-30

Insulation (Rim and band joist). An un-insulated band joist can account for a significant portion of a building's heat loss, as the only thing separating inside from outside is 2 inches of wood and the siding material covering it. The heat loss through an un-insulated band joist increases when the basement is kept warmer, or contains heating or water heating equipment. Insulating a band joist is an easy way to improve a building's energy efficiency. The baseline is no insulation.

Insulation (Slab). A substantial amount of heat is lost through an un-insulated slab, resulting in cold, uncomfortable floors. Even if the foundation wall is insulated vertically under the slab, significant heat is still lost from the slab edge that is closest to the cold outside air. Table B.42 compares the different slab insulations for this measure.

Table B.42. Insulation Slab Measures

Measure Insulation	Baseline Insulation
R-10	R-0
R-10	Existing insulation
R-15	R-10

Insulation (Wall) 2x4. Wall insulation can help slow the transfer of heat and reduce both the heating and cooling loads in houses. Table B.43 compares the different insulations for 2x4 framing.

Table B.43 2x4 Wall Insulation Measures

Measure Insulation	Baseline Insulation
R-13	R-0
R-13	Existing wall insulation R-8
R-13 + R-5 Sheathing	R-13

Insulation (Wall) 2x6. Wall insulation slows the transfer of heat and reduces both the heating and cooling loads in houses. Table B.44 compares the different insulations for 2x6 framing.

Table B.44 2x6 Wall Insulation Measures

Measure Insulation	Baseline Insulation
R-21	R-0
R-21	Existing wall insulation R-8
R-21 + R-5 Sheathing	R-21 (State Code)

Integrated Space Heating/Water Heating. Integrated hot water heating systems provide both space conditioning and hot water heating with one appliance or energy source. Domestic hot water is heated directly and space heating is accomplished with a hot water heat exchanger coil piped to the forced air heating system. Thus, a combination space/water heating system can provide high efficiency hot water heating and space heating for the cost of one high efficiency appliance.

Leak Proof Duct Fittings. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time. Although the use of mastics and mechanical fasteners is becoming more widespread, a low-cost, leak-proof system will help to transform the market.

Outlet Gasket. Provide sealing around electrical outlets to reduce drafts and heat loss through small air spaces.

SIP Construction. Structural insulated panels use continuous foam insulation throughout the panel that provides excellent energy efficiency and low levels of air infiltration. Baseline is standard wood framing.

Spray-On Foam Insulation. Unlike traditional insulation materials like fiberglass or cellulose, spray foam insulation seals and fills tiny cracks and seams, which virtually eliminates energy-wasting air infiltration. Because it provides a higher R-value per inch, homeowners using foam insulation can use 2x4 construction on exterior walls instead of the 2x6 studs required with traditional insulation. This measure proposes to increase the resistance value to R-26, compared to the baseline of R-13.[63]

Thermostat – Clock/Programmable. A programmable thermostat controls the set point temperatures automatically, ensuring the HVAC system is not running during low-occupancy hours.

Thermostat – Multi-Zone. A multi-zone programmable thermostat controls the set point temperatures automatically for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours.

Windows. This measure represents an increase in building thermal performance by reducing the U-value in existing construction and new construction windows, as shown in Table B.45. The cost for all increments of windows does not include any labor costs associated with installing the windows. If this value was include, it will only be included in the cost associated with going from Existing windows to a lower more efficiency window. Adding this additional labor for a single family home would increase the cost by approximately $2000 and would decrease the overall total resource cost effectiveness.

Table B.45. High-Efficiency Window Measures

Measure U-value	Baseline U-value
0.30	0.65
0.19	0.30

The code for either new construction or window replacement states the customer must go to code (U=0.40) at a minimum when installing new windows.

63 http://www.powerhousetv.com/stellent2/groups/public/documents/pub/phtv_se_in_bu_000575.hcsp

Pool Heat

Pool Heaters. Gas pool heaters use either natural gas or propane. As the pump circulates the pool's water, the water drawn from the pool passes through a filter and then to the heater. The gas burns in the heater's combustion chamber, generating heat that transfers to the water that's returned to the pool. They're most efficient when heating pools for short periods of time, and they're ideal for quickly heating pools. The baseline is a standard gas pool heater.[64]

Water Heat

Clothes Washer. Several Modified Energy Factor (MEF) models were compared in this measure, as shown in Table B.46.

Table B.46 Clothes Washer Modified Energy Factor Comparisons

Measure MEF	Baseline MEF
1.26 Federal Code	1.1 Existing Unit
1.72 ENERGY STAR	1.26 Federal Code
2.0 ENERGY STAR Tier 2	1.26 Federal Code
2.2 ENERGY STAR Tier 3	1.26 Federal Code

Desuperheater for Central Air Conditioner (Ground-Source Heat Pump) System. Desuperheaters are heat recovery devices that transfer heat from the air conditioning unit to the domestic water heater, that would normally be transferred to the ground. A desuperheater provides supplemental water heating only when the heat pump operates in the cooling mode.[65]

Dishwasher. ENERGY STAR dishwashers use an estimated 41% less energy than the federal minimum standard for energy consumption. Table B.3349 shows the following energy factors compared in this measure.

Table B.47. Dishwasher Energy Factor Comparisons

Measure Energy Factor	Baseline Energy Factor
0.65 Federal Code	0.46 Existing Unit
0.77	0.65 Federal Code

Drain Water Heat Recovery (Power-Pipe). Drain water heat recovery devices recover heat energy from drain water and are used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the entering water temperature. Only for new construction.

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64 http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13160
65 http://www1.eere.energy.gov/femp/procurement/eep_groundsource_heatpumps.html

Faucet Aerators. Faucet aerators, by mixing water and air, reduce the amount of water that flows through the faucet. The faucet aerator creates a fine water spray with a screen that is inserted in the faucet head. Flow rate requirements for this measure are presented in Table B.1735.

Table B.48. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.2	3.0 (existing)
1.5	2.2
0.5	2.2

* Gallons per minute

Hot Water Supply Pipe Insulation. Adding R-4 insulation around the pipes will decrease heat loss.

Integrated Space Heating/Water Heating. Integrated hot water heating systems provide both space conditioning and hot water heating with one appliance or energy source. Domestic hot water is heated directly and space heating is accomplished with a hot water heat exchanger coil piped to the forced air heating system. Thus, a combination space/water heating system can provide high efficiency hot water heating and space heating for the cost of one high efficiency appliance.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead. Flow rate requirements for this measure are presented in Table B.836.

Table B.49. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.5	3.0
1.75	2.5

Tankless Water Heater. The majority of energy savings from tankless water heaters is by avoiding standby losses that occurs for a normal storage tank when it is not being used. Tankless water heaters provide hot water at a preset temperature when needed without storage, thereby reducing or eliminating standby losses. An energy factor of 0.78 was used for the tankless system and compared to the standard code gas water heater with 0.59 EF.[66]

Water Heater Thermostat Setback. This measure generates savings by reducing the set point temperature from 135° to 120°. Often, the set point temperature on a hot water system is set higher than necessary.

66 http://www.toolbase.org/Technology-Inventory/Plumbing/tankless-water-heaters

Gas Equipment Measures

Clothes Dryer with Moisture Sensor. High efficiency dryers have a moisture sensor that stops the drying cycle when the humidity in the drum falls below a certain level. Conventional drying equipment uses thermostats or timers that do not determine when clothes are dry, thereby causing excessive energy consumption due to extended run time.

Gas Boiler. The National Energy Policy Act of 1992 mandates that all boiler manufacturers must meet the requirements of ASHRAE Standard 90.1. Boilers less than 300 kBtuh are rated using an Annual Fuel Utilization Efficiency (AFUE). AFUE measures the amount of heat actually delivered to the amount of fuel consumed during the heating season; sometimes referred to as the seasonal efficiency. Table B.50 displays the different AFUE values compared in this measure.

Table B.50. AFUE Gas Boiler Comparison

Measure AFUE	Baseline AFUE
AFUE 90%	AFUE 82%
AFUE 94%	

Gas Furnace. This furnace measure also compares several different AFUE values among different units. Table B.51 displays the different AFUE values compared and their baselines.

Table B.51. AFUE Gas Furnace Comparison

Measure AFUE	Baseline AFUE
AFUE 90% (condensing) AFUE 95% (condensing)	AFUE 78% (state code)

Water Heater (Gas). Gas water heaters have a range of thermal efficiencies. Table B.52 displays the different efficiencies compared and their baselines.

Table B.52. Residential Gas Water Heater Comparison

Measure Energy Factor	Baseline Energy Factor
0.62 0.80 (condensing) 0.86 (condensing)	0.59 (state code)

Passive Renewable Measures

Deciduous Trees. Provide shading and effectively reduce the overall solar heat gain during summer months, which reduces the cooling load on the HVAC system. Baseline for this measure is no trees.

Pellet Stove (Corn or other Biomass Fuel). Biomass energy is organic matter that can be processed into energy for heat, liquid fuels, or power generation. Examples of biomass energy include: wood grasses, animal wastes, agricultural residues, urban & industrial wastes, and corn. These fuels can be used to heat homes and reduce the use of fossil fuels.

Smart Siting. For new construction only, this measure analyzes the optimal building orientation to minimize the heating and cooling load on the HVAC system.

Solar Attic Fan. Forced attic fan ventilation reduces residential heat gains from the ceiling. The baseline uses passive ventilation without a fan.

Solar Hot Water (SHW). Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't. Either system actively increases the entering water temperature to the storage tank, reducing the amount of energy required by the hot water heater to achieve the set point temperature.[67]

Thermal (Trombe) Wall. Thermal walls slow heat movement by slowing convectional currents that occur in walls. This keeps buildings warmer in the winter and cooler in the summer.

Window Overhang. Overhangs shade windows, reducing solar heat gains and the overall cooling load on the home.

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67 http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12850

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Appendix B.3: Industrial Measure Descriptions

Electric Non-Equipment Measures

Process Related

Any measures to improve the industrial process, not specific to the building itself.

Process Cooling Improvements. Improvements that will decrease the energy required for process-related cooling. Examples would include avoid frost formation on evaporators, shutting of cooling water when not required, using economic thickness of insulation for low temperatures.

Process Heating Improvements. Improvements that will decrease the energy required for process-related heating. Examples would include optimizing schedule for drying oven, reducing temperature of process equipment when on standby, and modifying equipment to improve drying process.

Process Heating O&M. Changing operation and maintenance (O&M) procedures of process heating can improve overall energy efficiency of a plant. Some O&M examples include repair faulty insulation, adjust burners for efficient operation, and eliminate leaks in combustible gas lines.

Process Heat Steam Distribution. Any elimination in leaks or improved insulation to the ducting will reduce loss in a distribution system.

Fan System Improvements. Savings from variable-speed drives (VSD) and/or improvements to the design of the fan system, such as better fans, ducting, and flow design.

Pump System Improvements. Similar to fan system improvements, with savings from a VSD and/or improvements to the overall pump system, such as better pumps, more efficient piping and eliminating unnecessary flows. In irrigation, this would include nozzle improvements and scientific irrigation systems.

Other Motor Improvements. Improvements to motors not specific to fans or pumps. This would include using higher efficiency motors, improved rewind practices and correct motor sizing. In the mining industry, this would also include milling technique improvements.

Other Motor O&M. Changing operation and maintenance (O&M) procedures of motors can improve overall energy efficiency of a plant. Some O&M examples include develop and repair/replace policy, avoid emergency rewind of motors, and avoid rewinding motors more than twice.

Air Compressor Improvements. Air compressor energy efficiency, used in the industrial process, can be improved by installing compressor air intakes in coolest locations, or using optimum-sized compressors, amongst others.

Air Compressor O&M. Changing operation and maintenance (O&M) procedures of an air compressor can improve the overall energy efficiency of a plant. Some O&M examples include reducing the pressure of compressed air to the minimum required, cooling compressor air intake with a heat exchanger or eliminating leaks.

Refrigeration Improvements. Refrigeration improvements can include isolating hot equipment from refrigerated area, using highest allowable temperature for refrigerated space or modify refrigeration system to operate at a lower pressure.

Other Process Improvements/O&M. Some generic process improvements/O&M include upgrading obsolete equipment, replace hydraulic/pneumatic equipment with electrical equipment and use optimum size and capacity equipment.

Building Related

Any measures to improve the building itself, not specific to the industrial process.

Boiler Improvements. The boiler is generally used to create steam or hot water for process or non-process applications. Savings can be found by installing a waste heat boiler to provide direct power or using flue gas heat to preheat boiler feedwater.

Lighting Improvements. Any changes to overall illumination levels, use of natural lighting, or technology improvements to use more efficient bulbs or ballasts that will decrease the overall lighting energy consumption.

HVAC Improvements. There are many changes that can be made to reduce the energy consumption in HVAC control of a plant. Many are measures found in the commercial and residential lists. A sample of improvements include: conditioning only space in use, installing timers and/or thermostats, lowering ceiling to reduce conditioned space, and installing or upgrading insulation on distribution systems.

HVAC O&M. Some operation and maintenance (O&M) improvements to the HVAC control system include size air handling grills/ducts/coils to minimize air resistance, adjust vents to minimize energy use and maintain air filters by cleaning or replacement.

Other Building Improvements. Some generic improvements to the building include de-energizing excess transformer capacity, increase electrical conductor size to reduce distribution losses, and optimize plant power factor.

Gas Non-Equipment Measures

Process Related

Any measures to improve the industrial process, not specific to the building itself.

Process Heating Improvements. Improvements that will decrease the energy required for process-related heating. Examples would include optimizing schedule for drying oven, reducing temperature of process equipment when on standby, and modifying equipment to improve drying process.

Process Heating O&M. Changing operation and maintenance (O&M) procedures of process heating can improve overall energy efficiency of a plant. Some O&M examples include repair faulty insulation, adjust burners for efficient operation, and eliminate leaks in combustible gas lines.

Steam Distribution Systems. Any elimination in leaks or improved insulation to the ducting will reduce loss in a distribution system.

Other Process Improvements/O&M. Some generic process improvements/O&M include upgrading obsolete equipment, reducing fluid flow rates, and use optimum size and capacity equipment.

Building Related

Any measures to improve the building itself, not specific to the industrial process.

HVAC Improvements. There are many changes that can be made to reduce the energy consumption in HVAC control of a plant. Many are measures found in the commercial and residential lists. A sample of improvements include: conditioning only space in use, installing timers and/or thermostats, lowering ceiling to reduce conditioned space, and installing or upgrading insulation on distribution systems.

HVAC O&M. Some operation and maintenance (O&M) improvements to the HVAC control system include size air handling grills/ducts/coils to minimize air resistance, adjust vents to minimize energy use and maintain air filters by cleaning or replacement.

Boiler Improvements. The boiler is generally used to create steam or hot water for process or non-process applications. Savings can be found by installing a waste heat boiler to provide direct power or using flue gas heat to preheat boiler feedwater.

Boiler O&M. Such improvements to the boiler would include analyze flue gas for proper air/fuel ration, establishing maintenance schedule or reducing excessive boiler blowdown.

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Appendix B.4: Building Simulations

The consumption – both quantity and timing – of electricity associated with different end uses across building types is a critical component in the assessment of both capacity-based and energy efficiency potentials for the residential and commercial sectors. The primary sources for these data are energy model simulations, which served the following purposes in this study:

- Establish the baseline consumption for various end uses in both existing and new construction vintages
- Estimate the savings associated with equipment upgrades and improvements to both building shell and lighting
- Account for the interactive effects that occur between lighting improvements and HVAC
- Establish the annual hourly timing associated with consumption in different end uses

The two types of energy simulation programs used for this study are eQuest[68] (for commercial models) and Energy-10[69] (for residential models). eQuest is a user interface that uses the standard DOE-2 calculation engine with an emphasis on commercial building types. Energy-10 is a program developed by the National Renewable Energy Laboratory (NREL) Center for Building and Energy Storage with an emphasis on simulations for small commercial and residential building types.

Both of these programs provide hourly (8,760) demand and annual energy consumption for a specific end use (e.g., cooling, heating, water heating, etc.). The hourly values were then amalgamated and calibrated with actual hourly usage to determine the load basis for demand response programs. The annual energy consumption was used in the analysis of energy efficiency resources to determine specific building type end-use consumption. A secondary purpose of energy simulations is the ability to determine the energy savings associated with installing higher efficiency equipment (e.g., moving from a SEER 13 Central AC to a SEER 15) and shell improvements (e.g., increasing insulation values and/or using high efficiency windows). Lists of all measures modeled for the residential and commercial sectors are given in Table B.1 and Table B.2, respectively.

Table B.1. Residential Measures Modeled in Energy-10

End Use	Measure Name
Central AC	Central AC - Advanced Technology SEER 18
	Central AC - High Efficiency SEER 16
	Central AC - Premium Efficiency SEER 14
Heat Pump	ASHP - Advanced Efficiency
	ASHP - High Efficiency
	ASHP - Premium Efficiency

68 eQuest web page: http://doe2.com/equest/

69 Energy-10 web page: http://www.nrel.gov/buildings/energy10.html

Gas Furnace	Furnace - Advanced Efficiency
	Furnace - High Efficiency
	Furnace - Premium Efficiency
Gas Boiler	Boiler - Advanced Efficiency
	Boiler - High Efficiency
	Boiler - Premium Efficiency
HVAC	Blinds – Fixed Angle
	Doors – R-5 and R-11
	Insulation-Ceiling
	Insulation-Floor
	Insulation-Wall 2x4
	Insulation-Wall 2x6
	Windows, ENERGY STAR or better

Table B.2. Commercial Measures Modeled in eQuest

End Use	Measure Name
Cooling Chillers	Chiller-High Efficiency
	Chiller-Premium Efficiency
	Cooling Tower-Decrease Approach Temperature
	Cooling Tower-Two-Speed Fan Motor
	Chiller-Water Side Economizer
Cooling DX	DX Package-Air Side Economizer
	High Efficiency DX Package
	Premium Efficiency DX Package
	Advanced Efficiency DX Package
Heat Pump	High Efficiency ASHP
	Premium Efficiency ASHP
Gas Furnace	High Efficiency Furnace
	Premium Efficiency Furnace
Gas Boiler	High Efficiency Boiler
	Premium Efficiency Boiler
Lighting	Lighting Package, High Efficiency
	Lighting Package, Premium Efficiency
HVAC	Infiltration Control
	Insulation - 2*4 Walls
	Insulation - Floor
	Insulation - Roof / Ceiling
	Windows-High Efficiency
Water Heat	Water Heater Temperature Setback

There are three main steps involved in the building simulation process. The first step is the development of building prototypes, which define the typical characteristics associated with the different customer segments (residential dwelling type or commercial business type) for both existing and new construction. These characteristics, which play an important role in driving energy consumption, were developed from a number of sources. For existing buildings, values come from information gathered during the data auditing analysis for the PSE service territory in addition to energy audits and phone surveys with PSE customers. In cases where data are lacking, engineering judgment is applied. For new construction, the specific state energy code and/or federal code (whichever is the most stringent) is used to determine the building construction and equipment efficiency requirements (International Energy Conservation Code for 2006).

Commercial Building Prototype Parameters

Table B.3. Dry Goods Retail

Dry Goods Retail	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	6,176	6,176	6,176	6,176
Roof Area [sqft]	6,176	6,176	6,176	6,176
Envelope				
Window U-factor	U=0.68	U=0.55	U=0.68	U=0.55
Window to Wall Area	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-7	R-21	R-7	R-21
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.95	1.5	1.95	1.5
Occupancy Schedule WkDay	9am-7pm			
Occupancy Schedule WkEnd	10am-4pm (Sat)			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building cooled	100	100	100	100
Heating Daytime Set point [°F]	69	69	69	69
Heat. Setback/Setup Set point [°F]	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table B.4. Grocery

Grocery	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	12,474	12,474	12,474	12,474
Roof Area [sqft]	12,474	12,474	12,474	12,474
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	11%	11%	11%	11%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-7	R-21	R-7	R-21
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.7	1.5	1.7	1.5
Occupancy Schedule WkDay	7am-9pm			
Occupancy Schedule WkEnd	8am-9pm (Sat), 9am-8pm (Sun)			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table B.5. Hospital

Hospital	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	2	2
Total Floor Area [sqft]	13,561	13,561	13,561	13,561
Roof Area [sqft]	13,561	13,561	13,561	13,561
Envelope				
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	25%	25%	25%	25%
Wall Insulation (R Value)	R-0	R-19	R-0	R-19
Roof Insulation (R Value)	R-11	R-21	R-11	R-19
Floor Insulation (R Value)	R-19	R-19	R-19	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1
Occupancy Schedule WkDay	7am-6pm			
Occupancy Schedule WkEnd	9am-4pm (Sat)			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	71	71	71	71
Heat. Setback/Setup Set point [°F]	67	67	67	67
Cooling Daytime Set point [°F]	73	73	73	73
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table B.6. Hotel / Motel

Hotel / Motel	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	4	4	4	4
Total Floor Area [sqft]	3,559	3,559	3,559	3,559
Roof Area [sqft]	3,559	3,559	3,559	3,559
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	30%	30%	30%	30%
Wall Insulation (R Value)	R-3	0	R-3	R-13
Roof Insulation (R Value)	R-11	0	R-11	0
Floor Insulation (R Value)	R-7	0	R-7	0
Lighting Density [W/sqft]	1.52	1.35	1.52	1.35
Occupancy Schedule WkDay	24 hrs	24 hrs	24 hrs	24 hrs
Occupancy Schedule WkEnd	24 hrs	24 hrs	24 hrs	24 hrs
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	9.3 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.793 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	63	63	63	63
Cooling Daytime Set point [°F]	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78

Table B.7. Office

Office	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Floor Area [sqft]	4,819	4,819	4,819	4,819
Roof Area [sqft]	4,819	4,819	4,819	4,819
Envelope				
Window U-factor	U=0.60	U=0.55	U=0.60	U=0.55
Window to Wall Area	18%	18%	18%	18%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-11	R-21	R-11	R-21
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1
Occupancy Schedule WkDay	8am-5pm			
Occupancy Schedule WkEnd	11am-4pm - Sat			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Heating Daytime Set point [°F]	69	69	69	69
Heat. Setback/Setup Set point [°F]	61	61	61	61
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table B.8. Restaurant

Pacific Power Restaurant	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	2,247	2,247	2,247	2,247
Roof Area [sqft]	2,247	2,247	2,247	2,247
Envelope				
Window U-factor	U=0.65	0	U=0.65	0
Window to Wall Area	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	0	R-3	0
Roof Insulation (R Value)	R-11	0	R-11	0
Floor Insulation (R Value)	R-11	0	R-11	0
Lighting Density [W/sqft]	1.75	1	1.75	1.2
Occupancy Schedule WkDay	9am-9pm (Customer Operating Hours)			
Occupancy Schedule WkEnd	9-9 Sat 11-7 Sun (Customer Operating Hours)			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no
Cooling Efficiency	n/a	n/a	n/a	n/a
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	67	67	67	67
Heat. Setback/Setup Set point [°F]	64	64	64	64
Cooling Daytime Set point [°F]	71	71	71	71
Cool. Setback/Setup Set point [°F]	74	74	74	74

Table B.9. School

School	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	2	2
Total Floor Area [sqft]	27,289	27,289	27,289	27,289
Roof Area [sqft]	27,289	27,289	27,289	27,289
Envelope				
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	27%	27%	27%	27%
Wall Insulation (R Value)	R-0	R-19	R-0	R-13
Roof Insulation (R Value)	R-7	R-21	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.66	1.35	1.8	1.2
Occupancy Schedule WkDay	School sch.(8am-3pm), Winter-spring Break sch. (9am-2pm) Summer (9am-2pm)			
Occupancy Schedule WkEnd	closed			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	70	70	70	70
Heat. Setback/Setup Set point [°F]	66	66	66	66
Cooling Daytime Set point [°F]	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78

Table B.10. University

University	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	2	2
Total Floor Area [sqft]	27,289	27,289	27,289	27,289
Roof Area [sqft]	27,289	27,289	27,289	27,289
Envelope				
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	27%	27%	27%	27%
Wall Insulation (R Value)	R-0	R-19	R-0	R-13
Roof Insulation (R Value)	R-7	R-21	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.66	1.35	1.8	1.2
Occupancy Schedule WkDay	School sch.(8am-3pm), Winter-spring Break sch. (9am-2pm) Summer (9am-2pm)			
Occupancy Schedule WkEnd	closed			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	70	70	70	70
Heat. Setback/Setup Set point [°F]	66	66	66	66
Cooling Daytime Set point [°F]	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78

Table B.11. Warehouse

Warehouse	Gas for all Heating End Uses		Electric for All Heating End Uses	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	2	2
Total Floor Area [sqft]	171,167	171,167	171,167	171,167
Aspect Ratio				
Roof Area [sqft]	171,167	171,167	171,167	171,167
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	5%	5%	5%	5%
Wall Insulation (R Value)	R-3	R-19	R-3	R-13
Roof Insulation (R Value)	R-8	R-21	R-8	R-19
Floor Insulation (R Value)	R-8	R-19	R-8	R-19
Lighting Density [W/sqft]	0.75	0.5	1.05	0.7
Occupancy Schedule WkDay	10am-9pmM-F			
Occupancy Schedule WkEnd	10am-6pmSat only.			
HVAC				
Modeling Gas Furnace?	yes	yes	no	no
Heating Efficiency	76% AFUE	78% AFUE	n/a	n/a
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency	n/a	n/a	2.7 COP	3.2 COP
Percent Of Building Heated	80	80	80	80
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	n/a	n/a	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	80	80	80	80
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	60	60	60	60
Cooling Daytime Set point [°F]	75	75	75	75
Cool. Setback/Setup Set point [°F]	79	79	79	79

Residential Building Prototype Parameters

Table B.12. Single Family

	Gas for all Heating End Uses		Electric for all Heating End Uses	
General	**Existing**	**New**	**Existing**	**New**
Exterior Wall Construction	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board
Roof Construction	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12
# of Floors	2	2	2	2
Total Floor Area [sqft]	2035	2190	2035	2380
Roof Area [sqft]	1018	1095	1018	1190
Foundation	Above a Crawl Space	Above a Crawl Space	Above a Crawl Space	Above a Crawl Space
Glass Type	U=0.51,SHGC=0.55	U=0.35,SHGC=0.32	U=0.51,SHGC=0.55	U=0.35,SHGC=0.32
Percent of Double Pane Windows	84%	93%	84%	93%
Window Percentage of Wall Area (ACH)	18%	18%	18%	18%
Wall Insulation (R Value)	11	21	11	21
Floor Insulation (R Value)	15	30	15	30
Roof Insulation (R Value)	10	10	10	10
Rim & Band Joist Insulation (R Value)	0.58	0.58	0.58	0.58
Floor f Factor [Btu/h-F-ft]	30	38	30	38
Air leakage rate (ACH)	0.65	0.35	0.65	0.35
Duct leakage Rate	10%	5%	10%	3%
Lighting Density [W/sqft]	1.2	1.2	1.2	1.2
Peak, typical work day	0.36	0.30	0.36	0.30
Equipment Density [W/sqft]	0.4	0.4	0.4	0.4
Water Heating Fuel Type	Gas	Gas	Electric	Electric
Water Heater Energy Factor	0.57	0.59	0.88	0.92
Water Heater Heat Density [W/sqft]	0.31	0.25	0.31	0.25
Number of Occupants	2.7	3.3	2.7	3.3
Water Heater Temp	123	125	123	125
HVAC				
Distribution Type				
Heating Type	Furnace	Furnace	Furnace	Packaged Heat Pump
Heating Fuel	Gas	Gas	Electric	Electric
Heating Efficiency (AFUE/HSPF)	74%	78%	100%	7.7
Heating System Total Ouptut (Btu/h)	40000	40000	40000	40000
Cooling Type	Central AC	Central AC	Central AC	Central AC
Cooling SEER	11	13	11	13

Cooling System Total Output (Btu/h)	36000	36000	36000	36000
Cooling System Sensible Output (Btu/h)	27000	27000	27000	27000
Fan/Air Distribution (cfm)	1200	1200	1200	1200
Heating Daytime Setpoint [°F]	65	67	65	68
Heat. Setback/Setup Setpoint [°F]	58	62	58	62
Cooling Daytime Setpoint [°F]	75	74.5	75	74.5
Cool. Setback/Setup Setpoint [°F]	79	79	79	79

Table B.13. Manufactured

	Gas for all Heating End Uses		Electric for all Heating End Uses	
General	**Existing**	**New**	**Existing**	**New**
Exterior Wall Construction	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board
Roof Construction	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12
# of Floors	1	1	1	1
Total Floor Area [sqft]	1220	1640	1220	1640
Roof Area [sqft]	1220	1640	1220	1640
Foundation	Crawl Space	Crawl Space	Crawl Space	Crawl Space
Glass Type	U=0.51,SHGC=0.78	U=0.35,SHGC=0.32	U=0.51,SHGC=0.5	U=0.35,SHGC=0.32
Percent of Double Pane Windows	64%	64%	64%	64%
Window Percentage of Wall Area (ACH)	18%	18%	18%	18%
Wall Insulation (R Value)	8	21	10.7	21
Floor Insulation (R Value)	15	30	20	30
Roof Insulation (R Value)	19	38	30	38
Air leakage rate (ACH)	0.65	0.45	0.75	0.45
Duct leakage Rate	10%	5%	10%	5%
Lighting Density [W/sqft]	1.2	1.2	1.2	1.2
Equipment Density [W/sqft]	0.4	0.4	0.2	0.4
Water Heating Fuel Type	Gas	Gas	Electric	Electric
Water Heater Energy Factor	0.57	0.59	0.88	0.92
Number of Occupants	2	2.4	2	2.4
Water Heater Temp	128	128	128	128
HVAC				
Distribution Type				
Heating Type	Furnace	Furnace	Furnace	Packaged Heat Pump
Heating Fuel	Gas	Gas	Electric	Electric
Heating Efficiency (AFUE/HSPF)	74%	78%	100%	7.7

Cooling Type	Central AC	Central AC	Central AC	Central AC
Cooling SEER	10	13	11	13
Heating Daytime Setpoint [°F]	67	67	64	64
Heat. Setback/Setup Setpoint [°F]	59	59	59	59
Cooling Daytime Setpoint [°F]	71	71	75	75
Cool. Setback/Setup Setpoint [°F]	75	75	80	80

Table B.14. Multi Family

General	Gas for all Heating End Uses Existing	New	Electric for all Heating End Uses Existing	New
Exterior Wall Construction	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board	Brick, wood frame 2*4, insulation, gypsum board	Brick, wood frame 2*6, insulation, gypsum board
Roof Construction	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12	Pitched roofing 4*12
# of Floors	2	2	2	2
Total Floor Area [sqft]	4120	4800	3440	4800
Roof Area [sqft]	2060	2400	1720	2400
Foundation	Slab	Slab	Slab	Slab
Glass Type	U=0.51,SHGC=0.55	U=0.35,SHGC=0.32	U=0.51,SHGC=0.55	U=0.35,SHGC=0.32
Percent of Double Pane Windows	76%	76%	76%	76%
Window Percentage of Wall Area (ACH)	18%	18%	18%	18%
Wall Insulation (R Value)	8	21	8	21
Floor Insulation (R Value)	15	30	15	30
Rim and Band Joist Insulation (R Value)	10	10	10	10
Floor f factor	0.58	0.58	0.58	0.58
Roof Insulation (R Value)	19	38	19	38
Air leakage rate (ACH)	0.75	0.45	0.75	0.45
Duct leakage Rate	10%	5%	10%	5%
Lighting Density [W/sqft]	1.2	1.2	1.2	1.2
Peak, typical work day	0.39	0.28	0.39	0.28
Equipment Density [W/sqft]	0.2	0.29	0.2	0.29
Water Heating Fuel Type	Gas	Gas	Electric	Electric
Water Heater Energy Factor	0.57	0.59	0.88	0.92
Water Heater Heat Density [W/sqft]	0.42	0.29	0.42	0.29
Number of Occupants	6.6	6.6	6.6	6.6
Water Heater Temp	121	121	121	121
HVAC				
Distribution Type				
Heating Type	Furnace	Furnace	Furnace	Packaged Heat Pump

Heating Fuel	Gas	Gas	Electric	Electric
Heating Efficiency (AFUE/HSPF)	74%	78%	100%	7.7
Heating System Total Ouptut (Btu/h)	106,667	106,667	106,667	106,667
Cooling Type	Central AC	Central AC	Central AC	Central AC
Cooling SEER	11	13	11	13
Cooling System Total Output (Btu/h)	96000	96000	96000	96000
Cooling System Sensible Output (Btu/h)	72000	72000	72000	72000
Fan/Air Distribution (cfm)	3200	3200	3200	3200
Heating Daytime Setpoint [°F]	69	67.5	68	67.5
Heat. Setback/Setup Setpoint [°F]	65	61	64	61
Cooling Daytime Setpoint [°F]	71.5	71	72	71
Cool. Setback/Setup Setpoint [°F]	75.5	76	76	76

After the building prototypes are established, the second step is to select the weather station location representing the most typical weather conditions for each state. Although this step is not complicated, it is very important because weather is one of the most important factors underlying annual energy consumption for the HVAC-related measures. Weather is based on a "typical meteorological year," or TMY. The selection of the TMY file involves two considerations. First, the location should have the closest proximity to the area of the highest energy consumption and population. Second, the TMY should closely match typical weather conditions throughout the respective service territory. The weather file chosen for PSE service territory was Seattle.

Once the building characteristics and weather files are determined, an individual model is prepared for each building type.

Once the models are completed and run, both eQuest and Energy-10 produce output files that contain the estimates of energy consumption and hourly load by end use. For the commercial customer segments, the building-level estimates are converted to represent the kBTU per square foot, also called the end use intensity (EUI). Energy consumption for residential simulations remain at the site level and are referred to as the unit energy consumption, or UEC. The full set of UECs and EUIs are presented in the tables below.

Residential Sector Energy Consumption

Table B.15. Residential Electric UECs (kWh/yr)

	Manufactured		Multi-Family		Single Family	
	Exist.	New	Exist.	New	Exist.	New
Central AC	871	611	709	526	997	849
Central Heat	6635	4688	5354	3361	9000	5561
Cooking Oven	440	440	440	440	440	440
Cooking Range	536	536	536	536	536	536
Dryer	1070	676	960	654	852	805
Freezer	705	541	705	541	705	541
HVAC Aux	670	410	441	344	557	483
Heat Pump	5976	3398	4462	2824	7509	5421
Lighting	1266	1305	1160	1162	2534	2470
Plug Load	1500	1530	1320	1346	2070	2111
Pool Pump	- - -	- - -	- - -	- - -	1500	1500
Refrigeration	577	446	577	446	577	446
Room AC	461	351	375	302	527	488
Room Heat	5109	3610	4123	2588	6930	4282
Water Heat	3336	2783	1975	1687	3449	2885

Table B.16. Residential Gas UECs

	Manufactured		Multi-Family		Single Family	
	Exist.	New	Exist.	New	Exist.	New
Central Heat Boiler	615	557	444	372	759	591
Central Heat Furnace	468	413	354	310	616	450
Cooking Oven	19	19	19	19	19	19
Cooking Range	24	24	24	24	24	24
Dryer	36	34	36	34	36	34
Pool Heat	- - -	- - -	- - -	- - -	258	258
Water Heat	158	190	140	169	239	291

Commercial Sector Energy Consumption

For the commercial sector, existing and new EUIs and sources by state are presented in Table B.17 through Table B.19.

Table B.17. Electric EUIs for Commercial Sector by Building Type (kBTU/sq. ft. per Year)

Building Type	Cooking		Cooling Chillers		Cooling DX		HVAC Aux		Heat Pump	
	Exist.	New	Exist.	Exist.	Exist.	Exist.	Exist.	New	Exist.	New
Dry Goods Retail	- - -	- - -	1.94	0.98	2.11	1.07	2.71	2.22	3.21	1.57
Grocery	2.66	2.67	1.68	1.36	1.83	1.48	2.13	2.57	4.99	1.77
Hospital	0.54	0.54	1.86	0.47	2.02	0.51	5.37	4.22	3.98	1.66
Hotel / Motel	0.65	.66	1.75	.51	1.91	.55	3.24	2.04	4.26	2.14
Office	- - -	- - -	1.62	0.58	1.77	0.63	1.53	1.30	3.43	1.41
Other Comm.	0.39	0.39	1.78	0.78	1.94	0.85	2.12	1.76	3.32	1.49
Restaurant	9.42	9.51	- - -	- - -	4.40	1.60	3.57	2.87	5.46	2.26
School	0.22	0.22	0.36	0.16	0.39	0.17	1.32	0.90	3.04	1.23
University	0.42	0.42	0.36	0.16	0.39	0.17	1.32	0.90	3.04	1.23
Warehouse	- - -	- - -	0.19	0.22	0.20	0.24	0.58	0.57	0.82	0.57

Table B.18. Electric EUIs for Commercial Sector by Building Type (kBTU/sq. ft. per Year)

Building Type	Lighting		Other		Plug Load		Refrigeration		Space Heat		Water Heat	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Dry Goods Retail	5.33	4.20	0.78	0.78	2.64	2.71	2.03	2.04	2.02	0.45	0.28	0.28
Grocery	8.06	6.46	0.00	0.00	2.39	2.45	20.28	20.40	2.13	0.19	0.30	0.30
Hospital	4.55	2.87	0.00	0.00	3.75	3.85	0.50	0.50	1.26	0.70	1.38	1.39
Hotel / Motel	2.87	1.91	0.24	0.24	2.16	2.23	0.30	0.30	4.01	2.58	1.73	1.75
Office	3.80	2.37	0.07	0.07	2.20	2.27	- - -	- - -	3.21	0.67	0.47	0.37
Other Comm.	2.75	1.96	0.49	0.49	2.45	2.51	0.20	0.20	2.62	0.56	0.38	0.37
Restaurant	5.71	3.26	0.01	0.01	2.12	2.18	5.50	5.55	1.35	0.31	8.79	8.68
School	2.73	1.97	0.03	0.03	1.50	1.54	0.50	0.50	5.67	1.85	1.43	1.44
University	3.79	2.74	0.07	0.08	1.10	1.13	0.50	0.50	5.67	1.85	1.43	1.44
Warehouse	2.50	1.69	0.01	0.01	0.50	0.51	- - -	- - -	1.13	0.38	0.20	0.20

Table B.19. Gas EUIs for Commercial Sector by Building Type (kBTU/sq. ft. per Year)

Building Type	Cooking		Pool Heat		Space Heat Boiler		Space Heat Furnace		Water Heat	
	Exist	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Dry Goods Retail	- - -	- - -	- - -	- - -	0.08	0.04	0.11	0.06	0.03	0.02
Grocery	0.19	0.20	- - -	- - -	0.26	0.05	0.35	0.08	0.13	0.13
Hospital	0.04	0.04	0.03	0.02	0.36	0.32	0.49	0.47	0.42	0.43
Hotel / Motel	0.08	0.08	0.11	0.06	0.18	0.12	0.25	0.18	0.32	0.32
Office	- - -	- - -	- - -	- - -	0.24	0.11	0.33	0.17	0.03	0.04
Other Comm.	0.04	0.04	- - -	- - -	0.16	0.07	0.22	0.11	0.03	0.03
Restaurant	1.61	1.62	- - -	- - -	0.06	0.04	0.06	0.05	0.44	0.45
School	0.02	0.02	0.17	0.03	0.13	0.10	0.17	0.14	0.06	0.06
University	0.05	0.05	0.14	0.04	0.25	0.19	0.34	0.29	0.10	0.10
Warehouse	- - -	- - -	- - -	- - -	0.09	0.05	0.13	0.07	0.02	0.02

Industrial Sector Energy Consumption

The distribution of energy consumption in the industrial sector is based on data from the Energy Information Administration's Manufacturing Energy Consumption Survey. The allocation of total energy consumption by end use for the various industrial facility types are presented in Table B.20.

Table B.20. Industrial Gas Consumption by Industry Type and End Use

Industry Type	HVAC	Indirect Boiler	Process Heat	Process Other	Other
Chemical Mfg	2%	55%	35%	6%	2%
Computer Electronic Mfg	32%	42%	15%	2%	10%
Electrical Equip. Mfg	29%	12%	53%	0%	6%
Fabricated Metal Products	21%	16%	62%	1%	0%
Food Mfg	7%	51%	38%	5%	0%
Industrial Machinery	37%	18%	37%	3%	5%
Miscellaneous Mfg	33%	30%	27%	0%	10%
Nonmetallic Mineral Products	5%	3%	86%	0%	5%
Paper Mfg	4%	61%	26%	5%	5%
Petroleum Coal Products	1%	33%	60%	2%	4%
Plastics Rubber Products	19%	39%	29%	2%	10%
Primary Metal Mfg	7%	11%	81%	0%	1%
Printing Related Support	35%	21%	42%	2%	0%
Transportation Equipment Mfg	33%	27%	33%	2%	6%
Wastewater	0%	0%	0%	0%	100%
Water	0%	0%	0%	0%	100%
Wood Product Mfg	13%	27%	49%	4%	7%

Table B.21. Industrial Electric Consumption by Industry Type and End Use

Industry Type	HVAC	Process Cool	Process Electro Chem.	Fans	Process Air Comp.	Motors Other	Process Refrigeration
Chemical Mfg	6%	9%	18%	7%	16%	15%	4%
Computer Electronic Mfg	29%	9%	1%	5%	1%	9%	1%
Electrical Equip. Mfg	17%	4%	3%	4%	10%	10%	3%
Fabricated Metal Products	10%	3%	1%	6%	75	17%	3%
Food Mfg	7%	25%	0%	4%	4%	19%	15%
Industrial Machinery	18%	3%	1%	7%	8%	19%	3%
Miscellaneous Mfg	20%	6%	0%	6%	5%	22%	0%
Nonmetallic Mineral Products	6%	3%	0%	8%	9%	23%	4%
Paper Mfg	4%	1%	2%	16%	4%	32%	4%
Petroleum Coal Products	3%	6%	0%	11%	13%	31%	5%
Plastics Rubber Products	10%	8%	0%	7%	9%	21%	4%
Primary Metal Mfg	4%	1%	31%	5%	5%	20%	0%
Printing Related Support	18%	4%	0%	7%	8%	19%	3%
Transportation Equipment Mfg	19%	5%	1%	5%	12%	12%	3%
Wastewater	0%	0%	0%	0%	66%	0%	0%
Water	0%	0%	0%	10%	0%	10%	0%
Wood Product Mfg	7%	1%	0%	10%	11%	28%	5%

Table B.22. Industrial Electric Consumption by Industry Type and End Use

Industry Type	Other	Pumps	Process Heat	Process Other	Lighting	Indirect Boiler
Chemical Mfg	2%	15%	3%	0%	4%	1%
Computer Electronic Mfg	11%	7%	11%	3%	13%	0%
Electrical Equip. Mfg	8%	9%	19%	1%	13%	0%
Fabricated Metal Products	9%	11%	23%	0%	9%	0%
Food Mfg	7%	8%	3%	0%	7%	1%
Industrial Machinery	7%	12%	7%	1%	14%	0%
Miscellaneous Mfg	4%	3%	9%	0%	15%	9%
Nonmetallic Mineral Products	4%	15%	20%	1%	5%	0%
Paper Mfg	2%	25%	2%	0%	4%	3%
Petroleum Coal Products	1%	20%	6%	0%	2%	1%
Plastics Rubber Products	3%	13%	15%	1%	8%	0%
Primary Metal Mfg	1%	3%	28%	0%	3%	0%
Printing Related Support	14%	12%	2%	0%	11%	0%
Transportation Equipment Mfg	4%	11%	10%	1%	15%	0%
Wastewater	14%	18%	0%	0%	2%	0%
Water	14%	64%	0%	0%	2%	0%
Wood Product Mfg	8%	18%	5%	0%	7%	1%

Appendix C: Supplemental Material—Energy Efficiency

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Appendix C.1: Energy Efficiency (Supplemental Material)

Detailed Methodology

Determination of energy-efficiency potential is based on a sequential analysis of various energy-efficiency measures in terms of technical feasibility (technical potential) and economic viability based on standard cost-effectiveness criteria (economic potential). Most of the methodology is identical for electricity and natural gas analyses, but key differences are noted below when applicable. The assessment is carried out in two main steps:

- ***Baseline forecasts***: Determine 20-year future energy consumption by segment and end use calibrated to each utility's load forecasts. The baseline forecast reflects efficiency characteristics of current codes and standards, which are assumed to be fixed (frozen efficiency) over the forecast horizon.

- ***Estimation of alternative forecasts of technical and technical achievable potentials***: Estimate technical and achievable technical potential based on alternative forecasts reflecting technical impacts of specific energy efficiency measures and market constraints, respectively. The difference between the baseline and each alternative forecast represents the energy-efficiency potential associated with that particular type of potential.

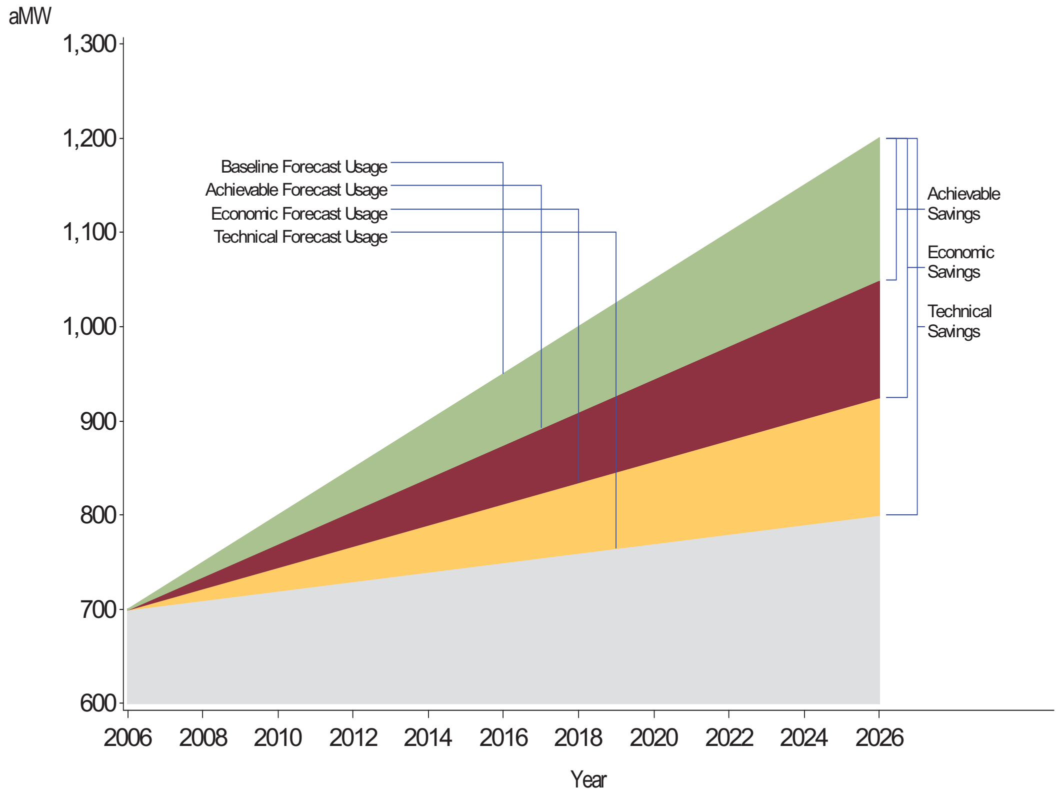
These steps are represented conceptually in Figure C.1, which shows a hypothetical baseline forecast along with the alternative forecasts associated with technical economic, and achievable potential.[1] Although economic and achievable potential were not explicitly estimated for this study, the figure shows the general method of the assessment. These alternative forecasts represent consumption under different sets of assumptions, and the difference between the baseline and each alternative forecasts represents their respective potential savings. For example, the technical potential forecast represents total consumption after incorporation of all measures, consistent with the definition above. The results are intuitive, with total consumption in the technical potential forecast much lower than the baseline, which also indicates the greatest amount of potential.

This approach has two advantages. First, savings estimates are driven by a baseline calibrated to the utility's sales forecasts and is thus consistent with filings. The sales forecast serves as a reality check and helps control for possible errors. Other approaches may simply generate the total potential by summing the estimated impacts of individual measures, which can result in estimates of total savings that represent an unrealistically high percentage of baseline sales. Second, the approach maintains consistency among all the assumptions underlying the baseline and alternative (technical and economic) forecasts. In the alternative forecasts, relevant inputs at

[1] The baseline and alternative forecasts shown in Figure C.1 are purely for example and do not represent the actual data underlying this assessment.

the end-use level are changed to reflect the impact of energy-efficiency measures. Because the estimated savings represent the difference between the baseline and alternative forecasts, they can be directly attributed to specific changes made to analysis inputs. A transparent framework results that allows tracing linkages between various assumptions and calculated measure impacts.

Figure C.1. Representation of Alternative Forecast Approach to Estimation of Energy-Efficiency Potential



Data Sources

The full assessment of energy-efficiency resource potential required the compilation of a large set of measure-specific technical, economic, and market data from secondary sources and through primary research. The main sources of data used in this study included:

- ***PSE***. 2006 sales, customers, and forecasts, historical energy-efficiency activities, non-residential customer databases, residential audits. A complete list of data elements provided by PSE is shown in Table C.1.

- ***Primary Data Collection***. Surveys of residential and non-residential customers.

Table C.1. Energy Efficiency Utility Data Sources

Data Element	Key Variables	Use in This Study
2006 sales and customer counts	Number of customers and total sales by customer segment.	Base year customers and sales for calibration in end-use model.
2006 load forecasts by rate class	Sales and customer forecasts by customer segment, excluding all DSM activity.	End-use model calibration, new customers as drivers in end-use model development.
Historical program activity/ achievements	Program participation and historical program achievements.	Measure saturations, validation of measure characterization (savings, costs).
Economic assumptions	Discount rate, inflation, line loss, etc.	Measure analysis and estimates of potential at customer meter and generation

- ***Building Simulations***. Estimates for normal consumption and load profiles for the majority of end uses in the residential and commercial sectors were developed specifically for this study using the eQuest (commercial) and Energy-10 (residential) building simulation models. Separate models were created for each fuel, customer segment, and construction vintage. Inputs and outputs for these models are presented in detail in Volume II, Appendix B4.

- ***Regional Technical Forum***. The RTF measure database was used extensively in this study to ensure consistency both in terms of measures analyzed and expected measure costs and savings.

- ***California Energy Commission***. This study used information available through the 2005 Database of Energy Efficiency Resources (DEER) to validate many of the assumptions and data collected on energy-efficiency measure costs and savings.

- ***Ancillary Sources***. Other data sources consisted primarily of available information from past energy-efficiency market studies, energy-efficiency potential studies, and evaluations of energy-efficiency programs around the country. The primary information sources on the industrial section were the U.S. Department of Energy, Energy Information Administration Office of Industrial Technologies (including the Industrial Assessment Centers database), and the Northwest Energy Efficiency Alliance's Industrial Efficiency Alliance initiative.

Baseline Forecasts

PSE's forecasts of sales form the basis for assessing energy-efficiency potential. Prior to estimating potential, these forecasts are disaggregated by customer sector (residential, commercial, and industrial), customer segment (business, dwelling, and facility types), building vintage (existing structures and new construction), and end uses (all applicable end-uses in each customer sector and segment).

The first step in developing the baseline forecasts is to determine the appropriate customer segments within each sector. These designations were based on categories available in some of the key data sources used in this study, as well as discussion with PSE and other parties. Table C.2 through Table C.4 show the full set of customer segments and end uses for each sector analyzed in this study.

Table C.2. Residential Sector Dwelling Types and End Uses

Residential Customer Segments	Electric End Uses	Gas End Uses
Manufactured	Central AC	Boiler
Multi-Family	Central Heat	Cooking Oven
Single-Family	Cooking Oven	Cooking Range
	Cooking Range	Dryer
	Dryer	Furnace
	Freezer	Pool Heat
	Heat Pump	Water Heat
	HVAC Auxiliary	
	Lighting	
	Plug Load	
	Pool Pump	
	Refrigerator	
	Room AC	
	Room Heat	
	Water Heat	

Table C.3. Commercial Sector Customer Segments and End Uses

Commercial Customer Segments	Electric End Uses	Gas End Uses
Dry Goods Retail	Cooking	Cooking
Grocery	Cooling - Chillers	Dryer
Hospital	Cooling - DX	Pool Heat
Hotel/Motel	Dryer	Space Heat - Boiler
Office	Heat Pump	Space Heat - Furnace
Other	HVAC Auxiliary	Water Heat
Restaurant	Lighting	
School	Plug Load	
University	Refrigeration	
Warehouse	Space Heat	
	Water Heat	

Table C.4. Industrial Sector and End Uses

Industrial Customer Segments (NAICS)	Electric End Uses	Gas End Uses
Chemical Manufacturing	Fans	HVAC
Computer Electronics Manufacturing	HVAC	Indirect Boiler
Electrical Equipment Manufacturing	Indirect Boiler	Other
Fabricated Metal Products	Lighting	Process - Heating
Food Manufacturing	Motors - Other	Process - Other
Industrial\ Machinery	Other	
Miscellaneous Manufacturing	Process – Air Compressors	
Nonmetallic Mineral Products	Process - Cooling	
Paper Manufacturing	Process – Electro-Chemical	
Petroleum and Coal Products	Process - Heating	
Plastics and Rubber Products	Process - Other	
Primary Metal Manufacturing	Process - Refrigeration	
Printing Related Support	Pumps	
Transportation Equipment Manufacturing		
Wastewater		
Water		
Wood Product Manufacturing		

Once the appropriate customer segments and end uses have been determined for each sector, the integration of current and forecasted customer counts with key market and equipment usage data produced the baseline end-use forecasts. For commercial and residential sectors, the total baseline annual consumption for each end use in each customer segment is calculated as shown below:

$$EUSE_{ij} = \Sigma_e\, ACCTS_i * UPA_i * SAT_{ij} * FSH_{ij} * ESH_{ije} * EUI_{ije}$$

where:

$EUSE_{ij}$ = total energy consumption for end use j in customer segment i

$ACCTS_i$ = the number of accounts/customers in customer segment i

UPA_i = the units per account in customer segment i (UPA_i is generally the average square feet per customer in commercial segments and 1.0 in residential dwellings, which are assessed at the whole-home level[2])

SAT_{ij} = the share of customers in customer segment i with end use j

FSH_{ij} = the share associated with electricity in end use j in customer segment i

ESH_{ije} = the market share of efficiency level e in the equipment for customer segment ij

2 It is important to note the average square footage by home type is an input into the building simulations, so weather and size of homes differences among building segments are reflected in the results.

EUI_{ije} = end-use intensity, energy consumption per unit (per square foot for commercial) for the equipment configuration *ije*

Total annual consumption in each sector is then determined as the sum of $EUSE_{ij}$ across the end uses and customer segments. The key to ensuring accuracy of the baseline forecasts is the calibration of the end-use model estimates of total consumption to actual sales. This calibration to base year sales includes making appropriate adjustments to data where necessary to conform to known information about customer counts, appliance and equipment saturations, and fuel shares from a variety of sources.

Consistent with other potential studies and commensurate with the industrial end use consumption data that vary widely in quality, the industrial sector's allocation of loads to end uses in various segments (NAICS) was based on data available from the U.S. Department of Energy's Energy Information Administration.[3]

Derivation of End-Use Consumption Estimates

Estimates of end-use energy consumption (EUI_{ije}) are one of the most important components in the development of the baseline forecast. In the residential sector, these estimates are based on the unit energy consumption (UEC), which represents the annual energy consumption associated with the end use (in some cases, the end use represents the specific type of equipment, such as a central air conditioner or heat pump) at the building level. For the commercial sector, the consumption estimates are treated as end-use intensities (EUIs), which represent the annual energy consumption per square foot of structure. The accuracy of these estimates is critical, so they account for weather and other factors described below that drive differences among the various segments. For the industrial sector, end-use energy consumption represents the total annual facility consumption by end use as allocated by the secondary data described above.

In the residential and commercial sectors, the majority of end-use consumption estimates are derived from building simulation models (eQuest and Energy-10 for commercial and residential segments, respectively)[4] to account for state code, building size, and shell characteristics. For non-weather-sensitive end uses that cannot be modeled within a building simulations framework (e.g., residential refrigerators), the consumption estimates are taken from the Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS) and the Commercial Building Energy Consumption Survey (CBECS). Most key drivers in developing the simulation models (operating schedules, setback temperatures, and building size) are developed from the primary data collection outlined above.[5] Summaries of the estimates for end-use consumption for residential (UECs), commercial (EUIs), and industrial (end-use percentages) are provided in Volume II, Appendix F.

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3 U.S. DOE, Energy Information Administration, Manufacturing Energy Consumption Survey (2002).

4 For details on eQuest and Energy-10, see http://www.doe2.com and http://www.sbicouncil.org/store/e10.php, respectively.

5 Extensive effort was made to validate and cross-check the results of this data collection with data from other sources, including RECS, CBECS, and other available studies.

Estimating Technical Potential

After the development of the baseline forecasts, the next step is estimation of technical potential. Because technical potential is based on creating an alternative forecast[6] that reflects the installation of all possible measures, the selection of appropriate energy-efficiency resources to include in this study is a central concern. For the residential and commercial sectors, the study began with a broad range of energy-efficiency measures for possible inclusion. These measures are screened to include only measures commonly available, based on well-understood technology, and applicable to Iowa buildings and end uses. Examples of these measures are found in California's Database of Energy Efficiency Resources (DEER).[7] The industrial sector measures are based on general categories of building or process improvements.[8]

Table C.5, Table C.7, and

Table C.9 outline the types of energy-efficiency measures assessed in the residential, commercial, and industrial sectors, respectively. Equipment measures are those replacing end-use equipment (e.g., high-efficiency central air conditioners), while non-equipment measures are those reducing end-use consumption without replacing end-use equipment (e.g., insulation). A complete list of all measures, with descriptions, is provided in Volume II, Appendix A.

Table C.5. Residential Electric Energy-Efficiency Measures

End Use	Measure Types
HVAC	Non-Equipment: 2-stage central AC units; HVAC proper sizing; AC ductless split-system; desuperheaters for heat pumps & central AC; appropriate duct location; duct repair/sealing; ECM motors; air-to-air heat exchanger; energy efficient heat pumps; radiant heaters; programmable and multi-zone thermostats; HVAC tune-up/maintenance, VSD Fan
	Equipment: high-efficiency heat pumps; high-efficiency central AC; high-efficiency room AC units.
Lighting	Non-Equipment: CFL lamps & fixtures; air tight fixture sealing; daylight photocell; fluorescent torchieres; halogen cap lights; LED lighting; occupancy sensors; time clocks;
Water Heating	Non-Equipment: drain water heat recovery; hot water pipe insulation; faucet aerators; low-flow showerheads; temperature setback; ENERGY STAR dishwashers and clothes washers; heat pump water heater; tankless water heating; tank insulation
	Equipment: high-efficiency water heaters.
Building Envelope	Non-Equipment. Window blinds; doors; fanfolds or dow board; ICF construction; infiltration control; insulation; interior shades or thermal drapes; outlet gaskets; radiant barriers; SIP construction; smart siting; vinyl siding; high efficiency windows;

6 The alternative forecast actually consists of four separate forecasts to allow delineation between existing and new construction and equipment and non-equipment measures. These distinctions are explained later in this section.

7 Details on DEER are available at http://eega.cpuc.ca.gov/deer

8 Industrial improvements are derived from a variety of practices and specific measures defined in the Department of Energy's Industrial Assessment Centers Database, http://www.iac.rutgers.edu/database/.

End Use	Measure Types
Appliances	Non-Equipment: Attic fan; battery chargers; clothes washer; convection ovens; dehumidifier; ENERGY STAR home audio, copiers, monitors, cordless phones, receivers, computers, printers, HDTV, televisions, VCR's, ceiling fans; induction stove; pool pump timers; VSD pool pumps; range and oven; early replacement of refrigerator/freezer; refrigerator eCube; removal of secondary refrigerator/freezer; whole-house fan; Equipment: ENERGY STAR freezers and refrigerators; high-efficiency clothes dryers.

Table C.6. Residential Gas Energy-Efficiency Measures

End Use	Measure Types
HVAC	*Non-Equipment*: HVAC proper sizing; desuperheaters for heat pumps & central AC; appropriate duct location; duct repair/sealing; programmable and multi-zone thermostats; HVAC tune-up/maintenance; integrated space/water heating. *Equipment*: high AFUE gas boilers; high AFUE furnace.
Water Heating	*Non-Equipment*: drain water heat recovery; hot water pipe insulation; faucet aerators; low-flow showerheads; temperature setback; ENERGY STAR dishwashers and clothes washers; tankless water heating; tank insulation; pool heaters. *Equipment*: high-efficiency water heaters.
Building Envelope	*Non-Equipment.* Doors; fanfolds or dow board; ICF construction; infiltration control; insulation; radiant barriers; vinyl siding; high efficiency windows.
Appliances	*Non-Equipment*: Clothes washer; convection ovens; range and oven. *Equipment*: high-efficiency clothes dryers.

Table C.7. Commercial Electric Energy-Efficiency Measures

End Use	Measure Types
HVAC	*Non-Equipment*: ventilation VFD control; chiller VSD control; chilled water piping loop w/ VSD control; chilled water reset; HVAC replacement/retro-commissioning & optimization; chiller economizer; compressed air optimization; VSD compressors; cooling tower approach temperature decrease; cooling tower (two speed and variable speed); evaporative cooling; DDC system (installation and optimization); duct repair & sealing; ductless AC unit; economizers; exhaust air to ventilation air heat recovery; high-efficiency condenser; exhaust hood makeup air; fan control shutoff; floating head pressure control; premium efficiency motors; constant air to VAV conversion; cooling tower improvements; optimized lab hood exhaust; pipe insulation; pump and fan (variable speed controls & optimization); radiant heating; programmable thermostats; sensible/total heat recovery units; spot coolers; VSD exhaust fans. *Equipment*: high-efficiency heat pumps; high-efficiency chillers and DX packages; Room AC units.
Lighting	*Non-Equipment*: bathroom LED light; bi-level controls; CFL lamps & fixtures; fluorescent lamps & fixtures; daylighting controls; delamping; induction lamps; halogen lamps; high-efficiency fixture design; HID lamps & fixtures; LED lamps & fixtures; traffic lights; occupancy sensors; continuous dimming and stepped dimming controls; time clock controls; task lights; twist timers; refrigeration lighting and exit signs; integrated classroom lighting.
Water Heating	*Non-Equipment*: hot water pipe insulation; temperature setback; chemical dishwashing systems; demand controlled circulating systems; drain water heat recovery; low-flow showerheads; low-flow spray heads; low-flow faucet aerators; heat pump water heater; tankless water heaters; ultrasonic faucet controls; water heater insulation. *Equipment*: high-efficiency water heaters.
Building Envelope	*Non-Equipment.* Blinds; infiltration control; insulation; Integrated Building design Tier I & II; interior shades/thermal drapes; natural ventilation; radiant barrier; high-efficiency windows.

End Use	Measure Types
Refrigeration	*Non-Equipment*: anti-sweat controls; ECM case fans; solid-door refrigerator/freezer; high-efficiency compressors; custom refrigeration system; demand control defrost; demand controlled circulation; high performance display cases; case fans; night cover for display cases; parallel unequal compressors; reduced speed or cycling of evaporator fans; commissioning; heat recovery; refrigerator eCube; low-e glass doors; strip curtains; vending miser; floating condenser heads; anti-sweat controls; high-efficiency ice maker.
Other / Appliances	*Non-Equipment:* chemical dishwashing system; ozonating & standard clothes washers; ENERGY STAR computers, copiers, fax machines, monitors, printers, scanners, hot food holding cabinets, & water coolers; convection oven; high-efficiency fryer; high-efficiency dishwashers; office computer network management system; PowerSupply 80+; high-efficiency steam cookers; high-efficiency vending machines; power supply transformer/converter; power strip with occupancy sensor; wireless monitoring. *Equipment:* high efficiency clothes dryer.

Table C.8. Commercial Gas Energy-Efficiency Measures

End Use	Measure Types
HVAC	*Non-Equipment*: HVAC replacement/retro-commissioning & optimization; boiler economizer; boiler turbulators; direct fired makeup air units; steam trap maintenance; steam pipe insulation; DDC system (installation and optimization); duct repair & sealing; vent damper for atmospheric boiler; exhaust hood makeup air; radiant/infrared heating; programmable thermostats; sensible/total heat recovery units. *Equipment*: high-efficiency boilers, high-efficiency dryers, high AFUE furnace
Water Heating	*Non-Equipment*: hot water pipe insulation; temperature setback; chemical dishwashing systems; demand controlled circulating systems; drain water heat recovery; integrated space/water heating; low-flow showerheads; low-flow faucet aerators; tankless water heaters (residential & commercial sized); water heater insulation.
Building Envelope	*Non-Equipment.* infiltration control; insulation; Integrated Building design Tier I & II; radiant barrier; high-efficiency windows.
Refrigeration	*Non-Equipment*: refrigeration with heat recovery.
Other / Appliances	*Non-Equipment:* ENERGY STAR broilers fryers, griddles, steam cookers, chemical dishwashing system; ozonating & standard clothes washers; power burner oven; range and oven; swimming pool/spa covers; convection oven; conveyor oven; wireless monitoring.

Table C.9. Industrial Electric Energy-Efficiency Measures

Electric Measure Types
Air Compressor Improvements
Air Compressor O&M
Building Improvements
Boiler Improvements
Process Cooling Improvements
Process Heating Improvements
HVAC Improvements
HVAC O&M
Lighting Improvements
Motor Improvements
Motor O&M

Electric Measure Types
Other Improvements
Other O&M
Refrigeration Improvements

Table C.10. Industrial Gas Energy-Efficiency Measures

Gas Measure Types
Boiler Improvements
Boiler O&M
Process Heating Improvements
Process Heating O&M
HVAC Improvements
HVAC O&M
Other O&M
Steam Distribution Improvements

Once various measures are properly characterized in terms of savings and costs, technical potential is calculated by subtracting the alternative forecast from the baseline, which yields savings by all dimensions included in the segmentation design (vintage, segment, etc.). The procedure involves three analytic steps, as follows.

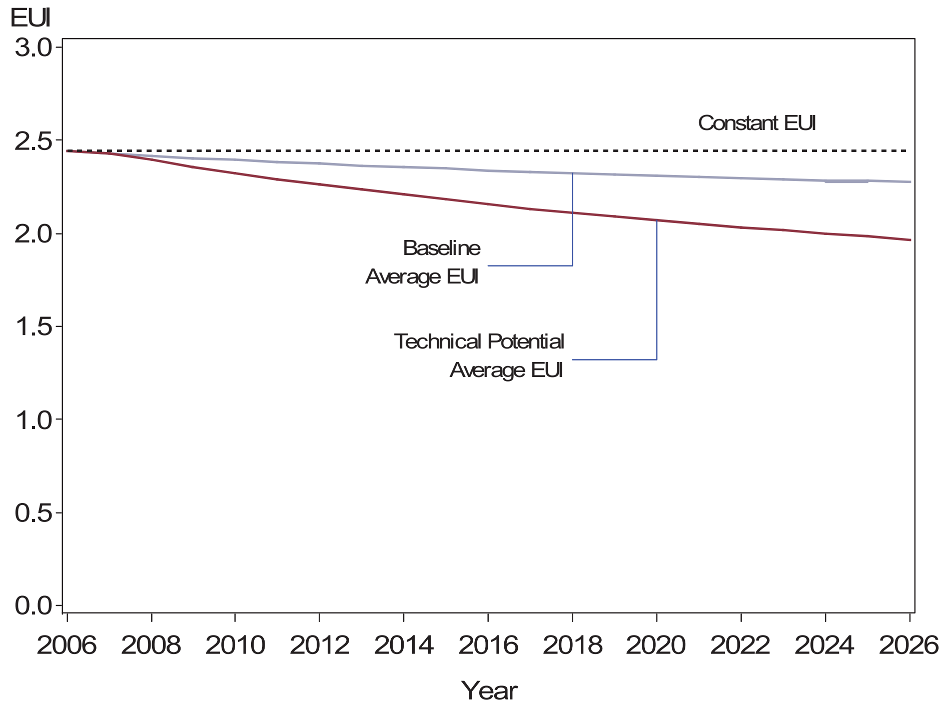
Determine Measure Impacts

The starting point in assessment of technical potential is the estimation of measure-level impacts. It begins by compiling and analyzing data on the following measure characteristics:

- ***Measure savings***: The energy savings associated with a measure as a percentage of the total end-use consumption. Sources include engineering calculations, energy simulation modeling, secondary data sources (case studies), and the California DEER database.
- ***Measure costs***: The per-unit cost (either full or incremental, depending on the application) associated with installation of the measure. Sources include the DEER database, RS Means, merchant websites (Home Depot, Trane, etc.), and other secondary sources.
- ***Measure life***: The expected lifetime of the measure. Sources include the DEER database, other potential studies, or DSM program evaluations.
- ***Measure applicability***: A general term encompassing a number of factors, including the technical feasibility of installation and the current or naturally occurring saturation of the measure as well as factors to allocate savings associated with competing.

In estimating potential savings of equipment measures, it is assumed the baseline efficiency for the measure would shift from its current level to prevailing codes upon burnout. Thus, it is assumed the average baseline efficiencies for this class of measures would improve over time as existing, sub-code equipment are replaced at the end of their normal, useful lives. An example of this methodology is provided in Figure C.2,[9] which shows the average EUI (annual kWh per square foot) associated with a piece of end use equipment in the baseline forecast, the technical potential scenario, and a constant EUI scenario, in which the effects of natural decay and current codes and standards are eliminated. The difference between the baseline EUI and the technical potential EUI represents the savings.

Figure C.2. Example of Equipment Potential: Average EUI Over Planning Horizon



The demonstration highlights two important aspects of the approach. First, the figure shows how average baseline usage gradually declines as more equipment decays and is replaced by units that comply with current code. In this case, based on an assumed 15-year life for this measure, its expected baseline efficiency would improve by almost 14% over 20 years. That is, by the end of this forecast period example, all the existing sub-code equipment would be replaced by code.

Second, by contrasting the average usage in the baseline with the constant efficiency scenario, the figure shows how estimates account for the effects of naturally occurring conservation. The technical potential savings are represented by the difference between the technical potential and the baseline, which would not be the case with a constant EUI. This demonstrates how this approach accurately estimates total potential and accurately accounts for naturally occurring potential. It is important to note, however, that the approach does not include any increased efficiency requirements embodied in future changes to codes and standards (that is, the baseline assumes a "frozen efficiency").

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9 This is a purely illustrative example and does not contain Iowa-specific data.

The approach for non-equipment (or "retrofit") measures is more complicated because it requires assessing the collective impacts of a variety of measures with interactive effects. For each segment and end-use combination, the objective of the analysis is to estimate the cumulative effect of the bundle of eligible measures and incorporate those impacts into the end-use model as a percentage adjustment to the baseline end-use consumption. In other words, the objective of the approach is to estimate the percentage reduction in end-use consumption that could be saved in a "typical"[10] structure (multifamily dwelling, small office, etc.) by installing all available measures. The starting point for this approach is characterizing individual measure savings in terms of the percentage of end-use consumption rather than their absolute energy savings. For each individual non-equipment measure, savings are estimated using the following basic relationship:

$$SAVE_{ijm} = EUI_{ije} * PCTSAV_{ijem} * APP_{ijem}$$

where:

$SAVE_{ijm}$ = annual energy savings for measure *m* for end use *j* in customer segment *i*

EUI_{ije} = calibrated annual end-use energy consumption for the equipment *e* for end use *j* and customer segment *i*

$PCTSAV_{ijem}$ = the percentage savings of measure *m* relative to the base usage for the equipment configuration *ije*, taking into account interactions among measures such as lighting and HVAC calibrated to annual end-use energy consumption

APP_{ijem} = measure applicability, a fraction that represents a combination of the technical feasibility, existing measure saturation, end-use interaction, and any adjustments to account for competing measures

As described later in this section, it is appropriate to view a measure's savings is in terms of what it saves as a percentage of baseline end-use consumption, given its overall applicability. In the case of wall insulation that saved 10% of space heating consumption, if the overall applicability is only 50%, the final percentage of the end use saved would be 5%. This value represents the percentage of baseline consumption the measure saves in an average home.

However, as stated previously, the study deals almost exclusively with cases where multiple measures affect a single end use. To avoid overestimation of total savings, the assessment of cumulative impact accounts for the interaction among the various measures, a treatment called "measure stacking." The primary means of accounting for stacking effects is to establish a

[10] This aspect of the approach requires careful determination of what a "typical" structure represents. For example, the average structure might have only a fraction of a measure installed, so it becomes necessary to think of the average single-family home, for instance, as having only 20% of a high-efficiency window already installed. Many of the attributes of structures – size, measures installed, number of stories – have been based on data collected in the surveys. These values were determined using averages from the survey results. When necessary an R-value was converted to a U-value to correctly calculate the average insulation level and then adjusted back to the typical R-value unit. Summaries of attributes associated with the prototypes used in the building simulations are presented in Volume II, Appendix F.

rolling, reduced baseline applied iteratively as measures in the stack are assessed. This is shown in the equations below, where measures 1, 2, and 3 are applied to the same end use:[11]

$$SAVE_{ij1} = EUI_{ij\,e} * PCTSAV_{ije1} * APP_{ije1}$$

$$SAVE_{ij2} = (EUI_{ije} - SAVE_{ij1}) * PCTSAV_{ije2} * APP_{ije2}$$

$$SAVE_{ij3} = (EUI_{ije} - SAVE_{ij1} - SAVE_{ij2}) * PCTSAV_{ije3} * APP_{ije3}$$

After iterating through all of the measures in a bundle, the final percentage of end-use consumption reduced is the sum of the individual measures' stacked savings divided by the original baseline consumption.

Finally, the nature of this approach requires clarification in that there are actually two different savings types associated with a measure. The first is called as stand-alone savings (the savings the measure would provide when installed entirely on its own). The second is called stacked savings (savings attributable to a measure when assessed in conjunction with other measures and accounting for the various factors that affect applicability). The former represents savings associated with a single, actual installation; the latter is intended to represent the average savings measure would achieve when installed across all homes. A summary of the factors that affect the overall potential associated with a measure are presented in Table C.11.

Estimate Phased-In Technical Potential

Savings from the technical energy-efficiency potential are estimated by incorporating measure impacts (equipment and non-equipment) into the baseline forecast in four steps to develop alternative forecasts. The steps are sequential, with each case building on the previous scenario:

1. Equipment measures in existing construction, in which all equipment is upgraded to the highest level of efficiency after decay.

2. Equipment measures in new construction, in which all new construction is upgraded to the highest level of equipment efficiency.

3. Non-equipment measures in existing construction, in which collective measure energy savings impacts are applied to end-use consumption estimates.

4. Non-equipment in new construction, in which collective measure energy savings are applied to end-use consumption estimates.

The sequence of this approach is necessary to account for the interaction between equipment and non-equipment measures. As equipment is replaced over time with the highest efficiency option, average consumption associated with an end use declines. This results in a reduction in the

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[11] In some cases, there may not be complete interaction between measures, e.g. wall and ceiling interaction. However, based on building simulation and engineering experience, it is believed that the interaction is substantial. This method provides a somewhat conservative approach to potential estimates in some cases, but to assume no interaction could greatly inflate the actual available potential.

absolute impact associated with non-equipment measures. Accounting for this interaction results in a more accurate estimate of the potential associated with non-equipment measures.

Table C.11. Measure Applicability Factors

Measure Impact	Explanation	Sources
Fuel Saturation	The percentage of customers that use a particular fuel (gas or electric) in Iowa for the specific end use (e.g., water heat, space heat, etc.).	Residential and commercial surveys
End-Use Saturation	The percentage of customers that have the specific end use. (If not all residential customers have a central AC unit, for example, the end-use saturation would be less than 100%.)	Residential and non-residential surveys
Measure Share	Used to distribute the percentage of market shares for competing measures (e.g., CFLs and LEDs each have their own measure share of the market share).	Survey of installation contractors. various secondary sources.
Measure Incomplete Factor	Represents the percentage of buildings that do not have the specific measure currently installed.	▪ ENERGY STAR Sales Records (2003, 2004, 2005 and partial 2006). ▪ Residential and commercial surveys
Technical Feasibility	Accounts for the percentage of buildings that can have the measure physically installed. A couple of factors may affect this percentage, including whether the building already has the baseline measure (e.g., dishwasher) as well as limitations on installation (e.g., size of unit and space available to install the unit).	Survey of installation contractors and trade allies.
Measure Interaction	Only considered for lighting and HVAC.	Energy Simulation Modeling Engineering Judgment.

Technical Achievable Potential

As described in Volume I, Section 2, this study did not rely on the traditional process of estimating technical potential followed by economic and achievable potentials. Instead, a "technical achievable" potential was estimated to represent the potential available after accounting for market barriers other than cost-effectiveness. This was accomplished by applying expected maximum market penetration percentages to the technical potential. These percentages are show in Table C.12.

Table C.12. 20 Year Market Penetration Rates by Fuel and Sector

	Electric		Gas	
Sector	Existing Construction	New Construction	Existing Construction	New Construction
Residential	85%	65%	75%	55%
Commercial	85%	65%	75%	55%
Industrial	85%	65%	75%	55%

This potential was then bundled by cost of conserved energy to create bundles for use in IRP modeling.

Data & Assumptions

Baseline Forecasts

Figure C.3. Residential Electric Sales Forecast

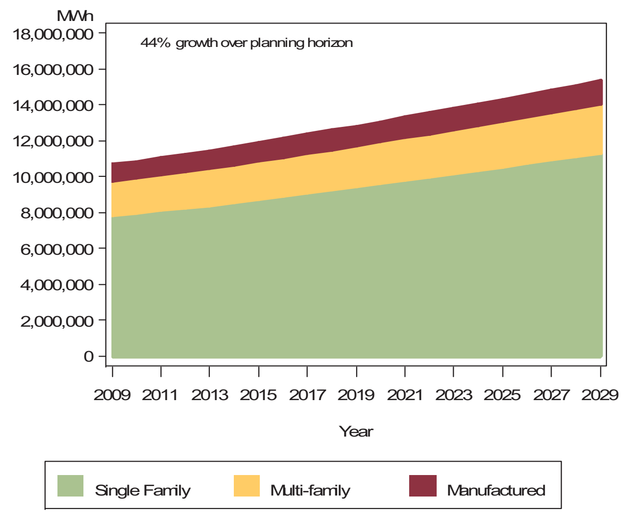


Figure C.4. Commercial Electric Sales Forecast

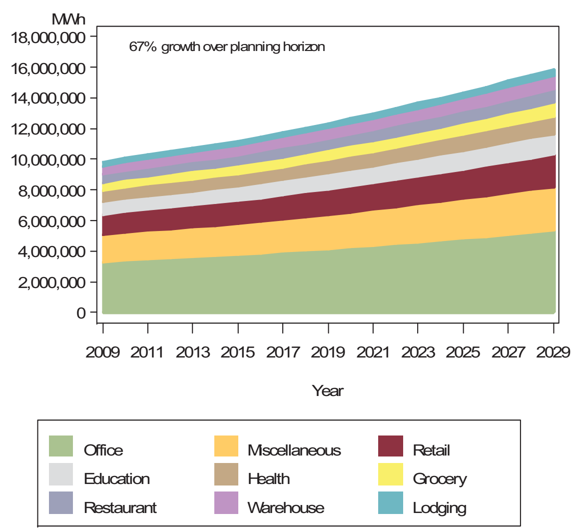


Figure C.5. Industrial Electric Sales Forecast

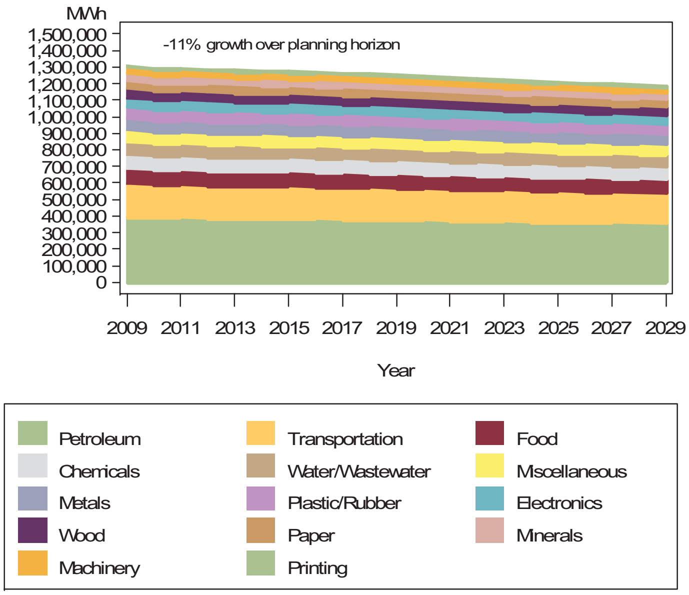


Figure C.6. Residential Gas Sales Forecast

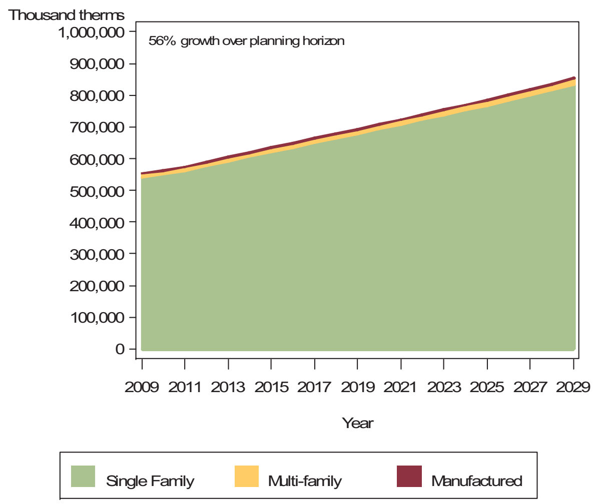


Figure C.7. Commercial Gas Sales Forecast

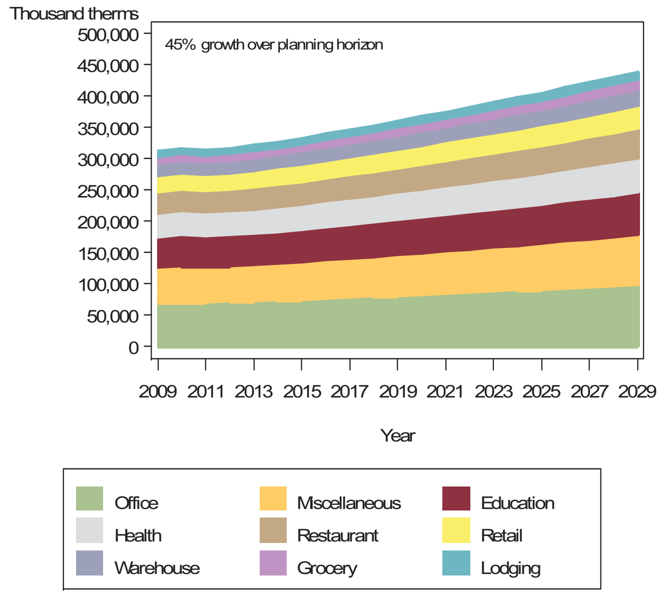
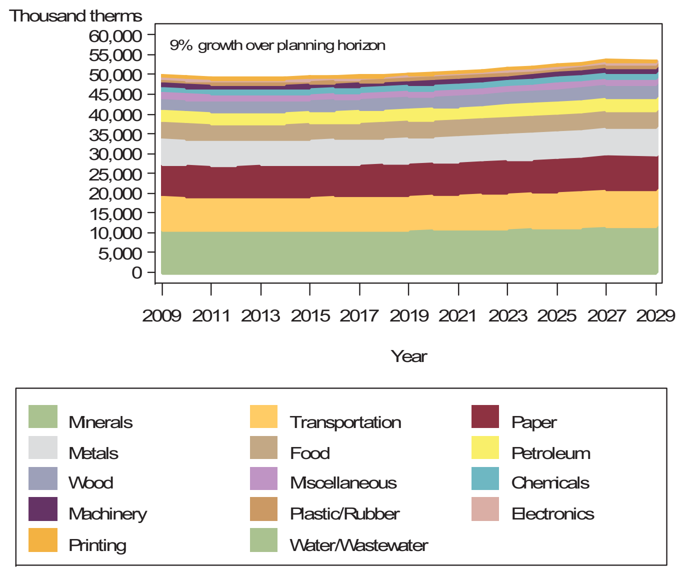


Figure C.8. Industrial Gas Sales Forecast



Baseline Equipment Saturations and Fuel Shares

Table C.13. Residential Electric Equipment Saturations and Fuel Shares

Customer Segment/End Use	Equipment Saturation	Electric Share
Manufactured		
Central AC	18%	100%
Central Heat	69%	58%
Cooking Oven	103%	97%
Cooking Range	103%	93%
Dryer	98%	96%
Freezer	71%	100%
HVAC Aux	100%	100%
Heat Pump	16%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Pool Pump	3%	100%
Refrigerator	109%	100%
Room AC	24%	100%
Room Heat	16%	100%
Water Heat	100%	85%
Multi Family		
Central AC	3%	100%
Central Heat	22%	25%
Cooking Oven	106%	96%
Cooking Range	95%	90%
Dryer	64%	98%
Freezer	5%	100%
HVAC Aux	100%	100%
Heat Pump	0%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Pool Pump	0%	100%
Refrigerator	103%	100%
Room AC	0%	100%
Room Heat	64%	100%
Water Heat	100%	73%
Single Family		
Central AC	14%	100%
Central Heat	73%	10%
Cooking Oven	117%	83%
Cooking Range	97%	68%
Dryer	99%	82%
Freezer	64%	100%
HVAC Aux	100%	100%
Heat Pump	5%	100%
Lighting	100%	100%
Other	100%	100%

Customer Segment/End Use	Equipment Saturation	Electric Share
Plug Load	100%	100%
Pool Pump	3%	100%
Refrigerator	136%	100%
Room AC	6%	100%
Room Heat	15%	94%
Water Heat	100%	42%

Table C.14. Residential Gas Equipment Saturations and Fuel Shares

Customer Segment /End Use	Equipment Saturation	Gas Share
Manufactured		
Central Heat Boiler	3%	100%
Central Heat Furnace	93%	100%
Cooking Oven	100%	20%
Cooking Range	100%	42%
Dryer	100%	21%
Other	100%	100%
Pool Heat	0%	100%
Water Heat	100%	82%
Multi Family		
Central Heat Boiler	5%	100%
Central Heat Furnace	51%	100%
Cooking Oven	105%	31%
Cooking Range	91%	39%
Dryer	74%	7%
Other	100%	100%
Pool Heat	0%	100%
Water Heat	100%	82%
Single Family		
Central Heat Boiler	3%	100%
Central Heat Furnace	93%	96%
Cooking Oven	115%	20%
Cooking Range	98%	42%
Dryer	99%	21%
Other	100%	100%
Pool Heat	3%	77%
Water Heat	100%	85%

Table C.15. Commercial Electric Equipment Saturations and Fuel Shares

Customer Segment /End Use	Equipment Saturation	Electric Share
Dry Goods Retail		
Cooking	0%	28%
Cooling Chillers	2%	100%
Cooling DX	37%	100%
Dryer	100%	25%
Heat Pump	9%	100%
HVAC Aux	74%	100%

Customer Segment /End Use	Equipment Saturation	Electric Share
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	62%	22%
Water Heat	100%	75%
Grocery		
Cooking	100%	72%
Cooling Chillers	2%	100%
Cooling DX	53%	100%
Dryer	100%	25%
Heat Pump	17%	100%
HVAC Aux	84%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	65%	15%
Water Heat	100%	24%
Hospital		
Cooking	100%	22%
Cooling Chillers	4%	100%
Cooling DX	16%	100%
Dryer	100%	25%
Heat Pump	7%	100%
HVAC Aux	76%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	69%	51%
Water Heat	100%	43%
Hotel / Motel		
Cooking	100%	8%
Cooling Chillers	22%	100%
Cooling DX	15%	100%
Dryer	100%	25%
Heat Pump	26%	100%
HVAC Aux	82%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	53%	40%
Water Heat	100%	33%
Office		
Cooking	0%	67%
Cooling Chillers	27%	100%
Cooling DX	31%	100%

Customer Segment /End Use	Equipment Saturation	Electric Share
Dryer	100%	25%
Heat Pump	25%	100%
HVAC Aux	79%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	53%	68%
Water Heat	100%	84%
Other		
Cooking	100%	66%
Cooling Chillers	2%	100%
Cooling DX	11%	100%
Dryer	100%	25%
Heat Pump	11%	100%
HVAC Aux	67%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	56%	36%
Water Heat	100%	58%
Restaurant		
Cooking	100%	16%
Cooling Chillers	0%	100%
Cooling DX	38%	100%
Dryer	100%	25%
Heat Pump	6%	100%
HVAC Aux	82%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	75%	3%
Water Heat	100%	29%
School		
Cooking	100%	62%
Cooling Chillers	2%	100%
Cooling DX	19%	100%
Dryer	100%	25%
Heat Pump	26%	100%
HVAC Aux	82%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	56%	21%
Water Heat	100%	29%
University		

Customer Segment /End Use	Equipment Saturation	Electric Share
Cooking	100%	62%
Cooling Chillers	2%	100%
Cooling DX	19%	100%
Dryer	100%	25%
Heat Pump	26%	100%
HVAC Aux	82%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	56%	21%
Water Heat	100%	29%
Warehouse		
Cooking	0%	100%
Cooling Chillers	5%	100%
Cooling DX	11%	100%
Dryer	100%	25%
Heat Pump	3%	100%
HVAC Aux	50%	100%
Lighting	100%	100%
Other	100%	100%
Plug Load	100%	100%
Refrigeration	100%	100%
Space Heat	44%	26%
Water Heat	100%	89%

Table C.16. Commercial Gas Equipment Saturations and Fuel Shares

Customer Segment /End Use	Equipment Saturation	Gas Share
Dry Goods Retail		
Cooking	0%	72%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	10%	100%
Space Heat Boiler	60%	87%
Water Heat	100%	30%
Grocery		
Cooking	100%	28%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	2%	100%
Space Heat Boiler	79%	91%
Water Heat	100%	88%
Hospital		

Customer Segment /End Use	Equipment Saturation	Gas Share
Cooking	100%	74%
Other	100%	100%
Pool Heat	100%	3%
Space Heat Furnace	9%	76%
Space Heat Boiler	43%	81%
Water Heat	100%	74%
Hotel / Motel		
Cooking	100%	99%
Other	100%	100%
Pool Heat	100%	44%
Space Heat Furnace	49%	72%
Space Heat Boiler	29%	57%
Water Heat	100%	94%
Office		
Cooking	0%	36%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	29%	56%
Space Heat Boiler	49%	30%
Water Heat	100%	31%
Other		
Cooking	100%	34%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	10%	100%
Space Heat Boiler	60%	66%
Water Heat	100%	63%
Restaurant		
Cooking	100%	84%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	0%	100%
Space Heat Boiler	79%	97%
Water Heat	100%	75%
School		
Cooking	100%	39%
Other	100%	100%
Pool Heat	100%	13%
Space Heat Furnace	58%	91%
Space Heat Boiler	22%	81%
Water Heat	100%	84%
University		
Cooking	100%	39%
Other	100%	100%
Pool Heat	100%	13%
Space Heat Furnace	58%	91%
Space Heat Boiler	22%	81%
Water Heat	100%	84%
Warehouse		

Customer Segment /End Use	Equipment Saturation	Gas Share
Cooking	0%	0%
Other	100%	100%
Pool Heat	100%	0%
Space Heat Furnace	0%	100%
Space Heat Boiler	58%	89%
Water Heat	100%	14%

Appendix C.2: Technical Measure Inputs

Residential Electric Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 14	SEER 13	765	6.2%	NA	NA	15	$336
Existing	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 16	SEER 13	765	14.2%	NA	NA	15	$880
Existing	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 18	SEER 13	765	20.8%	NA	NA	15	$1,353
Existing	Manufactured	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	840	10.0%	0%	95%	15	$990
Existing	Manufactured	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	840	41.3%	65%	30%	10	$353
Existing	Manufactured	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	840	3.3%	60%	55%	30	$53
Existing	Manufactured	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	840	0.5%	85%	45%	10	$104
Existing	Manufactured	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	840	10.0%	90%	50%	5	$236
Existing	Manufactured	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	840	20.0%	0%	95%	20	$34
Existing	Manufactured	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	840	0.1%	85%	50%	30	$116
Existing	Manufactured	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	840	0.1%	85%	55%	12	$42
Existing	Manufactured	Central AC	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	840	2.0%	80%	65%	6	$36
Existing	Manufactured	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	840	6.0%	60%	65%	20	$447
Existing	Manufactured	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	840	19.0%	50%	95%	25	$946
Existing	Manufactured	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	840	70.0%	75%	95%	10	$1,119
Existing	Manufactured	Central AC	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	840	10.0%	75%	85%	15	$455
Existing	Manufactured	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	840	0.3%	87%	85%	25	$471
Existing	Manufactured	Central AC	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	840	1.0%	95%	40%	25	$674
Existing	Manufactured	Central AC	Insulation (Ceiling) - below code	State Code (R-38)	R-9	840	0.6%	95%	10%	25	$674
Existing	Manufactured	Central AC	Insulation (Duct)	R-8	No Duct Insulation	840	3.2%	12%	75%	25	$201
Existing	Manufactured	Central AC	Insulation (Duct)	R-8	R-4	840	1.6%	12%	95%	25	$103
Existing	Manufactured	Central AC	Insulation (Floor)	R-38	State Code (R-30)	840	0.1%	75%	90%	25	$1,061
Existing	Manufactured	Central AC	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	840	0.1%	30%	40%	25	$532
Existing	Manufactured	Central AC	Insulation (Floor) - below code	State Code (R-30)	R-0	840	0.1%	30%	10%	25	$1,595
Existing	Manufactured	Central AC	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	840	0.0%	10%	90%	25	$1,007

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central AC	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	840	0.1%	75%	45%	25	$764
Existing	Manufactured	Central AC	Insulation (Wall) 2*4 - below code	R-13	R-0	840	0.1%	75%	5%	25	$764
Existing	Manufactured	Central AC	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	840	0.1%	0%	55%	25	$1,114
Existing	Manufactured	Central AC	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	840	0.1%	0%	45%	25	$1,114
Existing	Manufactured	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	840	15.0%	10%	95%	30	$216
Existing	Manufactured	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	840	4.5%	65%	95%	15	$368
Existing	Manufactured	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	840	2.0%	95%	60%	5	$6
Existing	Manufactured	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	840	6.0%	53%	85%	15	$1
Existing	Manufactured	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	840	6.7%	0%	97%	30	$365
Existing	Manufactured	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	840	6.0%	50%	95%	10	$762
Existing	Manufactured	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	840	6.8%	85%	50%	15	$27
Existing	Manufactured	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	840	7.0%	65%	95%	12	$1,150
Existing	Manufactured	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	840	13.5%	80%	85%	20	$341
Existing	Manufactured	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	840	6.0%	50%	95%	11	$1,439
Existing	Manufactured	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	840	22.0%	50%	96%	15	$334
Existing	Manufactured	Central AC	Windows	U = 0.19	U=0.30	840	13.0%	65%	95%	25	$2,378
Existing	Manufactured	Central AC	Windows	U=0.30	Existing Windows (U=0.65)	840	36.0%	65%	60%	25	$5,656
Existing	Manufactured	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	6,556	10.0%	0%	95%	15	$990
Existing	Manufactured	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	6,556	3.3%	60%	55%	30	$53
Existing	Manufactured	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	6,556	3.0%	85%	50%	30	$116
Existing	Manufactured	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	6,556	2.0%	85%	55%	12	$42
Existing	Manufactured	Central Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	6,556	2.0%	80%	65%	6	$36
Existing	Manufactured	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	6,556	6.0%	60%	65%	20	$447
Existing	Manufactured	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	6,556	19.0%	50%	95%	25	$946
Existing	Manufactured	Central Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	6,556	10.0%	75%	85%	15	$455
Existing	Manufactured	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	6,556	1.0%	87%	85%	25	$471

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	6,556	2.0%	95%	40%	25	$674
Existing	Manufactured	Central Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	6,556	10.2%	95%	10%	25	$674
Existing	Manufactured	Central Heat	Insulation (Duct)	R-8	No Duct Insulation	6,556	4.3%	12%	75%	25	$201
Existing	Manufactured	Central Heat	Insulation (Duct)	R-8	R-4	6,556	2.1%	12%	95%	25	$103
Existing	Manufactured	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	6,556	1.0%	75%	90%	25	$1,061
Existing	Manufactured	Central Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	6,556	2.0%	30%	40%	25	$532
Existing	Manufactured	Central Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	6,556	10.0%	30%	10%	25	$1,595
Existing	Manufactured	Central Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	6,556	2.2%	10%	90%	25	$1,007
Existing	Manufactured	Central Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	6,556	5.0%	75%	45%	25	$764
Existing	Manufactured	Central Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	6,556	44.0%	75%	5%	25	$764
Existing	Manufactured	Central Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	6,556	12.0%	0%	55%	25	$1,114
Existing	Manufactured	Central Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	6,556	49.0%	0%	45%	25	$1,114
Existing	Manufactured	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	6,556	15.0%	10%	95%	30	$216
Existing	Manufactured	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	6,556	2.0%	95%	60%	5	$6
Existing	Manufactured	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	6,556	2.0%	0%	97%	30	$365
Existing	Manufactured	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	6,556	12.0%	0%	95%	25	$3,675
Existing	Manufactured	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	6,556	6.8%	85%	50%	15	$27
Existing	Manufactured	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	6,556	7.0%	65%	95%	12	$1,150
Existing	Manufactured	Central Heat	Windows	U = 0.19	U=0.30	6,556	6.0%	65%	95%	25	$2,378
Existing	Manufactured	Central Heat	Windows	U=0.30	Existing Windows (U=0.65)	6,556	15.0%	65%	60%	25	$5,656
Existing	Manufactured	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
Existing	Manufactured	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	720	13.0%	NA	NA	18	$58
Existing	Manufactured	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
Existing	Manufactured	Freezer	Stand-Alone Freezer - Early Replacement	Energy Star Freezer	Existing Non-Efficient Freezer	665	9.4%	35%	80%	12	$489
Existing	Manufactured	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	665	248.7%	35%	80%	6	$103

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	662	25.0%	65%	95%	15	$368
Existing	Manufactured	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	662	25.0%	65%	95%	15	$368
Existing	Manufactured	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	662	75.0%	40%	85%	20	$447
Existing	Manufactured	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	662	75.0%	29%	85%	20	$447
Existing	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 14 SEER, 8.5 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	5,256	4.9%	NA	NA	15	$420
Existing	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 16 SEER, 8.8 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	5,256	7.4%	NA	NA	15	$543
Existing	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 18 SEER, 9.0 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	5,256	9.2%	NA	NA	15	$1,210
Existing	Manufactured	Heat Pump	Advanced Cold-Climate Heat Pump	16 SEER, 9.6 HSPF	13 SEER, 7.7 HSPF, 2.5 ton	5,478	14.0%	20%	99%	20	$3,677
Existing	Manufactured	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	5,478	10.0%	0%	95%	15	$990
Existing	Manufactured	Heat Pump	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	5,478	5.8%	65%	30%	10	$353
Existing	Manufactured	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	5,478	3.3%	60%	55%	30	$53
Existing	Manufactured	Heat Pump	Ceiling Fan	Ceiling Fan	No Ceiling Fan	5,478	0.1%	85%	45%	10	$104
Existing	Manufactured	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	5,478	2.8%	0%	95%	20	$34
Existing	Manufactured	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	5,478	2.0%	85%	50%	30	$116
Existing	Manufactured	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	5,478	2.0%	85%	55%	12	$42
Existing	Manufactured	Heat Pump	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	5,478	2.0%	80%	65%	6	$31
Existing	Manufactured	Heat Pump	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	5,478	10.0%	75%	85%	15	$455
Existing	Manufactured	Heat Pump	Insulation (Ceiling)	R-49	State Code (R-38)	5,478	1.0%	87%	85%	25	$471
Existing	Manufactured	Heat Pump	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	5,478	2.0%	95%	40%	25	$674
Existing	Manufactured	Heat Pump	Insulation (Ceiling) - below code	State Code (R-38)	R-9	5,478	8.0%	95%	10%	25	$674
Existing	Manufactured	Heat Pump	Insulation (Duct)	R-8	No Duct Insulation	5,478	4.1%	12%	75%	25	$201
Existing	Manufactured	Heat Pump	Insulation (Duct)	R-8	R-4	5,478	2.0%	12%	95%	25	$103
Existing	Manufactured	Heat Pump	Insulation (Floor)	R-38	State Code (R-30)	5,478	0.3%	75%	90%	25	$1,061
Existing	Manufactured	Heat Pump	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	5,478	1.0%	30%	40%	25	$532
Existing	Manufactured	Heat Pump	Insulation (Floor) - below code	State Code (R-30)	R-0	5,478	5.0%	30%	10%	25	$1,[illegible]95
Existing	Manufactured	Heat Pump	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	5,478	1.3%	10%	90%	25	$1,007
Existing	Manufactured	Heat Pump	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	5,478	3.0%	75%	45%	25	$764
Existing	Manufactured	Heat Pump	Insulation (Wall) 2*4 - below code	R-13	R-0	5,478	28.0%	75%	5%	25	$764

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Heat Pump	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	5,478	8.0%	0%	55%	25	$1,114
Existing	Manufactured	Heat Pump	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	5,478	37.0%	0%	45%	25	$1,114
Existing	Manufactured	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	5,478	15.0%	10%	95%	30	$216
Existing	Manufactured	Heat Pump	Micro Channel Heat Exchangers (Evaporator)	Micro Channel Heat Exchangers (5 ton unit)	13 SEER, 7.7 HSPF, 2.5 ton	5,478	5.0%	15%	99%	18	$3,890
Existing	Manufactured	Heat Pump	Motor - ECM Motor	ECM motor for Heat Pump	Standard Motor	5,478	1.3%	65%	95%	15	$368
Existing	Manufactured	Heat Pump	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	5,478	2.0%	95%	60%	5	$6
Existing	Manufactured	Heat Pump	PTCS Aerosol-Based Duct Sealing	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	5,478	19.0%	80%	65%	25	$946
Existing	Manufactured	Heat Pump	PTCS Duct Sealing	PTCS Duct Sealing	No Duct Sealing	5,478	15.0%	80%	65%	20	$447
Existing	Manufactured	Heat Pump	Proper Sizing - Heat Pump	Correctly Sized Heat_Pump (Cooling And Heating Unit)	Oversized Heat_Pump	5,478	8.6%	53%	85%	15	$1
Existing	Manufactured	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	5,478	2.7%	0%	97%	30	$365
Existing	Manufactured	Heat Pump	Small Scale Absorption Cooling	Small Scale Absorption Cooling (5 ton)	13 SEER, 7.7 HSPF, 2.5 ton	5,478	9.0%	0%	99%	20	$946
Existing	Manufactured	Heat Pump	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	5,478	0.8%	50%	95%	10	$762
Existing	Manufactured	Heat Pump	Solid state refrigeration (cool chips™) for heat pumps	Solid State Thermoelectric cooling system	13 SEER, 7.7 HSPF, 2.5 ton	5,478	18.0%	29%	99%	18	$2,101
Existing	Manufactured	Heat Pump	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	5,478	10.0%	0%	95%	25	$3,675
Existing	Manufactured	Heat Pump	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	5,478	6.8%	85%	25%	15	$27
Existing	Manufactured	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	5,478	7.0%	65%	95%	12	$1,150
Existing	Manufactured	Heat Pump	VSD Motor - ECM	Variable Speed Motor (ECM) for Heat Pump	Constant Speed Motor	5,478	3.8%	80%	85%	20	$341
Existing	Manufactured	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	5,478	3.3%	50%	96%	15	$334
Existing	Manufactured	Heat Pump	Windows	U = 0.19	U=0.30	5,478	8.0%	65%	95%	25	$2,378
Existing	Manufactured	Heat Pump	Windows	U=0.30	Existing Windows (U=0.65)	5,478	11.0%	65%	60%	25	$5,656
Existing	Manufactured	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	1,251	4.7%	98%	62%	20	$35
Existing	Manufactured	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	1,251	4.0%	98%	62%	20	$30
Existing	Manufactured	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	1,251	4.2%	98%	62%	20	$33
Existing	Manufactured	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	1,251	34.0%	86%	62%	7	$2
Existing	Manufactured	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	1,251	9.7%	86%	62%	27	$2
Existing	Manufactured	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	1,251	14.0%	86%	62%	11	$2
Existing	Manufactured	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	1,251	1.8%	75%	62%	7	$13

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,251	0.4%	70%	65%	7	$7
Existing	Manufactured	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,251	0.4%	70%	65%	27	$7
Existing	Manufactured	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	1,251	1.3%	70%	65%	11	$7
Existing	Manufactured	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	1,251	4.5%	0%	95%	10	$151
Existing	Manufactured	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	1,251	0.4%	40%	85%	13	$11
Existing	Manufactured	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	1,251	42.3%	85%	98%	13	$31
Existing	Manufactured	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	1,251	12.1%	85%	98%	13	$31
Existing	Manufactured	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	1,251	17.4%	85%	98%	13	$31
Existing	Manufactured	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	1,251	14.0%	75%	85%	10	$64
Existing	Manufactured	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	1,251	1.9%	75%	90%	10	$93
Existing	Manufactured	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	1,542	4.2%	15%	85%	7	$32
Existing	Manufactured	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	1,542	0.2%	55%	40%	7	$4
Existing	Manufactured	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	1,542	1.9%	100%	24%	7	$12
Existing	Manufactured	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	1,542	0.5%	15%	5%	10	$13
Existing	Manufactured	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	1,542	1.9%	94%	62%	6	$37
Existing	Manufactured	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	1,542	2.5%	24%	70%	9	$105
Existing	Manufactured	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	1,542	2.6%	92%	90%	7	$21
Existing	Manufactured	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	1,542	10.4%	73%	15%	4	$84
Existing	Manufactured	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	1,542	1.5%	17%	55%	6	$53
Existing	Manufactured	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	1,542	3.3%	100%	15%	4	$16
Existing	Manufactured	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	1,542	0.3%	62%	40%	5	$11
Existing	Manufactured	Plug Load	Energy Star TV	Energy Star TV	Standard TV	1,542	3.5%	100%	38%	9	$32
Existing	Manufactured	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	1,542	0.7%	100%	45%	4	$38
Existing	Manufactured	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	1,542	0.7%	85%	40%	7	$8
Existing	Manufactured	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	1,542	1.0%	75%	90%	10	$88
Existing	Manufactured	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32
Existing	Manufactured	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20cf, top-freezer	538	30.0%	90%	97%	19	$74
Existing	Manufactured	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	538	6.3%	85%	95%	5	$236

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Refrigerator	Refrigerator/Freezer - Early Replacement	Standard Refrigerator	Existing Refrigerator	538	100.0%	19%	85%	9	$452
Existing	Manufactured	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Existing Refrigerator	538	20.0%	0%	40%	18	$651
Existing	Manufactured	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	538	282.8%	19%	95%	9	$103
Existing	Manufactured	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	538	4.0%	75%	95%	19	$56
Existing	Manufactured	Room AC	Air Conditioner - Room (Individual Rooms) (10,000 BTU/HR)	EER = 10.8	EER = 9.8	440	8.3%	NA	NA	10	$42
Existing	Manufactured	Room AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	449	41.3%	65%	30%	10	$353
Existing	Manufactured	Room AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	449	3.3%	60%	55%	30	$53
Existing	Manufactured	Room AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	449	0.5%	85%	45%	10	$104
Existing	Manufactured	Room AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	449	20.0%	0%	95%	20	$34
Existing	Manufactured	Room AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	449	0.1%	85%	50%	30	$116
Existing	Manufactured	Room AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	449	0.1%	85%	55%	12	$42
Existing	Manufactured	Room AC	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	449	2.0%	80%	65%	6	$31
Existing	Manufactured	Room AC	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	449	10.0%	75%	85%	15	$455
Existing	Manufactured	Room AC	Insulation (Ceiling)	R-49	State Code (R-38)	449	0.3%	87%	85%	25	$471
Existing	Manufactured	Room AC	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	449	1.0%	95%	40%	25	$674
Existing	Manufactured	Room AC	Insulation (Ceiling) - below code	State Code (R-38)	R-9	449	0.6%	95%	10%	25	$674
Existing	Manufactured	Room AC	Insulation (Duct)	R-8	No Duct Insulation	449	3.2%	12%	75%	25	$201
Existing	Manufactured	Room AC	Insulation (Duct)	R-8	R-4	449	1.6%	12%	95%	25	$103
Existing	Manufactured	Room AC	Insulation (Floor)	R-38	State Code (R-30)	449	0.1%	75%	90%	25	$1,061
Existing	Manufactured	Room AC	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	449	0.1%	30%	40%	25	$532
Existing	Manufactured	Room AC	Insulation (Floor) - below code	State Code (R-30)	R-0	449	0.1%	30%	10%	25	$1,595
Existing	Manufactured	Room AC	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	449	0.0%	10%	90%	25	$1,007
Existing	Manufactured	Room AC	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	449	0.1%	75%	45%	25	$764
Existing	Manufactured	Room AC	Insulation (Wall) 2*4 - below code	R-13	R-0	449	0.1%	75%	5%	25	$764
Existing	Manufactured	Room AC	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	449	0.1%	0%	55%	25	$1,114
Existing	Manufactured	Room AC	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	449	0.1%	0%	45%	25	$1,114

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Room AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	449	2.0%	95%	60%	5	$6
Existing	Manufactured	Room AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	449	6.7%	0%	97%	30	$365
Existing	Manufactured	Room AC	Windows	U = 0.19	U=0.30	449	13.0%	65%	95%	25	$2,378
Existing	Manufactured	Room AC	Windows	U=0.30	Existing Windows (U=0.65)	449	36.0%	65%	60%	25	$5,656
Existing	Manufactured	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	5,048	3.3%	60%	55%	30	$53
Existing	Manufactured	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	5,048	3.0%	85%	50%	30	$116
Existing	Manufactured	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	5,048	2.0%	85%	55%	12	$42
Existing	Manufactured	Room Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	5,048	2.0%	80%	65%	6	$31
Existing	Manufactured	Room Heat	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	5,048	62.1%	25%	95%	15	$5,311
Existing	Manufactured	Room Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	5,048	10.0%	75%	85%	15	$455
Existing	Manufactured	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	5,048	1.0%	87%	85%	25	$471
Existing	Manufactured	Room Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	5,048	2.0%	95%	40%	25	$674
Existing	Manufactured	Room Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	5,048	10.2%	95%	10%	25	$674
Existing	Manufactured	Room Heat	Insulation (Duct)	R-8	No Duct Insulation	5,048	4.3%	12%	75%	25	$201
Existing	Manufactured	Room Heat	Insulation (Duct)	R-8	R-4	5,048	2.1%	12%	95%	25	$103
Existing	Manufactured	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	5,048	1.0%	75%	90%	25	$1,061
Existing	Manufactured	Room Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	5,048	2.0%	30%	40%	25	$532
Existing	Manufactured	Room Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	5,048	10.0%	30%	10%	25	$1,595
Existing	Manufactured	Room Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	5,048	2.2%	10%	90%	25	$1,007
Existing	Manufactured	Room Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	5,048	5.0%	75%	45%	25	$764
Existing	Manufactured	Room Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	5,048	44.0%	75%	5%	25	$764
Existing	Manufactured	Room Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	5,048	12.0%	0%	55%	25	$1,114
Existing	Manufactured	Room Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	5,048	49.0%	0%	45%	25	$1,[illegible]4
Existing	Manufactured	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	5,048	2.0%	95%	60%	5	$6
Existing	Manufactured	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	5,048	2.0%	0%	97%	30	$365
Existing	Manufactured	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	5,048	52.0%	45%	98%	20	$3,313
Existing	Manufactured	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	5,048	12.0%	0%	95%	25	$3,675

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Room Heat	Windows	U = 0.19	U=0.30	5,048	6.0%	65%	95%	25	$2,378
Existing	Manufactured	Room Heat	Windows	U=0.30	Existing Windows (U=0.65)	5,048	15.0%	65%	60%	25	$5,656
Existing	Manufactured	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	3,199	3.2%	NA	NA	15	$129
Existing	Manufactured	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	3,277	9.3%	30%	68%	14	$252
Existing	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	3,277	11.2%	30%	91%	14	$312
Existing	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	3,277	12.8%	30%	91%	14	$417
Existing	Manufactured	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	3,277	3.8%	30%	25%	14	$378
Existing	Manufactured	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	3,277	55.2%	5%	90%	10	$251
Existing	Manufactured	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	3,277	1.2%	23%	35%	13	$514
Existing	Manufactured	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	3,277	2.2%	23%	15%	13	$11
Existing	Manufactured	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	3,277	18.5%	0%	95%	30	$630
Existing	Manufactured	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	3,277	4.9%	95%	95%	9	$3
Existing	Manufactured	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	3,277	2.0%	95%	55%	9	$2
Existing	Manufactured	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	3,277	2.3%	95%	10%	9	$2
Existing	Manufactured	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	3,277	54.6%	30%	95%	15	$2,322
Existing	Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	3,277	1.2%	65%	25%	5	$8
Existing	Manufactured	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	3,277	8.4%	95%	85%	10	$5
Existing	Manufactured	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	3,277	5.6%	95%	33%	10	$12
Existing	Manufactured	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	3,277	44.4%	20%	95%	20	$8,930
Existing	Manufactured	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	3,277	3.2%	85%	96%	20	$1,429
Existing	Manufactured	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	3,277	6.5%	0%	55%	10	$19
Existing	Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	3,277	6.0%	95%	43%	4	$0
New	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 14	SEER 13	621	6.4%	NA	NA	15	$336
New	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 16	SEER 13	621	16.1%	NA	NA	15	$880
New	Manufactured	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 18	SEER 13	621	23.6%	NA	NA	15	$1,353
New	Manufactured	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	538	10.0%	0%	95%	15	$990
New	Manufactured	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	538	31.5%	65%	30%	10	$353
New	Manufactured	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	538	3.3%	75%	25%	30	$3
New	Manufactured	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	538	0.5%	85%	45%	10	$104

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	538	10.0%	90%	50%	5	$236
New	Manufactured	Central AC	Construction - ICF	Concrete Framing	Standard Wood Framing	538	32.0%	1%	95%	30	$6,442
New	Manufactured	Central AC	Construction - SIP	Specialty Framing	Standard Wood Framing	538	14.0%	1%	95%	30	$5,680
New	Manufactured	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	538	20.0%	0%	95%	20	$34
New	Manufactured	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	538	0.1%	85%	50%	30	$116
New	Manufactured	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	538	0.1%	85%	55%	12	$42
New	Manufactured	Central AC	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	538	8.0%	85%	75%	30	$126
New	Manufactured	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	538	6.0%	0%	65%	20	$447
New	Manufactured	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	538	19.0%	0%	95%	25	$525
New	Manufactured	Central AC	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	SEER 13 Central AC	538	10.8%	80%	95%	15	$1,713
New	Manufactured	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	538	70.0%	75%	95%	10	$1,119
New	Manufactured	Central AC	Green Roof	ecoroof	Standard Roof	538	6.5%	0%	98%	40	$12669
New	Manufactured	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	538	0.1%	87%	85%	25	$582
New	Manufactured	Central AC	Insulation (Floor)	R-38	State Code (R-30)	538	0.1%	75%	90%	25	$1,061
New	Manufactured	Central AC	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	538	0.0%	95%	50%	25	$372
New	Manufactured	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	538	15.0%	0%	95%	30	$96
New	Manufactured	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	538	4.5%	65%	95%	15	$368
New	Manufactured	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	538	2.0%	95%	40%	5	$6
New	Manufactured	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	538	6.0%	53%	85%	15	$1
New	Manufactured	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	538	6.7%	0%	97%	30	$365
New	Manufactured	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	538	6.0%	70%	95%	10	$762
New	Manufactured	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	538	6.8%	85%	50%	15	$27
New	Manufactured	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	538	7.0%	65%	95%	12	$1,150
New	Manufactured	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	538	13.5%	90%	85%	20	$341
New	Manufactured	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	538	6.0%	50%	95%	11	$1,439
New	Manufactured	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	538	22.0%	50%	96%	15	$334
New	Manufactured	Central AC	Window Overhang	Overhangs over windows for shading	No window overhangs	538	14.0%	50%	80%	30	$724

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Central AC	Windows	U = 0.19	U=0.30	538	5.0%	85%	95%	25	$2,757
New	Manufactured	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	4,632	10.0%	0%	95%	15	$990
New	Manufactured	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	4,632	3.3%	75%	25%	30	$3
New	Manufactured	Central Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	4,632	44.0%	1%	95%	30	$6,442
New	Manufactured	Central Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	4,632	14.0%	1%	95%	30	$5,680
New	Manufactured	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	4,632	5.0%	85%	50%	30	$116
New	Manufactured	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	4,632	3.0%	85%	55%	12	$42
New	Manufactured	Central Heat	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	4,632	8.0%	85%	75%	30	$126
New	Manufactured	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	4,632	6.0%	0%	65%	20	$447
New	Manufactured	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	4,632	19.0%	0%	95%	25	$525
New	Manufactured	Central Heat	Green Roof	ecoroof	Standard Roof	4,632	6.5%	0%	98%	40	$12669
New	Manufactured	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	4,632	3.0%	87%	85%	25	$582
New	Manufactured	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	4,632	2.0%	75%	90%	25	$1,061
New	Manufactured	Central Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	4,632	3.2%	95%	50%	25	$372
New	Manufactured	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	4,632	15.0%	0%	95%	30	$96
New	Manufactured	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	4,632	2.0%	95%	40%	5	$6
New	Manufactured	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	4,632	2.0%	0%	97%	30	$365
New	Manufactured	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	4,632	3.0%	90%	90%	25	$4,071
New	Manufactured	Central Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	4,632	10.0%	90%	90%	25	$5,843
New	Manufactured	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	4,632	6.8%	85%	50%	15	$27
New	Manufactured	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	4,632	7.0%	65%	95%	12	$1,150
New	Manufactured	Central Heat	Windows	U = 0.19	U=0.30	4,632	16.0%	85%	95%	25	$2,757
New	Manufactured	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
New	Manufactured	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	720	13.0%	NA	NA	18	$58
New	Manufactured	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
New	Manufactured	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	405	25.0%	6%	95%	15	$368
New	Manufactured	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	405	25.0%	72%	95%	15	$368

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	405	75.0%	40%	85%	20	$447
New	Manufactured	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	405	75.0%	29%	85%	20	$447
New	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 14 SEER, 8.5 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	3,441	4.9%	NA	NA	15	$420
New	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 16 SEER, 8.8 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	3,441	7.4%	NA	NA	15	$543
New	Manufactured	Heat Pump	Air Source Heat_Pump	2.5 ton, 18 SEER, 9.0 HSPF	2.5 ton, 13 SEER, 7.7 HSPF	3,441	9.2%	NA	NA	15	$1,210
New	Manufactured	Heat Pump	Advanced Cold-Climate Heat Pump	16 SEER, 9.6 HSPF	13 SEER, 7.7 HSPF, 2.5 ton	3,249	14.0%	20%	99%	20	$3,677
New	Manufactured	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	3,249	10.0%	0%	95%	15	$990
New	Manufactured	Heat Pump	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	3,249	4.4%	65%	30%	10	$353
New	Manufactured	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	3,249	3.3%	75%	25%	30	$3
New	Manufactured	Heat Pump	Ceiling Fan	Ceiling Fan	No Ceiling Fan	3,249	0.1%	85%	45%	10	$104
New	Manufactured	Heat Pump	Construction - ICF	Concrete Framing	Standard Wood Framing	3,249	43.3%	1%	95%	30	$6,442
New	Manufactured	Heat Pump	Construction - SIP	Specialty Framing	Standard Wood Framing	3,249	14.0%	1%	95%	30	$5,680
New	Manufactured	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	3,249	2.8%	0%	95%	20	$34
New	Manufactured	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	3,249	3.0%	85%	50%	30	$116
New	Manufactured	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	3,249	2.0%	85%	55%	12	$42
New	Manufactured	Heat Pump	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	3,249	8.0%	85%	75%	30	$126
New	Manufactured	Heat Pump	Green Roof	ecoroof	Standard Roof	3,249	6.5%	0%	98%	40	$12669
New	Manufactured	Heat Pump	Heat_Pump - Ground or Water-Source - Open Loop (Desuperheater)	EER = 16.2, COP = 3.6	Air Source Heat_Pump - 13 SEER, 7.7 HSPF (Federal Code) (11.3 EER, 3.2 COP)	3,249	16.8%	15%	99%	18	$13492
New	Manufactured	Heat Pump	Heat_Pump - Ground or Water-Source - Closed Loop (Desuperheater)	EER = 14.1, COP = 3.3	Air Source Heat_Pump - 13 SEER, 7.7 HSPF (Federal Code) (11.3 EER, 3.2 COP)	3,249	6.2%	30%	99%	18	$13492
New	Manufactured	Heat Pump	Insulation (Ceiling)	R-49	State Code (R-38)	3,249	2.0%	87%	85%	25	$582
New	Manufactured	Heat Pump	Insulation (Floor)	R-38	State Code (R-30)	3,249	1.0%	75%	90%	25	$1,061
New	Manufactured	Heat Pump	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	3,249	2.1%	95%	50%	25	$372
New	Manufactured	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (5 per unit)	13 SEER	3,249	15.0%	0%	95%	30	$96
New	Manufactured	Heat Pump	Micro Channel Heat Exchangers (Evaporator)	Micro Channel Heat Exchangers (5 ton unit)	13 SEER, 7.7 HSPF, 2.5 ton	3,249	5.0%	15%	99%	18	$3,890
New	Manufactured	Heat Pump	Motor - ECM Motor	ECM motor for Heat Pump	Standard Motor	3,249	1.3%	65%	95%	15	$368
New	Manufactured	Heat Pump	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	3,249	2.0%	95%	40%	5	$6
New	Manufactured	Heat Pump	PTCS Aerosol-Based Duct Sealing	Spray-in ductwork sealant to minimize duct leaks	No Duct Sealing	3,249	19.0%	60%	65%	25	$525

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Heat Pump	PTCS Duct Sealing	PTCS Duct Sealing	No Duct Sealing	3,249	15.0%	60%	65%	20	$447
New	Manufactured	Heat Pump	Proper Sizing - Heat Pump	Correctly Sized Heat_Pump (Cooling And Heating Unit)	Oversized Heat_Pump	3,249	8.6%	53%	85%	15	$1
New	Manufactured	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	3,249	2.7%	0%	97%	30	$365
New	Manufactured	Heat Pump	Small Scale Absorption Cooling	Small Scale Absorption Cooling (5 ton)	13 SEER, 7.7 HSPF, 2.5 ton	3,249	9.0%	0%	99%	20	$946
New	Manufactured	Heat Pump	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	3,249	0.8%	70%	95%	10	$762
New	Manufactured	Heat Pump	Solid state refrigeration (cool chips™) for heat pumps	Solid State Thermoelectric cooling system	13 SEER, 7.7 HSPF, 2.5 ton	3,249	18.0%	29%	99%	18	$2,101
New	Manufactured	Heat Pump	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	3,249	3.0%	90%	90%	25	$4,071
New	Manufactured	Heat Pump	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	3,249	8.0%	90%	90%	25	$5,843
New	Manufactured	Heat Pump	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	3,249	6.8%	0%	25%	15	$27
New	Manufactured	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	3,249	7.0%	65%	95%	12	$1,150
New	Manufactured	Heat Pump	VSD Motor - ECM	Variable Speed Motor (ECM) for Heat Pump	Constant Speed Motor	3,249	3.8%	90%	85%	20	$341
New	Manufactured	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	3,249	3.3%	50%	96%	15	$334
New	Manufactured	Heat Pump	Windows	U = 0.19	U=0.30	3,249	11.0%	85%	95%	25	$2,757
New	Manufactured	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	1,289	4.7%	98%	62%	20	$35
New	Manufactured	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	1,289	4.0%	98%	62%	20	$30
New	Manufactured	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	1,289	4.2%	98%	62%	20	$33
New	Manufactured	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	1,289	34.0%	86%	62%	7	$2
New	Manufactured	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	1,289	9.7%	86%	62%	27	$2
New	Manufactured	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	1,289	14.0%	86%	62%	11	$2
New	Manufactured	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	1,289	1.8%	75%	62%	7	$13
New	Manufactured	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,289	0.4%	70%	35%	7	$7
New	Manufactured	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,289	0.4%	70%	35%	27	$7
New	Manufactured	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	1,289	1.3%	70%	35%	11	$7
New	Manufactured	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	1,289	4.5%	0%	95%	10	$10
New	Manufactured	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	1,289	0.4%	40%	85%	13	$11
New	Manufactured	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	1,289	42.3%	85%	98%	13	$31
New	Manufactured	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	1,289	12.1%	85%	98%	13	$31
New	Manufactured	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	1,289	17.4%	85%	98%	13	$31

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	1,289	14.0%	75%	85%	10	$64
New	Manufactured	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	1,289	1.9%	75%	90%	10	$93
New	Manufactured	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	1,542	4.2%	15%	85%	7	$32
New	Manufactured	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	1,542	0.2%	55%	40%	7	$4
New	Manufactured	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	1,542	1.9%	100%	24%	7	$12
New	Manufactured	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	1,542	0.5%	15%	5%	10	$13
New	Manufactured	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	1,542	1.9%	94%	62%	6	$37
New	Manufactured	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	1,542	2.5%	24%	70%	9	$105
New	Manufactured	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	1,542	2.6%	92%	90%	7	$21
New	Manufactured	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	1,542	10.4%	73%	15%	4	$84
New	Manufactured	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	1,542	1.5%	17%	55%	6	$53
New	Manufactured	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	1,542	3.3%	100%	15%	4	$16
New	Manufactured	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	1,542	0.3%	62%	40%	5	$11
New	Manufactured	Plug Load	Energy Star TV	Energy Star TV	Standard TV	1,542	3.5%	100%	38%	9	$32
New	Manufactured	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	1,542	0.7%	100%	45%	4	$38
New	Manufactured	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	1,542	0.7%	85%	40%	7	$8
New	Manufactured	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	1,542	1.0%	75%	90%	10	$88
New	Manufactured	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32
New	Manufactured	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20cf, top-freezer	416	30.0%	90%	97%	19	$74
New	Manufactured	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	416	6.3%	85%	95%	5	$236
New	Manufactured	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	416	4.0%	75%	95%	19	$56
New	Manufactured	Room AC	Air Conditioner - Room (Individual Rooms) (10,000 BTU/HR)	EER = 10.8	EER = 9.8	357	8.6%	NA	NA	10	$42
New	Manufactured	Room AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	336	31.5%	65%	30%	10	$353
New	Manufactured	Room AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	336	3.3%	75%	25%	30	$3
New	Manufactured	Room AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	336	0.5%	85%	45%	10	$104
New	Manufactured	Room AC	Construction - ICF	Concrete Framing	Standard Wood Framing	336	32.0%	1%	95%	30	$6,442
New	Manufactured	Room AC	Construction - SIP	Specialty Framing	Standard Wood Framing	336	14.0%	1%	95%	30	$5,680

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Room AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	336	20.0%	0%	95%	20	$34
New	Manufactured	Room AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	336	0.1%	85%	50%	30	$116
New	Manufactured	Room AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	336	0.1%	85%	55%	12	$42
New	Manufactured	Room AC	Green Roof	ecoroof	Standard Roof	336	6.5%	0%	98%	40	$12669
New	Manufactured	Room AC	Insulation (Ceiling)	R-49	State Code (R-38)	336	0.1%	87%	85%	25	$582
New	Manufactured	Room AC	Insulation (Floor)	R-38	State Code (R-30)	336	0.1%	75%	90%	25	$1,061
New	Manufactured	Room AC	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	336	0.0%	95%	50%	25	$372
New	Manufactured	Room AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	336	2.0%	95%	40%	5	$6
New	Manufactured	Room AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	336	6.7%	0%	97%	30	$365
New	Manufactured	Room AC	Window Overhang	Overhangs over windows for shading	No window overhangs	336	14.0%	50%	80%	30	$724
New	Manufactured	Room AC	Windows	U = 0.19	U=0.30	336	5.0%	85%	95%	25	$2,757
New	Manufactured	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	3,567	3.3%	75%	25%	30	$3
New	Manufactured	Room Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	3,567	44.0%	1%	95%	30	$6,442
New	Manufactured	Room Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	3,567	14.0%	1%	95%	30	$5,680
New	Manufactured	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	3,567	5.0%	85%	50%	30	$116
New	Manufactured	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	3,567	3.0%	85%	55%	12	$42
New	Manufactured	Room Heat	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	3,567	62.1%	80%	95%	15	$5,311
New	Manufactured	Room Heat	Green Roof	ecoroof	Standard Roof	3,567	6.5%	0%	98%	40	$12669
New	Manufactured	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	3,567	3.0%	87%	85%	25	$582
New	Manufactured	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	3,567	2.0%	75%	90%	25	$1,061
New	Manufactured	Room Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	3,567	3.2%	95%	50%	25	$372
New	Manufactured	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	3,567	2.0%	95%	40%	5	$6
New	Manufactured	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	3,567	2.0%	0%	97%	30	$365
New	Manufactured	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	3,567	52.0%	75%	98%	20	$3,187
New	Manufactured	Room Heat	Radiant Electric Floor Heating	Radiant Heating with Electric Cables in Flooring	Electric Baseboard Heating	3,567	20.0%	75%	95%	25	$17460
New	Manufactured	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	3,567	3.0%	90%	90%	25	$4,071
New	Manufactured	Room Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	3,567	10.0%	90%	90%	25	$5,843
New	Manufactured	Room Heat	Windows	U = 0.19	U=0.30	3,567	16.0%	85%	95%	25	$2,757
New	Manufactured	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	2,765	3.2%	NA	NA	15	$129

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	2,713	9.3%	30%	68%	14	$252
New	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	2,713	11.2%	30%	91%	14	$312
New	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	2,713	12.8%	30%	91%	14	$417
New	Manufactured	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	2,713	55.2%	5%	90%	10	$251
New	Manufactured	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	2,713	1.2%	23%	35%	13	$514
New	Manufactured	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	2,713	2.2%	23%	15%	13	$11
New	Manufactured	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	2,713	18.5%	50%	95%	30	$630
New	Manufactured	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	2,713	5.9%	95%	95%	9	$3
New	Manufactured	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	2,713	2.4%	95%	55%	9	$2
New	Manufactured	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	2,713	54.6%	30%	95%	15	$2,322
New	Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	2,713	1.2%	85%	25%	5	$8
New	Manufactured	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	2,713	10.0%	95%	85%	10	$5
New	Manufactured	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	2,713	47.2%	20%	95%	20	$8,930
New	Manufactured	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	2,713	3.2%	85%	96%	20	$1,302
New	Manufactured	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	2,713	6.5%	0%	55%	10	$19
New	Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	2,713	6.0%	95%	43%	4	$0
Existing	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 14	SEER 13	619	5.9%	NA	NA	15	$336
Existing	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 16	SEER 13	619	15.0%	NA	NA	15	$880
Existing	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 18	SEER 13	619	22.2%	NA	NA	15	$1,353
Existing	Multi Family	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	683	10.0%	0%	95%	15	$990
Existing	Multi Family	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	683	41.3%	65%	30%	10	$172
Existing	Multi Family	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	683	3.3%	60%	55%	30	$53
Existing	Multi Family	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	683	0.4%	85%	45%	10	$104
Existing	Multi Family	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	683	10.0%	90%	50%	5	$236
Existing	Multi Family	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	683	20.0%	0%	95%	20	$24
Existing	Multi Family	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	683	0.1%	85%	50%	30	$58
Existing	Multi Family	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	683	0.1%	85%	55%	12	$21
Existing	Multi Family	Central AC	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	683	2.0%	80%	55%	6	$36
Existing	Multi Family	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	683	6.0%	60%	65%	20	$447

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	683	19.0%	50%	95%	25	$946
Existing	Multi Family	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	683	70.0%	0%	95%	10	$1,119
Existing	Multi Family	Central AC	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	683	10.0%	75%	75%	15	$228
Existing	Multi Family	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	683	0.3%	87%	85%	25	$246
Existing	Multi Family	Central AC	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	683	1.0%	95%	40%	25	$475
Existing	Multi Family	Central AC	Insulation (Ceiling) - below code	State Code (R-38)	R-9	683	0.6%	95%	10%	25	$475
Existing	Multi Family	Central AC	Insulation (Duct)	R-8	No Duct Insulation	683	3.2%	12%	75%	25	$141
Existing	Multi Family	Central AC	Insulation (Duct)	R-8	R-4	683	1.6%	12%	95%	25	$73
Existing	Multi Family	Central AC	Insulation (Floor)	R-38	State Code (R-30)	683	0.1%	75%	90%	25	$747
Existing	Multi Family	Central AC	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	683	0.1%	80%	40%	25	$375
Existing	Multi Family	Central AC	Insulation (Floor) - below code	State Code (R-30)	R-0	683	0.1%	80%	10%	25	$1,125
Existing	Multi Family	Central AC	Insulation (Slab)	R-15	State Code (R-10)	683	1.4%	0%	87%	25	$221
Existing	Multi Family	Central AC	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	683	1.3%	0%	65%	25	$994
Existing	Multi Family	Central AC	Insulation (Slab) - below code	State Code (R-10)	R-0	683	4.3%	0%	60%	25	$994
Existing	Multi Family	Central AC	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	683	0.0%	10%	90%	25	$452
Existing	Multi Family	Central AC	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	683	0.1%	75%	45%	25	$314
Existing	Multi Family	Central AC	Insulation (Wall) 2*4 - below code	R-13	R-0	683	0.1%	75%	5%	25	$314
Existing	Multi Family	Central AC	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	683	0.1%	0%	40%	25	$513
Existing	Multi Family	Central AC	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	683	0.1%	0%	35%	25	$513
Existing	Multi Family	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (4 per unit)	13 SEER	683	15.0%	10%	95%	30	$216
Existing	Multi Family	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	683	4.5%	65%	95%	15	$368
Existing	Multi Family	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	683	2.0%	95%	60%	5	$4
Existing	Multi Family	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	683	6.0%	53%	85%	15	$1
Existing	Multi Family	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	683	6.7%	0%	97%	30	$258
Existing	Multi Family	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	683	6.0%	50%	95%	10	$792
Existing	Multi Family	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	683	6.8%	85%	25%	15	$27

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	683	7.0%	65%	95%	12	$1,150
Existing	Multi Family	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	683	13.5%	80%	85%	20	$341
Existing	Multi Family	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	683	6.0%	0%	95%	11	$1,439
Existing	Multi Family	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	683	22.0%	0%	96%	15	$334
Existing	Multi Family	Central AC	Windows	U = 0.19	U=0.30	683	13.0%	75%	95%	25	$815
Existing	Multi Family	Central AC	Windows	U=0.30	Existing Windows (U=0.65)	683	36.0%	75%	60%	25	$1,939
Existing	Multi Family	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	5,290	10.0%	0%	95%	15	$990
Existing	Multi Family	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	5,290	3.3%	60%	55%	30	$53
Existing	Multi Family	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	5,290	3.0%	85%	50%	30	$58
Existing	Multi Family	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	5,290	2.0%	85%	55%	12	$21
Existing	Multi Family	Central Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	5,290	2.0%	80%	55%	6	$36
Existing	Multi Family	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	5,290	6.0%	60%	65%	20	$447
Existing	Multi Family	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	5,290	19.0%	50%	95%	25	$946
Existing	Multi Family	Central Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	5,290	10.0%	75%	75%	15	$228
Existing	Multi Family	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	5,290	1.0%	87%	85%	25	$246
Existing	Multi Family	Central Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	5,290	2.0%	95%	40%	25	$475
Existing	Multi Family	Central Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	5,290	10.2%	95%	10%	25	$475
Existing	Multi Family	Central Heat	Insulation (Duct)	R-8	No Duct Insulation	5,290	4.3%	12%	75%	25	$141
Existing	Multi Family	Central Heat	Insulation (Duct)	R-8	R-4	5,290	2.1%	12%	95%	25	$73
Existing	Multi Family	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	5,290	1.0%	75%	90%	25	$747
Existing	Multi Family	Central Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	5,290	2.0%	80%	40%	25	$375
Existing	Multi Family	Central Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	5,290	10.0%	80%	10%	25	$1,125
Existing	Multi Family	Central Heat	Insulation (Slab)	R-15	State Code (R-10)	5,290	1.4%	0%	87%	25	$221
Existing	Multi Family	Central Heat	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	5,290	1.3%	0%	65%	25	$994
Existing	Multi Family	Central Heat	Insulation (Slab) - below code	State Code (R-10)	R-0	5,290	4.3%	0%	60%	25	$994
Existing	Multi Family	Central Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	5,290	2.2%	10%	90%	25	$452

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	5,290	5.0%	75%	45%	25	$314
Existing	Multi Family	Central Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	5,290	44.0%	75%	5%	25	$314
Existing	Multi Family	Central Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	5,290	12.0%	0%	40%	25	$513
Existing	Multi Family	Central Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	5,290	49.0%	0%	35%	25	$513
Existing	Multi Family	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (4 per unit)	13 SEER	5,290	15.0%	10%	95%	30	$216
Existing	Multi Family	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	5,290	2.0%	95%	60%	5	$4
Existing	Multi Family	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	5,290	2.0%	0%	97%	30	$258
Existing	Multi Family	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	5,290	12.0%	0%	95%	25	$1,511
Existing	Multi Family	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	5,290	6.8%	85%	75%	15	$27
Existing	Multi Family	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	5,290	7.0%	65%	95%	12	$1,150
Existing	Multi Family	Central Heat	Windows	U = 0.19	U=0.30	5,290	6.0%	75%	95%	25	$815
Existing	Multi Family	Central Heat	Windows	U=0.30	Existing Windows (U=0.65)	5,290	15.0%	75%	60%	25	$1,939
Existing	Multi Family	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
Existing	Multi Family	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	646	13.0%	NA	NA	18	$58
Existing	Multi Family	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
Existing	Multi Family	Freezer	Stand-Alone Freezer - Early Replacement	Energy Star Freezer	Existing Non-Efficient Freezer	665	9.4%	35%	80%	12	$489
Existing	Multi Family	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	665	248.7%	35%	80%	6	$103
Existing	Multi Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	436	25.0%	65%	95%	15	$368
Existing	Multi Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	436	25.0%	65%	95%	15	$368
Existing	Multi Family	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	436	75.0%	5%	85%	20	$447
Existing	Multi Family	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	436	75.0%	16%	85%	20	$447
Existing	Multi Family	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	1,146	4.7%	98%	79%	20	$35
Existing	Multi Family	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	1,146	4.0%	98%	79%	20	$30
Existing	Multi Family	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	1,146	4.2%	98%	79%	20	$33
Existing	Multi Family	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	1,146	34.0%	86%	79%	7	$2
Existing	Multi Family	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	1,146	9.7%	86%	79%	27	$2

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	1,146	14.0%	86%	79%	11	$2
Existing	Multi Family	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	1,146	1.8%	75%	79%	7	$13
Existing	Multi Family	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,146	0.4%	70%	65%	7	$7
Existing	Multi Family	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,146	0.4%	70%	65%	27	$7
Existing	Multi Family	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	1,146	1.3%	70%	65%	11	$7
Existing	Multi Family	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	1,146	4.5%	0%	95%	10	$151
Existing	Multi Family	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	1,146	0.4%	40%	85%	13	$11
Existing	Multi Family	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	1,146	42.3%	85%	98%	13	$31
Existing	Multi Family	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	1,146	12.1%	85%	98%	13	$31
Existing	Multi Family	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	1,146	17.4%	85%	98%	13	$31
Existing	Multi Family	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	1,146	14.0%	75%	85%	10	$64
Existing	Multi Family	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	1,146	1.9%	75%	90%	10	$93
Existing	Multi Family	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	1,357	4.2%	15%	85%	7	$32
Existing	Multi Family	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	1,357	0.2%	55%	40%	7	$4
Existing	Multi Family	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	1,357	2.7%	74%	24%	7	$12
Existing	Multi Family	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	1,357	0.6%	15%	5%	10	$13
Existing	Multi Family	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	1,357	1.9%	68%	62%	6	$37
Existing	Multi Family	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	1,357	1.6%	22%	70%	9	$105
Existing	Multi Family	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	1,357	2.4%	66%	90%	7	$21
Existing	Multi Family	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	1,357	12.8%	64%	15%	4	$84
Existing	Multi Family	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	1,357	1.5%	14%	55%	6	$53
Existing	Multi Family	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	1,357	3.0%	82%	15%	4	$16
Existing	Multi Family	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	1,357	0.2%	56%	40%	5	$11
Existing	Multi Family	Plug Load	Energy Star TV	Energy Star TV	Standard TV	1,357	3.9%	100%	38%	9	$32
Existing	Multi Family	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	1,357	0.9%	85%	45%	4	$38
Existing	Multi Family	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	1,357	0.7%	85%	40%	7	$8
Existing	Multi Family	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	1,357	1.2%	65%	90%	10	$88
Existing	Multi Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20cf, top-freezer	538	30.0%	90%	97%	19	$74
Existing	Multi Family	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	538	6.3%	85%	95%	5	$236
Existing	Multi Family	Refrigerator	Refrigerator/Freezer - Early Replacement	Standard Refrigerator	Existing Refrigerator	538	100.0%	7%	85%	9	$452
Existing	Multi Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Existing Refrigerator	538	20.0%	0%	40%	18	$651
Existing	Multi Family	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	538	282.8%	7%	99%	9	$103
Existing	Multi Family	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	538	4.0%	75%	95%	19	$56
Existing	Multi Family	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	4,074	3.3%	60%	55%	30	$53
Existing	Multi Family	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	4,074	3.0%	85%	50%	30	$58
Existing	Multi Family	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	4,074	2.0%	85%	55%	12	$21
Existing	Multi Family	Room Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	4,074	2.0%	80%	55%	6	$31
Existing	Multi Family	Room Heat	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	4,074	62.1%	25%	95%	15	$5,311
Existing	Multi Family	Room Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	4,074	10.0%	75%	75%	15	$228
Existing	Multi Family	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	4,074	1.0%	87%	85%	25	$246
Existing	Multi Family	Room Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	4,074	2.0%	95%	40%	25	$475
Existing	Multi Family	Room Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	4,074	10.2%	95%	10%	25	$475
Existing	Multi Family	Room Heat	Insulation (Duct)	R-8	No Duct Insulation	4,074	4.3%	12%	75%	25	$141
Existing	Multi Family	Room Heat	Insulation (Duct)	R-8	R-4	4,074	2.1%	12%	95%	25	$73
Existing	Multi Family	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	4,074	1.0%	75%	90%	25	$747
Existing	Multi Family	Room Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	4,074	2.0%	80%	40%	25	$375
Existing	Multi Family	Room Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	4,074	10.0%	80%	10%	25	$1,125
Existing	Multi Family	Room Heat	Insulation (Slab)	R-15	State Code (R-10)	4,074	1.4%	0%	87%	25	$221
Existing	Multi Family	Room Heat	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	4,074	1.3%	0%	65%	25	$994
Existing	Multi Family	Room Heat	Insulation (Slab) - below code	State Code (R-10)	R-0	4,074	4.3%	0%	60%	25	$994
Existing	Multi Family	Room Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	4,074	2.2%	10%	90%	25	$452
Existing	Multi Family	Room Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	4,074	5.0%	75%	45%	25	$314
Existing	Multi Family	Room Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	4,074	44.0%	75%	5%	25	$314

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Room Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	4,074	12.0%	0%	40%	25	$513
Existing	Multi Family	Room Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	4,074	49.0%	0%	35%	25	$513
Existing	Multi Family	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	4,074	2.0%	95%	60%	5	$4
Existing	Multi Family	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	4,074	2.0%	0%	97%	30	$258
Existing	Multi Family	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	4,074	52.0%	45%	98%	20	$3,313
Existing	Multi Family	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	4,074	12.0%	0%	95%	25	$1,511
Existing	Multi Family	Room Heat	Windows	U = 0.19	U=0.30	4,074	6.0%	75%	95%	25	$815
Existing	Multi Family	Room Heat	Windows	U=0.30	Existing Windows (U=0.65)	4,074	15.0%	75%	60%	25	$1,939
Existing	Multi Family	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	1,893	3.1%	NA	NA	15	$129
Existing	Multi Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	1,940	9.3%	25%	68%	14	$252
Existing	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	1,940	11.2%	25%	85%	14	$312
Existing	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	1,940	12.8%	25%	85%	14	$417
Existing	Multi Family	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	1,940	3.8%	25%	25%	14	$378
Existing	Multi Family	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	1,940	55.2%	5%	90%	10	$251
Existing	Multi Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	1,940	1.6%	27%	35%	13	$514
Existing	Multi Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	1,940	3.0%	27%	15%	13	$11
Existing	Multi Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	1,940	18.5%	0%	95%	30	$630
Existing	Multi Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	1,940	8.3%	95%	95%	9	$3
Existing	Multi Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	1,940	3.4%	95%	55%	9	$2
Existing	Multi Family	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	1,940	3.9%	95%	10%	9	$2
Existing	Multi Family	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	1,940	54.6%	30%	95%	15	$2,322
Existing	Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	1,940	1.2%	65%	62%	5	$8
Existing	Multi Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	1,940	14.1%	95%	85%	10	$5
Existing	Multi Family	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	1,940	9.4%	95%	33%	10	$12
Existing	Multi Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	1,940	37.5%	20%	95%	20	$4,465
Existing	Multi Family	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	1,940	3.2%	85%	98%	20	$1,429
Existing	Multi Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	1,940	6.5%	0%	73%	10	$19
Existing	Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	1,940	6.0%	95%	64%	4	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 14	SEER 13	534	6.1%	NA	NA	15	$336
New	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 16	SEER 13	534	15.4%	NA	NA	15	$880
New	Multi Family	Central AC	Air Conditioner - Central (2.5 ton unit)	SEER 18	SEER 13	534	22.8%	NA	NA	15	$1,353
New	Multi Family	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	465	10.0%	0%	95%	15	$990
New	Multi Family	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	465	31.5%	65%	30%	10	$172
New	Multi Family	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	465	3.3%	75%	25%	30	$3
New	Multi Family	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	465	0.4%	85%	45%	10	$104
New	Multi Family	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	465	10.0%	90%	50%	5	$236
New	Multi Family	Central AC	Construction - ICF	Concrete Framing	Standard Wood Framing	465	32.0%	45%	95%	30	$2,650
New	Multi Family	Central AC	Construction - SIP	Specialty Framing	Standard Wood Framing	465	14.0%	20%	95%	30	$2,380
New	Multi Family	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	465	20.0%	0%	95%	20	$24
New	Multi Family	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	465	0.1%	85%	50%	30	$58
New	Multi Family	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	465	0.1%	85%	55%	12	$21
New	Multi Family	Central AC	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	465	8.0%	85%	10%	30	$106
New	Multi Family	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	465	6.0%	0%	65%	20	$447
New	Multi Family	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	465	19.0%	0%	95%	25	$525
New	Multi Family	Central AC	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	SEER 13 Central AC	465	11.3%	80%	95%	15	$2,114
New	Multi Family	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	465	70.0%	0%	95%	10	$1,119
New	Multi Family	Central AC	Green Roof	ecoroof	Standard Roof	465	6.5%	0%	98%	40	$6,206
New	Multi Family	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	465	0.1%	87%	85%	25	$336
New	Multi Family	Central AC	Insulation (Floor)	R-38	State Code (R-30)	465	0.1%	75%	90%	25	$747
New	Multi Family	Central AC	Insulation (Slab)	R-15	State Code (R-10)	465	1.4%	65%	64%	25	$221
New	Multi Family	Central AC	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	465	0.0%	95%	90%	25	$372
New	Multi Family	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (4 per unit)	13 SEER	465	15.0%	0%	95%	30	$96
New	Multi Family	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	465	4.5%	65%	95%	15	$368
New	Multi Family	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	465	2.0%	95%	40%	5	$4
New	Multi Family	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	465	6.0%	53%	85%	15	$31
New	Multi Family	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	465	6.7%	0%	97%	30	$258

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	465	6.0%	70%	95%	10	$762
New	Multi Family	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	465	6.8%	85%	25%	15	$27
New	Multi Family	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	465	7.0%	65%	95%	12	$1,150
New	Multi Family	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	465	13.5%	90%	85%	20	$341
New	Multi Family	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	465	6.0%	0%	95%	11	$1,439
New	Multi Family	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	465	22.0%	0%	96%	15	$334
New	Multi Family	Central AC	Window Overhang	Overhangs over windows for shading	No window overhangs	465	14.0%	50%	80%	30	$724
New	Multi Family	Central AC	Windows	U = 0.19	U=0.30	465	5.0%	85%	95%	25	$1,155
New	Multi Family	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	3,321	10.0%	0%	95%	15	$990
New	Multi Family	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	3,321	3.3%	75%	25%	30	$3
New	Multi Family	Central Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	3,321	44.0%	45%	95%	30	$2,650
New	Multi Family	Central Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	3,321	14.0%	20%	95%	30	$2,380
New	Multi Family	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	3,321	5.0%	85%	50%	30	$58
New	Multi Family	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	3,321	3.0%	85%	55%	12	$21
New	Multi Family	Central Heat	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	3,321	8.0%	85%	10%	30	$106
New	Multi Family	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	3,321	6.0%	0%	65%	20	$447
New	Multi Family	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	3,321	19.0%	0%	95%	25	$525
New	Multi Family	Central Heat	Green Roof	ecoroof	Standard Roof	3,321	6.5%	0%	98%	40	$6,206
New	Multi Family	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	3,321	3.0%	87%	85%	25	$336
New	Multi Family	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	3,321	2.0%	75%	90%	25	$747
New	Multi Family	Central Heat	Insulation (Slab)	R-15	State Code (R-10)	3,321	1.4%	65%	64%	25	$221
New	Multi Family	Central Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	3,321	3.2%	95%	90%	25	$372
New	Multi Family	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (4 per unit)	13 SEER	3,321	15.0%	0%	95%	30	$96
New	Multi Family	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	3,321	2.0%	95%	40%	5	$4
New	Multi Family	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	3,321	2.0%	0%	97%	30	$258
New	Multi Family	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	3,321	3.0%	90%	90%	25	$1,706
New	Multi Family	Central Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	3,321	10.0%	90%	90%	25	$2,448

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	3,321	6.8%	85%	75%	15	$27
New	Multi Family	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	3,321	7.0%	65%	95%	12	$1,150
New	Multi Family	Central Heat	Windows	U = 0.19	U=0.30	3,321	16.0%	85%	95%	25	$1,155
New	Multi Family	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
New	Multi Family	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	646	13.0%	NA	NA	18	$58
New	Multi Family	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
New	Multi Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	340	25.0%	10%	95%	15	$368
New	Multi Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	340	25.0%	72%	95%	15	$368
New	Multi Family	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	340	75.0%	5%	85%	20	$447
New	Multi Family	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	340	75.0%	16%	85%	20	$447
New	Multi Family	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	1,148	4.7%	98%	79%	20	$35
New	Multi Family	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	1,148	4.0%	98%	79%	20	$30
New	Multi Family	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	1,148	4.2%	98%	79%	20	$33
New	Multi Family	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	1,148	34.0%	86%	79%	7	$2
New	Multi Family	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	1,148	9.7%	86%	79%	27	$2
New	Multi Family	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	1,148	14.0%	86%	79%	11	$2
New	Multi Family	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	1,148	1.8%	75%	79%	7	$13
New	Multi Family	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,148	0.4%	70%	35%	7	$7
New	Multi Family	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	1,148	0.4%	70%	35%	27	$7
New	Multi Family	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	1,148	1.3%	70%	35%	11	$7
New	Multi Family	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	1,148	4.5%	0%	95%	10	$110
New	Multi Family	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	1,148	0.4%	40%	85%	13	$11
New	Multi Family	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	1,148	42.3%	85%	98%	13	$31
New	Multi Family	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	1,148	12.1%	85%	98%	13	$31
New	Multi Family	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	1,148	17.4%	85%	98%	13	$31
New	Multi Family	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	1,148	14.0%	75%	85%	10	$64
New	Multi Family	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	1,148	1.9%	75%	90%	10	$93

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	1,357	4.2%	15%	85%	7	$32
New	Multi Family	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	1,357	0.2%	55%	40%	7	$4
New	Multi Family	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	1,357	2.7%	74%	24%	7	$12
New	Multi Family	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	1,357	0.6%	15%	5%	10	$13
New	Multi Family	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	1,357	1.9%	68%	62%	6	$37
New	Multi Family	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	1,357	1.6%	22%	70%	9	$105
New	Multi Family	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	1,357	2.4%	66%	90%	7	$21
New	Multi Family	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	1,357	12.8%	64%	15%	4	$84
New	Multi Family	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	1,357	1.5%	14%	55%	6	$53
New	Multi Family	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	1,357	3.0%	82%	15%	4	$16
New	Multi Family	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	1,357	0.2%	56%	40%	5	$11
New	Multi Family	Plug Load	Energy Star TV	Energy Star TV	Standard TV	1,357	3.9%	100%	38%	9	$32
New	Multi Family	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	1,357	0.9%	85%	45%	4	$38
New	Multi Family	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	1,357	0.7%	85%	40%	7	$8
New	Multi Family	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	1,357	1.2%	65%	90%	10	$88
New	Multi Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32
New	Multi Family	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20cf, top-freezer	416	30.0%	90%	97%	19	$74
New	Multi Family	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	416	6.3%	85%	95%	5	$236
New	Multi Family	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	416	4.0%	75%	95%	19	$56
New	Multi Family	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	2,557	3.3%	75%	25%	30	$3
New	Multi Family	Room Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	2,557	44.0%	45%	95%	30	$2,650
New	Multi Family	Room Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	2,557	14.0%	20%	95%	30	$2,380
New	Multi Family	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	2,557	5.0%	85%	50%	30	$58
New	Multi Family	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	2,557	3.0%	85%	55%	12	$21
New	Multi Family	Room Heat	Ductless Mini-Split REM	2.5 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	2,557	62.1%	80%	95%	15	$5,311
New	Multi Family	Room Heat	Green Roof	ecoroof	Standard Roof	2,557	6.5%	0%	98%	40	$6,206
New	Multi Family	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	2,557	3.0%	87%	85%	25	$336
New	Multi Family	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	2,557	2.0%	75%	90%	25	$747

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Room Heat	Insulation (Slab)	R-15	State Code (R-10)	2,557	1.4%	65%	64%	25	$221
New	Multi Family	Room Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	2,557	3.2%	95%	90%	25	$372
New	Multi Family	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	2,557	2.0%	95%	40%	5	$4
New	Multi Family	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	2,557	2.0%	0%	97%	30	$258
New	Multi Family	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	2,557	52.0%	75%	98%	20	$3,187
New	Multi Family	Room Heat	Radiant Electric Floor Heating	Radiant Heating with Electric Cables in Flooring	Electric Baseboard Heating	2,557	20.0%	75%	95%	25	$12838
New	Multi Family	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	2,557	3.0%	90%	90%	25	$1,706
New	Multi Family	Room Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	2,557	10.0%	90%	90%	25	$2,448
New	Multi Family	Room Heat	Windows	U = 0.19	U=0.30	2,557	16.0%	85%	95%	25	$1,155
New	Multi Family	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	1,676	3.1%	NA	NA	15	$129
New	Multi Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	1,645	9.3%	25%	68%	14	$252
New	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	1,645	11.2%	25%	85%	14	$312
New	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	1,645	12.8%	25%	85%	14	$417
New	Multi Family	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	1,645	55.2%	5%	90%	10	$251
New	Multi Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	1,645	1.6%	27%	35%	13	$514
New	Multi Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	1,645	3.0%	27%	15%	13	$11
New	Multi Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	1,645	18.5%	50%	95%	30	$630
New	Multi Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	1,645	9.7%	95%	95%	9	$3
New	Multi Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	1,645	4.0%	95%	55%	9	$2
New	Multi Family	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	1,645	54.6%	30%	95%	15	$2,322
New	Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	1,645	1.2%	85%	62%	5	$8
New	Multi Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	1,645	16.5%	95%	85%	10	$5
New	Multi Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	1,645	38.9%	20%	95%	20	$4,465
New	Multi Family	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	1,645	3.2%	85%	98%	20	$1,302
New	Multi Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	1,645	6.5%	0%	73%	10	$19
New	Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	1,645	6.0%	95%	64%	4	$0
Existing	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 14	SEER 13	864	5.7%	NA	NA	15	$368
Existing	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 16	SEER 13	864	15.1%	NA	NA	15	$1,061
Existing	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 18	SEER 13	864	26.9%	NA	NA	15	$1,789

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	958	10.0%	0%	95%	15	$990
Existing	Single Family	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	958	41.3%	65%	30%	10	$603
Existing	Single Family	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	958	3.3%	60%	55%	30	$53
Existing	Single Family	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	958	0.3%	85%	20%	10	$104
Existing	Single Family	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	958	10.0%	90%	50%	5	$236
Existing	Single Family	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	958	20.0%	0%	95%	20	$57
Existing	Single Family	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	958	0.1%	85%	50%	30	$116
Existing	Single Family	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	958	0.1%	85%	55%	12	$42
Existing	Single Family	Central AC	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	958	2.0%	80%	45%	6	$36
Existing	Single Family	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	958	6.0%	60%	65%	20	$447
Existing	Single Family	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	958	19.0%	50%	95%	25	$946
Existing	Single Family	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	958	70.0%	75%	95%	10	$1,119
Existing	Single Family	Central AC	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	958	10.0%	75%	75%	15	$455
Existing	Single Family	Central AC	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	958	6.1%	13%	95%	25	$708
Existing	Single Family	Central AC	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	958	6.9%	13%	70%	25	$906
Existing	Single Family	Central AC	Insulation (Basement - Wall) 2*4 - below code	R-13	R-0	958	14.9%	13%	70%	25	$906
Existing	Single Family	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	958	0.3%	87%	85%	25	$344
Existing	Single Family	Central AC	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	958	1.0%	95%	40%	25	$562
Existing	Single Family	Central AC	Insulation (Ceiling) - below code	State Code (R-38)	R-9	958	0.6%	95%	10%	25	$562
Existing	Single Family	Central AC	Insulation (Duct)	R-8	No Duct Insulation	958	3.2%	12%	75%	25	$335
Existing	Single Family	Central AC	Insulation (Duct)	R-8	R-4	958	1.6%	12%	95%	25	$172
Existing	Single Family	Central AC	Insulation (Floor)	R-38	State Code (R-30)	958	0.1%	75%	90%	25	$884
Existing	Single Family	Central AC	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	958	0.1%	55%	40%	25	$443
Existing	Single Family	Central AC	Insulation (Floor) - below code	State Code (R-30)	R-0	958	0.1%	55%	10%	25	$1,[illegible]31
Existing	Single Family	Central AC	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	958	3.0%	60%	45%	25	$130
Existing	Single Family	Central AC	Insulation (Rim And Band Joist)	R-19	R-10	958	4.0%	60%	75%	25	$84
Existing	Single Family	Central AC	Insulation (Slab)	R-15	State Code (R-10)	958	1.4%	0%	87%	25	$223

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central AC	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	958	1.3%	0%	65%	25	$1,049
Existing	Single Family	Central AC	Insulation (Slab) - below code	State Code (R-10)	R-0	958	4.3%	0%	60%	25	$1,049
Existing	Single Family	Central AC	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	958	0.0%	10%	90%	25	$1,786
Existing	Single Family	Central AC	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	958	0.1%	75%	45%	25	$1,396
Existing	Single Family	Central AC	Insulation (Wall) 2*4 - below code	R-13	R-0	958	0.1%	75%	5%	25	$1,396
Existing	Single Family	Central AC	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	958	0.1%	0%	60%	25	$2,276
Existing	Single Family	Central AC	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	958	0.1%	0%	50%	25	$2,276
Existing	Single Family	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	958	15.0%	10%	95%	30	$288
Existing	Single Family	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	958	4.5%	65%	95%	15	$368
Existing	Single Family	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	958	2.0%	95%	60%	5	$7
Existing	Single Family	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	958	6.0%	53%	85%	15	$1
Existing	Single Family	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	958	6.7%	0%	97%	30	$305
Existing	Single Family	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	958	6.0%	50%	95%	10	$762
Existing	Single Family	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	958	6.8%	85%	24%	15	$27
Existing	Single Family	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	958	7.0%	65%	95%	12	$1,422
Existing	Single Family	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	958	13.5%	80%	85%	20	$341
Existing	Single Family	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	958	6.0%	50%	95%	11	$1,439
Existing	Single Family	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	958	22.0%	50%	96%	15	$334
Existing	Single Family	Central AC	Windows	U = 0.19	U=0.30	958	13.0%	75%	95%	25	$4,343
Existing	Single Family	Central AC	Windows	U=0.30	Existing Windows (U=0.65)	958	36.0%	75%	60%	25	$10331
Existing	Single Family	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	8,893	10.0%	0%	95%	15	$990
Existing	Single Family	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	8,893	3.3%	60%	55%	30	$53
Existing	Single Family	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	8,893	3.0%	85%	50%	30	$116
Existing	Single Family	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	8,893	2.0%	85%	55%	12	$142
Existing	Single Family	Central Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	8,893	2.0%	80%	45%	6	$36
Existing	Single Family	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	8,893	6.0%	60%	65%	20	$447

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	8,893	19.0%	50%	95%	25	$946
Existing	Single Family	Central Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	8,893	10.0%	75%	75%	15	$455
Existing	Single Family	Central Heat	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	8,893	6.1%	13%	95%	25	$708
Existing	Single Family	Central Heat	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	8,893	6.9%	13%	70%	25	$906
Existing	Single Family	Central Heat	Insulation (Basement - Wall) 2*4 - below code	R-13	R-0	8,893	14.9%	13%	70%	25	$906
Existing	Single Family	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	8,893	1.0%	87%	85%	25	$344
Existing	Single Family	Central Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	8,893	2.0%	95%	40%	25	$562
Existing	Single Family	Central Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	8,893	10.2%	95%	10%	25	$562
Existing	Single Family	Central Heat	Insulation (Duct)	R-8	No Duct Insulation	8,893	4.3%	12%	75%	25	$335
Existing	Single Family	Central Heat	Insulation (Duct)	R-8	R-4	8,893	2.1%	12%	95%	25	$172
Existing	Single Family	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	8,893	1.0%	75%	90%	25	$884
Existing	Single Family	Central Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	8,893	2.0%	55%	40%	25	$443
Existing	Single Family	Central Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	8,893	10.0%	55%	10%	25	$1,331
Existing	Single Family	Central Heat	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	8,893	3.0%	60%	45%	25	$130
Existing	Single Family	Central Heat	Insulation (Rim And Band Joist)	R-19	R-10	8,893	4.0%	60%	75%	25	$84
Existing	Single Family	Central Heat	Insulation (Slab)	R-15	State Code (R-10)	8,893	1.4%	0%	87%	25	$223
Existing	Single Family	Central Heat	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	8,893	1.3%	0%	65%	25	$1,049
Existing	Single Family	Central Heat	Insulation (Slab) - below code	State Code (R-10)	R-0	8,893	4.3%	0%	60%	25	$1,049
Existing	Single Family	Central Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	8,893	2.2%	10%	90%	25	$1,786
Existing	Single Family	Central Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	8,893	5.0%	75%	45%	25	$1,396
Existing	Single Family	Central Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	8,893	44.0%	75%	5%	25	$1,396
Existing	Single Family	Central Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	8,893	12.0%	0%	60%	25	$2,276
Existing	Single Family	Central Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	8,893	49.0%	0%	50%	25	$2,276
Existing	Single Family	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	8,893	15.0%	10%	95%	30	$288
Existing	Single Family	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	8,893	2.0%	95%	60%	5	$7

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	8,893	2.0%	0%	97%	30	$305
Existing	Single Family	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	8,893	12.0%	0%	95%	25	$6,711
Existing	Single Family	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	8,893	6.8%	85%	33%	15	$27
Existing	Single Family	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	8,893	7.0%	65%	95%	12	$1,422
Existing	Single Family	Central Heat	Windows	U = 0.19	U=0.30	8,893	6.0%	75%	95%	25	$4,343
Existing	Single Family	Central Heat	Windows	U=0.30	Existing Windows (U=0.65)	8,893	15.0%	75%	60%	25	$10331
Existing	Single Family	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
Existing	Single Family	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	858	13.0%	NA	NA	18	$58
Existing	Single Family	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
Existing	Single Family	Freezer	Stand-Alone Freezer - Early Replacement	Energy Star Freezer	Existing Non-Efficient Freezer	665	9.4%	35%	80%	12	$489
Existing	Single Family	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	665	248.7%	35%	80%	6	$103
Existing	Single Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	550	25.0%	65%	95%	15	$368
Existing	Single Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	550	25.0%	65%	95%	15	$368
Existing	Single Family	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	550	75.0%	7%	85%	20	$447
Existing	Single Family	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	550	75.0%	66%	85%	20	$447
Existing	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 14 SEER, 8.5 HSPF	3 ton, 13 SEER, 7.7 HSPF	6,748	4.9%	NA	NA	15	$517
Existing	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 16 SEER, 8.8 HSPF	3 ton, 13 SEER, 7.7 HSPF	6,748	7.4%	NA	NA	15	$660
Existing	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 18 SEER, 9.0 HSPF	3 ton, 13 SEER, 7.7 HSPF	6,748	9.2%	NA	NA	15	$1,435
Existing	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	16 SEER, 9.6 HSPF	13 SEER, 7.7 HSPF, 3 ton	7,033	14.0%	20%	99%	20	$3,677
Existing	Single Family	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	7,033	10.0%	0%	95%	15	$990
Existing	Single Family	Heat Pump	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	7,033	5.8%	65%	30%	10	$603
Existing	Single Family	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	7,033	3.3%	60%	55%	30	$53
Existing	Single Family	Heat Pump	Ceiling Fan	Ceiling Fan	No Ceiling Fan	7,033	0.0%	85%	20%	10	$104
Existing	Single Family	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	7,033	2.8%	0%	95%	20	$57
Existing	Single Family	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	7,033	2.0%	85%	50%	30	$116
Existing	Single Family	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	7,033	2.0%	85%	55%	12	$42
Existing	Single Family	Heat Pump	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	7,033	2.0%	80%	45%	6	$31

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Heat Pump	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	7,033	10.0%	75%	75%	15	$455
Existing	Single Family	Heat Pump	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	7,033	6.1%	13%	95%	25	$708
Existing	Single Family	Heat Pump	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	7,033	6.9%	13%	70%	25	$906
Existing	Single Family	Heat Pump	Insulation (Basement - Wall) 2*4 - below code	R-13	R-0	7,033	14.9%	13%	70%	25	$906
Existing	Single Family	Heat Pump	Insulation (Ceiling)	R-49	State Code (R-38)	7,033	1.0%	87%	85%	25	$344
Existing	Single Family	Heat Pump	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	7,033	2.0%	95%	40%	25	$562
Existing	Single Family	Heat Pump	Insulation (Ceiling) - below code	State Code (R-38)	R-9	7,033	8.0%	95%	10%	25	$562
Existing	Single Family	Heat Pump	Insulation (Duct)	R-8	No Duct Insulation	7,033	4.1%	12%	75%	25	$335
Existing	Single Family	Heat Pump	Insulation (Duct)	R-8	R-4	7,033	2.0%	12%	95%	25	$172
Existing	Single Family	Heat Pump	Insulation (Floor)	R-38	State Code (R-30)	7,033	0.3%	75%	90%	25	$884
Existing	Single Family	Heat Pump	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	7,033	1.0%	55%	40%	25	$443
Existing	Single Family	Heat Pump	Insulation (Floor) - below code	State Code (R-30)	R-0	7,033	5.0%	55%	10%	25	$1,331
Existing	Single Family	Heat Pump	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	7,033	3.0%	60%	45%	25	$130
Existing	Single Family	Heat Pump	Insulation (Rim And Band Joist)	R-19	R-10	7,033	4.0%	60%	75%	25	$84
Existing	Single Family	Heat Pump	Insulation (Slab)	R-15	State Code (R-10)	7,033	1.4%	0%	87%	25	$223
Existing	Single Family	Heat Pump	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	7,033	1.3%	0%	65%	25	$1,049
Existing	Single Family	Heat Pump	Insulation (Slab) - below code	State Code (R-10)	R-0	7,033	4.3%	0%	60%	25	$1,049
Existing	Single Family	Heat Pump	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	7,033	1.3%	10%	90%	25	$1,786
Existing	Single Family	Heat Pump	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	7,033	3.0%	75%	45%	25	$1,396
Existing	Single Family	Heat Pump	Insulation (Wall) 2*4 - below code	R-13	R-0	7,033	28.0%	75%	5%	25	$1,396
Existing	Single Family	Heat Pump	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	7,033	8.0%	0%	60%	25	$2,276
Existing	Single Family	Heat Pump	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	7,033	37.0%	0%	50%	25	$2,276
Existing	Single Family	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	7,033	15.0%	10%	95%	30	$288
Existing	Single Family	Heat Pump	Micro Channel Heat Exchangers (Evaporator)	Micro Channel Heat Exchangers (5 ton unit)	13 SEER, 7.7 HSPF, 3 ton	7,033	5.0%	15%	99%	18	$3,732
Existing	Single Family	Heat Pump	Motor - ECM Motor	ECM motor for Heat Pump	Standard Motor	7,033	1.3%	65%	95%	15	$368

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Heat Pump	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	7,033	2.0%	95%	60%	5	$7
Existing	Single Family	Heat Pump	PTCS Aerosol-Based Duct Sealing	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	7,033	19.0%	80%	65%	25	$946
Existing	Single Family	Heat Pump	PTCS Duct Sealing	PTCS Duct Sealing	No Duct Sealing	7,033	15.0%	80%	65%	20	$447
Existing	Single Family	Heat Pump	Proper Sizing - Heat Pump	Correctly Sized Heat_Pump (Cooling And Heating Unit)	Oversized Heat_Pump	7,033	8.6%	53%	85%	15	$1
Existing	Single Family	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	7,033	2.7%	0%	97%	30	$305
Existing	Single Family	Heat Pump	Small Scale Absorption Cooling	Small Scale Absorption Cooling (5 ton)	13 SEER, 7.7 HSPF, 3 ton	7,033	9.0%	0%	99%	20	$946
Existing	Single Family	Heat Pump	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	7,033	0.8%	50%	95%	10	$762
Existing	Single Family	Heat Pump	Solid state refrigeration (cool chips™) for heat pumps	Solid State Thermoelectric cooling system	13 SEER, 7.7 HSPF, 3 ton	7,033	18.0%	29%	99%	18	$2,101
Existing	Single Family	Heat Pump	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	7,033	10.0%	0%	95%	25	$6,711
Existing	Single Family	Heat Pump	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	7,033	6.8%	85%	27%	15	$27
Existing	Single Family	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	7,033	7.0%	65%	95%	12	$1,422
Existing	Single Family	Heat Pump	VSD Motor - ECM	Variable Speed Motor (ECM) for Heat Pump	Constant Speed Motor	7,033	3.8%	80%	85%	20	$341
Existing	Single Family	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	7,033	3.3%	50%	96%	15	$334
Existing	Single Family	Heat Pump	Windows	U = 0.19	U=0.30	7,033	8.0%	75%	95%	25	$4,343
Existing	Single Family	Heat Pump	Windows	U=0.30	Existing Windows (U=0.65)	7,033	11.0%	75%	60%	25	$10331
Existing	Single Family	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	2,504	4.7%	98%	73%	20	$35
Existing	Single Family	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	2,504	4.0%	98%	73%	20	$30
Existing	Single Family	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	2,504	4.2%	98%	73%	20	$33
Existing	Single Family	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	2,504	34.0%	86%	73%	7	$2
Existing	Single Family	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	2,504	9.7%	86%	73%	27	$2
Existing	Single Family	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	2,504	14.0%	86%	73%	11	$2
Existing	Single Family	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	2,504	1.8%	75%	73%	7	$13
Existing	Single Family	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	2,504	0.4%	70%	65%	7	$7
Existing	Single Family	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	2,504	0.4%	70%	65%	27	$7
Existing	Single Family	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	2,504	1.3%	70%	65%	11	$7
Existing	Single Family	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	2,504	4.5%	0%	95%	10	$31
Existing	Single Family	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	2,504	0.4%	40%	85%	13	$11
Existing	Single Family	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	2,504	42.3%	85%	98%	13	$31

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	2,504	12.1%	85%	98%	13	$31
Existing	Single Family	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	2,504	17.4%	85%	98%	13	$31
Existing	Single Family	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	2,504	14.0%	75%	85%	10	$64
Existing	Single Family	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	2,504	1.9%	75%	90%	10	$93
Existing	Single Family	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	2,128	4.2%	15%	85%	7	$32
Existing	Single Family	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	2,128	0.2%	55%	40%	7	$4
Existing	Single Family	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	2,128	1.9%	100%	24%	7	$12
Existing	Single Family	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	2,128	0.4%	15%	5%	10	$13
Existing	Single Family	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	2,128	1.7%	81%	62%	6	$37
Existing	Single Family	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	2,128	3.2%	38%	70%	9	$105
Existing	Single Family	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	2,128	2.5%	91%	90%	7	$21
Existing	Single Family	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	2,128	13.7%	100%	15%	4	$84
Existing	Single Family	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	2,128	1.9%	25%	55%	6	$53
Existing	Single Family	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	2,128	4.1%	100%	15%	4	$16
Existing	Single Family	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	2,128	0.0%	75%	40%	5	$11
Existing	Single Family	Plug Load	Energy Star TV	Energy Star TV	Standard TV	2,128	3.3%	100%	38%	9	$32
Existing	Single Family	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	2,128	0.6%	100%	45%	4	$38
Existing	Single Family	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	2,128	0.3%	85%	40%	7	$8
Existing	Single Family	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	2,128	0.6%	85%	90%	10	$88
Existing	Single Family	Pool Pump	Pool Pump Timers	Pool Pump Timers	Pool Pump No Timers	1,482	50.0%	3%	83%	10	$52
Existing	Single Family	Pool Pump	Pool Pumps - VSD	Pool Pumps (VSD)	Pool Pumps constant speed	1,482	85.0%	3%	92%	10	$714
Existing	Single Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20.5 cf, top-freezer	538	30.0%	90%	97%	19	$74
Existing	Single Family	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	538	6.3%	85%	95%	5	$236
Existing	Single Family	Refrigerator	Refrigerator/Freezer - Early Replacement	Standard Refrigerator	Existing Refrigerator	538	100.0%	11%	85%	9	$452
Existing	Single Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Existing Refrigerator	538	20.0%	0%	40%	18	$651
Existing	Single Family	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	538	282.8%	11%	82%	9	$103
Existing	Single Family	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	538	4.0%	75%	95%	19	$56

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Room AC	Air Conditioner - Room (Individual Rooms) (10,000 BTU/HR)	EER = 10.8	EER = 9.8	497	8.0%	NA	NA	10	$42
Existing	Single Family	Room AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	513	41.3%	65%	30%	10	$603
Existing	Single Family	Room AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	513	3.3%	60%	55%	30	$53
Existing	Single Family	Room AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	513	0.3%	85%	20%	10	$104
Existing	Single Family	Room AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	513	20.0%	0%	95%	20	$57
Existing	Single Family	Room AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	513	0.1%	85%	50%	30	$116
Existing	Single Family	Room AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	513	0.1%	85%	55%	12	$42
Existing	Single Family	Room AC	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	513	2.0%	80%	45%	6	$31
Existing	Single Family	Room AC	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	513	10.0%	75%	75%	15	$455
Existing	Single Family	Room AC	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	513	6.1%	13%	95%	25	$708
Existing	Single Family	Room AC	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	513	6.9%	13%	70%	25	$906
Existing	Single Family	Room AC	Insulation (Basement - Wall) 2*4 - below code	R-13	R-0	513	14.9%	13%	70%	25	$906
Existing	Single Family	Room AC	Insulation (Ceiling)	R-49	State Code (R-38)	513	0.3%	87%	85%	25	$344
Existing	Single Family	Room AC	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	513	1.0%	95%	40%	25	$562
Existing	Single Family	Room AC	Insulation (Ceiling) - below code	State Code (R-38)	R-9	513	0.6%	95%	10%	25	$562
Existing	Single Family	Room AC	Insulation (Duct)	R-8	No Duct Insulation	513	3.2%	12%	75%	25	$335
Existing	Single Family	Room AC	Insulation (Duct)	R-8	R-4	513	1.6%	12%	95%	25	$172
Existing	Single Family	Room AC	Insulation (Floor)	R-38	State Code (R-30)	513	0.1%	75%	90%	25	$884
Existing	Single Family	Room AC	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	513	0.1%	55%	40%	25	$443
Existing	Single Family	Room AC	Insulation (Floor) - below code	State Code (R-30)	R-0	513	0.1%	55%	10%	25	$1,331
Existing	Single Family	Room AC	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	513	3.0%	60%	45%	25	$130
Existing	Single Family	Room AC	Insulation (Rim And Band Joist)	R-19	R-10	513	4.0%	60%	75%	25	$84
Existing	Single Family	Room AC	Insulation (Slab)	R-15	State Code (R-10)	513	1.4%	0%	87%	25	$223
Existing	Single Family	Room AC	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	513	1.3%	0%	65%	25	$1,049
Existing	Single Family	Room AC	Insulation (Slab) - below code	State Code (R-10)	R-0	513	4.3%	0%	60%	25	$1,049
Existing	Single Family	Room AC	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	513	0.0%	10%	90%	25	$1,786

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Room AC	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	513	0.1%	75%	45%	25	$1,396
Existing	Single Family	Room AC	Insulation (Wall) 2*4 - below code	R-13	R-0	513	0.1%	75%	5%	25	$1,396
Existing	Single Family	Room AC	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	513	0.1%	0%	60%	25	$2,276
Existing	Single Family	Room AC	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	513	0.1%	0%	50%	25	$2,276
Existing	Single Family	Room AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	513	2.0%	95%	60%	5	$7
Existing	Single Family	Room AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	513	6.7%	0%	97%	30	$305
Existing	Single Family	Room AC	Windows	U = 0.19	U=0.30	513	13.0%	75%	95%	25	$4,343
Existing	Single Family	Room AC	Windows	U=0.30	Existing Windows (U=0.65)	513	36.0%	75%	60%	25	$10331
Existing	Single Family	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	6,847	3.3%	60%	55%	30	$53
Existing	Single Family	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	6,847	3.0%	85%	50%	30	$116
Existing	Single Family	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	6,847	2.0%	85%	55%	12	$42
Existing	Single Family	Room Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	6,847	2.0%	80%	45%	6	$31
Existing	Single Family	Room Heat	Ductless Mini-Split REM	3 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	6,847	62.1%	25%	95%	15	$5,700
Existing	Single Family	Room Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	6,847	10.0%	75%	75%	15	$455
Existing	Single Family	Room Heat	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	6,847	6.1%	13%	95%	25	$708
Existing	Single Family	Room Heat	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	6,847	6.9%	13%	70%	25	$906
Existing	Single Family	Room Heat	Insulation (Basement - Wall) 2*4 - below code	R-13	R-0	6,847	14.9%	13%	70%	25	$906
Existing	Single Family	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	6,847	1.0%	87%	85%	25	$344
Existing	Single Family	Room Heat	Insulation (Ceiling) - average existing value	State Code (R-38)	Average Existing Insulation Value (R-19)	6,847	2.0%	95%	40%	25	$562
Existing	Single Family	Room Heat	Insulation (Ceiling) - below code	State Code (R-38)	R-9	6,847	10.2%	95%	10%	25	$562
Existing	Single Family	Room Heat	Insulation (Duct)	R-8	No Duct Insulation	6,847	4.3%	12%	75%	25	$335
Existing	Single Family	Room Heat	Insulation (Duct)	R-8	R-4	6,847	2.1%	12%	95%	25	$172
Existing	Single Family	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	6,847	1.0%	75%	90%	25	$884
Existing	Single Family	Room Heat	Insulation (Floor) - average existing value	State Code (R-30)	Average Existing Insulation Value and/or Code Value (R-20)	6,847	2.0%	55%	40%	25	$443
Existing	Single Family	Room Heat	Insulation (Floor) - below code	State Code (R-30)	R-0	6,847	10.0%	55%	10%	25	$1,331
Existing	Single Family	Room Heat	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	6,847	3.0%	60%	45%	25	$130
Existing	Single Family	Room Heat	Insulation (Rim And Band Joist)	R-19	R-10	6,847	4.0%	60%	75%	25	$84

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Room Heat	Insulation (Slab)	R-15	State Code (R-10)	6,847	1.4%	0%	87%	25	$223
Existing	Single Family	Room Heat	Insulation (Slab) - average existing value	State Code (R-10)	Average Existing Insulation Value and/or Code Value (R-7)	6,847	1.3%	0%	65%	25	$1,049
Existing	Single Family	Room Heat	Insulation (Slab) - below code	State Code (R-10)	R-0	6,847	4.3%	0%	60%	25	$1,049
Existing	Single Family	Room Heat	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	6,847	2.2%	10%	90%	25	$1,786
Existing	Single Family	Room Heat	Insulation (Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-8)	6,847	5.0%	75%	45%	25	$1,396
Existing	Single Family	Room Heat	Insulation (Wall) 2*4 - below code	R-13	R-0	6,847	44.0%	75%	5%	25	$1,396
Existing	Single Family	Room Heat	Insulation (wall) 2*6 - average existing value	State Code (R-21)	Average Existing Insulation Value and/or Code Value (R-8)	6,847	12.0%	0%	60%	25	$2,276
Existing	Single Family	Room Heat	Insulation (wall) 2*6 - below code	State Code (R-21)	R-0	6,847	49.0%	0%	50%	25	$2,276
Existing	Single Family	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	6,847	2.0%	95%	60%	5	$7
Existing	Single Family	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	6,847	2.0%	0%	97%	30	$305
Existing	Single Family	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	6,847	52.0%	45%	98%	20	$4,364
Existing	Single Family	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	6,847	12.0%	0%	95%	25	$6,711
Existing	Single Family	Room Heat	Windows	U = 0.19	U=0.30	6,847	6.0%	75%	95%	25	$4,343
Existing	Single Family	Room Heat	Windows	U=0.30	Existing Windows (U=0.65)	6,847	15.0%	75%	60%	25	$10331
Existing	Single Family	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	3,308	3.2%	NA	NA	15	$129
Existing	Single Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	3,392	9.3%	35%	68%	14	$252
Existing	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	3,392	11.2%	35%	77%	14	$312
Existing	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	3,392	12.8%	35%	77%	14	$417
Existing	Single Family	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	3,392	3.8%	35%	25%	14	$378
Existing	Single Family	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	3,392	55.2%	5%	90%	10	$251
Existing	Single Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	3,392	1.1%	30%	35%	13	$514
Existing	Single Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	3,392	2.1%	30%	15%	13	$11
Existing	Single Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	3,392	18.5%	0%	95%	30	$630
Existing	Single Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	3,392	7.1%	95%	95%	9	$4
Existing	Single Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	3,392	2.9%	95%	55%	9	$3
Existing	Single Family	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	3,392	3.3%	95%	10%	9	$2
Existing	Single Family	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	3,392	54.6%	30%	95%	15	$2,322

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	3,392	1.2%	65%	38%	5	$8
Existing	Single Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	3,392	16.2%	95%	85%	10	$11
Existing	Single Family	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	3,392	10.8%	95%	33%	10	$25
Existing	Single Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	3,392	42.9%	20%	95%	20	$8,930
Existing	Single Family	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	3,392	3.2%	85%	97%	20	$1,429
Existing	Single Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	3,392	6.5%	0%	65%	10	$19
Existing	Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	3,392	6.0%	95%	43%	4	$0
New	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 14	SEER 13	863	6.3%	NA	NA	15	$368
New	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 16	SEER 13	863	15.9%	NA	NA	15	$1,061
New	Single Family	Central AC	Air Conditioner - Central (3.0 ton unit)	SEER 18	SEER 13	863	23.4%	NA	NA	15	$1,789
New	Single Family	Central AC	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	749	10.0%	0%	95%	15	$990
New	Single Family	Central AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	749	31.5%	65%	30%	10	$603
New	Single Family	Central AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	749	3.3%	75%	25%	30	$3
New	Single Family	Central AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	749	0.3%	85%	20%	10	$104
New	Single Family	Central AC	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	749	10.0%	90%	50%	5	$236
New	Single Family	Central AC	Construction - ICF	Concrete Framing	Standard Wood Framing	749	32.0%	45%	95%	30	$11629
New	Single Family	Central AC	Construction - SIP	Specialty Framing	Standard Wood Framing	749	14.0%	45%	95%	30	$4,839
New	Single Family	Central AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	749	20.0%	0%	95%	20	$57
New	Single Family	Central AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	749	0.1%	85%	50%	30	$116
New	Single Family	Central AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	749	0.1%	85%	55%	12	$42
New	Single Family	Central AC	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	749	8.0%	85%	15%	30	$210
New	Single Family	Central AC	Duct Sealing	Duct Sealing	No Duct Sealing	749	6.0%	0%	65%	20	$447
New	Single Family	Central AC	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	749	19.0%	0%	95%	25	$525
New	Single Family	Central AC	Ductless Mini-Split REM	3 ton, SEER 15, HSPF 9.0	SEER 13 Central AC	749	11.1%	80%	95%	15	$1,480
New	Single Family	Central AC	Evaporative Space Cooling	SEER 40	SEER 13	749	70.0%	75%	95%	10	$1,119
New	Single Family	Central AC	Green Roof	ecoroof	Standard Roof	749	6.5%	0%	98%	40	$21,956
New	Single Family	Central AC	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	749	6.1%	20%	95%	25	$474
New	Single Family	Central AC	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	749	6.9%	20%	70%	25	$671

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Central AC	Insulation (Ceiling)	R-49	State Code (R-38)	749	0.1%	87%	85%	25	$390
New	Single Family	Central AC	Insulation (Floor)	R-38	State Code (R-30)	749	0.1%	75%	90%	25	$884
New	Single Family	Central AC	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	749	3.0%	80%	45%	25	$130
New	Single Family	Central AC	Insulation (Rim And Band Joist)	R-19	R-10	749	4.0%	80%	75%	25	$84
New	Single Family	Central AC	Insulation (Slab)	R-15	State Code (R-10)	749	1.4%	32%	64%	25	$223
New	Single Family	Central AC	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	749	0.0%	95%	85%	25	$2,363
New	Single Family	Central AC	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	749	15.0%	0%	95%	30	$127
New	Single Family	Central AC	Motor - ECM Motor	ECM motor for Central Air Conditioner	Standard Motor	749	4.5%	65%	95%	15	$368
New	Single Family	Central AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	749	2.0%	95%	40%	5	$7
New	Single Family	Central AC	Proper Sizing - Central Air Conditioner	Correctly Sized Air Conditioner Unit	Oversized Air Conditioner Unit	749	6.0%	53%	85%	15	$1
New	Single Family	Central AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	749	6.7%	0%	97%	30	$305
New	Single Family	Central AC	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	749	6.0%	70%	95%	10	$762
New	Single Family	Central AC	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	749	6.8%	85%	24%	15	$27
New	Single Family	Central AC	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	749	7.0%	65%	95%	12	$1,422
New	Single Family	Central AC	VSD Motor - ECM	Variable Speed Motor (ECM) for Central Air Conditioner	Constant Speed Motor	749	13.5%	90%	85%	20	$341
New	Single Family	Central AC	Whole-House Dehumidifier	Whole-House Dehumidifier	No Dehumidifier	749	6.0%	50%	95%	11	$1,439
New	Single Family	Central AC	Whole-House Fan	Whole-House Fan	No Whole-House Fan	749	22.0%	50%	96%	15	$334
New	Single Family	Central AC	Window Overhang	Overhangs over windows for shading	No window overhangs	749	14.0%	50%	80%	30	$905
New	Single Family	Central AC	Windows	U = 0.19	U=0.30	749	5.0%	85%	95%	25	$4,696
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	5,495	10.0%	0%	95%	15	$990
New	Single Family	Central Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	5,495	3.3%	75%	25%	30	$3
New	Single Family	Central Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	5,495	44.0%	45%	95%	30	$11629
New	Single Family	Central Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	5,495	14.0%	45%	95%	30	$4,839
New	Single Family	Central Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	5,495	5.0%	85%	50%	30	$416
New	Single Family	Central Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	5,495	3.0%	85%	55%	12	$42
New	Single Family	Central Heat	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	5,495	8.0%	85%	15%	30	$210
New	Single Family	Central Heat	Duct Sealing	Duct Sealing	No Duct Sealing	5,495	6.0%	0%	65%	20	$447

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Central Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	5,495	19.0%	0%	95%	25	$525
New	Single Family	Central Heat	Green Roof	ecoroof	Standard Roof	5,495	6.5%	0%	98%	40	$21956
New	Single Family	Central Heat	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	5,495	6.1%	20%	95%	25	$474
New	Single Family	Central Heat	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	5,495	6.9%	20%	70%	25	$671
New	Single Family	Central Heat	Insulation (Ceiling)	R-49	State Code (R-38)	5,495	3.0%	87%	85%	25	$390
New	Single Family	Central Heat	Insulation (Floor)	R-38	State Code (R-30)	5,495	2.0%	75%	90%	25	$884
New	Single Family	Central Heat	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	5,495	3.0%	80%	45%	25	$130
New	Single Family	Central Heat	Insulation (Rim And Band Joist)	R-19	R-10	5,495	4.0%	80%	75%	25	$84
New	Single Family	Central Heat	Insulation (Slab)	R-15	State Code (R-10)	5,495	1.4%	32%	64%	25	$223
New	Single Family	Central Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	5,495	3.2%	95%	85%	25	$2,363
New	Single Family	Central Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	5,495	15.0%	0%	95%	30	$127
New	Single Family	Central Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	5,495	2.0%	95%	40%	5	$7
New	Single Family	Central Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	5,495	2.0%	0%	97%	30	$305
New	Single Family	Central Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	5,495	3.0%	90%	90%	25	$6,935
New	Single Family	Central Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	5,495	10.0%	90%	90%	25	$9,954
New	Single Family	Central Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	5,495	6.8%	85%	33%	15	$27
New	Single Family	Central Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	5,495	7.0%	65%	95%	12	$1,422
New	Single Family	Central Heat	Windows	U = 0.19	U=0.30	5,495	16.0%	85%	95%	25	$4,696
New	Single Family	Cooking Oven	Convection Oven	Convection Oven (wall oven)	Standard Oven (wall oven)	435	23.0%	85%	85%	15	$432
New	Single Family	Dryer	Clothes Dryer With Moisture Sensor	High-Efficiency Clothes Dryer With Moisture Sensor	Standard Dryer Without Moisture Sensor	858	13.0%	NA	NA	18	$58
New	Single Family	Freezer	Freezer - Stand-Alone	Energy Star 14.8 cu ft Chest Freezer	Standard 14.8 cu ft Freezer	553	10.0%	NA	NA	12	$26
New	Single Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Electric Furnace	Standard Motor	477	25.0%	0%	95%	15	$368
New	Single Family	HVAC Aux	Motor - ECM Motor	ECM Motor for Forced Air Gas Furnace	Standard Motor	477	25.0%	71%	95%	15	$368
New	Single Family	HVAC Aux	VSD Fan	Variable Speed Fan - Electric Furnace	Constant Speed Fan	477	75.0%	7%	85%	20	$447
New	Single Family	HVAC Aux	VSD Fan	Variable Speed Fan - Gas Furnace	Constant Speed Fan	477	75.0%	66%	85%	20	$447
New	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 14 SEER, 8.5 HSPF	3 ton, 13 SEER, 7.7 HSPF	5,438	4.9%	NA	NA	15	$517
New	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 16 SEER, 8.8 HSPF	3 ton, 13 SEER, 7.7 HSPF	5,438	7.4%	NA	NA	15	$660

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Heat Pump	Air Source Heat_Pump	3 ton, 18 SEER, 9.0 HSPF	3 ton, 13 SEER, 7.7 HSPF	5,438	9.2%	NA	NA	15	$1,435
New	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	16 SEER, 9.6 HSPF	13 SEER, 7.7 HSPF, 3 ton	5,134	14.0%	20%	99%	20	$3,677
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	5,134	10.0%	0%	95%	15	$990
New	Single Family	Heat Pump	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	5,134	4.4%	65%	30%	10	$603
New	Single Family	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	5,134	3.3%	75%	25%	30	$3
New	Single Family	Heat Pump	Ceiling Fan	Ceiling Fan	No Ceiling Fan	5,134	0.0%	85%	20%	10	$104
New	Single Family	Heat Pump	Construction - ICF	Concrete Framing	Standard Wood Framing	5,134	43.3%	45%	95%	30	$11629
New	Single Family	Heat Pump	Construction - SIP	Specialty Framing	Standard Wood Framing	5,134	14.0%	45%	95%	30	$4,839
New	Single Family	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	5,134	2.8%	0%	95%	20	$57
New	Single Family	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	5,134	3.0%	85%	50%	30	$116
New	Single Family	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	5,134	2.0%	85%	55%	12	$42
New	Single Family	Heat Pump	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	5,134	8.0%	85%	15%	30	$210
New	Single Family	Heat Pump	Green Roof	ecoroof	Standard Roof	5,134	6.5%	0%	98%	40	$21956
New	Single Family	Heat Pump	Heat_Pump - Ground or Water-Source - Open Loop (Desuperheater)	EER = 16.2, COP = 3.6	Air Source Heat_Pump - 13 SEER, 7.7 HSPF (Federal Code) (11.3 EER, 3.2 COP)	5,134	16.8%	15%	95%	18	$14703
New	Single Family	Heat Pump	Heat_Pump - Ground or Water-Source - Closed Loop (Desuperheater)	EER = 14.1, COP = 3.3	Air Source Heat_Pump - 13 SEER, 7.7 HSPF (Federal Code) (11.3 EER, 3.2 COP)	5,134	6.2%	30%	95%	18	$14703
New	Single Family	Heat Pump	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	5,134	6.1%	20%	95%	25	$474
New	Single Family	Heat Pump	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	5,134	6.9%	20%	70%	25	$671
New	Single Family	Heat Pump	Insulation (Ceiling)	R-49	State Code (R-38)	5,134	2.0%	87%	85%	25	$390
New	Single Family	Heat Pump	Insulation (Floor)	R-38	State Code (R-30)	5,134	1.0%	75%	90%	25	$884
New	Single Family	Heat Pump	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	5,134	3.0%	80%	45%	25	$130
New	Single Family	Heat Pump	Insulation (Rim And Band Joist)	R-19	R-10	5,134	4.0%	80%	75%	25	$84
New	Single Family	Heat Pump	Insulation (Slab)	R-15	State Code (R-10)	5,134	1.4%	32%	64%	25	$223
New	Single Family	Heat Pump	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	5,134	2.1%	95%	85%	25	$1,430
New	Single Family	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands (6 per unit)	13 SEER	5,134	15.0%	0%	95%	30	$127
New	Single Family	Heat Pump	Micro Channel Heat Exchangers (Evaporator)	Micro Channel Heat Exchangers (5 ton unit)	13 SEER, 7.7 HSPF, 3 ton	5,134	5.0%	15%	99%	18	$3,132
New	Single Family	Heat Pump	Motor - ECM Motor	ECM motor for Heat Pump	Standard Motor	5,134	1.3%	65%	95%	15	$368
New	Single Family	Heat Pump	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	5,134	2.0%	95%	40%	5	$7

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Heat Pump	PTCS Aerosol-Based Duct Sealing	Spray-in ductwork sealant to minimize duct leaks	No Duct Sealing	5,134	19.0%	60%	65%	25	$525
New	Single Family	Heat Pump	PTCS Duct Sealing	PTCS Duct Sealing	No Duct Sealing	5,134	15.0%	60%	65%	20	$447
New	Single Family	Heat Pump	Proper Sizing - Heat Pump	Correctly Sized Heat_Pump (Cooling And Heating Unit)	Oversized Heat_Pump	5,134	8.6%	53%	85%	15	$1
New	Single Family	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	5,134	2.7%	0%	97%	30	$305
New	Single Family	Heat Pump	Small Scale Absorption Cooling	Small Scale Absorption Cooling (5 ton)	13 SEER, 7.7 HSPF, 3 ton	5,134	9.0%	0%	99%	20	$946
New	Single Family	Heat Pump	Solar Attic Fan	Solar electric attic ventilation	Standard passive ventilation	5,134	0.8%	70%	95%	10	$762
New	Single Family	Heat Pump	Solid state refrigeration (cool chips™) for heat pumps	Solid State Thermoelectric cooling system	13 SEER, 7.7 HSPF, 3 ton	5,134	18.0%	29%	99%	18	$2,101
New	Single Family	Heat Pump	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	5,134	3.0%	90%	90%	25	$6,935
New	Single Family	Heat Pump	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	5,134	8.0%	90%	90%	25	$9,954
New	Single Family	Heat Pump	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	5,134	6.8%	0%	27%	15	$27
New	Single Family	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	5,134	7.0%	65%	95%	12	$1,422
New	Single Family	Heat Pump	VSD Motor - ECM	Variable Speed Motor (ECM) for Heat Pump	Constant Speed Motor	5,134	3.8%	90%	85%	20	$341
New	Single Family	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	5,134	3.3%	50%	96%	15	$334
New	Single Family	Heat Pump	Windows	U = 0.19	U=0.30	5,134	11.0%	85%	95%	25	$4,696
New	Single Family	Lighting	CFL Fixtures, High Use	2-15 W CFLs, 4.0 hr/day (37%)	2-60 W Incandescent	2,441	4.7%	98%	73%	20	$35
New	Single Family	Lighting	CFL Fixtures, Low Use	2-15 W CFLs, 1.0 hr/day (32%)	2-60 W Incandescent	2,441	4.0%	98%	73%	20	$30
New	Single Family	Lighting	CFL Fixtures, Medium Use	2-15 W CFLs, 2.5 hr/day (33%)	2-60 W Incandescent	2,441	4.2%	98%	73%	20	$33
New	Single Family	Lighting	CFL Lamps, High Use	1-15W, 4.0 hr/day (37%)	Incandescent 60W	2,441	34.0%	86%	73%	7	$2
New	Single Family	Lighting	CFL Lamps, Low Use	1-15W, 1.0 hr/day (32%)	Incandescent 60W	2,441	9.7%	86%	73%	27	$2
New	Single Family	Lighting	CFL Lamps, Medium Use	1-15W, 2.5 hr/day (33%)	Incandescent 60W	2,441	14.0%	86%	73%	11	$2
New	Single Family	Lighting	CFL Lighting - 3-Way	13 W, 20W And 25W	30W, 75W, 100W	2,441	1.8%	75%	73%	7	$13
New	Single Family	Lighting	CFL Torchieries, High Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	2,441	0.4%	70%	35%	7	$7
New	Single Family	Lighting	CFL Torchieries, Low Use	55 W CFL, (20%)	Incandescent Torchieries, 180W Halogen	2,441	0.4%	70%	35%	27	$7
New	Single Family	Lighting	CFL Torchieries, Medium Use	55 W CFL, (60%)	Incandescent Torchieries, 180W Halogen	2,441	1.3%	70%	35%	11	$7
New	Single Family	Lighting	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	2,441	4.5%	0%	95%	10	$110
New	Single Family	Lighting	LED Christmas Lighting	LED Christmas Lighting	Incandescent Christmas Lighting	2,441	0.4%	40%	85%	13	$11
New	Single Family	Lighting	LED Interior Lighting (White), High Use	LED 4W	Incandescent 60W	2,441	42.3%	85%	98%	13	$31
New	Single Family	Lighting	LED Interior Lighting (White), Low Use	LED 4W	Incandescent 60W	2,441	12.1%	85%	98%	13	$31

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Lighting	LED Interior Lighting (White), Medium Use	LED 4W	Incandescent 60W	2,441	17.4%	85%	98%	13	$31
New	Single Family	Lighting	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	2,441	14.0%	75%	85%	10	$64
New	Single Family	Lighting	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	2,441	1.9%	75%	90%	10	$93
New	Single Family	Plug Load	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	2,128	4.2%	15%	85%	7	$32
New	Single Family	Plug Load	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	2,128	0.2%	55%	40%	7	$4
New	Single Family	Plug Load	Energy Star DVD System	Energy Star DVD System	Standard DVD System	2,128	1.9%	100%	24%	7	$12
New	Single Family	Plug Load	Energy Star Dehumidifiers	Energy Star Dehumidifiers	Standard Dehumidifiers	2,128	0.4%	15%	5%	10	$13
New	Single Family	Plug Load	Energy Star Digital Set Top Receiver	Energy Star Digital Set Top Receiver	Standard Digital Set Top Receiver	2,128	1.7%	81%	62%	6	$37
New	Single Family	Plug Load	Energy Star HDTV	Energy Star HDTV	Standard HDTV	2,128	3.2%	38%	70%	9	$105
New	Single Family	Plug Load	Energy Star Home Audio System	Energy Star Home Audio System	Standard Home Audio system	2,128	2.5%	91%	90%	7	$21
New	Single Family	Plug Load	Energy Star Office Computer	Energy Star Office Computer	Standard Office Computer	2,128	13.7%	100%	15%	4	$84
New	Single Family	Plug Load	Energy Star Office Copiers	Energy Star Office Copiers	Standard Office Copiers	2,128	1.9%	25%	55%	6	$53
New	Single Family	Plug Load	Energy Star Office Monitor	Energy Star Office Monitor	Standard Office Monitor	2,128	4.1%	100%	15%	4	$16
New	Single Family	Plug Load	Energy Star Office Printer	Energy Star Office Printer	Standard Office Printer	2,128	0.0%	75%	40%	5	$11
New	Single Family	Plug Load	Energy Star TV	Energy Star TV	Standard TV	2,128	3.3%	100%	38%	9	$32
New	Single Family	Plug Load	Energy Star VCR	Energy Star VCR/DVD Combo	Standard Home VCR	2,128	0.6%	100%	45%	4	$38
New	Single Family	Plug Load	Power supply transformer/converter - External power adapters	Power supply transformer/converter - High efficiency External power adapters	Standard Efficiency	2,128	0.3%	85%	40%	7	$8
New	Single Family	Plug Load	Powerstrip with Occupancy Sensor	Powerstrip with Occupancy Sensor	Powerstrip w/o Occupany Sensor	2,128	0.6%	85%	90%	10	$88
New	Single Family	Pool Pump	Pool Pump Timers	Pool Pump Timers	Pool Pump No Timers	1,482	50.0%	3%	83%	10	$52
New	Single Family	Pool Pump	Pool Pumps - VSD	Pool Pumps (VSD)	Pool Pumps constant speed	1,482	85.0%	3%	92%	10	$714
New	Single Family	Refrigerator	Refrigerator/Freezer - Energy Star	Energy Star Refrigerator	Standard Refrigerator	490	20.0%	NA	NA	18	$32
New	Single Family	Refrigerator	1 kWh/day Refrigerator	20 cf top-freezer using no more than 1 kWh/day	Standard Refrigerator, 20cf, top-freezer	416	30.0%	90%	97%	19	$74
New	Single Family	Refrigerator	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	416	6.3%	85%	95%	5	$236
New	Single Family	Refrigerator	Solid state refrigeration (cool chips™) for refrigerators	Thermoelectric refrigerator, 1.7 cubic ft.	Compact refrigerator, 1.7 cubic ft.	416	4.0%	75%	95%	19	$56
New	Single Family	Room AC	Air Conditioner - Room (Individual Rooms) (10,000 BTU/HR)	EER = 10.8	EER = 9.8	496	8.4%	NA	NA	10	$42
New	Single Family	Room AC	Blinds - Fixed Angle/Automatic	Install Blinds (Reduce Window SHGC by 50%)	No Interior Shading Device	468	31.5%	65%	30%	10	$603
New	Single Family	Room AC	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	468	3.3%	75%	25%	30	$3

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Room AC	Ceiling Fan	Ceiling Fan	No Ceiling Fan	468	0.3%	85%	20%	10	$104
New	Single Family	Room AC	Construction - ICF	Concrete Framing	Standard Wood Framing	468	32.0%	45%	95%	30	$11629
New	Single Family	Room AC	Construction - SIP	Specialty Framing	Standard Wood Framing	468	14.0%	45%	95%	30	$4,839
New	Single Family	Room AC	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	468	20.0%	0%	95%	20	$57
New	Single Family	Room AC	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	468	0.1%	85%	50%	30	$116
New	Single Family	Room AC	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	468	0.1%	85%	55%	12	$42
New	Single Family	Room AC	Green Roof	ecoroof	Standard Roof	468	6.5%	0%	98%	40	$21956
New	Single Family	Room AC	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	468	6.1%	20%	95%	25	$474
New	Single Family	Room AC	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	468	6.9%	20%	70%	25	$671
New	Single Family	Room AC	Insulation (Ceiling)	R-49	State Code (R-38)	468	0.1%	87%	85%	25	$390
New	Single Family	Room AC	Insulation (Floor)	R-38	State Code (R-30)	468	0.1%	75%	90%	25	$884
New	Single Family	Room AC	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	468	3.0%	80%	45%	25	$130
New	Single Family	Room AC	Insulation (Rim And Band Joist)	R-19	R-10	468	4.0%	80%	75%	25	$84
New	Single Family	Room AC	Insulation (Slab)	R-15	State Code (R-10)	468	1.4%	32%	64%	25	$223
New	Single Family	Room AC	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	468	0.0%	95%	85%	25	$2,363
New	Single Family	Room AC	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	468	2.0%	95%	40%	5	$7
New	Single Family	Room AC	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	468	6.7%	0%	97%	30	$305
New	Single Family	Room AC	Window Overhang	Overhangs over windows for shading	No window overhangs	468	14.0%	50%	80%	30	$905
New	Single Family	Room AC	Windows	U = 0.19	U=0.30	468	5.0%	85%	95%	25	$4,696
New	Single Family	Room Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	4,231	3.3%	75%	25%	30	$3
New	Single Family	Room Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	4,231	44.0%	45%	95%	30	$11629
New	Single Family	Room Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	4,231	14.0%	45%	95%	30	$4,839
New	Single Family	Room Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	4,231	5.0%	85%	50%	30	$116
New	Single Family	Room Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	4,231	3.0%	85%	55%	12	$42
New	Single Family	Room Heat	Ductless Mini-Split REM	3 ton, SEER 15, HSPF 9.0	Electric Baseboard Heating HSPF=1	4,231	62.1%	80%	95%	15	$5,700
New	Single Family	Room Heat	Green Roof	ecoroof	Standard Roof	4,231	6.5%	0%	98%	40	$21956
New	Single Family	Room Heat	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	4,231	6.1%	20%	95%	25	$474
New	Single Family	Room Heat	Insulation (Basement - Wall) 2*4 - average existing value	R-13	Average Existing Insulation Value and/or Code Value (R-7)	4,231	6.9%	20%	70%	25	$671

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Room Heat	Insulation (Ceiling)	R-49	State Code (R-38)	4,231	3.0%	87%	85%	25	$390
New	Single Family	Room Heat	Insulation (Floor)	R-38	State Code (R-30)	4,231	2.0%	75%	90%	25	$884
New	Single Family	Room Heat	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	4,231	3.0%	80%	45%	25	$130
New	Single Family	Room Heat	Insulation (Rim And Band Joist)	R-19	R-10	4,231	4.0%	80%	75%	25	$84
New	Single Family	Room Heat	Insulation (Slab)	R-15	State Code (R-10)	4,231	1.4%	32%	64%	25	$223
New	Single Family	Room Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	4,231	3.2%	95%	85%	25	$2,363
New	Single Family	Room Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	4,231	2.0%	95%	40%	5	$7
New	Single Family	Room Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	4,231	2.0%	0%	97%	30	$305
New	Single Family	Room Heat	Radiant Electric Ceiling Panels	Radiant Electric Heating with Ceiling Panels	Electric Baseboard Heating	4,231	52.0%	75%	98%	20	$4,238
New	Single Family	Room Heat	Radiant Electric Floor Heating	Radiant Heating with Electric Cables in Flooring	Electric Baseboard Heating	4,231	20.0%	75%	95%	25	$25183
New	Single Family	Room Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	4,231	3.0%	90%	90%	25	$6,935
New	Single Family	Room Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	4,231	10.0%	90%	90%	25	$9,954
New	Single Family	Room Heat	Windows	U = 0.19	U=0.30	4,231	16.0%	85%	95%	25	$4,696
New	Single Family	Water Heat	Water_Heater (40 Gallon Electric)	EF = 0.95	EF = 0.92	2,865	3.2%	NA	NA	15	$129
New	Single Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	2,812	9.3%	35%	68%	14	$252
New	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	2,812	11.2%	35%	77%	14	$312
New	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	2,812	12.8%	35%	77%	14	$417
New	Single Family	Water Heat	Desuperheater (Ground-Source Heat_Pump) system	Desuperheater with Standard Water_Heater	Standard Water_Heater - EF = 0.92	2,812	55.2%	5%	90%	10	$251
New	Single Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	2,812	1.1%	30%	35%	13	$514
New	Single Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	2,812	2.1%	30%	15%	13	$11
New	Single Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	2,812	18.5%	50%	95%	30	$630
New	Single Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	2,812	8.5%	95%	95%	9	$4
New	Single Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	2,812	3.5%	95%	55%	9	$3
New	Single Family	Water Heat	Heat Pump Water Heater	EF=2.9	No Heat Pump Water Heater	2,812	54.6%	30%	95%	15	$2,322
New	Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	2,812	1.2%	85%	38%	5	$8
New	Single Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	2,812	19.3%	95%	85%	10	$11
New	Single Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	2,812	45.5%	20%	95%	20	$8,[illegible]30
New	Single Family	Water Heat	Tankless Water_Heater	EF = 0.95, 4.0 gpm	EF = 0.92	2,812	3.2%	85%	97%	20	$1,302

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	2,812	6.5%	0%	65%	10	$19
New	Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	2,812	6.0%	95%	43%	4	$0

Residential Gas Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central Boiler Heat	Gas Boiler	AFUE=90%	AFUE=82%	626	9.0%	NA	NA	18	$2,399
Existing	Manufactured	Central Boiler Heat	Gas Boiler	AFUE=94%	AFUE=82%	626	12.7%	NA	NA	18	$3,344
Existing	Manufactured	Central Boiler Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	601	3.3%	60%	55%	30	$53
Existing	Manufactured	Central Boiler Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	601	3.0%	85%	50%	30	$116
Existing	Manufactured	Central Boiler Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	601	2.0%	85%	55%	12	$42
Existing	Manufactured	Central Boiler Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	601	1.3%	80%	65%	3	$36
Existing	Manufactured	Central Boiler Heat	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	601	5.0%	53%	85%	30	$1
Existing	Manufactured	Central Boiler Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	601	10.0%	85%	85%	15	$435
Existing	Manufactured	Central Boiler Heat	Insulation (Ceiling)	R-49	State Code (R-38)	601	1.0%	87%	85%	25	$471
Existing	Manufactured	Central Boiler Heat	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	601	2.0%	95%	40%	25	$674
Existing	Manufactured	Central Boiler Heat	Insulation (Ceiling)	State Code (R-38)	R-9	601	10.5%	95%	10%	25	$674
Existing	Manufactured	Central Boiler Heat	Insulation (Duct)	R-8	R-4	601	1.6%	12%	95%	25	$103
Existing	Manufactured	Central Boiler Heat	Insulation (Floor)	R-38	State Code (R-30)	601	1.0%	75%	90%	25	$1,061
Existing	Manufactured	Central Boiler Heat	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	601	2.0%	30%	40%	25	$532
Existing	Manufactured	Central Boiler Heat	Insulation (Floor)	State Code (R-30)	R-0	601	8.0%	30%	10%	25	$532
Existing	Manufactured	Central Boiler Heat	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	601	4.0%	75%	40%	25	$764
Existing	Manufactured	Central Boiler Heat	Insulation (Wall) 2*4	R-13	R-0	601	40.0%	75%	10%	25	$764

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central Heat Boiler	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	601	1.8%	10%	90%	25	$1,007
Existing	Manufactured	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	601	11.0%	0%	55%	25	$1,246
Existing	Manufactured	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	R-0	601	45.0%	0%	45%	25	$1,246
Existing	Manufactured	Central Heat Boiler	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	601	2.0%	95%	60%	5	$6
Existing	Manufactured	Central Heat Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	601	2.0%	0%	97%	30	$365
Existing	Manufactured	Central Heat Boiler	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	601	14.0%	0%	95%	25	$3,000
Existing	Manufactured	Central Heat Boiler	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	601	6.8%	85%	50%	15	$27
Existing	Manufactured	Central Heat Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	601	7.0%	65%	95%	12	$1,150
Existing	Manufactured	Central Heat Boiler	Windows	U = 0.19	U = 0.30	601	8.0%	65%	95%	25	$2,378
Existing	Manufactured	Central Heat Boiler	Windows	U = 0.30	Existing Windows (U=0.65)	601	8.0%	65%	15%	25	$5,656
Existing	Manufactured	Central Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	481	11.0%	NA	NA	18	$788
Existing	Manufactured	Central Heat Furnace	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	481	16.0%	NA	NA	18	$1,103
Existing	Manufactured	Central Heat Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	457	3.3%	60%	55%	30	$53
Existing	Manufactured	Central Heat Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	457	3.0%	85%	50%	30	$116
Existing	Manufactured	Central Heat Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	457	2.0%	85%	55%	12	$42
Existing	Manufactured	Central Heat Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	457	1.3%	80%	65%	3	$36
Existing	Manufactured	Central Heat Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	457	6.0%	60%	65%	20	$447
Existing	Manufactured	Central Heat Furnace	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	457	19.0%	50%	95%	25	$946
Existing	Manufactured	Central Heat Furnace	Gas Furnace - Maintenance	Maintenance	No Maintenance	457	5.0%	95%	75%	2	$105

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central Heat Furnace	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	457	5.0%	6%	75%	1	$105
Existing	Manufactured	Central Heat Furnace	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	457	5.0%	53%	85%	18	$1
Existing	Manufactured	Central Heat Furnace	Insulation (Ceiling)	R-49	State Code (R-38)	457	1.0%	87%	85%	25	$471
Existing	Manufactured	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	457	2.0%	95%	40%	25	$674
Existing	Manufactured	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	R-9	457	10.5%	95%	10%	25	$674
Existing	Manufactured	Central Heat Furnace	Insulation (Duct)	R-8	No Duct Insulation	457	4.3%	12%	75%	25	$201
Existing	Manufactured	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	457	1.0%	75%	90%	25	$1,061
Existing	Manufactured	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	457	2.0%	30%	40%	25	$532
Existing	Manufactured	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	R-0	457	9.0%	30%	10%	25	$532
Existing	Manufactured	Central Heat Furnace	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	457	5.0%	75%	40%	25	$764
Existing	Manufactured	Central Heat Furnace	Insulation (Wall) 2*4	R-13	R-0	457	43.0%	75%	10%	25	$764
Existing	Manufactured	Central Heat Furnace	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	457	2.2%	10%	90%	25	$1,007
Existing	Manufactured	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	457	10.0%	0%	55%	25	$1,246
Existing	Manufactured	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	R-0	457	48.0%	0%	45%	25	$1,246
Existing	Manufactured	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	457	15.0%	10%	95%	30	$216
Existing	Manufactured	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	457	2.0%	95%	60%	5	$6
Existing	Manufactured	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	457	2.0%	0%	97%	30	$365
Existing	Manufactured	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	457	14.0%	0%	95%	25	$3,000
Existing	Manufactured	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	457	6.8%	85%	60%	15	$27

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Manufactured	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	457	7.0%	65%	95%	12	$1,150
Existing	Manufactured	Central Heat Furnace	Windows	U = 0.19	U = 0.30	457	9.0%	65%	95%	25	$2,378
Existing	Manufactured	Central Heat Furnace	Windows	U = 0.30	Existing Windows (U=0.65)	457	10.0%	65%	15%	25	$5,656
Existing	Manufactured	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305
Existing	Manufactured	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
Existing	Manufactured	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	156	4.4%	NA	NA	13	$81
Existing	Manufactured	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	156	26.4%	NA	NA	13	$1,212
Existing	Manufactured	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	156	31.4%	NA	NA	13	$1,289
Existing	Manufactured	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	152	9.3%	85%	68%	14	$252
Existing	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	152	11.2%	85%	91%	14	$312
Existing	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	152	12.8%	85%	91%	14	$417
Existing	Manufactured	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	152	12.7%	30%	25%	14	$378
Existing	Manufactured	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	152	30.0%	5%	90%	10	$251
Existing	Manufactured	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	152	2.2%	23%	35%	13	$514
Existing	Manufactured	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	152	4.1%	23%	15%	13	$11
Existing	Manufactured	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	152	3.5%	0%	95%	30	$630
Existing	Manufactured	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	152	5.6%	95%	95%	9	$3
Existing	Manufactured	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	152	2.3%	95%	55%	9	$2
Existing	Manufactured	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	152	2.6%	95%	10%	9	$2
Existing	Manufactured	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	152	1.2%	65%	25%	15	$8
Existing	Manufactured	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	152	9.5%	95%	85%	10	$5
Existing	Manufactured	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	152	6.4%	95%	33%	10	$12
Existing	Manufactured	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	152	33.6%	20%	95%	20	$8,930
Existing	Manufactured	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	152	24.4%	75%	99%	20	$1,525
Existing	Manufactured	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	152	6.5%	0%	75%	10	$19
Existing	Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	152	6.0%	95%	43%	5	$0
New	Manufactured	Central Heat Boiler	Gas Boiler	AFUE=90%	AFUE=82%	585	8.9%	NA	NA	18	$2,399

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Central Boiler Heat	Gas Boiler	AFUE=94%	AFUE=82%	585	12.8%	NA	NA	18	$3,344
New	Manufactured	Central Boiler Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	529	3.3%	75%	25%	30	$3
New	Manufactured	Central Boiler Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	529	44.0%	1%	95%	30	$6,442
New	Manufactured	Central Boiler Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	529	14.0%	1%	95%	30	$5,680
New	Manufactured	Central Boiler Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	529	4.0%	85%	50%	30	$116
New	Manufactured	Central Boiler Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	529	3.0%	85%	55%	12	$42
New	Manufactured	Central Boiler Heat	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	529	5.0%	53%	85%	30	$1
New	Manufactured	Central Boiler Heat	Green Roof	ecoroof	Standard Roof	529	6.5%	0%	98%	40	$26327
New	Manufactured	Central Boiler Heat	Insulation (Ceiling)	R-49	State Code (R-38)	529	2.0%	87%	85%	25	$582
New	Manufactured	Central Boiler Heat	Insulation (Floor)	R-38	State Code (R-30)	529	1.0%	75%	90%	25	$1,061
New	Manufactured	Central Boiler Heat	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	529	2.8%	95%	50%	25	$812
New	Manufactured	Central Boiler Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	529	2.0%	95%	40%	5	$6
New	Manufactured	Central Boiler Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	529	2.0%	0%	97%	30	$365
New	Manufactured	Central Boiler Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	529	3.0%	95%	95%	25	$3,289
New	Manufactured	Central Boiler Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	529	11.0%	95%	95%	25	$5,061
New	Manufactured	Central Boiler Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	529	6.8%	85%	50%	15	$27
New	Manufactured	Central Boiler Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	529	7.0%	65%	95%	12	$1,450
New	Manufactured	Central Boiler Heat	Windows	U = 0.19	U = 0.30	529	14.0%	85%	95%	25	$2,737
New	Manufactured	Central Furnace Heat	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	441	10.9%	NA	NA	18	$788

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Central Heat Furnace	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	441	15.6%	NA	NA	18	$1,103
New	Manufactured	Central Heat Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	389	3.3%	75%	25%	30	$3
New	Manufactured	Central Heat Furnace	Construction - ICF	Concrete Framing	Standard Wood Framing	389	44.0%	1%	95%	30	$6,442
New	Manufactured	Central Heat Furnace	Construction - SIP	Specialty Framing	Standard Wood Framing	389	14.0%	1%	95%	30	$5,680
New	Manufactured	Central Heat Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	389	5.0%	85%	50%	30	$116
New	Manufactured	Central Heat Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	389	3.0%	85%	55%	12	$42
New	Manufactured	Central Heat Furnace	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	389	8.0%	85%	75%	30	$126
New	Manufactured	Central Heat Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	389	6.0%	0%	65%	20	$447
New	Manufactured	Central Heat Furnace	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	389	19.0%	0%	95%	25	$525
New	Manufactured	Central Heat Furnace	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	389	4.0%	95%	75%	1	$105
New	Manufactured	Central Heat Furnace	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	389	5.0%	53%	85%	18	$1
New	Manufactured	Central Heat Furnace	Green Roof	ecoroof	Standard Roof	389	6.5%	0%	98%	40	$26327
New	Manufactured	Central Heat Furnace	Insulation (Ceiling)	R-49	State Code (R-38)	389	2.0%	87%	85%	25	$582
New	Manufactured	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	389	2.0%	75%	90%	25	$1,061
New	Manufactured	Central Heat Furnace	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	389	2.8%	95%	50%	25	$812
New	Manufactured	Central Heat Furnace	Integrated Space and Water Heating	Premium Efficiency AFUE = 90 - Condensing Furnace	Standard Efficiency AFUE = 78- Condensing Furnace	389	13.3%	15%	95%	15	$184
New	Manufactured	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	389	15.0%	0%	95%	30	$396
New	Manufactured	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	389	2.0%	95%	40%	5	$6
New	Manufactured	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	389	2.0%	0%	97%	30	$365

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Manufactured	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	389	3.0%	95%	95%	25	$3,289
New	Manufactured	Central Heat Furnace	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	389	11.0%	95%	95%	25	$5,061
New	Manufactured	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	389	6.8%	85%	60%	15	$27
New	Manufactured	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	389	7.0%	65%	95%	12	$1,150
New	Manufactured	Central Heat Furnace	Windows	U = 0.19	U = 0.30	389	16.0%	85%	95%	25	$2,757
New	Manufactured	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305
New	Manufactured	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
New	Manufactured	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	193	4.6%	NA	NA	13	$81
New	Manufactured	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	193	26.0%	NA	NA	13	$1,212
New	Manufactured	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	193	31.1%	NA	NA	13	$1,289
New	Manufactured	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	159	9.3%	85%	68%	14	$252
New	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	159	11.2%	85%	91%	14	$312
New	Manufactured	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	159	12.8%	85%	91%	14	$417
New	Manufactured	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	159	30.0%	5%	90%	10	$251
New	Manufactured	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	159	2.2%	23%	35%	13	$514
New	Manufactured	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	159	4.1%	23%	15%	13	$11
New	Manufactured	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	159	3.5%	50%	95%	30	$630
New	Manufactured	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	159	4.6%	95%	95%	9	$3
New	Manufactured	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	159	1.9%	95%	55%	9	$2
New	Manufactured	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	159	1.2%	0%	75%	15	$8
New	Manufactured	Water Heat	Integrated Space and Water Heating	High Efficiency Water Heater EF =0.62	Standard efficiency Water Heater EF = 0.59	159	4.8%	15%	95%	15	$71
New	Manufactured	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	159	7.9%	95%	65%	10	$[illegible]5
New	Manufactured	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	159	33.7%	20%	95%	20	$8,[illegible]30
New	Manufactured	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	159	24.4%	75%	99%	20	$1,[illegible]98
New	Manufactured	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	159	6.5%	0%	75%	10	$[illegible]9
New	Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	159	6.0%	95%	43%	5	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central Boiler Heat	Gas Boiler	AFUE=90%	AFUE=82%	453	9.1%	NA	NA	18	$2,399
Existing	Multi Family	Central Boiler Heat	Gas Boiler	AFUE=94%	AFUE=82%	453	12.8%	NA	NA	18	$3,344
Existing	Multi Family	Central Boiler Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	435	3.3%	60%	55%	30	$53
Existing	Multi Family	Central Boiler Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	435	3.0%	85%	50%	30	$58
Existing	Multi Family	Central Boiler Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	435	2.0%	85%	55%	12	$21
Existing	Multi Family	Central Boiler Heat	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	435	1.3%	80%	55%	3	$36
Existing	Multi Family	Central Boiler Heat	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	435	5.0%	53%	85%	30	$1
Existing	Multi Family	Central Boiler Heat	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	435	10.0%	85%	75%	15	$218
Existing	Multi Family	Central Boiler Heat	Insulation (Ceiling)	R-49	State Code (R-38)	435	1.0%	87%	85%	25	$291
Existing	Multi Family	Central Boiler Heat	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	435	2.0%	95%	40%	25	$520
Existing	Multi Family	Central Boiler Heat	Insulation (Ceiling)	State Code (R-38)	R-9	435	10.5%	95%	10%	25	$520
Existing	Multi Family	Central Boiler Heat	Insulation (Duct)	R-8	R-4	435	1.6%	12%	95%	25	$73
Existing	Multi Family	Central Boiler Heat	Insulation (Floor)	R-38	State Code (R-30)	435	1.0%	75%	90%	25	$747
Existing	Multi Family	Central Boiler Heat	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	435	2.0%	80%	40%	25	$375
Existing	Multi Family	Central Boiler Heat	Insulation (Floor)	State Code (R-30)	R-0	435	8.0%	80%	10%	25	$375
Existing	Multi Family	Central Boiler Heat	Insulation (Slab)	R-10	Average Existing Insulation Value and/or Code Value	435	1.3%	47%	65%	25	$994
Existing	Multi Family	Central Boiler Heat	Insulation (Slab)	R-10	R-0	435	4.3%	47%	60%	25	$994
Existing	Multi Family	Central Boiler Heat	Insulation (Slab)	R-15	R-10	435	1.4%	47%	87%	25	$221
Existing	Multi Family	Central Boiler Heat	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	435	4.0%	75%	40%	25	$314

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central Heat Boiler	Insulation (Wall) 2*4	R-13	R-0	435	40.0%	75%	10%	25	$314
Existing	Multi Family	Central Heat Boiler	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	435	1.8%	10%	90%	25	$452
Existing	Multi Family	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	435	11.0%	0%	40%	25	$513
Existing	Multi Family	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	R-0	435	45.0%	0%	35%	25	$513
Existing	Multi Family	Central Heat Boiler	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	435	2.0%	95%	60%	5	$4
Existing	Multi Family	Central Heat Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	435	2.0%	0%	97%	30	$258
Existing	Multi Family	Central Heat Boiler	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	435	14.0%	0%	95%	25	$1,125
Existing	Multi Family	Central Heat Boiler	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	435	6.8%	85%	75%	15	$27
Existing	Multi Family	Central Heat Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	435	7.0%	65%	95%	12	$1,150
Existing	Multi Family	Central Heat Boiler	Windows	U = 0.19	U = 0.30	435	8.0%	75%	95%	25	$815
Existing	Multi Family	Central Heat Boiler	Windows	U = 0.30	Existing Windows (U=0.65)	435	8.0%	75%	15%	25	$1,939
Existing	Multi Family	Central Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	364	11.1%	NA	NA	18	$788
Existing	Multi Family	Central Heat Furnace	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	364	15.9%	NA	NA	18	$1,103
Existing	Multi Family	Central Heat Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	345	3.3%	60%	55%	30	$53
Existing	Multi Family	Central Heat Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	345	3.0%	85%	50%	30	$58
Existing	Multi Family	Central Heat Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	345	2.0%	85%	55%	12	$21
Existing	Multi Family	Central Heat Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	345	1.3%	80%	55%	3	$36
Existing	Multi Family	Central Heat Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	345	6.0%	60%	65%	20	$447
Existing	Multi Family	Central Heat Furnace	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	345	19.0%	50%	95%	25	$946

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central Heat Furnace	Gas Furnace - Maintenance	Maintenance	No Maintenance	345	5.0%	95%	75%	2	$105
Existing	Multi Family	Central Heat Furnace	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	345	5.0%	6%	75%	1	$105
Existing	Multi Family	Central Heat Furnace	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	345	5.0%	53%	85%	18	$1
Existing	Multi Family	Central Heat Furnace	Insulation (Ceiling)	R-49	State Code (R-38)	345	1.0%	87%	85%	25	$291
Existing	Multi Family	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	345	2.0%	95%	40%	25	$520
Existing	Multi Family	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	R-9	345	10.5%	95%	10%	25	$520
Existing	Multi Family	Central Heat Furnace	Insulation (Duct)	R-8	No Duct Insulation	345	4.3%	12%	75%	25	$141
Existing	Multi Family	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	345	1.0%	75%	90%	25	$747
Existing	Multi Family	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	345	2.0%	80%	40%	25	$375
Existing	Multi Family	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	R-0	345	9.0%	80%	10%	25	$375
Existing	Multi Family	Central Heat Furnace	Insulation (Slab)	R-10	Average Existing Insulation Value and/or Code Value	345	1.3%	47%	65%	25	$994
Existing	Multi Family	Central Heat Furnace	Insulation (Slab)	R-10	R-0	345	4.3%	47%	60%	25	$994
Existing	Multi Family	Central Heat Furnace	Insulation (Slab)	R-15	R-10	345	1.4%	47%	87%	25	$221
Existing	Multi Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	345	5.0%	75%	40%	25	$314
Existing	Multi Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13	R-0	345	43.0%	75%	10%	25	$314
Existing	Multi Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	345	2.2%	10%	90%	25	$452
Existing	Multi Family	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	345	10.0%	0%	40%	25	$513
Existing	Multi Family	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	R-0	345	48.0%	0%	35%	25	$513
Existing	Multi Family	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	345	15.0%	10%	95%	30	$216

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	345	2.0%	95%	60%	5	$4
Existing	Multi Family	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	345	2.0%	0%	97%	30	$258
Existing	Multi Family	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	345	14.0%	0%	95%	25	$1,125
Existing	Multi Family	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	345	6.8%	85%	55%	15	$27
Existing	Multi Family	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	345	7.0%	65%	95%	12	$1,150
Existing	Multi Family	Central Heat Furnace	Windows	U = 0.19	U = 0.30	345	9.0%	75%	95%	25	$815
Existing	Multi Family	Central Heat Furnace	Windows	U = 0.30	Existing Windows (U=0.65)	345	10.0%	75%	15%	25	$1,939
Existing	Multi Family	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305
Existing	Multi Family	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
Existing	Multi Family	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	139	5.0%	NA	NA	13	$81
Existing	Multi Family	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	139	26.2%	NA	NA	13	$1,212
Existing	Multi Family	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	139	31.2%	NA	NA	13	$1,289
Existing	Multi Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	135	9.3%	67%	68%	14	$252
Existing	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	135	11.2%	67%	85%	14	$312
Existing	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	135	12.8%	67%	85%	14	$417
Existing	Multi Family	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	135	12.7%	25%	25%	14	$378
Existing	Multi Family	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	135	30.0%	5%	90%	10	$251
Existing	Multi Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	135	2.2%	27%	35%	13	$514
Existing	Multi Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	135	4.1%	27%	15%	13	$11
Existing	Multi Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	135	3.5%	0%	95%	30	$630
Existing	Multi Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	135	6.3%	95%	95%	9	$3
Existing	Multi Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	135	2.6%	95%	55%	9	$2
Existing	Multi Family	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	135	3.0%	95%	10%	9	$2
Existing	Multi Family	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	135	1.2%	65%	62%	15	$8
Existing	Multi Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	135	10.8%	95%	85%	10	$5

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Multi Family	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	135	7.2%	95%	33%	10	$12
Existing	Multi Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	135	19.0%	20%	95%	20	$4,465
Existing	Multi Family	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	135	24.4%	75%	99%	20	$1,525
Existing	Multi Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	135	6.5%	0%	78%	10	$19
Existing	Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	135	6.0%	95%	64%	5	$0
New	Multi Family	Central Heat Boiler	Gas Boiler	AFUE=90%	AFUE=82%	391	8.8%	NA	NA	18	$2,399
New	Multi Family	Central Heat Boiler	Gas Boiler	AFUE=94%	AFUE=82%	391	12.8%	NA	NA	18	$3,344
New	Multi Family	Central Heat Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	353	3.3%	75%	25%	30	$3
New	Multi Family	Central Heat Boiler	Construction - ICF	Concrete Framing	Standard Wood Framing	353	44.0%	45%	95%	30	$2,650
New	Multi Family	Central Heat Boiler	Construction - SIP	Specialty Framing	Standard Wood Framing	353	14.0%	20%	95%	30	$1,984
New	Multi Family	Central Heat Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	353	4.0%	85%	50%	30	$58
New	Multi Family	Central Heat Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	353	3.0%	85%	55%	12	$68
New	Multi Family	Central Heat Boiler	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	353	5.0%	53%	85%	30	$1
New	Multi Family	Central Heat Boiler	Green Roof	ecoroof	Standard Roof	353	6.5%	0%	98%	40	$11078
New	Multi Family	Central Heat Boiler	Insulation (Ceiling)	R-49	State Code (R-38)	353	2.0%	87%	85%	25	$336
New	Multi Family	Central Heat Boiler	Insulation (Floor)	R-38	State Code (R-30)	353	1.0%	75%	90%	25	$747
New	Multi Family	Central Heat Boiler	Insulation (Slab)	R-15	R-10	353	1.4%	47%	64%	25	$221
New	Multi Family	Central Heat Boiler	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	353	2.8%	95%	90%	25	$372
New	Multi Family	Central Heat Boiler	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	353	2.0%	95%	40%	5	$4
New	Multi Family	Central Heat Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	353	2.0%	0%	97%	30	$258

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Central Boiler Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	353	3.0%	95%	95%	25	$1,149
New	Multi Family	Central Boiler Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	353	11.0%	95%	95%	25	$1,767
New	Multi Family	Central Boiler Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	353	6.8%	85%	75%	15	$27
New	Multi Family	Central Boiler Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	353	7.0%	65%	95%	12	$1,150
New	Multi Family	Central Boiler Heat	Windows	U = 0.19	U = 0.30	353	14.0%	85%	95%	25	$1,155
New	Multi Family	Central Furnace Heat	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	331	11.0%	NA	NA	18	$788
New	Multi Family	Central Furnace Heat	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	331	15.8%	NA	NA	18	$1,103
New	Multi Family	Central Furnace Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	291	3.3%	75%	25%	30	$3
New	Multi Family	Central Furnace Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	291	44.0%	45%	95%	30	$2,650
New	Multi Family	Central Furnace Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	291	14.0%	20%	95%	30	$1,984
New	Multi Family	Central Furnace Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	291	5.0%	85%	50%	30	$58
New	Multi Family	Central Furnace Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	291	3.0%	85%	55%	12	$21
New	Multi Family	Central Furnace Heat	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	291	8.0%	85%	10%	30	$106
New	Multi Family	Central Furnace Heat	Duct Sealing	Duct Sealing	No Duct Sealing	291	6.0%	0%	65%	20	$447
New	Multi Family	Central Furnace Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	291	19.0%	0%	95%	25	$525
New	Multi Family	Central Furnace Heat	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	291	4.0%	95%	75%	1	$105
New	Multi Family	Central Furnace Heat	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	291	5.0%	53%	85%	18	$1
New	Multi Family	Central Furnace Heat	Green Roof	ecoroof	Standard Roof	291	6.5%	0%	98%	40	$1,078
New	Multi Family	Central Furnace Heat	Insulation (Ceiling)	R-49	State Code (R-38)	291	2.0%	87%	85%	25	$36

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	291	2.0%	75%	90%	25	$747
New	Multi Family	Central Heat Furnace	Insulation (Slab)	R-15	R-10	291	1.4%	47%	64%	25	$221
New	Multi Family	Central Heat Furnace	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	291	2.8%	95%	90%	25	$372
New	Multi Family	Central Heat Furnace	Integrated Space and Water Heating	Premium Efficiency AFUE = 90 - Condensing Furnace	Standard Efficiency AFUE = 78- Condensing Furnace	291	13.3%	25%	95%	15	$184
New	Multi Family	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	291	15.0%	0%	95%	30	$96
New	Multi Family	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	291	2.0%	95%	40%	5	$4
New	Multi Family	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	291	2.0%	0%	97%	30	$258
New	Multi Family	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	291	3.0%	95%	95%	25	$1,149
New	Multi Family	Central Heat Furnace	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	291	11.0%	95%	95%	25	$1,767
New	Multi Family	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	291	6.8%	85%	55%	15	$27
New	Multi Family	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	291	7.0%	65%	95%	12	$1,150
New	Multi Family	Central Heat Furnace	Windows	U = 0.19	U = 0.30	291	16.0%	85%	95%	25	$1,155
New	Multi Family	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305
New	Multi Family	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
New	Multi Family	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	171	5.2%	NA	NA	13	$81
New	Multi Family	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	171	26.4%	NA	NA	13	$1,212
New	Multi Family	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	171	31.6%	NA	NA	13	$1,289
New	Multi Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	141	9.3%	67%	68%	14	$252
New	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	141	11.2%	67%	85%	14	$312
New	Multi Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	141	12.8%	67%	85%	14	$417
New	Multi Family	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	141	30.0%	5%	90%	10	$751
New	Multi Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	141	2.2%	27%	35%	13	$514

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Multi Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	141	4.1%	27%	15%	13	$11
New	Multi Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	141	3.5%	50%	95%	30	$630
New	Multi Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	141	5.2%	95%	95%	9	$3
New	Multi Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	141	2.1%	95%	55%	9	$2
New	Multi Family	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	141	1.2%	0%	67%	15	$8
New	Multi Family	Water Heat	Integrated Space and Water Heating	High Efficiency Water Heater EF =0.62	Standard efficiency Water Heater EF = 0.59	141	4.8%	25%	95%	15	$71
New	Multi Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	141	8.9%	95%	65%	10	$5
New	Multi Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	141	19.1%	20%	95%	20	$4,465
New	Multi Family	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	141	24.4%	75%	99%	20	$1,398
New	Multi Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	141	6.5%	0%	78%	10	$19
New	Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	141	6.0%	95%	64%	5	$0
Existing	Single Family	Central Heat Boiler	Gas Boiler	AFUE=90%	AFUE=82%	772	8.9%	NA	NA	18	$2,399
Existing	Single Family	Central Heat Boiler	Gas Boiler	AFUE=94%	AFUE=82%	772	12.9%	NA	NA	18	$3,344
Existing	Single Family	Central Heat Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	742	3.3%	60%	55%	30	$53
Existing	Single Family	Central Heat Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	742	3.0%	85%	50%	30	$116
Existing	Single Family	Central Heat Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	742	2.0%	85%	55%	12	$42
Existing	Single Family	Central Heat Boiler	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	742	1.3%	80%	45%	3	$36
Existing	Single Family	Central Heat Boiler	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	742	5.0%	53%	85%	30	$1
Existing	Single Family	Central Heat Boiler	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	742	10.0%	85%	75%	15	$435
Existing	Single Family	Central Heat Boiler	Insulation (Basement - Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	742	6.9%	14%	70%	25	$906
Existing	Single Family	Central Heat Boiler	Insulation (Basement - Wall) 2*4	R-13	R-0	742	14.9%	14%	70%	25	$906
Existing	Single Family	Central Heat Boiler	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	742	6.1%	14%	95%	25	$708
Existing	Single Family	Central Heat Boiler	Insulation (Ceiling)	R-49	State Code (R-38)	742	1.0%	87%	85%	25	$344

Exhibit No. ___(RG-3)
Page 1067 of 1396

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat Boiler	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	742	2.0%	95%	40%	25	$562
Existing	Single Family	Central Heat Boiler	Insulation (Ceiling)	State Code (R-38)	R-9	742	10.5%	95%	10%	25	$562
Existing	Single Family	Central Heat Boiler	Insulation (Duct)	R-8	R-4	742	1.6%	12%	95%	25	$172
Existing	Single Family	Central Heat Boiler	Insulation (Floor)	R-38	State Code (R-30)	742	1.0%	75%	90%	25	$884
Existing	Single Family	Central Heat Boiler	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	742	2.0%	55%	40%	25	$443
Existing	Single Family	Central Heat Boiler	Insulation (Floor)	State Code (R-30)	R-0	742	8.0%	55%	10%	25	$443
Existing	Single Family	Central Heat Boiler	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	742	3.0%	60%	45%	25	$130
Existing	Single Family	Central Heat Boiler	Insulation (Rim And Band Joist)	R-19	R-10	742	4.0%	60%	75%	25	$84
Existing	Single Family	Central Heat Boiler	Insulation (Slab)	R-10	Average Existing Insulation Value and/or Code Value	742	1.3%	28%	65%	25	$1,049
Existing	Single Family	Central Heat Boiler	Insulation (Slab)	R-10	R-0	742	4.3%	28%	60%	25	$1,049
Existing	Single Family	Central Heat Boiler	Insulation (Slab)	R-15	R-10	742	1.4%	28%	87%	25	$223
Existing	Single Family	Central Heat Boiler	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	742	4.0%	75%	40%	25	$1,396
Existing	Single Family	Central Heat Boiler	Insulation (Wall) 2*4	R-13	R-0	742	40.0%	75%	10%	25	$1,396
Existing	Single Family	Central Heat Boiler	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	742	1.8%	10%	90%	25	$1,786
Existing	Single Family	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	742	11.0%	0%	60%	25	$2,276
Existing	Single Family	Central Heat Boiler	Insulation (wall) 2*6	State Code (R-21)	R-0	742	45.0%	0%	50%	25	$2,276
Existing	Single Family	Central Heat Boiler	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	742	2.0%	95%	60%	5	$7
Existing	Single Family	Central Heat Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	742	2.0%	0%	97%	30	$305
Existing	Single Family	Central Heat Boiler	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	742	14.0%	0%	95%	25	$7,750

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat Boiler	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	742	6.8%	85%	37%	15	$27
Existing	Single Family	Central Heat Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	742	7.0%	65%	95%	12	$1,422
Existing	Single Family	Central Heat Boiler	Windows	U = 0.19	U = 0.30	742	8.0%	75%	95%	25	$4,343
Existing	Single Family	Central Heat Boiler	Windows	U = 0.30	Existing Windows (U=0.65)	742	8.0%	75%	15%	25	$10331
Existing	Single Family	Central Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	634	11.0%	NA	NA	18	$788
Existing	Single Family	Central Heat Furnace	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	634	15.8%	NA	NA	18	$1,103
Existing	Single Family	Central Heat Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	602	3.3%	60%	55%	30	$53
Existing	Single Family	Central Heat Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	602	3.0%	85%	50%	30	$116
Existing	Single Family	Central Heat Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	602	2.0%	85%	55%	12	$42
Existing	Single Family	Central Heat Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	602	1.3%	80%	45%	3	$36
Existing	Single Family	Central Heat Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	602	6.0%	60%	65%	20	$447
Existing	Single Family	Central Heat Furnace	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	Older homes with AFUE HVAC, SEER 9	602	19.0%	50%	95%	25	$946
Existing	Single Family	Central Heat Furnace	Gas Furnace - Maintenance	Maintenance	No Maintenance	602	5.0%	95%	75%	2	$105
Existing	Single Family	Central Heat Furnace	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	602	5.0%	6%	75%	1	$105
Existing	Single Family	Central Heat Furnace	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	602	5.0%	53%	85%	18	$1
Existing	Single Family	Central Heat Furnace	Insulation (Basement - Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	602	6.9%	14%	70%	25	$906
Existing	Single Family	Central Heat Furnace	Insulation (Basement - Wall) 2*4	R-13	R-0	602	14.9%	14%	70%	25	$906
Existing	Single Family	Central Heat Furnace	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	602	6.1%	14%	95%	25	$708
Existing	Single Family	Central Heat Furnace	Insulation (Ceiling)	R-49	State Code (R-38)	602	1.0%	87%	85%	25	$344

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	Average Existing Insulation Value (R-19)	602	2.0%	95%	40%	25	$562
Existing	Single Family	Central Heat Furnace	Insulation (Ceiling)	State Code (R-38)	R-9	602	10.5%	95%	10%	25	$562
Existing	Single Family	Central Heat Furnace	Insulation (Duct)	R-8	No Duct Insulation	602	4.3%	12%	75%	25	$335
Existing	Single Family	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	602	1.0%	75%	90%	25	$884
Existing	Single Family	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	Average Existing Insulation Value and/or Code Value	602	2.0%	55%	40%	25	$443
Existing	Single Family	Central Heat Furnace	Insulation (Floor)	State Code (R-30)	R-0	602	9.0%	55%	10%	25	$443
Existing	Single Family	Central Heat Furnace	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	602	3.0%	60%	45%	25	$130
Existing	Single Family	Central Heat Furnace	Insulation (Rim And Band Joist)	R-19	R-10	602	4.0%	60%	75%	25	$84
Existing	Single Family	Central Heat Furnace	Insulation (Slab)	R-10	Average Existing Insulation Value and/or Code Value	602	1.3%	28%	65%	25	$1,049
Existing	Single Family	Central Heat Furnace	Insulation (Slab)	R-10	R-0	602	4.3%	28%	60%	25	$1,049
Existing	Single Family	Central Heat Furnace	Insulation (Slab)	R-15	R-10	602	1.4%	28%	87%	25	$223
Existing	Single Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	602	5.0%	75%	40%	25	$1,396
Existing	Single Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13	R-0	602	43.0%	75%	10%	25	$1,396
Existing	Single Family	Central Heat Furnace	Insulation (Wall) 2*4	R-13 + R5 Sheathing	R-13	602	2.2%	10%	90%	25	$1,786
Existing	Single Family	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	Average Existing Insulation Value and/or Code Value	602	10.0%	0%	60%	25	$2,276
Existing	Single Family	Central Heat Furnace	Insulation (wall) 2*6	State Code (R-21)	R-0	602	48.0%	0%	50%	25	$2,276
Existing	Single Family	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	602	15.0%	10%	95%	30	$288
Existing	Single Family	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	602	2.0%	95%	60%	5	$7
Existing	Single Family	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	602	2.0%	0%	97%	30	$305

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*4Wall R-13	602	14.0%	0%	95%	25	$7,750
Existing	Single Family	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	602	6.8%	85%	32%	15	$27
Existing	Single Family	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	602	7.0%	65%	95%	12	$1,422
Existing	Single Family	Central Heat Furnace	Windows	U = 0.19	U = 0.30	602	9.0%	75%	95%	25	$4,343
Existing	Single Family	Central Heat Furnace	Windows	U = 0.30	Existing Windows (U=0.65)	602	10.0%	75%	15%	25	$10331
Existing	Single Family	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305
Existing	Single Family	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
Existing	Single Family	Pool Heat	Pool Heaters	Energy Efficient Heaters - 88% efficiency	Standard Heaters - 83% efficiency	253	5.7%	85%	65%	8	$483
Existing	Single Family	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	238	5.0%	NA	NA	13	$81
Existing	Single Family	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	238	26.4%	NA	NA	13	$1,212
Existing	Single Family	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	238	31.4%	NA	NA	13	$1,289
Existing	Single Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	231	9.3%	99%	68%	14	$252
Existing	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	231	11.2%	99%	77%	14	$312
Existing	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	231	12.8%	99%	77%	14	$417
Existing	Single Family	Water Heat	Clothes Washer - Early Replacement	Standard Clothes Washer (1.26)	Existing Clothes Washer (MEF = 1.1)	231	12.7%	35%	25%	14	$378
Existing	Single Family	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	231	30.0%	5%	90%	10	$251
Existing	Single Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	231	2.2%	30%	35%	13	$514
Existing	Single Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	231	4.1%	30%	15%	13	$11
Existing	Single Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	231	3.5%	0%	95%	30	$630
Existing	Single Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	231	5.5%	95%	95%	9	$4
Existing	Single Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	231	2.3%	95%	55%	9	$3
Existing	Single Family	Water Heat	Faucet Aerators	2.2 GPM	Existing Faucet Aerator (3.0 GPM)	231	2.6%	95%	10%	9	$2
Existing	Single Family	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	231	1.2%	65%	38%	15	$8
Existing	Single Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	231	12.5%	95%	85%	10	$11
Existing	Single Family	Water Heat	Low-Flow Showerheads	2.5 GPM	3.0 GPM	231	8.4%	95%	33%	10	$25
Existing	Single Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	231	22.2%	20%	95%	20	$8,930

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Single Family	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	231	24.4%	75%	97%	20	$1,525
Existing	Single Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	231	6.5%	0%	63%	10	$19
Existing	Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	231	6.0%	95%	43%	5	$0
New	Single Family	Central Heat Boiler	Gas Boiler	AFUE=90%	AFUE=82%	621	9.0%	NA	NA	18	$2,399
New	Single Family	Central Heat Boiler	Gas Boiler	AFUE=94%	AFUE=82%	621	12.7%	NA	NA	18	$3,344
New	Single Family	Central Heat Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	561	3.3%	75%	25%	30	$3
New	Single Family	Central Heat Boiler	Construction - ICF	Concrete Framing	Standard Wood Framing	561	44.0%	45%	95%	30	$11629
New	Single Family	Central Heat Boiler	Construction - SIP	Specialty Framing	Standard Wood Framing	561	14.0%	45%	95%	30	$6,564
New	Single Family	Central Heat Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	561	4.0%	85%	50%	30	$116
New	Single Family	Central Heat Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	561	3.0%	85%	55%	12	$42
New	Single Family	Central Heat Boiler	Gas Boiler - Proper Sizing	Proper Sizing of Gas Boiler	Oversized Gas Boiler	561	5.0%	53%	85%	30	$1
New	Single Family	Central Heat Boiler	Green Roof	ecoroof	Standard Roof	561	6.5%	0%	98%	40	$21956
New	Single Family	Central Heat Boiler	Insulation (Basement - Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	561	6.9%	14%	70%	25	$671
New	Single Family	Central Heat Boiler	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	561	6.1%	14%	95%	25	$474
New	Single Family	Central Heat Boiler	Insulation (Ceiling)	R-49	State Code (R-38)	561	2.0%	87%	85%	25	$365
New	Single Family	Central Heat Boiler	Insulation (Floor)	R-38	State Code (R-30)	561	1.0%	75%	90%	25	$884
New	Single Family	Central Heat Boiler	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	561	3.0%	80%	45%	25	$130
New	Single Family	Central Heat Boiler	Insulation (Rim And Band Joist)	R-19	R-10	561	4.0%	80%	75%	25	$84
New	Single Family	Central Heat Boiler	Insulation (Slab)	R-15	R-10	561	1.4%	28%	64%	25	$223
New	Single Family	Central Heat Boiler	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	561	2.8%	95%	85%	25	$2,363

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Central Boiler Heat	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	561	2.0%	95%	40%	5	$7
New	Single Family	Central Boiler Heat	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	561	2.0%	0%	97%	30	$305
New	Single Family	Central Boiler Heat	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	561	3.0%	95%	95%	25	$7,602
New	Single Family	Central Boiler Heat	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	561	11.0%	95%	95%	25	$11697
New	Single Family	Central Boiler Heat	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	561	6.8%	85%	37%	15	$27
New	Single Family	Central Boiler Heat	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	561	7.0%	65%	95%	12	$1,422
New	Single Family	Central Boiler Heat	Windows	U = 0.19	U = 0.30	561	14.0%	85%	95%	25	$4,696
New	Single Family	Central Furnace Heat	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE = 80%	480	11.1%	NA	NA	18	$788
New	Single Family	Central Furnace Heat	Gas Furnace	AFUE = 95% (Condensing Furnace)	AFUE = 80%	480	15.8%	NA	NA	18	$1,103
New	Single Family	Central Furnace Heat	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	423	3.3%	75%	25%	30	$3
New	Single Family	Central Furnace Heat	Construction - ICF	Concrete Framing	Standard Wood Framing	423	44.0%	45%	95%	30	$11629
New	Single Family	Central Furnace Heat	Construction - SIP	Specialty Framing	Standard Wood Framing	423	14.0%	45%	95%	30	$6,564
New	Single Family	Central Furnace Heat	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2)	423	5.0%	85%	50%	30	$116
New	Single Family	Central Furnace Heat	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2)	423	3.0%	85%	55%	12	$42
New	Single Family	Central Furnace Heat	Duct Location	Conditioned Space Design - Duct Loss Is Not A Concern	Ducts in Unconditioned Space (Duct loss)	423	8.0%	85%	15%	30	$210
New	Single Family	Central Furnace Heat	Duct Sealing	Duct Sealing	No Duct Sealing	423	6.0%	0%	65%	20	$447
New	Single Family	Central Furnace Heat	Duct Sealing - Aerosol-Based	Spray-in ductwork sealant to minimize duct leaks	New homes with AFUE HVAC, SEER 13	423	19.0%	0%	95%	25	$525
New	Single Family	Central Furnace Heat	Gas Furnace - Maintenance - New Equipment	Maintenance	No Maintenance	423	4.0%	95%	75%	1	$105
New	Single Family	Central Furnace Heat	Gas Furnace - Proper Sizing	Proper Sizing of Gas Furnace	Oversized Gas Furnace	423	5.0%	53%	85%	18	$1

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Central Heat Furnace	Green Roof	ecoroof	Standard Roof	423	6.5%	0%	98%	40	$21956
New	Single Family	Central Heat Furnace	Insulation (Basement - Wall) 2*4	R-13	Average Existing Insulation Value and/or Code Value	423	6.9%	14%	70%	25	$671
New	Single Family	Central Heat Furnace	Insulation (Basement - Wall) 2*4	R-13 + R-5 sheathing	R-13	423	6.1%	14%	95%	25	$474
New	Single Family	Central Heat Furnace	Insulation (Ceiling)	R-49	State Code (R-38)	423	2.0%	87%	85%	25	$365
New	Single Family	Central Heat Furnace	Insulation (Floor)	R-38	State Code (R-30)	423	2.0%	75%	90%	25	$884
New	Single Family	Central Heat Furnace	Insulation (Rim And Band Joist)	R-10	No Rim And Band Joist Insulation	423	3.0%	80%	45%	25	$130
New	Single Family	Central Heat Furnace	Insulation (Rim And Band Joist)	R-19	R-10	423	4.0%	80%	75%	25	$84
New	Single Family	Central Heat Furnace	Insulation (Slab)	R-15	R-10	423	1.4%	28%	64%	25	$223
New	Single Family	Central Heat Furnace	Insulation (wall) 2*6	R-21 + R5 Sheathing	State Code (R-21)	423	2.8%	95%	85%	25	$2,363
New	Single Family	Central Heat Furnace	Integrated Space and Water Heating	Premium Efficiency AFUE = 90 - Condensing Furnace	Standard Efficiency AFUE = 78- Condensing Furnace	423	13.3%	60%	95%	15	$184
New	Single Family	Central Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	3-ton AC/furnace, 13 SEER	423	15.0%	0%	95%	30	$127
New	Single Family	Central Heat Furnace	Outlet Gasket	Install Outlet Gasket (Reduce Air Leakage)	No Outlet Gasket	423	2.0%	95%	40%	5	$7
New	Single Family	Central Heat Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	423	2.0%	0%	97%	30	$305
New	Single Family	Central Heat Furnace	Spray in insulation 2*4 Wall	2*4Wall - closed cell foam insulation R-23	2*6Wall R-21	423	3.0%	95%	95%	25	$7,602
New	Single Family	Central Heat Furnace	Spray in insulation 2*6 Wall	2*6Wall - closed cell foam insulation R-37	2*6Wall R-21	423	11.0%	95%	95%	25	$11697
New	Single Family	Central Heat Furnace	Thermostat - Clock/Programmable	Programmable Thermostat	Manual Thermostat	423	6.8%	85%	32%	15	$27
New	Single Family	Central Heat Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	423	7.0%	65%	95%	12	$1,422
New	Single Family	Central Heat Furnace	Windows	U = 0.19	U = 0.30	423	16.0%	85%	95%	25	$4,696
New	Single Family	Cooking Oven	Convection Oven	Convection Oven	Standard Oven	19	23.0%	85%	85%	15	$305

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Single Family	Dryer	Clothes Dryer w Moisture Sensor	High-Efficiency Clothes Dryer w Moisture Sensor	Standard Dryer without Moisture Sensor	36	13.0%	NA	NA	18	$53
New	Single Family	Pool Heat	Pool Heaters	Energy Efficient Heaters - 88% efficiency	Standard Heaters - 83% efficiency	253	5.7%	85%	65%	8	$483
New	Single Family	Water Heat	Water Heater (40 Gallon Gas)	EF=0.62	EF = 0.59	295	5.0%	NA	NA	13	$81
New	Single Family	Water Heat	Water Heater (Gas)	EF=0.80 Condensing Water Heater	EF = 0.59	295	26.3%	NA	NA	13	$1,212
New	Single Family	Water Heat	Water Heater (Gas)	EF=0.86 Condensing Water Heater	EF = 0.59	295	31.3%	NA	NA	13	$1,289
New	Single Family	Water Heat	Clothes Washer	Energy Star MEF = 1.83 (top Load)	Standard Clothes Washer (1.26)	243	9.3%	99%	68%	14	$252
New	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.01 (front load)	Standard Clothes Washer (1.26)	243	11.2%	99%	77%	14	$312
New	Single Family	Water Heat	Clothes Washer	Tier 2. MEF = 2.2 (front load)	Standard Clothes Washer (1.26)	243	12.8%	99%	77%	14	$417
New	Single Family	Water Heat	Desuperheater (Ground-Source Heat Pump) system	Desuperheater	Standard Water_Heater - EF = 0.59 (40 Gallon Tank)	243	30.0%	5%	90%	10	$251
New	Single Family	Water Heat	Dishwasher	EF = 0.77	EF = 0.65 (ENERGY STAR)	243	2.2%	30%	35%	13	$514
New	Single Family	Water Heat	Dishwasher - Existing	EF = 0.65 (ENERGY STAR)	EF = 0.46 Existing Dishwasher	243	4.1%	30%	15%	13	$11
New	Single Family	Water Heat	Drain Water Heat Recovery	Drain Water Heat Recovery (GFX or Power-Pipe)	No Drain Water Heat Recovery	243	3.5%	50%	95%	30	$630
New	Single Family	Water Heat	Faucet Aerators	0.5 GPM	2.2 GPM	243	4.5%	95%	95%	9	$4
New	Single Family	Water Heat	Faucet Aerators	1.5 GPM	2.2 GPM	243	1.9%	95%	55%	9	$3
New	Single Family	Water Heat	Hot Water Pipe Insulation	Install Insulation (R-4)	No insulation	243	1.2%	0%	37%	15	$8
New	Single Family	Water Heat	Integrated Space and Water Heating	High Efficiency Water Heater EF =0.62	Standard efficiency Water Heater EF = 0.59	243	4.8%	60%	95%	15	$71
New	Single Family	Water Heat	Low-Flow Showerheads	1.75 GPM	2.5 GPM	243	10.3%	95%	65%	10	$11
New	Single Family	Water Heat	Solar Hot Water (SHW)	Solar thermal collector	Non-solar hot water heater	243	22.1%	20%	95%	20	$8,930
New	Single Family	Water Heat	Tankless Water_Heater	EF = 0.78, 4.3 gpm	EF = 0.59	243	24.4%	75%	97%	20	$1,398
New	Single Family	Water Heat	Water_Heater Tank Blanket/Insulation	Install Insulation (R-5)	No Tank Insulation	243	6.5%	0%	63%	10	$19
New	Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	243	6.0%	95%	43%	5	$0

Commercial Electric Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.82	20.0%	NA	NA	20	$3,334
Existing	Dry Goods Retail	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.82	27.3%	NA	NA	20	$4,156
Existing	Dry Goods Retail	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.82	9.5%	NA	NA	20	$1,196
Existing	Dry Goods Retail	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.87	40.0%	43%	45%	10	$6,220
Existing	Dry Goods Retail	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.87	7.6%	25%	70%	10	$7,543
Existing	Dry Goods Retail	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.87	5.0%	95%	95%	10	$7,158
Existing	Dry Goods Retail	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.87	5.0%	45%	90%	10	$17517
Existing	Dry Goods Retail	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.87	12.5%	90%	40%	3	$2,071
Existing	Dry Goods Retail	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.87	8.0%	50%	94%	15	$746
Existing	Dry Goods Retail	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.87	14.0%	95%	35%	10	$83
Existing	Dry Goods Retail	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.87	4.0%	95%	75%	10	$675
Existing	Dry Goods Retail	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.87	15.0%	75%	59%	5	$10103
Existing	Dry Goods Retail	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.87	10.0%	75%	80%	5	$5,658
Existing	Dry Goods Retail	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.87	15.0%	50%	80%	5	$4,083
Existing	Dry Goods Retail	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.87	2.5%	45%	45%	18	$4,203
Existing	Dry Goods Retail	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.87	10.0%	15%	98%	30	106431
Existing	Dry Goods Retail	Cooling Chillers	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.87	5.0%	40%	10%	10	$2,460

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.87	2.0%	75%	95%	25	$5,463
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.87	3.0%	75%	98%	25	$7,249
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.87	2.4%	75%	85%	25	$6,409
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.87	6.0%	75%	0%	25	$6,409
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.87	4.4%	10%	15%	25	$1,175
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.87	2.4%	10%	15%	25	$1,224
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.87	3.0%	10%	95%	25	$2,479
Existing	Dry Goods Retail	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.87	10.0%	10%	0%	25	$2,685
Existing	Dry Goods Retail	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.87	1.0%	35%	90%	25	$946
Existing	Dry Goods Retail	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.87	3.0%	35%	90%	25	$5,463
Existing	Dry Goods Retail	Cooling Chillers	Pipe Insulation	R-4	R-0	1.87	1.0%	65%	45%	15	$215
Existing	Dry Goods Retail	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.87	25.0%	25%	98%	10	$22168
Existing	Dry Goods Retail	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.87	44.8%	60%	99%	20	$20427
Existing	Dry Goods Retail	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.87	0.9%	80%	80%	25	$9,436
Existing	Dry Goods Retail	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.87	0.5%	10%	80%	25	$26640
Existing	Dry Goods Retail	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.98	14.2%	NA	NA	15	$7,460
Existing	Dry Goods Retail	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.98	6.4%	NA	NA	15	$3,971
Existing	Dry Goods Retail	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.98	10.4%	NA	NA	15	$6,156

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.03	12.5%	90%	40%	3	$2,071
Existing	Dry Goods Retail	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	2.03	15.0%	10%	80%	15	$6,043
Existing	Dry Goods Retail	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	2.03	25.0%	50%	85%	15	$21889
Existing	Dry Goods Retail	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.03	15.0%	75%	59%	5	$10103
Existing	Dry Goods Retail	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.03	10.0%	75%	80%	5	$5,658
Existing	Dry Goods Retail	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.03	15.0%	50%	80%	5	$4,083
Existing	Dry Goods Retail	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.03	2.5%	45%	45%	18	$4,203
Existing	Dry Goods Retail	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	2.03	10.0%	15%	98%	30	106431
Existing	Dry Goods Retail	Cooling DX	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	2.03	5.0%	40%	10%	10	$2,460
Existing	Dry Goods Retail	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	2.03	2.0%	75%	95%	25	$5,463
Existing	Dry Goods Retail	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	2.03	3.0%	75%	98%	25	$7,249
Existing	Dry Goods Retail	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	2.03	2.4%	75%	85%	25	$6,409
Existing	Dry Goods Retail	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	2.03	6.0%	75%	0%	25	$6,409
Existing	Dry Goods Retail	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.03	4.4%	10%	15%	25	$1,175
Existing	Dry Goods Retail	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.03	2.4%	10%	15%	25	$1,224
Existing	Dry Goods Retail	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.03	3.0%	10%	95%	25	$2,479
Existing	Dry Goods Retail	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.03	8.4%	10%	35%	25	$2,716
Existing	Dry Goods Retail	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.03	10.0%	10%	0%	25	$2,685
Existing	Dry Goods Retail	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.03	1.0%	35%	90%	25	$946

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.03	3.0%	35%	90%	25	$5,463
Existing	Dry Goods Retail	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.03	3.0%	95%	54%	15	$145
Existing	Dry Goods Retail	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	2.03	0.9%	80%	80%	25	$9,436
Existing	Dry Goods Retail	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	2.03	0.5%	10%	80%	25	$26640
Existing	Dry Goods Retail	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.74	20.0%	1%	85%	10	$2,147
Existing	Dry Goods Retail	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.74	7.5%	25%	65%	10	$13133
Existing	Dry Goods Retail	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.74	3.8%	85%	81%	10	$274
Existing	Dry Goods Retail	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.74	33.8%	85%	75%	20	$2,132
Existing	Dry Goods Retail	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.74	8.8%	10%	77%	10	$3,837
Existing	Dry Goods Retail	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.74	1.6%	5%	94%	10	$1,791
Existing	Dry Goods Retail	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.90	16.8%	NA	NA	15	$5,288
Existing	Dry Goods Retail	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.90	30.2%	NA	NA	15	$11323
Existing	Dry Goods Retail	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.02	12.5%	90%	40%	3	$2,071
Existing	Dry Goods Retail	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.02	15.0%	75%	59%	5	$10103
Existing	Dry Goods Retail	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.02	10.0%	75%	80%	5	$5,658
Existing	Dry Goods Retail	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.02	15.0%	50%	80%	5	$4,083
Existing	Dry Goods Retail	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.02	2.5%	45%	45%	18	$4,203
Existing	Dry Goods Retail	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.02	4.8%	5%	94%	10	$9,529

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	3.02	2.0%	15%	98%	30	106431
Existing	Dry Goods Retail	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.02	17.8%	5%	92%	20	$61334
Existing	Dry Goods Retail	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.02	40.9%	5%	92%	20	115230
Existing	Dry Goods Retail	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.02	19.1%	5%	90%	20	$12337
Existing	Dry Goods Retail	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.02	32.0%	5%	90%	20	$16294
Existing	Dry Goods Retail	Heat Pump	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	3.02	8.3%	40%	10%	10	$2,460
Existing	Dry Goods Retail	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	3.02	5.9%	75%	95%	25	$5,463
Existing	Dry Goods Retail	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	3.02	8.9%	75%	98%	25	$7,249
Existing	Dry Goods Retail	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	3.02	5.5%	75%	85%	25	$6,409
Existing	Dry Goods Retail	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	3.02	13.8%	75%	0%	25	$6,409
Existing	Dry Goods Retail	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.02	4.4%	10%	15%	25	$1,175
Existing	Dry Goods Retail	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.02	2.4%	10%	15%	25	$1,224
Existing	Dry Goods Retail	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.02	5.0%	10%	95%	25	$2,479
Existing	Dry Goods Retail	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.02	16.6%	10%	35%	25	$2,716
Existing	Dry Goods Retail	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.02	19.8%	10%	0%	25	$2,685
Existing	Dry Goods Retail	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.02	3.7%	35%	90%	25	$946
Existing	Dry Goods Retail	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.02	11.1%	35%	90%	25	$5,463
Existing	Dry Goods Retail	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.02	3.0%	95%	54%	15	$145
Existing	Dry Goods Retail	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	3.02	6.4%	80%	80%	25	$9,436

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	3.02	4.2%	10%	80%	25	$26640
Existing	Dry Goods Retail	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	5.39	2.0%	10%	75%	9	$828
Existing	Dry Goods Retail	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	5.39	6.0%	30%	84%	9	$1,261
Existing	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.5	5.39	15.0%	90%	70%	14	$2,566
Existing	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.5	5.39	20.0%	75%	85%	14	$5,686
Existing	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.5	5.39	25.0%	70%	90%	14	$8,876
Existing	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.5	5.39	31.5%	50%	95%	14	$3,675
Existing	Dry Goods Retail	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.5	Existing Lighting Design	5.39	38.5%	95%	45%	14	$12250
Existing	Dry Goods Retail	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	5.39	1.6%	95%	65%	11	$53
Existing	Dry Goods Retail	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	5.39	0.4%	10%	80%	13	$630
Existing	Dry Goods Retail	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	5.39	2.3%	10%	95%	14	$37
Existing	Dry Goods Retail	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	5.39	4.0%	45%	88%	9	$196
Existing	Dry Goods Retail	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	5.39	4.9%	85%	86%	9	$215
Existing	Dry Goods Retail	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.78	0.4%	95%	90%	7	$2
Existing	Dry Goods Retail	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.78	13.6%	64%	25%	4	$1
Existing	Dry Goods Retail	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.78	4.3%	20%	45%	6	$165
Existing	Dry Goods Retail	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.78	1.8%	75%	55%	4	[illegible]
Existing	Dry Goods Retail	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.78	18.4%	64%	15%	4	[illegible]
Existing	Dry Goods Retail	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.78	1.3%	75%	40%	5	[illegible]

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.78	0.9%	75%	45%	4	$1
Existing	Dry Goods Retail	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.78	1.4%	15%	75%	10	$1
Existing	Dry Goods Retail	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.78	1.8%	95%	30%	3	$310
Existing	Dry Goods Retail	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.78	1.0%	95%	86%	7	$0
Existing	Dry Goods Retail	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.78	1.2%	75%	95%	10	$86
Existing	Dry Goods Retail	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.78	0.3%	5%	65%	13	$126
Existing	Dry Goods Retail	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.78	3.6%	25%	35%	7	$578
Existing	Dry Goods Retail	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.78	6.6%	5%	80%	14	$189
Existing	Dry Goods Retail	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.78	6.8%	5%	25%	3	$297
Existing	Dry Goods Retail	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.04	12.5%	90%	40%	3	$2,071
Existing	Dry Goods Retail	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.04	15.0%	75%	59%	5	$10103
Existing	Dry Goods Retail	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.04	10.0%	75%	80%	5	$5,658
Existing	Dry Goods Retail	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.04	15.0%	50%	80%	5	$4,083
Existing	Dry Goods Retail	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.04	2.5%	45%	45%	18	$4,203
Existing	Dry Goods Retail	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.04	15.0%	5%	94%	10	$9,529
Existing	Dry Goods Retail	Space Heat	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	2.04	10.0%	40%	10%	10	$2,460
Existing	Dry Goods Retail	Space Heat	Insulation (Ceiling)	R-49	R-30	2.04	8.0%	75%	98%	25	$5,463
Existing	Dry Goods Retail	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	2.04	12.5%	75%	85%	25	$6,409
Existing	Dry Goods Retail	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	2.04	25.0%	75%	0%	25	$6,409

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.04	4.4%	10%	15%	25	$1,175
Existing	Dry Goods Retail	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.04	2.4%	10%	15%	25	$1,224
Existing	Dry Goods Retail	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.04	6.0%	10%	95%	25	$2,479
Existing	Dry Goods Retail	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.04	21.1%	10%	35%	25	$2,716
Existing	Dry Goods Retail	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.04	25.0%	10%	0%	25	$2,685
Existing	Dry Goods Retail	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.04	5.0%	35%	90%	25	$946
Existing	Dry Goods Retail	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.04	15.0%	35%	90%	25	$5,463
Existing	Dry Goods Retail	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	2.04	25.0%	25%	98%	10	$22168
Existing	Dry Goods Retail	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.04	3.0%	95%	54%	15	$145
Existing	Dry Goods Retail	Space Heat	Windows	U = 0.35	U = 0.40	2.04	3.1%	80%	80%	25	$2,359
Existing	Dry Goods Retail	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	2.04	9.3%	10%	80%	25	$33717
Existing	Dry Goods Retail	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.27	3.3%	NA	NA	20	$162
Existing	Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.28	15.1%	5%	95%	10	$8,704
Existing	Dry Goods Retail	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.28	9.1%	5%	80%	11	$305
Existing	Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.28	5.0%	75%	94%	15	$2,919
Existing	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.28	4.8%	45%	25%	13	$32
Existing	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.28	6.7%	45%	55%	13	$630
Existing	Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.28	20.0%	5%	92%	25	$875

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.28	4.0%	95%	25%	10	$0
Existing	Dry Goods Retail	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.28	3.8%	95%	15%	10	$2
Existing	Dry Goods Retail	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.28	58.9%	40%	94%	15	$9,627
Existing	Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.28	1.0%	80%	90%	15	$111
Existing	Dry Goods Retail	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.28	2.3%	10%	45%	5	$5
Existing	Dry Goods Retail	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.28	1.1%	15%	75%	10	$6
Existing	Dry Goods Retail	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.28	2.5%	15%	20%	10	$12
Existing	Dry Goods Retail	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.28	55.6%	20%	95%	20	$8,930
Existing	Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.28	3.3%	95%	95%	10	$207
Existing	Dry Goods Retail	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.28	7.7%	75%	45%	11	$107
New	Dry Goods Retail	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.99	20.0%	NA	NA	20	$3,334
New	Dry Goods Retail	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.99	27.3%	NA	NA	20	$4,156
New	Dry Goods Retail	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.99	9.5%	NA	NA	20	$1,196
New	Dry Goods Retail	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.91	7.6%	25%	70%	10	$7,543
New	Dry Goods Retail	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.91	5.0%	95%	95%	10	$7,158
New	Dry Goods Retail	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.91	12.5%	90%	80%	3	$7,670
New	Dry Goods Retail	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.91	8.0%	50%	94%	15	$746
New	Dry Goods Retail	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.91	10.0%	75%	80%	5	$5,658
New	Dry Goods Retail	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.91	10.0%	15%	98%	30	106431

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.91	2.0%	75%	95%	25	$5,463
New	Dry Goods Retail	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.91	3.0%	75%	98%	25	$7,249
New	Dry Goods Retail	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.91	3.0%	95%	95%	25	$2,479
New	Dry Goods Retail	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.91	1.0%	35%	90%	25	$946
New	Dry Goods Retail	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.91	10.0%	40%	98%	25	$1,628
New	Dry Goods Retail	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.91	25.0%	50%	98%	10	$22168
New	Dry Goods Retail	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.91	44.8%	95%	99%	20	$16350
New	Dry Goods Retail	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.91	1.9%	75%	75%	30	$2,960
New	Dry Goods Retail	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.91	0.9%	80%	80%	25	$9,436
New	Dry Goods Retail	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.08	14.2%	NA	NA	15	$7,460
New	Dry Goods Retail	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.08	6.4%	NA	NA	15	$3,971
New	Dry Goods Retail	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.08	10.4%	NA	NA	15	$6,156
New	Dry Goods Retail	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.99	12.5%	90%	80%	3	$7,670
New	Dry Goods Retail	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.99	25.0%	50%	85%	15	$21889
New	Dry Goods Retail	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.99	10.0%	75%	80%	5	$5,658
New	Dry Goods Retail	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.99	10.0%	15%	98%	30	106431
New	Dry Goods Retail	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.99	2.0%	75%	95%	25	$5,463
New	Dry Goods Retail	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.99	3.0%	75%	98%	25	$7,249

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.99	3.0%	95%	95%	25	$2,479
New	Dry Goods Retail	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.99	1.0%	35%	90%	25	$946
New	Dry Goods Retail	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.99	10.0%	40%	98%	25	$1,628
New	Dry Goods Retail	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.99	1.9%	75%	75%	30	$2,960
New	Dry Goods Retail	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.99	0.9%	80%	80%	25	$9,436
New	Dry Goods Retail	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.23	20.0%	1%	75%	10	$2,147
New	Dry Goods Retail	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.23	7.5%	25%	65%	10	$6,829
New	Dry Goods Retail	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.23	3.8%	85%	81%	10	$274
New	Dry Goods Retail	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.23	33.8%	85%	75%	20	$2,132
New	Dry Goods Retail	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.23	8.8%	20%	77%	10	$3,837
New	Dry Goods Retail	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.23	1.6%	5%	94%	10	$1,791
New	Dry Goods Retail	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.58	16.8%	NA	NA	15	$5,288
New	Dry Goods Retail	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.58	30.2%	NA	NA	15	$11323
New	Dry Goods Retail	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.42	12.5%	90%	80%	3	$7,670
New	Dry Goods Retail	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.42	10.0%	75%	80%	5	$5,658
New	Dry Goods Retail	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.42	4.8%	5%	94%	10	$9,529
New	Dry Goods Retail	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.42	2.0%	15%	98%	30	106431
New	Dry Goods Retail	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.42	17.8%	45%	92%	20	$61334

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.42	40.9%	45%	92%	20	115230
New	Dry Goods Retail	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.42	19.1%	10%	90%	20	$12337
New	Dry Goods Retail	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.42	32.0%	10%	90%	20	$16294
New	Dry Goods Retail	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.42	5.9%	75%	95%	25	$5,463
New	Dry Goods Retail	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.42	8.9%	75%	98%	25	$7,249
New	Dry Goods Retail	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.42	5.0%	95%	95%	25	$2,479
New	Dry Goods Retail	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.42	3.7%	35%	90%	25	$946
New	Dry Goods Retail	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.42	10.0%	40%	98%	25	$1,628
New	Dry Goods Retail	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.42	6.4%	80%	80%	25	$9,436
New	Dry Goods Retail	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	4.23	2.0%	10%	75%	9	$828
New	Dry Goods Retail	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	4.23	6.0%	60%	84%	9	$1,261
New	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.5	4.23	15.0%	90%	70%	14	$1,702
New	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.5	4.23	20.0%	75%	85%	14	$4,539
New	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.5	4.23	25.0%	70%	90%	14	$7,438
New	Dry Goods Retail	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.5	4.23	31.5%	50%	95%	14	$2,711
New	Dry Goods Retail	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	4.23	0.5%	10%	80%	13	$630
New	Dry Goods Retail	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	4.23	2.3%	10%	95%	14	$[illegible]37
New	Dry Goods Retail	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	4.23	4.0%	45%	88%	10	$196
New	Dry Goods Retail	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.78	0.4%	95%	90%	7	$2

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.78	13.6%	64%	25%	4	$1
New	Dry Goods Retail	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.78	4.2%	20%	45%	6	$165
New	Dry Goods Retail	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.78	1.8%	75%	55%	4	$1
New	Dry Goods Retail	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.78	18.4%	64%	15%	4	$158
New	Dry Goods Retail	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.78	1.3%	75%	40%	5	$16
New	Dry Goods Retail	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.78	0.9%	75%	45%	4	$1
New	Dry Goods Retail	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.78	1.3%	15%	75%	10	$1
New	Dry Goods Retail	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.78	1.8%	95%	30%	3	$310
New	Dry Goods Retail	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.78	1.0%	95%	86%	7	$0
New	Dry Goods Retail	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.78	1.2%	75%	95%	10	$86
New	Dry Goods Retail	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.78	0.3%	5%	65%	13	$126
New	Dry Goods Retail	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.78	3.5%	25%	35%	7	$578
New	Dry Goods Retail	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.78	6.4%	5%	80%	14	$189
New	Dry Goods Retail	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.45	12.5%	90%	80%	3	$7,670
New	Dry Goods Retail	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.45	10.0%	75%	80%	5	$5,658
New	Dry Goods Retail	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.45	15.0%	5%	94%	10	$9,529
New	Dry Goods Retail	Space Heat	Insulation (Ceiling)	R-49	R-30	0.45	8.0%	75%	98%	25	$5,463
New	Dry Goods Retail	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.45	6.0%	95%	95%	25	$2,479
New	Dry Goods Retail	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.45	5.0%	35%	90%	25	$946

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.45	10.0%	40%	98%	25	$1,628
New	Dry Goods Retail	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.45	25.0%	50%	98%	10	$22168
New	Dry Goods Retail	Space Heat	Windows	U = 0.35	U = 0.40	0.45	3.1%	80%	80%	25	$2,359
New	Dry Goods Retail	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.28	3.3%	NA	NA	20	$162
New	Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.28	15.1%	5%	95%	10	$8,704
New	Dry Goods Retail	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.28	9.2%	5%	80%	11	$305
New	Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.28	5.0%	90%	94%	15	$2,919
New	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.28	4.9%	45%	25%	13	$32
New	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.28	6.7%	45%	55%	13	$630
New	Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.28	20.0%	25%	92%	25	$875
New	Dry Goods Retail	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.28	4.0%	95%	25%	10	$0
New	Dry Goods Retail	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.28	58.9%	50%	94%	15	$9,627
New	Dry Goods Retail	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.28	2.3%	10%	45%	5	$5
New	Dry Goods Retail	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.28	1.1%	15%	75%	10	$6
New	Dry Goods Retail	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.28	55.6%	20%	95%	20	$8,930
New	Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.28	3.3%	95%	95%	10	$207
New	Dry Goods Retail	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.28	7.7%	75%	45%	11	$107
Existing	Grocery	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	2.69	2.5%	35%	70%	12	$4,946
Existing	Grocery	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	2.69	8.4%	55%	85%	12	$1,800

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Cooking	Oven - Convection	Convection Oven	Standard Oven	2.69	3.4%	85%	85%	15	$1,734
Existing	Grocery	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	2.69	2.3%	25%	75%	10	$1
Existing	Grocery	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.51	20.0%	NA	NA	20	$2,218
Existing	Grocery	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.51	27.3%	NA	NA	20	$2,765
Existing	Grocery	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.51	9.5%	NA	NA	20	$795
Existing	Grocery	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.58	40.0%	43%	45%	10	$4,139
Existing	Grocery	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.58	7.6%	25%	70%	10	$5,019
Existing	Grocery	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.58	5.0%	48%	95%	10	$5,726
Existing	Grocery	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.58	5.0%	23%	90%	10	$11656
Existing	Grocery	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.58	12.5%	45%	40%	3	$1,657
Existing	Grocery	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.58	8.0%	25%	94%	15	$497
Existing	Grocery	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.58	14.0%	48%	35%	10	$55
Existing	Grocery	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.58	4.0%	48%	75%	10	$449
Existing	Grocery	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.58	15.0%	75%	61%	5	$8,082
Existing	Grocery	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.58	10.0%	75%	80%	5	$4,526
Existing	Grocery	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.58	15.0%	50%	80%	5	$3,266
Existing	Grocery	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.58	2.5%	45%	45%	18	$3,352
Existing	Grocery	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.58	4.5%	64%	85%	10	$5,726
Existing	Grocery	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.58	5.0%	15%	98%	30	$85145

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Cooling Chillers	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.58	5.0%	40%	10%	10	$1,968
Existing	Grocery	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.58	2.0%	75%	45%	25	$4,371
Existing	Grocery	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.58	3.0%	75%	85%	25	$5,799
Existing	Grocery	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.58	2.4%	75%	10%	25	$5,127
Existing	Grocery	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.58	6.0%	75%	0%	25	$5,127
Existing	Grocery	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.58	4.4%	10%	15%	25	$940
Existing	Grocery	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.58	2.4%	10%	15%	25	$979
Existing	Grocery	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.58	3.0%	10%	95%	25	$2,218
Existing	Grocery	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.58	8.4%	10%	35%	25	$2,430
Existing	Grocery	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.58	10.0%	10%	0%	25	$2,402
Existing	Grocery	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.58	1.0%	35%	45%	25	$756
Existing	Grocery	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.58	3.0%	35%	45%	25	$4,371
Existing	Grocery	Cooling Chillers	Pipe Insulation	R-4	R-0	1.58	1.0%	65%	45%	15	$172
Existing	Grocery	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.58	25.0%	25%	98%	10	$17735
Existing	Grocery	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.58	44.8%	60%	99%	20	$13592
Existing	Grocery	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.58	0.7%	80%	85%	25	$5,361
Existing	Grocery	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.58	0.4%	10%	85%	25	$15137
Existing	Grocery	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.65	14.2%	NA	NA	15	$5,386

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.65	6.4%	NA	NA	15	$2,867
Existing	Grocery	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.65	10.4%	NA	NA	15	$4,444
Existing	Grocery	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.71	12.5%	90%	40%	3	$1,657
Existing	Grocery	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	1.71	15.0%	10%	90%	15	$4,021
Existing	Grocery	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.71	25.0%	50%	85%	15	$17511
Existing	Grocery	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.71	15.0%	75%	61%	5	$8,082
Existing	Grocery	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.71	10.0%	75%	80%	5	$4,526
Existing	Grocery	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.71	15.0%	50%	80%	5	$3,266
Existing	Grocery	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.71	2.5%	45%	45%	18	$3,362
Existing	Grocery	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.71	4.5%	64%	85%	10	$5,726
Existing	Grocery	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.71	5.0%	15%	98%	30	$85145
Existing	Grocery	Cooling DX	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.71	5.0%	40%	10%	10	$1,968
Existing	Grocery	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.71	2.0%	75%	45%	25	$4,371
Existing	Grocery	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.71	3.0%	75%	85%	25	$5,799
Existing	Grocery	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.71	2.4%	75%	10%	25	$5,127
Existing	Grocery	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.71	6.0%	75%	0%	25	$5,127
Existing	Grocery	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.71	4.4%	10%	15%	25	$940
Existing	Grocery	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.71	2.4%	10%	15%	25	$979
Existing	Grocery	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.71	3.0%	10%	95%	25	$2,218
Existing	Grocery	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.71	8.4%	10%	35%	25	$2,430
Existing	Grocery	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.71	10.0%	10%	0%	25	$2,402
Existing	Grocery	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.71	1.0%	35%	45%	25	$756
Existing	Grocery	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.71	3.0%	35%	45%	25	$4,371
Existing	Grocery	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.71	3.0%	95%	46%	15	$145
Existing	Grocery	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.71	0.7%	80%	85%	25	$5,361

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.71	0.4%	10%	85%	25	$15137
Existing	Grocery	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.15	20.0%	5%	85%	10	$1,718
Existing	Grocery	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.15	7.5%	60%	65%	10	$13133
Existing	Grocery	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.15	3.8%	85%	81%	10	$395
Existing	Grocery	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.15	33.8%	85%	75%	20	$1,705
Existing	Grocery	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.15	8.8%	10%	77%	10	$3,070
Existing	Grocery	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.15	1.6%	0%	94%	10	$1,791
Existing	Grocery	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	4.53	16.8%	NA	NA	15	$3,818
Existing	Grocery	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	4.53	30.2%	NA	NA	15	$8,175
Existing	Grocery	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	4.70	12.5%	90%	40%	3	$1,657
Existing	Grocery	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	4.70	15.0%	75%	61%	5	$8,082
Existing	Grocery	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	4.70	10.0%	75%	80%	5	$4,526
Existing	Grocery	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	4.70	15.0%	50%	80%	5	$3,266
Existing	Grocery	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	4.70	2.5%	45%	45%	18	$3,362
Existing	Grocery	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	4.70	10.0%	5%	94%	10	$14457
Existing	Grocery	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	4.70	4.5%	64%	85%	10	$5,726
Existing	Grocery	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	4.70	0.5%	15%	98%	30	$85145
Existing	Grocery	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	4.70	10.3%	5%	92%	20	$44280
Existing	Grocery	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	4.70	31.5%	5%	92%	20	$83190
Existing	Grocery	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	4.70	22.7%	5%	90%	20	$8,907
Existing	Grocery	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	4.70	33.7%	5%	90%	20	$11764
Existing	Grocery	Heat Pump	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	4.70	8.3%	40%	10%	10	$1,968
Existing	Grocery	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	4.70	5.9%	75%	45%	25	$4,371

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	4.70	8.9%	75%	85%	25	$5,799
Existing	Grocery	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	4.70	5.5%	75%	10%	25	$5,127
Existing	Grocery	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	4.70	13.8%	75%	0%	25	$5,127
Existing	Grocery	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	4.70	4.4%	10%	15%	25	$940
Existing	Grocery	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	4.70	2.4%	10%	15%	25	$979
Existing	Grocery	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	4.70	5.0%	10%	95%	25	$2,218
Existing	Grocery	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	4.70	16.6%	10%	35%	25	$2,430
Existing	Grocery	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	4.70	19.8%	10%	0%	25	$2,402
Existing	Grocery	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	4.70	3.7%	35%	45%	25	$756
Existing	Grocery	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	4.70	11.1%	35%	45%	25	$4,371
Existing	Grocery	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	4.70	3.0%	95%	46%	15	$145
Existing	Grocery	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	4.70	5.0%	80%	85%	25	$5,361
Existing	Grocery	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	4.70	3.3%	10%	85%	25	$15137
Existing	Grocery	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	8.15	2.0%	75%	75%	9	$662
Existing	Grocery	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	8.15	6.0%	30%	96%	9	$1,009
Existing	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.5	8.15	15.0%	90%	70%	14	$2,053
Existing	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.5	8.15	20.0%	75%	85%	14	$4,549
Existing	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.5	8.15	25.0%	70%	90%	14	$7,101
Existing	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.5	8.15	31.5%	65%	95%	14	$2,940
Existing	Grocery	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.5	Existing Lighting Design	8.15	35.0%	95%	45%	14	$9,800
Existing	Grocery	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	8.15	1.6%	95%	65%	11	$53
Existing	Grocery	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	8.15	0.7%	90%	80%	13	$630
Existing	Grocery	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	8.15	0.8%	10%	95%	14	$36
Existing	Grocery	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	8.15	4.0%	45%	90%	9	$157
Existing	Grocery	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	8.15	4.9%	85%	81%	9	$215

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.51	0.4%	95%	90%	7	$2
Existing	Grocery	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.51	13.6%	64%	25%	4	$1
Existing	Grocery	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.51	5.9%	35%	45%	6	$165
Existing	Grocery	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.51	1.8%	75%	55%	4	$1
Existing	Grocery	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.51	18.4%	64%	15%	4	$157
Existing	Grocery	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.51	1.3%	75%	40%	5	$16
Existing	Grocery	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.51	0.9%	75%	45%	4	$1
Existing	Grocery	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.51	1.9%	15%	75%	10	$1
Existing	Grocery	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.51	1.8%	95%	30%	3	$310
Existing	Grocery	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.51	1.0%	95%	86%	7	$0
Existing	Grocery	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.51	1.2%	75%	95%	10	$86
Existing	Grocery	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.51	0.4%	5%	65%	13	$126
Existing	Grocery	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.51	5.0%	25%	35%	7	$578
Existing	Grocery	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.51	9.1%	75%	80%	14	$189
Existing	Grocery	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.51	9.4%	75%	25%	3	$298
Existing	Grocery	Refrigeration	Anti-Sweat (Humidistat) Controls	Variable Temp. Controls (Humidistat)	Constant Controls	21	35.8%	90%	45%	12	$5,634
Existing	Grocery	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	21	3.0%	95%	100%	12	$345
Existing	Grocery	Refrigeration	Compressor VSD Retrofit	Compressor VSD Retrofit	Standard Compressor	21	16.8%	60%	77%	10	$11556
Existing	Grocery	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	21	3.6%	85%	65%	10	$9,595
Existing	Grocery	Refrigeration	Defrost Demand Control - Hot Gas	Refrigerant Defrost w/ Hot Gas	No Defrost Demand Control - Hot Gas	21	2.6%	95%	68%	10	$5,559
Existing	Grocery	Refrigeration	Display Cases	High-Efficiency Display Cases	Display Cases - Standard	21	3.6%	100%	90%	15	$7,543
Existing	Grocery	Refrigeration	Evaporative Condenser - High-Efficiency	High-Efficiency Evaporative Condenser	Air-Cooled Condenser	21	0.7%	90%	65%	15	$9,744
Existing	Grocery	Refrigeration	Floating Head Pressure Control	Install Floating Head Pressure Control	No Floating Head Pressure Control	21	3.0%	50%	81%	14	$698
Existing	Grocery	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	21	8.4%	85%	72%	10	$9,308
Existing	Grocery	Refrigeration	High-Efficiency Evaporator Fans - Walk-ins	High-Efficiency Evaporator Fans, Walk-in Refrigerators	Standard Evaporator Fans	21	1.0%	92%	75%	15	$1,195
Existing	Grocery	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	21	1.0%	90%	86%	9	$376
Existing	Grocery	Refrigeration	Motor - Case Fans with ECM motors	ECM motors on evaporator fan, on display cases	48 cf 2-door reach-in commercial refrigerator	21	0.5%	80%	50%	20	$1,350

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	21	1.4%	95%	85%	10	$3,110
Existing	Grocery	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	21	6.0%	75%	70%	10	$449
Existing	Grocery	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	21	5.0%	80%	90%	3	$556
Existing	Grocery	Refrigeration	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	21	28.0%	75%	55%	16	$7,649
Existing	Grocery	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	21	3.2%	95%	77%	16	$1,856
Existing	Grocery	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	21	2.0%	95%	20%	4	$189
Existing	Grocery	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.16	12.5%	90%	40%	3	$1,657
Existing	Grocery	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.16	15.0%	75%	61%	5	$8,082
Existing	Grocery	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.16	10.0%	75%	80%	5	$4,526
Existing	Grocery	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.16	15.0%	50%	80%	5	$3,266
Existing	Grocery	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.16	2.5%	45%	45%	18	$3,362
Existing	Grocery	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.16	15.0%	5%	94%	10	$14457
Existing	Grocery	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	2.16	4.5%	64%	85%	10	$5,726
Existing	Grocery	Space Heat	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	2.16	10.0%	40%	10%	10	$1,968
Existing	Grocery	Space Heat	Insulation (Ceiling)	R-49	R-30	2.16	8.0%	75%	85%	25	$4,371
Existing	Grocery	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	2.16	12.5%	75%	10%	25	$5,127
Existing	Grocery	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	2.16	25.0%	75%	0%	25	$5,127
Existing	Grocery	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.16	4.4%	10%	15%	25	$940
Existing	Grocery	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.16	2.4%	10%	15%	25	$979
Existing	Grocery	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.16	6.0%	10%	95%	25	$2,218
Existing	Grocery	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.16	21.1%	10%	35%	25	$2,430
Existing	Grocery	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.16	25.0%	10%	0%	25	$2,402
Existing	Grocery	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.16	5.0%	35%	45%	25	$756
Existing	Grocery	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.16	15.0%	35%	45%	25	$4,371

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	2.16	25.0%	25%	98%	10	$17735
Existing	Grocery	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.16	3.0%	95%	46%	15	$145
Existing	Grocery	Space Heat	Windows	U = 0.35	U = 0.40	2.16	2.4%	80%	85%	25	$1,341
Existing	Grocery	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	2.16	7.3%	10%	85%	25	$19158
Existing	Grocery	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.29	3.3%	NA	NA	20	$323
Existing	Grocery	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.30	15.1%	5%	95%	10	$8,704
Existing	Grocery	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.30	10.7%	5%	80%	11	$304
Existing	Grocery	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.30	5.0%	75%	94%	15	$2,335
Existing	Grocery	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.30	2.1%	75%	80%	10	$2,700
Existing	Grocery	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.30	5.6%	75%	95%	10	$841
Existing	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.30	5.7%	45%	25%	13	$32
Existing	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.30	7.8%	45%	55%	13	$630
Existing	Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.30	20.0%	5%	92%	25	$1,751
Existing	Grocery	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.30	4.0%	95%	25%	10	$0
Existing	Grocery	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.30	3.8%	95%	15%	10	$2
Existing	Grocery	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.30	58.9%	40%	94%	15	$9,272
Existing	Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.30	1.0%	80%	90%	15	$89
Existing	Grocery	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.30	2.3%	95%	40%	5	$5
Existing	Grocery	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.30	1.1%	15%	75%	10	$6
Existing	Grocery	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.30	2.5%	15%	20%	10	$12
Existing	Grocery	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.30	38.6%	20%	95%	20	$8,930
Existing	Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.30	3.3%	95%	95%	10	$297
Existing	Grocery	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.30	7.7%	75%	50%	11	$108
New	Grocery	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	2.69	2.5%	35%	70%	12	$4,946
New	Grocery	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	2.69	8.3%	55%	85%	12	$1,800

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Cooking	Oven - Convection	Convection Oven	Standard Oven	2.69	3.4%	85%	85%	15	$1,734
New	Grocery	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	2.69	2.3%	25%	75%	10	$1
New	Grocery	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.37	20.0%	NA	NA	20	$2,218
New	Grocery	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.37	27.3%	NA	NA	20	$2,765
New	Grocery	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.37	9.5%	NA	NA	20	$795
New	Grocery	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.25	7.6%	25%	70%	10	$5,019
New	Grocery	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.25	5.0%	48%	95%	10	$5,726
New	Grocery	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.25	12.5%	45%	80%	3	$6,136
New	Grocery	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.25	8.0%	25%	94%	15	$497
New	Grocery	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.25	10.0%	75%	80%	5	$4,526
New	Grocery	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.25	4.5%	64%	85%	10	$5,726
New	Grocery	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.25	5.0%	15%	98%	30	$85145
New	Grocery	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.25	2.0%	75%	45%	25	$4,371
New	Grocery	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.25	3.0%	75%	85%	25	$5,799
New	Grocery	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.25	3.0%	95%	95%	25	$2,218
New	Grocery	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.25	1.0%	35%	45%	25	$756
New	Grocery	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.25	10.0%	40%	98%	25	$1,303
New	Grocery	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.25	25.0%	50%	98%	10	$17735
New	Grocery	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.25	44.8%	95%	99%	20	$11709

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	1.25	0.5%	75%	75%	30	$1,681
New	Grocery	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.25	0.7%	80%	85%	25	$5,361
New	Grocery	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.49	14.2%	NA	NA	15	$5,386
New	Grocery	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.49	6.4%	NA	NA	15	$2,867
New	Grocery	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.49	10.4%	NA	NA	15	$4,444
New	Grocery	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.36	12.5%	90%	80%	3	$6,136
New	Grocery	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.36	25.0%	50%	85%	15	$17511
New	Grocery	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.36	10.0%	75%	80%	5	$4,526
New	Grocery	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.36	4.5%	64%	85%	10	$5,726
New	Grocery	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.36	5.0%	15%	98%	30	$85145
New	Grocery	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.36	2.0%	75%	45%	25	$4,371
New	Grocery	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.36	3.0%	75%	85%	25	$5,799
New	Grocery	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.36	3.0%	95%	95%	25	$2,218
New	Grocery	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.36	1.0%	35%	45%	25	$756
New	Grocery	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.36	10.0%	40%	98%	25	$1,303
New	Grocery	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	1.36	0.5%	75%	75%	30	$1,681
New	Grocery	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.36	0.7%	80%	85%	25	$5,361
New	Grocery	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.58	20.0%	5%	75%	10	$1,718
New	Grocery	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.58	7.5%	60%	65%	10	$6,829
New	Grocery	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.58	3.8%	85%	81%	10	$395
New	Grocery	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.58	33.8%	85%	75%	20	$1,705

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.58	8.8%	20%	77%	10	$3,070
New	Grocery	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.58	1.6%	0%	94%	10	$1,791
New	Grocery	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.78	16.8%	NA	NA	15	$3,818
New	Grocery	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.78	30.2%	NA	NA	15	$8,175
New	Grocery	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.62	12.5%	90%	80%	3	$6,136
New	Grocery	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.62	10.0%	75%	80%	5	$4,526
New	Grocery	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.62	10.0%	5%	94%	10	$14457
New	Grocery	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.62	4.5%	64%	85%	10	$5,726
New	Grocery	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.62	0.5%	15%	98%	30	$85145
New	Grocery	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.62	10.3%	45%	92%	20	$44280
New	Grocery	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.62	31.5%	45%	92%	20	$83190
New	Grocery	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.62	22.7%	10%	90%	20	$8,907
New	Grocery	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.62	33.7%	10%	90%	20	$11764
New	Grocery	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.62	5.9%	75%	45%	25	$4,371
New	Grocery	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.62	8.9%	75%	85%	25	$5,799
New	Grocery	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.62	5.0%	95%	95%	25	$2,218
New	Grocery	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.62	3.7%	35%	45%	25	$756
New	Grocery	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.62	10.0%	40%	98%	25	$1,303
New	Grocery	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.62	5.0%	80%	85%	25	$5,361
New	Grocery	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	6.49	2.0%	75%	75%	9	$662
New	Grocery	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	6.49	6.0%	60%	96%	9	$1,009
New	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.5	6.49	15.0%	90%	70%	14	$1,362
New	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.5	6.49	20.0%	75%	85%	14	$3,631

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.5	6.49	25.0%	70%	90%	14	$5,951
New	Grocery	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.5	6.49	31.5%	65%	95%	14	$2,168
New	Grocery	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	6.49	0.9%	90%	80%	13	$630
New	Grocery	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	6.49	0.8%	10%	95%	14	$36
New	Grocery	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	6.49	4.0%	45%	90%	10	$157
New	Grocery	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.51	0.4%	95%	90%	7	$3
New	Grocery	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.51	13.6%	64%	25%	4	$1
New	Grocery	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.51	5.7%	35%	45%	6	$165
New	Grocery	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.51	1.8%	75%	55%	4	$1
New	Grocery	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.51	18.4%	64%	15%	4	$157
New	Grocery	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.51	1.3%	75%	40%	5	$16
New	Grocery	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.51	0.9%	75%	45%	4	$1
New	Grocery	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.51	1.8%	15%	75%	10	$1
New	Grocery	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.51	1.8%	95%	30%	3	$310
New	Grocery	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.51	1.0%	95%	86%	7	$0
New	Grocery	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.51	1.2%	75%	95%	10	$86
New	Grocery	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.51	0.4%	5%	65%	13	$126
New	Grocery	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.51	4.8%	25%	35%	7	$578
New	Grocery	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.51	8.9%	75%	80%	14	$189
New	Grocery	Refrigeration	Anti-Sweat (Humidistat) Controls	Variable Temp. Controls (Humidistat)	Constant Controls	21	35.6%	90%	45%	12	$5,634
New	Grocery	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	21	2.9%	95%	100%	12	$345
New	Grocery	Refrigeration	Compressor VSD Retrofit	Compressor VSD Retrofit	Standard Compressor	21	16.8%	60%	77%	10	$11556
New	Grocery	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	21	3.6%	85%	65%	10	$9,595
New	Grocery	Refrigeration	Defrost Demand Control - Hot Gas	Refrigerant Defrost w/ Hot Gas	No Defrost Demand Control - Hot Gas	21	2.6%	95%	68%	10	$5,559
New	Grocery	Refrigeration	Display Cases	High-Efficiency Display Cases	Display Cases - Standard	21	3.6%	100%	90%	15	$7,543
New	Grocery	Refrigeration	Evaporative Condenser - High-Efficiency	High-Efficiency Evaporative Condenser	Air-Cooled Condenser	21	0.7%	90%	65%	15	$9,744
New	Grocery	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	21	8.4%	85%	72%	10	$9,308

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Refrigeration	High-Efficiency Evaporator Fans - Walk-ins	High-Efficiency Evaporator Fans, Walk-in Refrigerators	Standard Evaporator Fans	21	1.0%	92%	75%	15	$1,195
New	Grocery	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	21	1.0%	90%	86%	9	$376
New	Grocery	Refrigeration	Motor - Case Fans with ECM motors	ECM motors on evaporator fan, on display cases	48 cf 2-door reach-in commercial refrigerator	21	0.5%	95%	50%	20	$1,350
New	Grocery	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	21	1.4%	95%	85%	10	$3,110
New	Grocery	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	21	6.0%	75%	70%	10	$449
New	Grocery	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	21	5.0%	80%	90%	3	$556
New	Grocery	Refrigeration	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	21	28.0%	75%	55%	16	$4,287
New	Grocery	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	21	3.2%	95%	77%	16	$1,856
New	Grocery	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	21	2.0%	95%	20%	4	$189
New	Grocery	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.19	12.5%	90%	80%	3	$6,136
New	Grocery	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.19	10.0%	75%	80%	5	$4,526
New	Grocery	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.19	15.0%	5%	94%	10	$14457
New	Grocery	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.19	4.5%	64%	85%	10	$5,726
New	Grocery	Space Heat	Insulation (Ceiling)	R-49	R-30	0.19	8.0%	75%	85%	25	$4,371
New	Grocery	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.19	6.0%	95%	95%	25	$2,218
New	Grocery	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.19	5.0%	35%	45%	25	$756
New	Grocery	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.19	10.0%	40%	98%	25	$1,303
New	Grocery	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.19	25.0%	50%	98%	10	$17735
New	Grocery	Space Heat	Windows	U = 0.35	U = 0.40	0.19	2.4%	80%	85%	25	$1,341
New	Grocery	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.30	3.3%	NA	NA	20	$323
New	Grocery	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.30	15.1%	5%	95%	10	$8,704
New	Grocery	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.30	10.7%	5%	80%	11	$304
New	Grocery	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.30	5.0%	90%	94%	15	$2,335
New	Grocery	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.30	2.1%	75%	80%	10	$2,700

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.30	5.6%	75%	95%	10	$841
New	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.30	5.7%	45%	25%	13	$32
New	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.30	7.8%	45%	55%	13	$630
New	Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.30	20.0%	25%	92%	25	$1,751
New	Grocery	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.30	4.0%	95%	25%	10	$0
New	Grocery	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.30	58.9%	50%	94%	15	$9,272
New	Grocery	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.30	2.3%	95%	40%	5	$5
New	Grocery	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.30	1.1%	15%	75%	10	$6
New	Grocery	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.30	38.6%	20%	95%	20	$8,930
New	Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.30	3.3%	95%	95%	10	$207
New	Grocery	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.30	7.7%	75%	50%	11	$108
Existing	Hospital	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.55	2.5%	35%	70%	12	$4,946
Existing	Hospital	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.55	8.4%	75%	85%	12	$1,800
Existing	Hospital	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.55	3.4%	85%	55%	15	$1,734
Existing	Hospital	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.55	2.3%	25%	75%	10	$2
Existing	Hospital	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.67	20.0%	NA	NA	20	$3,708
Existing	Hospital	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.67	27.3%	NA	NA	20	$4,624
Existing	Hospital	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.67	9.5%	NA	NA	20	$1,329
Existing	Hospital	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.75	10.0%	5%	94%	15	$11583
Existing	Hospital	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.75	40.0%	43%	45%	10	$6,919
Existing	Hospital	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.75	7.6%	25%	70%	10	$8,391
Existing	Hospital	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.75	5.0%	95%	75%	10	$12526
Existing	Hospital	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.75	5.0%	45%	90%	10	$19485

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.75	12.5%	90%	40%	3	$3,624
Existing	Hospital	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.75	8.0%	50%	94%	15	$829
Existing	Hospital	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.75	14.0%	95%	35%	10	$94
Existing	Hospital	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.75	4.0%	95%	75%	10	$750
Existing	Hospital	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.75	15.0%	35%	26%	5	$17680
Existing	Hospital	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.75	10.0%	75%	80%	5	$9,901
Existing	Hospital	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.75	15.0%	75%	80%	5	$7,145
Existing	Hospital	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.75	2.5%	45%	45%	18	$7,354
Existing	Hospital	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.75	4.5%	62%	85%	10	$5,725
Existing	Hospital	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.75	5.0%	15%	98%	30	$93127
Existing	Hospital	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.75	1.0%	75%	45%	25	$4,780
Existing	Hospital	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.75	1.5%	75%	85%	25	$6,343
Existing	Hospital	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.75	1.2%	75%	13%	25	$5,608
Existing	Hospital	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.75	3.0%	75%	0%	25	$5,608
Existing	Hospital	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.75	4.4%	10%	15%	25	$2,056
Existing	Hospital	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.75	2.4%	10%	15%	25	$2,142
Existing	Hospital	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.75	3.0%	10%	95%	25	$4,039
Existing	Hospital	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.75	8.4%	10%	35%	25	$5,082
Existing	Hospital	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.75	10.0%	10%	0%	25	$5,025

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.75	0.5%	35%	35%	25	$827
Existing	Hospital	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.75	1.5%	35%	35%	25	$4,780
Existing	Hospital	Cooling Chillers	Pipe Insulation	R-4	R-0	1.75	1.0%	65%	45%	15	$379
Existing	Hospital	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.75	25.0%	25%	98%	10	$38794
Existing	Hospital	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.75	44.8%	60%	99%	20	$22721
Existing	Hospital	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.75	1.2%	80%	60%	25	$15284
Existing	Hospital	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.75	0.6%	10%	60%	25	$43155
Existing	Hospital	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.82	14.2%	NA	NA	15	$7,943
Existing	Hospital	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.82	6.4%	NA	NA	15	$4,229
Existing	Hospital	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.82	10.4%	NA	NA	15	$6,555
Existing	Hospital	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.90	10.0%	5%	94%	15	$11583
Existing	Hospital	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.90	12.5%	90%	40%	3	$3,624
Existing	Hospital	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	1.90	15.0%	10%	30%	15	$6,722
Existing	Hospital	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.90	25.0%	50%	85%	15	$38305
Existing	Hospital	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.90	15.0%	35%	26%	5	$17680
Existing	Hospital	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.90	10.0%	75%	80%	5	$9,901
Existing	Hospital	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.90	15.0%	75%	80%	5	$7,145
Existing	Hospital	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.90	2.5%	45%	45%	18	$7,354
Existing	Hospital	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.90	4.5%	62%	85%	10	$5,725
Existing	Hospital	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.90	5.0%	15%	98%	30	$93127

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.90	1.0%	75%	45%	25	$4,780
Existing	Hospital	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.90	1.5%	75%	85%	25	$6,343
Existing	Hospital	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.90	1.2%	75%	13%	25	$5,608
Existing	Hospital	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.90	3.0%	75%	0%	25	$5,608
Existing	Hospital	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.90	4.4%	10%	15%	25	$2,056
Existing	Hospital	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.90	2.4%	10%	15%	25	$2,142
Existing	Hospital	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.90	3.0%	10%	95%	25	$4,639
Existing	Hospital	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.90	8.4%	10%	35%	25	$5,082
Existing	Hospital	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.90	10.0%	10%	0%	25	$5,025
Existing	Hospital	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.90	0.5%	35%	35%	25	$827
Existing	Hospital	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.90	1.5%	35%	35%	25	$4,780
Existing	Hospital	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.90	3.0%	95%	71%	15	$145
Existing	Hospital	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.90	1.2%	80%	60%	25	$15284
Existing	Hospital	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.90	0.6%	10%	60%	25	$43155
Existing	Hospital	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	5.44	20.0%	20%	85%	10	$3,758
Existing	Hospital	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	5.44	7.5%	35%	85%	10	$13133
Existing	Hospital	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	5.44	3.8%	85%	81%	10	$480
Existing	Hospital	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	5.44	33.8%	85%	75%	20	$3,731
Existing	Hospital	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	5.44	8.8%	50%	77%	10	$6,715
Existing	Hospital	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	5.44	1.6%	65%	94%	10	$1,791
Existing	Hospital	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	3.55	16.8%	NA	NA	15	$5,630
Existing	Hospital	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	3.55	30.2%	NA	NA	15	$12056
Existing	Hospital	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	3.71	10.0%	5%	94%	15	$11583
Existing	Hospital	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.71	12.5%	90%	40%	3	$3,624

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.71	15.0%	35%	26%	5	$17680
Existing	Hospital	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.71	10.0%	75%	80%	5	$9,901
Existing	Hospital	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.71	15.0%	75%	80%	5	$7,145
Existing	Hospital	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.71	2.5%	45%	45%	18	$7,354
Existing	Hospital	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.71	7.3%	5%	94%	10	$16676
Existing	Hospital	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	3.71	4.5%	62%	85%	10	$5,725
Existing	Hospital	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	3.71	0.8%	15%	98%	30	$93127
Existing	Hospital	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.71	14.2%	5%	92%	20	$65303
Existing	Hospital	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.71	36.4%	5%	92%	20	122688
Existing	Hospital	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.71	20.9%	5%	90%	20	$13135
Existing	Hospital	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.71	32.8%	5%	90%	20	$17349
Existing	Hospital	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	3.71	3.0%	75%	45%	25	$4,780
Existing	Hospital	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	3.71	4.4%	75%	85%	25	$6,343
Existing	Hospital	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	3.71	2.8%	75%	13%	25	$5,608
Existing	Hospital	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	3.71	6.9%	75%	0%	25	$5,608
Existing	Hospital	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.71	4.4%	10%	15%	25	$2,056
Existing	Hospital	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.71	2.4%	10%	15%	25	$2,142
Existing	Hospital	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.71	5.0%	10%	95%	25	$4,639
Existing	Hospital	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.71	16.6%	10%	35%	25	$5,082
Existing	Hospital	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.71	19.8%	10%	0%	25	$5,025
Existing	Hospital	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.71	1.9%	35%	35%	25	$827
Existing	Hospital	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.71	5.6%	35%	35%	25	$4,780
Existing	Hospital	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.71	3.0%	95%	71%	15	$245
Existing	Hospital	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	3.71	8.5%	80%	60%	25	$15284
Existing	Hospital	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	3.71	5.6%	10%	60%	25	$43155
Existing	Hospital	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	4.60	2.0%	85%	75%	9	$1,449

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	4.60	6.0%	30%	51%	9	$2,206
Existing	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.1	4.60	15.0%	90%	70%	14	$2,791
Existing	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.1	4.60	20.0%	75%	85%	14	$7,038
Existing	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.1	4.60	25.0%	70%	90%	14	$11164
Existing	Hospital	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.1	Existing Lighting Design	4.60	15.0%	95%	45%	14	$17150
Existing	Hospital	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	4.60	1.6%	95%	65%	11	$53
Existing	Hospital	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	4.60	0.5%	50%	80%	13	$631
Existing	Hospital	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	4.60	2.3%	10%	95%	14	$37
Existing	Hospital	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	4.60	4.0%	90%	70%	9	$344
Existing	Hospital	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	4.60	4.9%	85%	100%	9	$215
Existing	Hospital	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	3.94	0.4%	95%	90%	7	$2
Existing	Hospital	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	3.94	13.6%	64%	25%	4	$2
Existing	Hospital	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	3.94	1.7%	90%	45%	6	$165
Existing	Hospital	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	3.94	1.8%	75%	55%	4	$2
Existing	Hospital	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	3.94	18.4%	64%	15%	4	$158
Existing	Hospital	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	3.94	1.3%	75%	40%	5	$17
Existing	Hospital	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	3.94	0.9%	75%	45%	4	$2
Existing	Hospital	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	3.94	0.6%	45%	75%	10	$2
Existing	Hospital	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	3.94	1.8%	95%	30%	3	$311
Existing	Hospital	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	3.94	1.0%	95%	86%	7	$0
Existing	Hospital	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	3.94	1.2%	75%	95%	10	$171
Existing	Hospital	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	3.94	0.1%	25%	65%	13	$127
Existing	Hospital	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	3.94	1.4%	25%	35%	7	$377
Existing	Hospital	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	3.94	2.7%	50%	80%	14	$189
Existing	Hospital	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	3.94	2.7%	50%	25%	3	$298

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.51	27.4%	95%	95%	12	$344
Existing	Hospital	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.51	3.6%	85%	65%	10	$9,596
Existing	Hospital	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.51	1.1%	90%	86%	9	$375
Existing	Hospital	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.51	6.0%	75%	70%	10	$24
Existing	Hospital	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	0.51	5.0%	80%	90%	3	$29
Existing	Hospital	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.51	3.2%	95%	77%	16	$99
Existing	Hospital	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.51	2.0%	95%	20%	4	$189
Existing	Hospital	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.28	10.0%	5%	94%	15	$11583
Existing	Hospital	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.28	12.5%	90%	40%	3	$3,624
Existing	Hospital	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.28	15.0%	35%	26%	5	$17680
Existing	Hospital	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.28	10.0%	75%	80%	5	$9,901
Existing	Hospital	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.28	15.0%	75%	80%	5	$7,145
Existing	Hospital	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.28	2.5%	45%	45%	18	$7,354
Existing	Hospital	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.28	15.0%	5%	94%	10	$16676
Existing	Hospital	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.28	4.5%	62%	85%	10	$5,725
Existing	Hospital	Space Heat	Insulation (Ceiling)	R-49	R-30	1.28	4.0%	75%	85%	25	$4,780
Existing	Hospital	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	1.28	6.3%	75%	13%	25	$5,608
Existing	Hospital	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	1.28	12.5%	75%	0%	25	$5,608
Existing	Hospital	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.28	4.4%	10%	15%	25	$2,056
Existing	Hospital	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.28	2.4%	10%	15%	25	$2,142
Existing	Hospital	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.28	6.0%	10%	95%	25	$4,639
Existing	Hospital	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.28	21.1%	10%	35%	25	$5,[illegible]82
Existing	Hospital	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.28	25.0%	10%	0%	25	$5,025
Existing	Hospital	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.28	2.5%	35%	35%	25	$827
Existing	Hospital	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.28	7.5%	35%	35%	25	$4,780

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.28	25.0%	25%	98%	10	$38794
Existing	Hospital	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.28	3.0%	95%	71%	15	$145
Existing	Hospital	Space Heat	Windows	U = 0.35	U = 0.40	1.28	4.1%	80%	60%	25	$3,821
Existing	Hospital	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	1.28	12.3%	10%	60%	25	$54619
Existing	Hospital	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.34	3.3%	NA	NA	20	$1,938
Existing	Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.38	15.1%	15%	95%	10	$8,704
Existing	Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.38	2.6%	15%	80%	11	$305
Existing	Hospital	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.38	5.0%	55%	94%	15	$5,108
Existing	Hospital	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.38	2.1%	25%	80%	10	$2,701
Existing	Hospital	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.38	5.6%	25%	95%	10	$840
Existing	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.38	0.6%	20%	25%	13	$31
Existing	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.38	0.8%	20%	55%	13	$631
Existing	Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.38	20.0%	5%	92%	25	$10506
Existing	Hospital	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.38	4.0%	95%	25%	10	$0
Existing	Hospital	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	1.38	3.8%	95%	15%	10	$2
Existing	Hospital	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.38	58.9%	40%	94%	15	$5,725
Existing	Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	1.38	1.0%	80%	70%	15	$195
Existing	Hospital	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.38	2.3%	50%	45%	5	$6
Existing	Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.38	2.6%	35%	75%	10	$6
Existing	Hospital	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	1.38	5.8%	35%	20%	10	$11
Existing	Hospital	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.38	66.6%	20%	95%	20	$89302
Existing	Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.38	3.3%	95%	90%	10	$206
Existing	Hospital	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.38	7.7%	75%	80%	11	$107
New	Hospital	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.55	2.5%	35%	70%	12	$4,946
New	Hospital	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.55	8.3%	75%	85%	12	$1,800

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.55	3.4%	85%	55%	15	$1,734
New	Hospital	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.55	2.3%	25%	75%	10	$2
New	Hospital	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.47	20.0%	NA	NA	20	$3,708
New	Hospital	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.47	27.3%	NA	NA	20	$4,624
New	Hospital	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.47	9.5%	NA	NA	20	$1,329
New	Hospital	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.43	10.0%	5%	94%	15	$11583
New	Hospital	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.43	7.6%	25%	70%	10	$8,391
New	Hospital	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.43	5.0%	95%	75%	10	$12526
New	Hospital	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.43	12.5%	90%	80%	3	$13422
New	Hospital	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.43	8.0%	50%	94%	15	$829
New	Hospital	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.43	10.0%	75%	80%	5	$9,901
New	Hospital	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.43	4.5%	62%	85%	10	$5,725
New	Hospital	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.43	5.0%	15%	98%	30	$93127
New	Hospital	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.43	1.0%	75%	45%	25	$4,780
New	Hospital	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.43	1.5%	75%	85%	25	$6,343
New	Hospital	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.43	3.0%	95%	95%	25	$4,639
New	Hospital	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.43	0.5%	35%	35%	25	$827
New	Hospital	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.43	10.0%	40%	98%	25	$2,850
New	Hospital	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.43	25.0%	50%	98%	10	$38794

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.43	44.8%	95%	99%	20	$18743
New	Hospital	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.43	1.2%	80%	60%	25	$15284
New	Hospital	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.51	14.2%	NA	NA	15	$7,943
New	Hospital	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.51	6.4%	NA	NA	15	$4,229
New	Hospital	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.51	10.4%	NA	NA	15	$6,555
New	Hospital	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.47	10.0%	5%	94%	15	$11583
New	Hospital	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.47	12.5%	90%	80%	3	$13422
New	Hospital	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.47	25.0%	50%	85%	15	$38305
New	Hospital	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.47	10.0%	75%	80%	5	$9,901
New	Hospital	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.47	4.5%	62%	85%	10	$5,725
New	Hospital	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.47	5.0%	15%	98%	30	$93127
New	Hospital	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.47	1.0%	75%	45%	25	$4,780
New	Hospital	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.47	1.5%	75%	85%	25	$6,343
New	Hospital	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.47	3.0%	95%	95%	25	$4,639
New	Hospital	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.47	0.5%	35%	35%	25	$827
New	Hospital	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.47	10.0%	40%	98%	25	$2,850
New	Hospital	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.47	1.2%	80%	60%	25	$15284
New	Hospital	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	4.24	20.0%	20%	75%	10	$3,758
New	Hospital	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	4.24	7.5%	35%	85%	10	$6,829
New	Hospital	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	4.24	3.8%	85%	81%	10	$480
New	Hospital	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	4.24	33.8%	85%	75%	20	$3,[illegible]

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	4.24	8.8%	65%	77%	10	$6,715
New	Hospital	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	4.24	1.6%	65%	94%	10	$1,791
New	Hospital	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.67	16.8%	NA	NA	15	$5,630
New	Hospital	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.67	30.2%	NA	NA	15	$12056
New	Hospital	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.52	10.0%	5%	94%	15	$11583
New	Hospital	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.52	12.5%	90%	80%	3	$13422
New	Hospital	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.52	10.0%	75%	80%	5	$9,901
New	Hospital	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.52	7.3%	5%	94%	10	$16676
New	Hospital	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.52	4.5%	62%	85%	10	$5,725
New	Hospital	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.52	0.8%	15%	98%	30	$93127
New	Hospital	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.52	14.2%	45%	92%	20	$65303
New	Hospital	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.52	36.4%	45%	92%	20	122688
New	Hospital	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.52	20.9%	10%	90%	20	$13135
New	Hospital	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.52	32.8%	10%	90%	20	$17349
New	Hospital	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.52	3.0%	75%	45%	25	$4,780
New	Hospital	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.52	4.4%	75%	85%	25	$6,343
New	Hospital	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.52	5.0%	95%	95%	25	$4,639
New	Hospital	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.52	1.9%	35%	35%	25	$827
New	Hospital	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.52	10.0%	40%	98%	25	$2,850
New	Hospital	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.52	8.5%	80%	60%	25	$15284
New	Hospital	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.89	2.0%	85%	75%	9	$1,449
New	Hospital	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.89	6.0%	60%	51%	9	$2,206
New	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.1	2.89	15.0%	90%	70%	14	$1,655

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.1	2.89	20.0%	75%	85%	14	$5,516
New	Hospital	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.1	2.89	25.0%	70%	90%	14	$9,267
New	Hospital	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.89	0.8%	50%	80%	13	$631
New	Hospital	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.89	2.3%	10%	95%	14	$37
New	Hospital	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.89	4.0%	90%	70%	10	$344
New	Hospital	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	3.94	0.4%	95%	90%	7	$2
New	Hospital	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	3.94	13.6%	64%	25%	4	$2
New	Hospital	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	3.94	1.7%	90%	45%	6	$165
New	Hospital	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	3.94	1.8%	75%	55%	4	$2
New	Hospital	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	3.94	18.4%	64%	15%	4	$158
New	Hospital	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	3.94	1.3%	75%	40%	5	$17
New	Hospital	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	3.94	0.9%	75%	45%	4	$2
New	Hospital	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	3.94	0.5%	45%	75%	10	$2
New	Hospital	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	3.94	1.8%	95%	30%	3	$311
New	Hospital	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	3.94	1.0%	95%	86%	7	$0
New	Hospital	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	3.94	1.2%	75%	95%	10	$171
New	Hospital	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	3.94	0.1%	25%	65%	13	$127
New	Hospital	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	3.94	1.4%	25%	35%	7	$577
New	Hospital	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	3.94	2.6%	50%	80%	14	$189
New	Hospital	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.51	27.2%	95%	95%	12	$344
New	Hospital	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.51	3.6%	85%	65%	10	$9,596
New	Hospital	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.51	1.1%	90%	86%	9	$375
New	Hospital	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.51	6.0%	75%	70%	10	$[illegible]24
New	Hospital	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	0.51	5.0%	80%	90%	3	$29
New	Hospital	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.51	3.2%	95%	77%	16	$99

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.51	2.0%	95%	20%	4	$189
New	Hospital	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.70	10.0%	5%	94%	15	$11583
New	Hospital	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.70	12.5%	90%	80%	3	$13422
New	Hospital	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.70	10.0%	75%	80%	5	$9,901
New	Hospital	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.70	15.0%	5%	94%	10	$16676
New	Hospital	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.70	4.5%	62%	85%	10	$5,725
New	Hospital	Space Heat	Insulation (Ceiling)	R-49	R-30	0.70	4.0%	75%	85%	25	$4,780
New	Hospital	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.70	6.0%	95%	95%	25	$4,639
New	Hospital	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.70	2.5%	35%	35%	25	$827
New	Hospital	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.70	10.0%	40%	98%	25	$2,850
New	Hospital	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.70	25.0%	50%	98%	10	$38794
New	Hospital	Space Heat	Windows	U = 0.35	U = 0.40	0.70	4.1%	80%	60%	25	$3,821
New	Hospital	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.40	3.3%	NA	NA	20	$1,938
New	Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.38	15.1%	15%	95%	10	$8,704
New	Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.38	2.6%	15%	80%	11	$305
New	Hospital	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.38	5.0%	55%	94%	15	$5,108
New	Hospital	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.38	2.1%	25%	80%	10	$2,701
New	Hospital	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.38	5.6%	25%	95%	10	$840
New	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.38	0.6%	20%	25%	13	$31
New	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.38	0.8%	20%	55%	13	$631
New	Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.38	20.0%	25%	92%	25	$10506
New	Hospital	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.38	4.0%	95%	25%	10	$0
New	Hospital	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.38	58.9%	50%	94%	15	$5,725
New	Hospital	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.38	2.3%	50%	45%	5	$6

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.38	2.6%	35%	75%	10	$6
New	Hospital	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.38	66.1%	20%	95%	20	$89302
New	Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.38	3.3%	95%	90%	10	$206
New	Hospital	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.38	7.7%	75%	80%	11	$107
Existing	Hotel Motel	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.66	2.5%	45%	70%	12	$4,947
Existing	Hotel Motel	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.66	8.4%	55%	85%	12	$1,800
Existing	Hotel Motel	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.66	3.4%	85%	55%	15	$1,733
Existing	Hotel Motel	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.66	2.3%	15%	75%	10	$2
Existing	Hotel Motel	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.60	2.0%	50%	94%	15	$2,269
Existing	Hotel Motel	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.60	40.0%	43%	45%	10	$5,628
Existing	Hotel Motel	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.60	7.6%	25%	70%	10	$6,827
Existing	Hotel Motel	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.60	5.0%	95%	100%	10	$11453
Existing	Hotel Motel	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.60	5.0%	45%	30%	10	$15854
Existing	Hotel Motel	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.60	12.5%	90%	40%	3	$3,313
Existing	Hotel Motel	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.60	8.0%	50%	94%	15	$676
Existing	Hotel Motel	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.60	14.0%	95%	35%	10	$76
Existing	Hotel Motel	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.60	4.0%	95%	75%	10	$610
Existing	Hotel Motel	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.60	15.0%	5%	52%	5	$16164
Existing	Hotel Motel	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.60	10.0%	75%	80%	5	$9,052
Existing	Hotel Motel	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.60	15.0%	50%	80%	5	$6,532
Existing	Hotel Motel	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.60	2.5%	45%	45%	18	$6,724

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.60	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.60	10.0%	15%	98%	30	$85144
Existing	Hotel Motel	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.60	1.0%	75%	45%	25	$4,371
Existing	Hotel Motel	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.60	1.5%	75%	85%	25	$5,799
Existing	Hotel Motel	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.60	1.2%	75%	25%	25	$5,127
Existing	Hotel Motel	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.60	3.0%	75%	0%	25	$5,127
Existing	Hotel Motel	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.60	4.4%	10%	15%	25	$1,879
Existing	Hotel Motel	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.60	2.4%	10%	15%	25	$1,958
Existing	Hotel Motel	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.60	3.0%	10%	95%	25	$4,436
Existing	Hotel Motel	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.60	8.4%	10%	35%	25	$4,860
Existing	Hotel Motel	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.60	10.0%	10%	0%	25	$4,804
Existing	Hotel Motel	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.60	0.5%	35%	35%	25	$756
Existing	Hotel Motel	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.60	1.5%	35%	35%	25	$4,371
Existing	Hotel Motel	Cooling Chillers	Pipe Insulation	R-4	R-0	1.60	1.0%	65%	45%	15	$345
Existing	Hotel Motel	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.60	25.0%	25%	98%	10	$35469
Existing	Hotel Motel	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.60	44.8%	60%	99%	20	$18486
Existing	Hotel Motel	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.60	1.7%	80%	50%	25	$28774
Existing	Hotel Motel	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.60	0.8%	10%	50%	25	$81238

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.59	14.2%	NA	NA	15	$6,803
Existing	Hotel Motel	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.59	6.4%	NA	NA	15	$3,621
Existing	Hotel Motel	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.59	10.4%	NA	NA	15	$5,613
Existing	Hotel Motel	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.72	2.0%	50%	94%	15	$2,269
Existing	Hotel Motel	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.72	12.5%	90%	40%	3	$3,313
Existing	Hotel Motel	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	1.72	15.0%	10%	30%	15	$5,468
Existing	Hotel Motel	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.72	25.0%	50%	85%	15	$35022
Existing	Hotel Motel	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.72	15.0%	5%	52%	5	$16164
Existing	Hotel Motel	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.72	10.0%	75%	80%	5	$9,052
Existing	Hotel Motel	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.72	15.0%	50%	80%	5	$6,532
Existing	Hotel Motel	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.72	2.5%	45%	45%	18	$6,724
Existing	Hotel Motel	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.72	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.72	5.0%	15%	98%	30	$85144
Existing	Hotel Motel	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.72	1.0%	75%	45%	25	$4,371
Existing	Hotel Motel	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.72	1.5%	75%	85%	25	$5,799
Existing	Hotel Motel	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.72	1.2%	75%	25%	25	$5,127
Existing	Hotel Motel	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.72	3.0%	75%	0%	25	$5,127
Existing	Hotel Motel	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.72	4.4%	10%	15%	25	$1,879
Existing	Hotel Motel	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.72	2.4%	10%	15%	25	$1,958
Existing	Hotel Motel	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.72	3.0%	10%	95%	25	$4,436
Existing	Hotel Motel	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.72	8.4%	10%	35%	25	$4,850
Existing	Hotel Motel	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.72	10.0%	10%	0%	25	$4,804
Existing	Hotel Motel	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.72	0.5%	35%	45%	25	$756
Existing	Hotel Motel	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.72	1.5%	35%	45%	25	$4,371

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.72	3.0%	95%	78%	15	$146
Existing	Hotel Motel	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.72	1.7%	80%	50%	25	$28774
Existing	Hotel Motel	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.72	0.8%	10%	50%	25	$81238
Existing	Hotel Motel	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	3.30	20.0%	20%	85%	10	$3,436
Existing	Hotel Motel	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	3.30	7.5%	60%	45%	10	$13132
Existing	Hotel Motel	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	3.30	3.8%	85%	81%	10	$439
Existing	Hotel Motel	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	3.30	33.8%	85%	75%	20	$3,411
Existing	Hotel Motel	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	3.30	8.8%	10%	77%	10	$6,139
Existing	Hotel Motel	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	3.30	1.6%	0%	94%	10	$1,792
Existing	Hotel Motel	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	3.83	16.8%	NA	NA	15	$4,823
Existing	Hotel Motel	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	3.83	30.2%	NA	NA	15	$10326
Existing	Hotel Motel	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	3.99	2.0%	50%	94%	15	$2,269
Existing	Hotel Motel	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.99	12.5%	90%	40%	3	$3,313
Existing	Hotel Motel	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.99	15.0%	5%	52%	5	$16164
Existing	Hotel Motel	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.99	10.0%	75%	80%	5	$9,052
Existing	Hotel Motel	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.99	15.0%	50%	80%	5	$6,532
Existing	Hotel Motel	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.99	2.5%	45%	45%	18	$6,724
Existing	Hotel Motel	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.99	8.8%	5%	94%	10	$15247
Existing	Hotel Motel	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	3.99	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	3.99	0.6%	15%	98%	30	$85144
Existing	Hotel Motel	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.99	12.0%	5%	92%	20	$55935
Existing	Hotel Motel	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.99	33.7%	5%	92%	20	105086
Existing	Hotel Motel	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.99	21.9%	0%	90%	20	$11251

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.99	33.3%	0%	90%	20	$14860
Existing	Hotel Motel	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	3.99	3.0%	75%	45%	25	$4,371
Existing	Hotel Motel	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	3.99	4.4%	75%	85%	25	$5,799
Existing	Hotel Motel	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	3.99	2.8%	75%	25%	25	$5,127
Existing	Hotel Motel	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	3.99	6.9%	75%	0%	25	$5,127
Existing	Hotel Motel	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.99	4.4%	10%	15%	25	$1,879
Existing	Hotel Motel	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.99	2.4%	10%	15%	25	$1,958
Existing	Hotel Motel	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.99	5.0%	10%	95%	25	$4,436
Existing	Hotel Motel	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.99	16.6%	10%	35%	25	$4,860
Existing	Hotel Motel	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.99	19.8%	10%	0%	25	$4,804
Existing	Hotel Motel	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.99	1.9%	35%	45%	25	$756
Existing	Hotel Motel	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.99	5.6%	35%	45%	25	$4,371
Existing	Hotel Motel	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.99	3.0%	95%	78%	15	$146
Existing	Hotel Motel	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	3.99	11.4%	80%	50%	25	$28774
Existing	Hotel Motel	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	3.99	7.5%	10%	50%	25	$81238
Existing	Hotel Motel	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.92	2.0%	85%	75%	9	$1,325
Existing	Hotel Motel	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.92	6.0%	30%	92%	9	$2,017
Existing	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.0	2.92	15.0%	90%	70%	14	$2,179
Existing	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.0	2.92	20.0%	75%	85%	14	$5,396
Existing	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.0	2.92	25.0%	70%	90%	14	$8,613
Existing	Hotel Motel	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.0	Existing Lighting Design	2.92	53.0%	95%	45%	14	$13008
Existing	Hotel Motel	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	2.92	1.6%	95%	65%	11	$52
Existing	Hotel Motel	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.92	1.2%	25%	80%	13	$630
Existing	Hotel Motel	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.92	0.8%	10%	95%	14	$37
Existing	Hotel Motel	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.92	4.0%	90%	98%	9	$314

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	2.92	4.9%	85%	100%	9	$215
Existing	Hotel Motel	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.29	0.4%	95%	90%	7	$2
Existing	Hotel Motel	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.29	13.6%	64%	25%	4	$2
Existing	Hotel Motel	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.29	3.3%	90%	45%	6	$165
Existing	Hotel Motel	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.29	1.8%	75%	55%	4	$2
Existing	Hotel Motel	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.29	18.4%	64%	15%	4	$158
Existing	Hotel Motel	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.29	1.3%	75%	40%	5	$15
Existing	Hotel Motel	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.29	0.9%	75%	45%	4	$2
Existing	Hotel Motel	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.29	1.0%	5%	75%	10	$2
Existing	Hotel Motel	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.29	1.8%	95%	30%	3	$309
Existing	Hotel Motel	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.29	1.0%	95%	86%	7	$0
Existing	Hotel Motel	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.29	1.2%	75%	95%	10	$171
Existing	Hotel Motel	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.29	0.2%	45%	65%	13	$126
Existing	Hotel Motel	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.29	2.7%	25%	35%	7	$578
Existing	Hotel Motel	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.29	5.0%	90%	80%	14	$190
Existing	Hotel Motel	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.29	5.2%	90%	25%	3	$298
Existing	Hotel Motel	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.31	24.9%	95%	95%	12	$345
Existing	Hotel Motel	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.31	3.6%	85%	65%	10	$9,595
Existing	Hotel Motel	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.31	1.1%	100%	86%	9	$377
Existing	Hotel Motel	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.31	6.0%	75%	70%	10	$13
Existing	Hotel Motel	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	0.31	5.0%	80%	90%	3	$17
Existing	Hotel Motel	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.31	3.2%	95%	77%	16	$55
Existing	Hotel Motel	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.31	2.0%	95%	20%	4	$188
Existing	Hotel Motel	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	4.09	2.0%	50%	94%	15	$2,269
Existing	Hotel Motel	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	4.09	12.5%	90%	40%	3	$3,313

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	4.09	15.0%	5%	52%	5	$16164
Existing	Hotel Motel	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	4.09	10.0%	75%	80%	5	$9,052
Existing	Hotel Motel	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	4.09	15.0%	50%	80%	5	$6,532
Existing	Hotel Motel	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	4.09	2.5%	45%	45%	18	$6,724
Existing	Hotel Motel	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	4.09	15.0%	5%	94%	10	$15247
Existing	Hotel Motel	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	4.09	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Space Heat	Insulation (Ceiling)	R-49	R-30	4.09	4.0%	75%	85%	25	$4,371
Existing	Hotel Motel	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	4.09	6.3%	75%	25%	25	$5,127
Existing	Hotel Motel	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	4.09	12.5%	75%	0%	25	$5,127
Existing	Hotel Motel	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	4.09	4.4%	10%	15%	25	$1,879
Existing	Hotel Motel	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	4.09	2.4%	10%	15%	25	$1,958
Existing	Hotel Motel	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	4.09	6.0%	10%	95%	25	$4,436
Existing	Hotel Motel	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	4.09	21.1%	10%	35%	25	$4,860
Existing	Hotel Motel	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	4.09	25.0%	10%	0%	25	$4,804
Existing	Hotel Motel	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	4.09	2.5%	35%	45%	25	$756
Existing	Hotel Motel	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	4.09	7.5%	35%	45%	25	$4,371
Existing	Hotel Motel	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	4.09	25.0%	25%	98%	10	$35469
Existing	Hotel Motel	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	4.09	3.0%	95%	78%	15	$146
Existing	Hotel Motel	Space Heat	Windows	U = 0.35	U = 0.40	4.09	5.5%	80%	50%	25	$7,193
Existing	Hotel Motel	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	4.09	16.6%	10%	50%	25	102818
Existing	Hotel Motel	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.69	3.3%	NA	NA	20	$1,615
Existing	Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.73	15.1%	35%	95%	10	$8,704
Existing	Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.73	2.3%	35%	80%	11	$304
Existing	Hotel Motel	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.73	5.0%	55%	80%	15	$4,670
Existing	Hotel Motel	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.73	2.1%	45%	80%	10	$2,700

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.73	5.6%	45%	95%	10	$841
Existing	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.73	0.5%	45%	25%	13	$32
Existing	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.73	0.7%	45%	55%	13	$630
Existing	Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.73	20.0%	5%	92%	25	$8,755
Existing	Hotel Motel	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.73	4.0%	95%	25%	10	$0
Existing	Hotel Motel	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	1.73	3.8%	95%	15%	10	$2
Existing	Hotel Motel	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.73	58.9%	40%	94%	15	$6,435
Existing	Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	1.73	1.0%	80%	90%	15	$178
Existing	Hotel Motel	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.73	2.3%	85%	50%	5	$5
Existing	Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.73	7.5%	100%	75%	10	$7
Existing	Hotel Motel	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	1.73	16.7%	100%	20%	10	$12
Existing	Hotel Motel	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.73	56.1%	20%	95%	20	$89303
Existing	Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.73	3.3%	95%	85%	10	$207
Existing	Hotel Motel	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.73	7.7%	75%	5%	11	$108
New	Hotel Motel	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.66	2.5%	45%	70%	12	$4,947
New	Hotel Motel	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.66	8.3%	55%	85%	12	$1,800
New	Hotel Motel	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.66	3.4%	85%	55%	15	$1,733
New	Hotel Motel	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.66	2.3%	15%	75%	10	$2
New	Hotel Motel	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.51	2.0%	50%	94%	15	$2,269
New	Hotel Motel	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.51	7.6%	25%	70%	10	$6,827
New	Hotel Motel	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.51	5.0%	95%	100%	10	$11453
New	Hotel Motel	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.51	12.5%	90%	80%	3	$12271
New	Hotel Motel	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.51	8.0%	50%	94%	15	$676
New	Hotel Motel	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.51	10.0%	75%	80%	5	$9,052

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.51	4.5%	58%	85%	10	$5,725
New	Hotel Motel	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.51	10.0%	15%	98%	30	$85144
New	Hotel Motel	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.51	1.0%	75%	45%	25	$4,371
New	Hotel Motel	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.51	1.5%	75%	85%	25	$5,799
New	Hotel Motel	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.51	3.0%	95%	95%	25	$4,436
New	Hotel Motel	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.51	0.5%	35%	35%	25	$756
New	Hotel Motel	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.51	10.0%	40%	98%	25	$2,606
New	Hotel Motel	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.51	25.0%	50%	98%	10	$35469
New	Hotel Motel	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.51	44.8%	95%	99%	20	$13061
New	Hotel Motel	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.51	9.6%	75%	75%	30	$12033
New	Hotel Motel	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.51	1.7%	80%	50%	25	$28774
New	Hotel Motel	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.56	14.2%	NA	NA	15	$6,803
New	Hotel Motel	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.56	6.4%	NA	NA	15	$3,621
New	Hotel Motel	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.56	10.4%	NA	NA	15	$5,613
New	Hotel Motel	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.51	2.0%	50%	94%	15	$2,269
New	Hotel Motel	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.51	12.5%	90%	80%	3	$12271
New	Hotel Motel	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.51	25.0%	50%	85%	15	$36622
New	Hotel Motel	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.51	10.0%	75%	80%	5	$9,052
New	Hotel Motel	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.51	4.5%	58%	85%	10	$5,725

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.51	5.0%	15%	98%	30	$85144
New	Hotel Motel	Cooling DX	Hotel Key Card Room Energy Control System	Key card system to control room HVAC and lighting during non-occupied periods	325 sqft room, $100/room	0.51	25.0%	60%	95%	15	$5,275
New	Hotel Motel	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.51	1.0%	75%	45%	25	$4,371
New	Hotel Motel	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.51	1.5%	75%	85%	25	$5,799
New	Hotel Motel	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.51	3.0%	95%	95%	25	$4,436
New	Hotel Motel	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.51	0.5%	35%	45%	25	$756
New	Hotel Motel	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.51	10.0%	40%	98%	25	$2,606
New	Hotel Motel	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.51	9.6%	75%	75%	30	$12033
New	Hotel Motel	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.51	1.7%	80%	50%	25	$28774
New	Hotel Motel	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.06	20.0%	20%	75%	10	$3,436
New	Hotel Motel	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.06	7.5%	60%	45%	10	$6,828
New	Hotel Motel	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.06	3.8%	85%	81%	10	$439
New	Hotel Motel	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.06	33.8%	85%	75%	20	$3,411
New	Hotel Motel	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.06	8.8%	20%	77%	10	$6,139
New	Hotel Motel	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.06	1.6%	0%	94%	10	$1,792
New	Hotel Motel	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.16	16.8%	NA	NA	15	$4,823
New	Hotel Motel	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.16	30.2%	NA	NA	15	$10326
New	Hotel Motel	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.93	2.0%	50%	94%	15	$2,269
New	Hotel Motel	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.93	12.5%	90%	80%	3	$12271
New	Hotel Motel	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.93	10.0%	75%	80%	5	$9,052
New	Hotel Motel	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.93	8.8%	5%	94%	10	$10247
New	Hotel Motel	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.93	4.5%	58%	85%	10	$5,725
New	Hotel Motel	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.93	0.6%	15%	98%	30	$85144
New	Hotel Motel	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.93	12.0%	45%	92%	20	$55935

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.93	33.7%	45%	92%	20	105086
New	Hotel Motel	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.93	21.9%	0%	90%	20	$11251
New	Hotel Motel	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.93	33.3%	0%	90%	20	$14860
New	Hotel Motel	Heat Pump	Hotel Key Card Room Energy Control System	Key card system to control room HVAC and lighting during non-occupied periods	325 sqft room, $100/room	1.93	25.0%	60%	95%	15	$5,275
New	Hotel Motel	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.93	3.0%	75%	45%	25	$4,371
New	Hotel Motel	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.93	4.4%	75%	85%	25	$5,799
New	Hotel Motel	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.93	5.0%	95%	95%	25	$4,436
New	Hotel Motel	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.93	1.9%	35%	45%	25	$756
New	Hotel Motel	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.93	10.0%	40%	98%	25	$2,606
New	Hotel Motel	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.93	11.4%	80%	50%	25	$28774
New	Hotel Motel	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	1.93	2.0%	85%	75%	9	$1,325
New	Hotel Motel	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	1.93	6.0%	60%	92%	9	$2,017
New	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.0	1.93	15.0%	90%	70%	14	$1,311
New	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.0	1.93	20.0%	75%	85%	14	$4,236
New	Hotel Motel	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.0	1.93	25.0%	70%	90%	14	$7,161
New	Hotel Motel	Lighting	Hotel Key Card Room Energy Control System	Key card system to control room HVAC and lighting during non-occupied periods	325 sqft room, $100/room	1.93	25.0%	60%	95%	15	$5,275
New	Hotel Motel	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	1.93	1.8%	25%	80%	13	$630
New	Hotel Motel	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	1.93	0.8%	10%	95%	14	$37
New	Hotel Motel	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	1.93	4.0%	90%	98%	10	$314
New	Hotel Motel	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.29	0.4%	95%	90%	7	$2
New	Hotel Motel	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.29	13.6%	64%	25%	4	$2
New	Hotel Motel	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.29	3.2%	90%	45%	6	$165
New	Hotel Motel	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.29	1.8%	75%	55%	4	$2
New	Hotel Motel	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.29	18.4%	64%	15%	4	$158

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.29	1.3%	75%	40%	5	$15
New	Hotel Motel	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.29	0.9%	75%	45%	4	$2
New	Hotel Motel	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.29	1.0%	5%	75%	10	$2
New	Hotel Motel	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.29	1.8%	95%	30%	3	$309
New	Hotel Motel	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.29	1.0%	95%	86%	7	$0
New	Hotel Motel	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.29	1.2%	75%	95%	10	$171
New	Hotel Motel	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.29	0.2%	45%	65%	13	$126
New	Hotel Motel	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.29	2.7%	25%	35%	7	$578
New	Hotel Motel	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.29	4.9%	90%	80%	14	$190
New	Hotel Motel	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.31	24.7%	95%	95%	12	$345
New	Hotel Motel	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.31	3.6%	85%	65%	10	$9,595
New	Hotel Motel	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.31	1.1%	100%	86%	9	$377
New	Hotel Motel	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.31	6.0%	75%	70%	10	$13
New	Hotel Motel	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	0.31	5.0%	80%	90%	3	$17
New	Hotel Motel	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.31	3.2%	95%	77%	16	$55
New	Hotel Motel	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.31	2.0%	95%	20%	4	$188
New	Hotel Motel	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	2.60	2.0%	50%	94%	15	$2,269
New	Hotel Motel	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	2.60	12.5%	90%	80%	3	$12271
New	Hotel Motel	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.60	10.0%	75%	80%	5	$9,052
New	Hotel Motel	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.60	15.0%	5%	94%	10	$15247
New	Hotel Motel	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	2.60	4.5%	58%	85%	10	$5,725
New	Hotel Motel	Space Heat	Hotel Key Card Room Energy Control System	Key card system to control room HVAC and lighting during non-occupied periods	325 sqft room, $100/room	2.60	25.0%	60%	95%	15	$5,275
New	Hotel Motel	Space Heat	Insulation (Ceiling)	R-49	R-30	2.60	4.0%	75%	85%	25	$4,371
New	Hotel Motel	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.60	6.0%	95%	95%	25	$4,436
New	Hotel Motel	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.60	2.5%	35%	45%	25	$756

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	2.60	10.0%	40%	98%	25	$2,606
New	Hotel Motel	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	2.60	25.0%	50%	98%	10	$35469
New	Hotel Motel	Space Heat	Windows	U = 0.35	U = 0.40	2.60	5.5%	80%	50%	25	$7,193
New	Hotel Motel	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.76	3.3%	NA	NA	20	$1,615
New	Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.73	15.1%	35%	95%	10	$8,704
New	Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.73	2.2%	35%	80%	11	$304
New	Hotel Motel	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.73	5.0%	55%	80%	15	$4,670
New	Hotel Motel	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.73	2.1%	45%	80%	10	$2,700
New	Hotel Motel	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.73	5.6%	45%	95%	10	$841
New	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.73	0.5%	45%	25%	13	$32
New	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.73	0.7%	45%	55%	13	$630
New	Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.73	20.0%	25%	92%	25	$8,755
New	Hotel Motel	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.73	4.0%	95%	25%	10	$0
New	Hotel Motel	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.73	58.9%	50%	94%	15	$6,435
New	Hotel Motel	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.73	2.3%	85%	50%	5	$5
New	Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.73	7.5%	100%	75%	10	$7
New	Hotel Motel	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.73	56.1%	20%	95%	20	$89303
New	Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.73	3.3%	95%	85%	10	$207
New	Hotel Motel	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.73	7.7%	75%	5%	11	$108
Existing	Office	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.47	20.0%	NA	NA	20	$2,205
Existing	Office	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.47	27.3%	NA	NA	20	$2,748
Existing	Office	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.47	9.5%	NA	NA	20	$790
Existing	Office	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.54	10.0%	75%	94%	15	$5,295

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.54	40.0%	43%	45%	10	$4,113
Existing	Office	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.54	7.6%	25%	70%	10	$4,988
Existing	Office	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.54	5.0%	95%	95%	10	$5,726
Existing	Office	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.54	5.0%	45%	45%	10	$11583
Existing	Office	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.54	12.5%	90%	40%	3	$1,657
Existing	Office	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.54	8.0%	50%	94%	15	$493
Existing	Office	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.54	14.0%	95%	35%	10	$55
Existing	Office	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.54	4.0%	95%	75%	10	$446
Existing	Office	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.54	15.0%	45%	28%	5	$8,082
Existing	Office	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.54	10.0%	75%	80%	5	$4,526
Existing	Office	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.54	15.0%	50%	80%	5	$3,266
Existing	Office	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.54	2.5%	45%	45%	18	$3,362
Existing	Office	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.54	10.0%	15%	98%	30	$85145
Existing	Office	Cooling Chillers	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.54	5.0%	40%	10%	10	$1,968
Existing	Office	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.54	2.0%	75%	25%	25	$4,371
Existing	Office	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.54	3.0%	75%	65%	25	$5,799
Existing	Office	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.54	2.4%	75%	4%	25	$5,127
Existing	Office	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.54	6.0%	75%	0%	25	$5,127
Existing	Office	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.54	4.4%	10%	15%	25	$940

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.54	2.4%	10%	15%	25	$979
Existing	Office	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.54	3.0%	10%	95%	25	$2,218
Existing	Office	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.54	8.4%	10%	35%	25	$2,430
Existing	Office	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.54	10.0%	10%	0%	25	$2,402
Existing	Office	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.54	1.0%	35%	15%	25	$756
Existing	Office	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.54	3.0%	35%	15%	25	$4,371
Existing	Office	Cooling Chillers	Pipe Insulation	R-4	R-0	1.54	1.0%	65%	45%	15	$172
Existing	Office	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.54	25.0%	25%	98%	10	$17735
Existing	Office	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.54	44.8%	60%	99%	20	$13507
Existing	Office	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.54	1.0%	80%	95%	25	$8,757
Existing	Office	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.54	0.5%	10%	95%	25	$24726
Existing	Office	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.60	14.2%	NA	NA	15	$4,521
Existing	Office	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.60	6.4%	NA	NA	15	$2,406
Existing	Office	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.60	10.4%	NA	NA	15	$3,730
Existing	Office	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.67	10.0%	75%	94%	15	$5,295
Existing	Office	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.67	12.5%	90%	40%	3	$1,657
Existing	Office	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	1.67	15.0%	10%	20%	15	$3,996
Existing	Office	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.67	25.0%	50%	85%	15	$17511
Existing	Office	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.67	15.0%	5%	28%	5	$8,[illegible]82

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.67	10.0%	75%	80%	5	$4,526
Existing	Office	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.67	15.0%	75%	80%	5	$3,266
Existing	Office	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.67	2.5%	45%	45%	18	$3,362
Existing	Office	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.67	10.0%	15%	98%	30	$85145
Existing	Office	Cooling DX	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.67	5.0%	40%	10%	10	$1,968
Existing	Office	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.67	2.0%	75%	25%	25	$4,371
Existing	Office	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.67	3.0%	75%	65%	25	$5,799
Existing	Office	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.67	2.4%	75%	4%	25	$5,127
Existing	Office	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.67	6.0%	75%	0%	25	$5,127
Existing	Office	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.67	4.4%	10%	15%	25	$940
Existing	Office	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.67	2.4%	10%	15%	25	$979
Existing	Office	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.67	3.0%	10%	95%	25	$2,218
Existing	Office	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.67	8.4%	10%	35%	25	$2,430
Existing	Office	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.67	10.0%	10%	0%	25	$2,402
Existing	Office	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.67	1.0%	35%	15%	25	$756
Existing	Office	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.67	3.0%	35%	15%	25	$4,371
Existing	Office	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.67	3.0%	95%	67%	15	$145
Existing	Office	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.67	1.0%	80%	95%	25	$8,757
Existing	Office	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.67	0.5%	10%	95%	25	$24726
Existing	Office	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	1.56	20.0%	20%	85%	10	$1,718
Existing	Office	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	1.56	7.5%	0%	85%	10	$13133
Existing	Office	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	1.56	3.8%	85%	81%	10	$395
Existing	Office	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	1.56	33.8%	85%	75%	20	$1,705
Existing	Office	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	1.56	8.8%	50%	77%	10	$3,070

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	1.56	1.6%	0%	94%	10	$1,791
Existing	Office	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	3.09	16.8%	NA	NA	15	$3,205
Existing	Office	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	3.09	30.2%	NA	NA	15	$6,862
Existing	Office	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	3.22	10.0%	75%	94%	15	$5,295
Existing	Office	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.22	12.5%	90%	40%	3	$1,657
Existing	Office	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.22	15.0%	5%	28%	5	$8,082
Existing	Office	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.22	10.0%	75%	80%	5	$4,526
Existing	Office	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.22	15.0%	75%	80%	5	$3,266
Existing	Office	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.22	2.5%	45%	45%	18	$3,362
Existing	Office	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.22	7.2%	5%	94%	10	$14457
Existing	Office	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	3.22	1.6%	15%	98%	30	$85145
Existing	Office	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.22	14.3%	5%	92%	20	$37170
Existing	Office	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.22	36.5%	5%	92%	20	$69833
Existing	Office	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.22	20.8%	20%	90%	20	$7,477
Existing	Office	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.22	32.8%	20%	90%	20	$9,875
Existing	Office	Heat Pump	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	3.22	8.3%	40%	10%	10	$1,968
Existing	Office	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	3.22	5.9%	75%	25%	25	$4,371
Existing	Office	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	3.22	8.9%	75%	65%	25	$5,799
Existing	Office	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	3.22	5.5%	75%	4%	25	$5,127
Existing	Office	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	3.22	13.8%	75%	0%	25	$5,127
Existing	Office	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.22	4.4%	10%	15%	25	$940
Existing	Office	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.22	2.4%	10%	15%	25	$979
Existing	Office	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.22	5.0%	10%	95%	25	$2,218
Existing	Office	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.22	16.6%	10%	35%	25	$2,430
Existing	Office	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.22	19.8%	10%	0%	25	$2,402
Existing	Office	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.22	3.7%	35%	15%	25	$756

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.22	11.1%	35%	15%	25	$4,371
Existing	Office	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.22	3.0%	95%	67%	15	$145
Existing	Office	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	3.22	6.6%	80%	95%	25	$8,757
Existing	Office	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	3.22	4.3%	10%	95%	25	$24726
Existing	Office	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	3.87	2.0%	85%	75%	9	$662
Existing	Office	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	3.87	15.0%	30%	78%	9	$2,522
Existing	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.0	3.87	15.0%	90%	70%	14	$1,089
Existing	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.0	3.87	20.0%	75%	85%	14	$2,698
Existing	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.0	3.87	25.0%	70%	90%	14	$4,307
Existing	Office	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.0	Existing Lighting Design	3.87	39.5%	95%	45%	14	$6,504
Existing	Office	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	3.87	1.6%	95%	65%	11	$53
Existing	Office	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	3.87	0.7%	5%	80%	13	$630
Existing	Office	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	3.87	0.8%	10%	95%	14	$36
Existing	Office	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	3.87	4.0%	90%	87%	9	$157
Existing	Office	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	3.87	4.9%	85%	88%	9	$215
Existing	Office	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.33	0.4%	95%	90%	7	$3
Existing	Office	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.33	13.6%	64%	25%	4	$1
Existing	Office	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.33	6.4%	90%	45%	6	$165
Existing	Office	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.33	1.8%	75%	55%	4	$1
Existing	Office	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.33	18.4%	64%	15%	4	$158
Existing	Office	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.33	1.3%	75%	40%	5	$16
Existing	Office	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.33	0.9%	75%	45%	4	$1
Existing	Office	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.33	2.1%	65%	75%	10	$1
Existing	Office	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.33	1.8%	95%	30%	3	$310
Existing	Office	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.33	1.0%	95%	86%	7	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.33	0.5%	35%	65%	13	$126
Existing	Office	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.33	5.4%	25%	35%	7	$578
Existing	Office	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.33	9.9%	10%	80%	14	$189
Existing	Office	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.33	10.2%	10%	25%	3	$298
Existing	Office	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	3.28	10.0%	75%	94%	15	$5,295
Existing	Office	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.28	12.5%	90%	40%	3	$1,657
Existing	Office	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.28	15.0%	5%	28%	5	$8,082
Existing	Office	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.28	10.0%	75%	80%	5	$4,526
Existing	Office	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.28	15.0%	75%	80%	5	$3,266
Existing	Office	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.28	2.5%	45%	45%	18	$3,362
Existing	Office	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.28	15.0%	5%	94%	10	$14457
Existing	Office	Space Heat	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	3.28	10.0%	40%	10%	10	$1,968
Existing	Office	Space Heat	Insulation (Ceiling)	R-49	R-30	3.28	8.0%	75%	65%	25	$4,371
Existing	Office	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	3.28	12.5%	75%	4%	25	$5,127
Existing	Office	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	3.28	25.0%	75%	0%	25	$5,127
Existing	Office	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.28	4.4%	10%	15%	25	$940
Existing	Office	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.28	2.4%	10%	15%	25	$979
Existing	Office	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.28	6.0%	10%	95%	25	$2,218
Existing	Office	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.28	21.1%	10%	35%	25	$2,430
Existing	Office	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.28	25.0%	10%	0%	25	$2,402
Existing	Office	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.28	5.0%	35%	15%	25	$756
Existing	Office	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.28	15.0%	35%	15%	25	$4,371
Existing	Office	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	3.28	25.0%	25%	98%	10	$17735
Existing	Office	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.28	3.0%	95%	67%	15	$145

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Space Heat	Windows	U = 0.35	U = 0.40	3.28	3.2%	80%	95%	25	$2,190
Existing	Office	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	3.28	9.6%	10%	95%	25	$31294
Existing	Office	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.46	3.3%	NA	NA	20	$161
Existing	Office	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.47	15.1%	5%	95%	10	$8,704
Existing	Office	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.47	6.9%	5%	80%	11	$304
Existing	Office	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.47	5.0%	55%	80%	15	$2,335
Existing	Office	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.47	2.1%	10%	80%	10	$2,700
Existing	Office	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.47	5.6%	10%	95%	10	$841
Existing	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.47	3.6%	15%	25%	13	$32
Existing	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.47	5.0%	15%	55%	13	$630
Existing	Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.47	20.0%	5%	92%	25	$876
Existing	Office	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.47	4.0%	95%	25%	10	$0
Existing	Office	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.47	3.8%	95%	15%	10	$2
Existing	Office	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.47	58.9%	40%	94%	15	$9,626
Existing	Office	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.47	1.0%	80%	30%	15	$89
Existing	Office	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.47	1.1%	15%	75%	10	$6
Existing	Office	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.47	2.5%	15%	20%	10	$12
Existing	Office	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.47	55.8%	20%	95%	20	$17861
Existing	Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.47	3.3%	95%	85%	10	$207
Existing	Office	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.47	7.7%	75%	40%	11	$108
New	Office	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.58	20.0%	NA	NA	20	$2,205
New	Office	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.58	27.3%	NA	NA	20	$2,748
New	Office	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.58	9.5%	NA	NA	20	$790
New	Office	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.53	10.0%	75%	94%	15	$5,295

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.53	7.6%	25%	70%	10	$4,988
New	Office	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.53	5.0%	95%	95%	10	$5,726
New	Office	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.53	12.5%	90%	80%	3	$6,136
New	Office	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.53	8.0%	50%	94%	15	$493
New	Office	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.53	10.0%	75%	80%	5	$4,526
New	Office	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.53	10.0%	15%	98%	30	$85145
New	Office	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.53	2.0%	75%	25%	25	$4,371
New	Office	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.53	3.0%	75%	65%	25	$5,799
New	Office	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.53	3.0%	95%	95%	25	$2,218
New	Office	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.53	1.0%	35%	15%	25	$756
New	Office	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.53	10.0%	40%	98%	25	$1,303
New	Office	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.53	25.0%	50%	98%	10	$17735
New	Office	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.53	44.8%	95%	99%	20	$12413
New	Office	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.53	3.1%	75%	75%	30	$2,747
New	Office	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.53	1.0%	80%	95%	25	$8,757
New	Office	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.63	14.2%	NA	NA	15	$4,621
New	Office	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.63	6.4%	NA	NA	15	$2,406
New	Office	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.63	10.4%	NA	NA	15	$3,730

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.58	10.0%	75%	94%	15	$5,295
New	Office	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.58	12.5%	90%	80%	3	$6,136
New	Office	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.58	25.0%	50%	85%	15	$17511
New	Office	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.58	10.0%	75%	80%	5	$4,526
New	Office	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.58	10.0%	15%	98%	30	$85145
New	Office	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.58	2.0%	75%	25%	25	$4,371
New	Office	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.58	3.0%	75%	65%	25	$5,799
New	Office	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.58	3.0%	95%	95%	25	$2,218
New	Office	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.58	1.0%	35%	15%	25	$756
New	Office	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.58	10.0%	40%	98%	25	$1,303
New	Office	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.58	3.1%	75%	75%	30	$2,747
New	Office	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.58	1.0%	80%	95%	25	$8,757
New	Office	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	1.31	20.0%	20%	75%	10	$1,718
New	Office	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	1.31	7.5%	0%	85%	10	$6,829
New	Office	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	1.31	3.8%	85%	81%	10	$395
New	Office	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	1.31	33.8%	85%	75%	20	$1,705
New	Office	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	1.31	8.8%	65%	77%	10	$3,070
New	Office	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	1.31	1.6%	0%	94%	10	$1,791
New	Office	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.42	16.8%	NA	NA	15	$3,205
New	Office	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.42	30.2%	NA	NA	15	$6,862
New	Office	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.30	10.0%	75%	94%	15	$5,295
New	Office	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.30	12.5%	90%	80%	3	$6,136
New	Office	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.30	10.0%	75%	80%	5	$4,526
New	Office	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.30	7.2%	5%	94%	10	$14457

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.30	1.6%	15%	98%	30	$85145
New	Office	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.30	14.3%	45%	92%	20	$37170
New	Office	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.30	36.5%	45%	92%	20	$69833
New	Office	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.30	20.8%	40%	90%	20	$7,477
New	Office	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.30	32.8%	40%	90%	20	$9,875
New	Office	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.30	5.9%	75%	25%	25	$4,371
New	Office	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.30	8.9%	75%	65%	25	$5,799
New	Office	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.30	5.0%	95%	95%	25	$2,218
New	Office	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.30	3.7%	35%	15%	25	$756
New	Office	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.30	10.0%	40%	98%	25	$1,303
New	Office	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.30	6.6%	80%	95%	25	$8,757
New	Office	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.39	2.0%	85%	75%	9	$662
New	Office	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.39	15.0%	60%	78%	9	$2,522
New	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.0	2.39	15.0%	90%	70%	14	$656
New	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.0	2.39	20.0%	75%	85%	14	$2,118
New	Office	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.0	2.39	25.0%	70%	90%	14	$3,581
New	Office	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.39	1.1%	5%	80%	13	$630
New	Office	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.39	0.8%	10%	95%	14	$36
New	Office	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.39	4.0%	90%	87%	10	$157
New	Office	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.33	0.4%	95%	90%	7	$3
New	Office	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.33	13.6%	64%	25%	4	$1
New	Office	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.33	6.2%	90%	45%	6	$165
New	Office	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.33	1.8%	75%	55%	4	$1
New	Office	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.33	18.4%	64%	15%	4	$157
New	Office	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.33	1.3%	75%	40%	5	$16

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.33	0.9%	75%	45%	4	$1
New	Office	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.33	2.0%	65%	75%	10	$1
New	Office	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.33	1.8%	95%	30%	3	$310
New	Office	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.33	1.0%	95%	86%	7	$0
New	Office	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.33	0.4%	35%	65%	13	$126
New	Office	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.33	5.2%	25%	35%	7	$578
New	Office	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.33	9.6%	10%	80%	14	$189
New	Office	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.67	10.0%	75%	94%	15	$5,295
New	Office	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.67	12.5%	90%	80%	3	$6,136
New	Office	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.67	10.0%	75%	80%	5	$4,526
New	Office	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.67	15.0%	5%	94%	10	$14457
New	Office	Space Heat	Insulation (Ceiling)	R-49	R-30	0.67	8.0%	75%	65%	25	$4,371
New	Office	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.67	6.0%	95%	95%	25	$2,218
New	Office	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.67	5.0%	35%	15%	25	$756
New	Office	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.67	10.0%	40%	98%	25	$1,303
New	Office	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.67	25.0%	50%	98%	10	$17735
New	Office	Space Heat	Windows	U = 0.35	U = 0.40	0.67	3.2%	80%	95%	25	$2,190
New	Office	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.48	3.3%	NA	NA	20	$161
New	Office	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.47	15.1%	5%	95%	10	$8,704
New	Office	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.47	6.8%	5%	80%	11	$304
New	Office	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.47	5.0%	55%	80%	15	$2,335
New	Office	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.47	2.1%	10%	80%	10	$2,700
New	Office	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.47	5.6%	10%	95%	10	$841
New	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.47	3.6%	15%	25%	13	$32

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.47	5.0%	15%	55%	13	$630
New	Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.47	20.0%	25%	92%	25	$876
New	Office	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.47	4.0%	95%	25%	10	$0
New	Office	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.47	58.9%	50%	94%	15	$9,626
New	Office	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.47	1.1%	15%	75%	10	$6
New	Office	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.47	55.8%	20%	95%	20	$17861
New	Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.47	3.3%	95%	85%	10	$207
New	Office	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.47	7.7%	75%	40%	11	$108
Existing	Other	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.39	2.5%	25%	70%	12	$4,946
Existing	Other	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.39	8.4%	35%	85%	12	$1,800
Existing	Other	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.39	3.4%	85%	85%	15	$1,734
Existing	Other	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.39	2.3%	15%	75%	10	$1
Existing	Other	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	1.64	20.0%	NA	NA	20	$1,069
Existing	Other	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	1.64	27.3%	NA	NA	20	$1,333
Existing	Other	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	1.64	9.5%	NA	NA	20	$383
Existing	Other	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.69	10.0%	50%	94%	15	$3,640
Existing	Other	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	1.69	40.0%	43%	45%	10	$1,995
Existing	Other	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	1.69	7.6%	25%	70%	10	$2,419
Existing	Other	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	1.69	5.0%	95%	95%	10	$3,937
Existing	Other	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	1.69	5.0%	45%	85%	10	$5,617
Existing	Other	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.69	12.5%	90%	40%	3	$1,139
Existing	Other	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	1.69	8.0%	50%	94%	15	$239

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	1.69	14.0%	95%	35%	10	$27
Existing	Other	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	1.69	4.0%	95%	75%	10	$217
Existing	Other	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.69	15.0%	5%	66%	5	$5,557
Existing	Other	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.69	10.0%	75%	80%	5	$3,112
Existing	Other	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.69	15.0%	50%	80%	5	$2,246
Existing	Other	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.69	2.5%	45%	45%	18	$2,311
Existing	Other	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.69	4.5%	100%	85%	10	$5,726
Existing	Other	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	1.69	5.0%	15%	98%	30	$58537
Existing	Other	Cooling Chillers	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.69	5.0%	40%	10%	10	$1,353
Existing	Other	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	1.69	2.0%	75%	45%	25	$3,005
Existing	Other	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	1.69	3.0%	75%	85%	25	$3,987
Existing	Other	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.69	2.4%	75%	30%	25	$3,525
Existing	Other	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.69	6.0%	75%	0%	25	$3,525
Existing	Other	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.69	4.4%	10%	15%	25	$646
Existing	Other	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.69	2.4%	10%	15%	25	$673
Existing	Other	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.69	3.0%	10%	95%	25	$1,839
Existing	Other	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.69	8.4%	10%	35%	25	$2,014
Existing	Other	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.69	10.0%	10%	0%	25	$1,592
Existing	Other	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.69	1.0%	35%	50%	25	$520

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.69	3.0%	35%	50%	25	$3,005
Existing	Other	Cooling Chillers	Pipe Insulation	R-4	R-0	1.69	1.0%	65%	45%	15	$119
Existing	Other	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.69	25.0%	25%	98%	10	$12193
Existing	Other	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	1.69	44.8%	60%	99%	20	$6,550
Existing	Other	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	1.69	0.7%	80%	70%	25	$2,851
Existing	Other	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.69	0.4%	10%	70%	25	$8,049
Existing	Other	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.78	14.2%	NA	NA	15	$2,411
Existing	Other	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.78	6.4%	NA	NA	15	$1,283
Existing	Other	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.78	10.4%	NA	NA	15	$1,989
Existing	Other	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.84	10.0%	50%	94%	15	$3,640
Existing	Other	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.84	12.5%	90%	40%	3	$1,139
Existing	Other	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	1.84	15.0%	10%	70%	15	$1,938
Existing	Other	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.84	25.0%	50%	85%	15	$12039
Existing	Other	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.84	15.0%	45%	66%	5	$5,557
Existing	Other	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.84	10.0%	75%	80%	5	$3,112
Existing	Other	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.84	15.0%	50%	80%	5	$2,246
Existing	Other	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.84	2.5%	45%	45%	18	$2,311
Existing	Other	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.84	4.5%	5%	85%	10	$5,726
Existing	Other	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.84	10.0%	15%	98%	30	$58537
Existing	Other	Cooling DX	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.84	5.0%	40%	10%	10	$1,353

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.84	2.0%	75%	45%	25	$3,005
Existing	Other	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.84	3.0%	75%	85%	25	$3,987
Existing	Other	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	1.84	2.4%	75%	30%	25	$3,525
Existing	Other	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	1.84	6.0%	75%	0%	25	$3,525
Existing	Other	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.84	4.4%	10%	15%	25	$646
Existing	Other	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.84	2.4%	10%	15%	25	$673
Existing	Other	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.84	3.0%	10%	95%	25	$1,839
Existing	Other	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.84	8.4%	10%	35%	25	$2,014
Existing	Other	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.84	10.0%	10%	0%	25	$1,992
Existing	Other	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.84	1.0%	35%	50%	25	$520
Existing	Other	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.84	3.0%	35%	50%	25	$3,005
Existing	Other	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.84	3.0%	95%	63%	15	$146
Existing	Other	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.84	0.7%	80%	70%	25	$2,851
Existing	Other	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	1.84	0.4%	10%	70%	25	$8,049
Existing	Other	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.14	20.0%	5%	85%	10	$1,181
Existing	Other	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.14	7.5%	5%	85%	10	$13133
Existing	Other	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.14	3.8%	85%	81%	10	$272
Existing	Other	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.14	33.8%	85%	75%	20	$1,172
Existing	Other	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.14	8.8%	10%	77%	10	$2,110
Existing	Other	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.14	1.6%	5%	94%	10	$1,791
Existing	Other	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.98	16.8%	NA	NA	15	$1,709
Existing	Other	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.98	30.2%	NA	NA	15	$3,659
Existing	Other	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	3.10	10.0%	50%	94%	15	$3,640
Existing	Other	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	3.10	12.5%	90%	40%	3	$1,139

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	3.10	15.0%	45%	66%	5	$5,557
Existing	Other	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	3.10	10.0%	75%	80%	5	$3,112
Existing	Other	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	3.10	15.0%	50%	80%	5	$2,246
Existing	Other	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	3.10	2.5%	45%	45%	18	$2,311
Existing	Other	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	3.10	6.0%	5%	94%	10	$9,939
Existing	Other	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	3.10	4.5%	5%	85%	10	$5,726
Existing	Other	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	3.10	1.8%	15%	98%	30	$58537
Existing	Other	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.10	16.0%	5%	92%	20	$19820
Existing	Other	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	3.10	38.7%	5%	92%	20	$37237
Existing	Other	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.10	20.0%	5%	90%	20	$3,987
Existing	Other	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	3.10	32.4%	5%	90%	20	$5,265
Existing	Other	Heat Pump	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	3.10	8.3%	40%	10%	10	$1,353
Existing	Other	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	3.10	5.9%	75%	45%	25	$3,005
Existing	Other	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	3.10	8.9%	75%	85%	25	$3,987
Existing	Other	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	3.10	5.5%	75%	30%	25	$3,525
Existing	Other	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	3.10	13.8%	75%	0%	25	$3,525
Existing	Other	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	3.10	4.4%	10%	15%	25	$646
Existing	Other	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	3.10	2.4%	10%	15%	25	$673
Existing	Other	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	3.10	5.0%	10%	95%	25	$1,839
Existing	Other	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	3.10	16.6%	10%	35%	25	$2,014
Existing	Other	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	3.10	19.8%	10%	0%	25	$1,992
Existing	Other	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	3.10	3.7%	35%	50%	25	$520
Existing	Other	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	3.10	11.1%	35%	50%	25	$3,005
Existing	Other	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	3.10	3.0%	95%	63%	15	$146
Existing	Other	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	3.10	4.8%	80%	70%	25	$2,851
Existing	Other	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	3.10	3.2%	10%	70%	25	$8,049

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.78	2.0%	25%	75%	9	$455
Existing	Other	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.78	15.0%	30%	84%	9	$1,734
Existing	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.23	2.78	15.0%	90%	70%	14	$984
Existing	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.23	2.78	20.0%	75%	85%	14	$2,332
Existing	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.23	2.78	25.0%	70%	90%	14	$3,683
Existing	Other	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.23	Existing Lighting Design	2.78	34.2%	95%	45%	14	$5,404
Existing	Other	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	2.78	1.6%	95%	65%	11	$53
Existing	Other	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.78	1.6%	5%	80%	13	$630
Existing	Other	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.78	1.5%	10%	95%	14	$36
Existing	Other	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.78	4.0%	90%	83%	9	$108
Existing	Other	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	2.78	4.9%	85%	100%	9	$216
Existing	Other	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.57	0.4%	95%	90%	7	$2
Existing	Other	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.57	13.6%	64%	25%	4	$1
Existing	Other	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.57	8.4%	10%	45%	6	$165
Existing	Other	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.57	1.8%	75%	55%	4	$1
Existing	Other	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.57	18.4%	64%	15%	4	$158
Existing	Other	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.57	1.3%	75%	40%	5	$16
Existing	Other	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.57	0.9%	75%	45%	4	$1
Existing	Other	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.57	2.7%	10%	75%	10	$1
Existing	Other	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.57	1.8%	95%	30%	3	$310
Existing	Other	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.57	1.0%	95%	86%	7	$1
Existing	Other	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.57	1.2%	75%	95%	10	$86
Existing	Other	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.57	0.6%	5%	65%	13	$126
Existing	Other	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.57	7.0%	25%	35%	7	$578
Existing	Other	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.57	13.0%	10%	80%	14	$189

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.57	13.3%	10%	25%	3	$298
Existing	Other	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.20	108.9%	95%	95%	12	$344
Existing	Other	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.20	3.6%	85%	65%	10	$9,596
Existing	Other	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.20	1.1%	5%	86%	9	$376
Existing	Other	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.20	6.0%	75%	70%	10	$3
Existing	Other	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	0.20	5.0%	80%	90%	3	$4
Existing	Other	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.20	3.2%	95%	77%	16	$13
Existing	Other	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.20	2.0%	95%	20%	4	$189
Existing	Other	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	2.64	10.0%	50%	94%	15	$3,640
Existing	Other	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.64	12.5%	90%	40%	3	$1,139
Existing	Other	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.64	15.0%	45%	66%	5	$5,557
Existing	Other	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.64	10.0%	75%	80%	5	$3,112
Existing	Other	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.64	15.0%	50%	80%	5	$2,246
Existing	Other	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.64	2.5%	45%	45%	18	$2,311
Existing	Other	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.64	15.0%	5%	94%	10	$9,939
Existing	Other	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	2.64	4.5%	5%	85%	10	$5,726
Existing	Other	Space Heat	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	2.64	10.0%	40%	10%	10	$1,353
Existing	Other	Space Heat	Insulation (Ceiling)	R-49	R-30	2.64	8.0%	75%	85%	25	$3,005
Existing	Other	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	2.64	12.5%	75%	30%	25	$3,525
Existing	Other	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	2.64	25.0%	75%	0%	25	$3,525
Existing	Other	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.64	4.4%	10%	15%	25	$646
Existing	Other	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.64	2.4%	10%	15%	25	$673
Existing	Other	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.64	6.0%	10%	95%	25	$1,639
Existing	Other	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.64	21.1%	10%	35%	25	$2,014

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.64	25.0%	10%	0%	25	$1,992
Existing	Other	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.64	5.0%	35%	50%	25	$520
Existing	Other	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.64	15.0%	35%	50%	25	$3,005
Existing	Other	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	2.64	25.0%	25%	98%	10	$12193
Existing	Other	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.64	3.0%	95%	63%	15	$146
Existing	Other	Space Heat	Windows	U = 0.35	U = 0.40	2.64	2.3%	80%	70%	25	$712
Existing	Other	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	2.64	7.0%	10%	70%	25	$10187
Existing	Other	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.36	3.3%	NA	NA	20	$162
Existing	Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.37	15.1%	5%	95%	10	$8,705
Existing	Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.37	12.5%	5%	80%	11	$305
Existing	Other	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.37	5.0%	75%	94%	15	$1,605
Existing	Other	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.37	2.1%	10%	80%	10	$2,700
Existing	Other	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.37	5.6%	10%	95%	10	$841
Existing	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.37	6.6%	10%	25%	13	$32
Existing	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.37	9.1%	10%	55%	13	$630
Existing	Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.37	20.0%	5%	92%	25	$875
Existing	Other	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.37	4.0%	95%	25%	10	$0
Existing	Other	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.37	3.8%	95%	15%	10	$2
Existing	Other	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.37	58.9%	40%	94%	15	$9,626
Existing	Other	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.37	1.0%	80%	90%	15	$61
Existing	Other	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.37	2.3%	50%	50%	5	$5
Existing	Other	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.37	1.1%	15%	75%	10	$6
Existing	Other	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.37	2.5%	15%	20%	10	$12
Existing	Other	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.37	62.3%	20%	95%	20	$17861
Existing	Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.37	3.3%	95%	95%	10	$206

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.37	7.7%	75%	55%	11	$107
New	Other	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.39	2.5%	25%	70%	12	$4,946
New	Other	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.39	8.3%	35%	85%	12	$1,800
New	Other	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.39	3.4%	85%	85%	15	$1,734
New	Other	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.39	2.3%	15%	75%	10	$1
New	Other	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.78	20.0%	NA	NA	20	$1,069
New	Other	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.78	27.3%	NA	NA	20	$1,333
New	Other	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.78	9.5%	NA	NA	20	$383
New	Other	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.72	10.0%	50%	94%	15	$3,640
New	Other	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.72	7.6%	25%	70%	10	$2,419
New	Other	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.72	5.0%	95%	95%	10	$3,937
New	Other	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.72	12.5%	90%	80%	3	$4,218
New	Other	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.72	8.0%	50%	94%	15	$239
New	Other	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.72	10.0%	75%	80%	5	$3,112
New	Other	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.72	4.5%	100%	85%	10	$5,726
New	Other	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.72	5.0%	15%	98%	30	$58537
New	Other	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.72	2.0%	75%	45%	25	$3,005
New	Other	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.72	3.0%	75%	85%	25	$3,[illegible]87
New	Other	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.72	3.0%	95%	95%	25	$1,839
New	Other	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.72	1.0%	35%	50%	25	$520

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.72	10.0%	40%	98%	25	$896
New	Other	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.72	25.0%	50%	98%	10	$12193
New	Other	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.72	44.8%	95%	99%	20	$4,629
New	Other	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.72	0.7%	80%	70%	25	$2,851
New	Other	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.85	14.2%	NA	NA	15	$2,411
New	Other	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.85	6.4%	NA	NA	15	$1,283
New	Other	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.85	10.4%	NA	NA	15	$1,989
New	Other	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.78	10.0%	50%	94%	15	$3,640
New	Other	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.78	12.5%	90%	80%	3	$4,218
New	Other	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.78	25.0%	50%	85%	15	$12039
New	Other	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.78	10.0%	75%	80%	5	$3,112
New	Other	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.78	4.5%	5%	85%	10	$5,726
New	Other	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.78	10.0%	15%	98%	30	$58537
New	Other	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.78	2.0%	75%	45%	25	$3,005
New	Other	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.78	3.0%	75%	85%	25	$3,987
New	Other	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.78	3.0%	95%	95%	25	$1,839
New	Other	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.78	1.0%	35%	50%	25	$520
New	Other	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.78	10.0%	40%	98%	25	$896
New	Other	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.78	0.7%	80%	70%	25	$2,851
New	Other	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	1.77	20.0%	5%	75%	10	$1,181
New	Other	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	1.77	7.5%	5%	85%	10	$6,829

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	1.77	3.8%	85%	81%	10	$272
New	Other	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	1.77	33.8%	85%	75%	20	$1,172
New	Other	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	1.77	8.8%	20%	77%	10	$2,110
New	Other	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	1.77	1.6%	5%	94%	10	$1,791
New	Other	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.49	16.8%	NA	NA	15	$1,709
New	Other	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.49	30.2%	NA	NA	15	$3,659
New	Other	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.35	10.0%	50%	94%	15	$3,640
New	Other	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.35	12.5%	90%	80%	3	$4,218
New	Other	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.35	10.0%	75%	80%	5	$3,112
New	Other	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.35	6.0%	5%	94%	10	$9,939
New	Other	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.35	4.5%	5%	85%	10	$5,726
New	Other	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.35	1.8%	15%	98%	30	$58537
New	Other	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.35	16.0%	45%	92%	20	$19820
New	Other	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.35	38.7%	45%	92%	20	$37237
New	Other	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.35	20.0%	10%	90%	20	$3,987
New	Other	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.35	32.4%	10%	90%	20	$5,265
New	Other	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.35	5.9%	75%	45%	25	$3,005
New	Other	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.35	8.9%	75%	85%	25	$3,987
New	Other	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.35	5.0%	95%	95%	25	$1,839
New	Other	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.35	3.7%	35%	50%	25	$520
New	Other	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.35	10.0%	40%	98%	25	$896
New	Other	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.35	4.8%	80%	70%	25	$2,851
New	Other	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	1.97	2.0%	25%	75%	9	$455
New	Other	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	1.97	15.0%	60%	84%	9	$1,734

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.23	1.97	15.0%	90%	70%	14	$617
New	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.23	1.97	20.0%	75%	85%	14	$1,842
New	Other	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.23	1.97	25.0%	70%	90%	14	$3,070
New	Other	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	1.97	2.2%	5%	80%	13	$630
New	Other	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	1.97	1.5%	10%	95%	14	$36
New	Other	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	1.97	4.0%	90%	83%	10	$108
New	Other	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.57	0.4%	95%	90%	7	$2
New	Other	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.57	13.6%	64%	25%	4	$1
New	Other	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.57	8.2%	10%	45%	6	$165
New	Other	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.57	1.8%	75%	55%	4	$1
New	Other	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.57	18.4%	64%	15%	4	$158
New	Other	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.57	1.3%	75%	40%	5	$16
New	Other	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.57	0.9%	75%	45%	4	$1
New	Other	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.57	2.6%	10%	75%	10	$1
New	Other	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.57	1.8%	95%	30%	3	$310
New	Other	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.57	1.0%	95%	86%	7	$1
New	Other	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.57	1.2%	75%	95%	10	$86
New	Other	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.57	0.6%	5%	65%	13	$126
New	Other	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.57	6.9%	25%	35%	7	$578
New	Other	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.57	12.6%	10%	80%	14	$189
New	Other	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.20	54.2%	95%	95%	12	$344
New	Other	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.20	3.6%	85%	65%	10	$9,596
New	Other	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.20	1.1%	5%	86%	9	$376
New	Other	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.20	6.0%	75%	70%	10	$3
New	Other	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	0.20	5.0%	80%	90%	3	$4

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.20	3.2%	95%	77%	16	$13
New	Other	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.20	2.0%	95%	20%	4	$189
New	Other	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.56	10.0%	50%	94%	15	$3,640
New	Other	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.56	12.5%	90%	80%	3	$4,218
New	Other	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.56	10.0%	75%	80%	5	$3,112
New	Other	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.56	15.0%	5%	94%	10	$9,939
New	Other	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.56	4.5%	5%	85%	10	$5,726
New	Other	Space Heat	Insulation (Ceiling)	R-49	R-30	0.56	8.0%	75%	85%	25	$3,005
New	Other	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.56	6.0%	95%	95%	25	$1,839
New	Other	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.56	5.0%	35%	50%	25	$520
New	Other	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.56	10.0%	40%	98%	25	$896
New	Other	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.56	25.0%	50%	98%	10	$12193
New	Other	Space Heat	Windows	U = 0.35	U = 0.40	0.56	2.3%	80%	70%	25	$712
New	Other	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.38	3.3%	NA	NA	20	$162
New	Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.37	15.1%	5%	95%	10	$8,705
New	Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.37	12.5%	5%	80%	11	$305
New	Other	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.37	5.0%	90%	94%	15	$1,605
New	Other	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.37	2.1%	10%	80%	10	$2,700
New	Other	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.37	5.6%	10%	95%	10	$841
New	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.37	6.6%	10%	25%	13	$32
New	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.37	9.1%	10%	55%	13	$630
New	Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.37	20.0%	25%	92%	25	$875
New	Other	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.37	4.0%	95%	25%	10	$0
New	Other	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.37	58.9%	50%	94%	15	$9,626

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.37	2.3%	50%	50%	5	$5
New	Other	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.37	1.1%	15%	75%	10	$6
New	Other	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.37	62.3%	20%	95%	20	$17861
New	Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.37	3.3%	95%	95%	10	$206
New	Other	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.37	7.7%	75%	55%	11	$107
Existing	Restaurant	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	9.60	2.5%	45%	70%	12	$4,946
Existing	Restaurant	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	9.60	8.4%	35%	85%	12	$1,800
Existing	Restaurant	Cooking	Oven - Convection	Convection Oven	Standard Oven	9.60	3.4%	85%	85%	15	$1,734
Existing	Restaurant	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	9.60	5.5%	35%	75%	10	$1
Existing	Restaurant	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	4.00	14.2%	NA	NA	15	$4,353
Existing	Restaurant	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	4.00	6.4%	NA	NA	15	$2,317
Existing	Restaurant	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	4.00	10.4%	NA	NA	15	$3,592
Existing	Restaurant	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	4.16	12.5%	90%	40%	3	$1,035
Existing	Restaurant	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	4.16	15.0%	10%	50%	15	$3,173
Existing	Restaurant	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	4.16	25.0%	50%	85%	15	$10944
Existing	Restaurant	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	4.16	15.0%	5%	100%	5	$5,051
Existing	Restaurant	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	4.16	10.0%	75%	100%	5	$2,829
Existing	Restaurant	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	4.16	15.0%	50%	100%	5	$2,041
Existing	Restaurant	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	4.16	2.5%	45%	45%	18	$2,101
Existing	Restaurant	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	4.16	4.5%	100%	85%	10	$5,726
Existing	Restaurant	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	4.16	5.0%	15%	98%	30	$50[illegible]16
Existing	Restaurant	Cooling DX	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	4.16	5.0%	40%	10%	10	$1,230
Existing	Restaurant	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	4.16	2.0%	75%	95%	25	$2,732
Existing	Restaurant	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	4.16	3.0%	75%	98%	25	$3,625

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	4.16	2.4%	75%	85%	25	$3,204
Existing	Restaurant	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	4.16	6.0%	75%	0%	25	$3,204
Existing	Restaurant	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	4.16	4.4%	10%	15%	25	$587
Existing	Restaurant	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	4.16	2.4%	10%	15%	25	$612
Existing	Restaurant	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	4.16	3.0%	10%	95%	25	$1,753
Existing	Restaurant	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	4.16	8.4%	10%	35%	25	$1,921
Existing	Restaurant	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	4.16	10.0%	10%	0%	25	$1,899
Existing	Restaurant	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	4.16	1.0%	35%	90%	25	$473
Existing	Restaurant	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	4.16	3.0%	35%	90%	25	$2,732
Existing	Restaurant	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	4.16	3.0%	95%	42%	15	$146
Existing	Restaurant	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	4.16	1.0%	80%	80%	25	$6,876
Existing	Restaurant	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	4.16	0.5%	10%	80%	25	$19413
Existing	Restaurant	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	3.64	20.0%	1%	85%	10	$1,074
Existing	Restaurant	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	3.64	7.5%	100%	25%	10	$13133
Existing	Restaurant	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	3.64	3.8%	85%	81%	10	$247
Existing	Restaurant	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	3.64	33.8%	85%	75%	20	$1,066
Existing	Restaurant	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	3.64	8.8%	10%	77%	10	$1,918
Existing	Restaurant	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	3.64	1.6%	0%	94%	10	$1,791
Existing	Restaurant	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	4.79	16.8%	NA	NA	15	$3,086
Existing	Restaurant	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	4.79	30.2%	NA	NA	15	$6,607
Existing	Restaurant	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	5.06	12.5%	90%	40%	3	$1,035
Existing	Restaurant	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	5.06	15.0%	5%	100%	5	$5,051
Existing	Restaurant	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	5.06	10.0%	75%	100%	5	$2,829
Existing	Restaurant	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	5.06	15.0%	50%	100%	5	$2,041

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	5.06	2.5%	45%	45%	18	$2,101
Existing	Restaurant	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	5.06	2.5%	5%	94%	10	$9,035
Existing	Restaurant	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	5.06	4.5%	100%	85%	10	$5,726
Existing	Restaurant	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	5.06	1.3%	15%	98%	30	$53216
Existing	Restaurant	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	5.06	21.1%	5%	92%	20	$35790
Existing	Restaurant	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	5.06	45.0%	5%	92%	20	$67238
Existing	Restaurant	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	5.06	17.6%	0%	90%	20	$7,199
Existing	Restaurant	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	5.06	31.2%	0%	90%	20	$9,508
Existing	Restaurant	Heat Pump	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	5.06	8.3%	40%	10%	10	$1,230
Existing	Restaurant	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	5.06	5.9%	75%	95%	25	$2,732
Existing	Restaurant	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	5.06	8.9%	75%	98%	25	$3,625
Existing	Restaurant	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	5.06	5.5%	75%	85%	25	$3,204
Existing	Restaurant	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	5.06	13.8%	75%	0%	25	$3,204
Existing	Restaurant	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	5.06	4.4%	10%	15%	25	$587
Existing	Restaurant	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	5.06	2.4%	10%	15%	25	$612
Existing	Restaurant	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	5.06	5.0%	10%	95%	25	$1,753
Existing	Restaurant	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	5.06	16.6%	10%	35%	25	$1,921
Existing	Restaurant	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	5.06	19.8%	10%	0%	25	$1,899
Existing	Restaurant	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	5.06	3.7%	35%	90%	25	$473
Existing	Restaurant	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	5.06	11.1%	35%	90%	25	$2,732
Existing	Restaurant	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	5.06	3.0%	95%	42%	15	$146
Existing	Restaurant	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	5.06	6.8%	80%	80%	25	$6,876
Existing	Restaurant	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	5.06	4.5%	10%	80%	25	$19,413
Existing	Restaurant	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	5.82	2.0%	10%	75%	9	$414
Existing	Restaurant	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	5.82	6.0%	30%	98%	9	$6[illegible]1

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.43	5.82	15.0%	90%	70%	14	$1,283
Existing	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.43	5.82	20.0%	75%	85%	14	$2,843
Existing	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.43	5.82	25.0%	70%	90%	14	$4,438
Existing	Restaurant	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.43	Existing Lighting Design	5.82	22.0%	95%	45%	14	$6,125
Existing	Restaurant	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	5.82	1.6%	95%	65%	11	$53
Existing	Restaurant	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	5.82	1.1%	50%	80%	13	$630
Existing	Restaurant	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	5.82	1.5%	10%	95%	14	$37
Existing	Restaurant	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	5.82	4.0%	45%	100%	9	$98
Existing	Restaurant	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	5.82	4.9%	85%	100%	9	$215
Existing	Restaurant	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.25	0.4%	95%	90%	7	$2
Existing	Restaurant	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.25	13.6%	64%	25%	4	$1
Existing	Restaurant	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.25	10.6%	5%	45%	6	$165
Existing	Restaurant	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.25	1.8%	75%	55%	4	$1
Existing	Restaurant	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.25	18.4%	64%	15%	4	$158
Existing	Restaurant	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.25	1.3%	75%	40%	5	$16
Existing	Restaurant	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.25	0.9%	75%	45%	4	$1
Existing	Restaurant	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.25	3.4%	35%	75%	10	$1
Existing	Restaurant	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.25	1.8%	95%	30%	3	$310
Existing	Restaurant	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.25	1.0%	95%	86%	7	$1
Existing	Restaurant	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.25	1.2%	75%	95%	10	$86
Existing	Restaurant	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.25	0.8%	35%	65%	13	$126
Existing	Restaurant	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.25	8.9%	25%	35%	7	$578
Existing	Restaurant	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.25	16.5%	5%	80%	14	$489
Existing	Restaurant	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	2.25	16.9%	5%	25%	3	$298
Existing	Restaurant	Refrigeration	Anti-Sweat (Humidistat) Controls	Variable Temp. Controls (Humidistat)	Constant Controls	5.60	35.8%	25%	45%	12	$954
Existing	Restaurant	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	5.60	17.4%	95%	100%	12	$345

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	5.60	3.6%	85%	65%	10	$9,595
Existing	Restaurant	Refrigeration	Display Cases	High-Efficiency Display Cases	Display Cases - Standard	5.60	3.6%	40%	90%	15	$1,278
Existing	Restaurant	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	5.60	8.4%	85%	72%	10	$1,578
Existing	Restaurant	Refrigeration	High-Efficiency Evaporator Fans - Walk-ins	High-Efficiency Evaporator Fans, Walk-in Refrigerators	Standard Evaporator Fans	5.60	1.0%	92%	75%	15	$203
Existing	Restaurant	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	5.60	5.8%	85%	86%	9	$376
Existing	Restaurant	Refrigeration	Motor - Case Fans with ECM motors	ECM motors on evaporator fan, on display cases	48 cf 2-door reach-in commercial refrigerator	5.60	0.5%	80%	50%	20	$229
Existing	Restaurant	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	5.60	6.0%	75%	70%	10	$76
Existing	Restaurant	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	5.60	5.0%	80%	90%	3	$94
Existing	Restaurant	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	5.60	3.2%	95%	77%	16	$315
Existing	Restaurant	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	5.60	2.0%	95%	20%	4	$189
Existing	Restaurant	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.38	12.5%	90%	40%	3	$1,035
Existing	Restaurant	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.38	15.0%	5%	100%	5	$5,051
Existing	Restaurant	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.38	10.0%	75%	100%	5	$2,829
Existing	Restaurant	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.38	15.0%	50%	100%	5	$2,041
Existing	Restaurant	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.38	2.5%	45%	45%	18	$2,101
Existing	Restaurant	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.38	15.0%	5%	94%	10	$9,035
Existing	Restaurant	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.38	4.5%	100%	85%	10	$5,726
Existing	Restaurant	Space Heat	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	1.38	10.0%	40%	10%	10	$1,230
Existing	Restaurant	Space Heat	Insulation (Ceiling)	R-49	R-30	1.38	8.0%	75%	98%	25	$2,732
Existing	Restaurant	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	1.38	12.5%	75%	85%	25	$3,204
Existing	Restaurant	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	1.38	25.0%	75%	0%	25	$3,204
Existing	Restaurant	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.38	4.4%	10%	15%	25	$587
Existing	Restaurant	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.38	2.4%	10%	15%	25	$612
Existing	Restaurant	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.38	6.0%	10%	95%	25	$1,753
Existing	Restaurant	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.38	21.1%	10%	35%	25	$1,921

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.38	25.0%	10%	0%	25	$1,899
Existing	Restaurant	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.38	5.0%	35%	90%	25	$473
Existing	Restaurant	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.38	15.0%	35%	90%	25	$2,732
Existing	Restaurant	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.38	25.0%	25%	98%	10	$11084
Existing	Restaurant	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.38	3.0%	95%	42%	15	$146
Existing	Restaurant	Space Heat	Windows	U = 0.35	U = 0.40	1.38	3.3%	80%	80%	25	$1,719
Existing	Restaurant	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	1.38	9.9%	10%	80%	25	$24570
Existing	Restaurant	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	8.57	3.3%	NA	NA	20	$420
Existing	Restaurant	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	8.81	15.1%	5%	95%	10	$8,704
Existing	Restaurant	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	8.81	0.6%	5%	80%	11	$305
Existing	Restaurant	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	8.81	5.0%	75%	94%	15	$1,459
Existing	Restaurant	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	8.81	2.1%	100%	80%	10	$2,700
Existing	Restaurant	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	8.81	5.6%	100%	95%	10	$841
Existing	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	8.81	0.3%	85%	25%	13	$32
Existing	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	8.81	0.4%	85%	55%	13	$630
Existing	Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	8.81	20.0%	5%	92%	25	$2,276
Existing	Restaurant	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	8.81	4.0%	95%	25%	10	$0
Existing	Restaurant	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	8.81	3.8%	95%	15%	10	$2
Existing	Restaurant	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	8.81	58.9%	40%	94%	15	$9,059
Existing	Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	8.81	1.0%	80%	90%	15	$56
Existing	Restaurant	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	8.81	2.3%	95%	25%	5	$5
Existing	Restaurant	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	8.81	1.1%	15%	75%	10	$6
Existing	Restaurant	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	8.81	2.5%	15%	20%	10	$12
Existing	Restaurant	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	8.81	39.5%	20%	95%	20	107184
Existing	Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	8.81	3.3%	95%	75%	10	$206

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	8.81	7.7%	75%	75%	11	$108
New	Restaurant	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	9.60	2.5%	45%	70%	12	$4,946
New	Restaurant	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	9.60	8.3%	35%	85%	12	$1,800
New	Restaurant	Cooking	Oven - Convection	Convection Oven	Standard Oven	9.60	3.4%	85%	85%	15	$1,734
New	Restaurant	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	9.60	5.5%	35%	75%	10	$1
New	Restaurant	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	1.61	14.2%	NA	NA	15	$4,353
New	Restaurant	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	1.61	6.4%	NA	NA	15	$2,317
New	Restaurant	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	1.61	10.4%	NA	NA	15	$3,592
New	Restaurant	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.48	12.5%	90%	80%	3	$3,835
New	Restaurant	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	1.48	25.0%	50%	85%	15	$10944
New	Restaurant	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.48	10.0%	75%	100%	5	$2,829
New	Restaurant	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.48	4.5%	100%	85%	10	$5,726
New	Restaurant	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	1.48	5.0%	15%	98%	30	$53216
New	Restaurant	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	1.48	2.0%	75%	95%	25	$2,732
New	Restaurant	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	1.48	3.0%	75%	98%	25	$3,625
New	Restaurant	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.48	3.0%	95%	95%	25	$1,753
New	Restaurant	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.48	1.0%	35%	90%	25	$473
New	Restaurant	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.48	10.0%	40%	98%	25	$814
New	Restaurant	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	1.48	2.3%	75%	75%	30	$2,156
New	Restaurant	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	1.48	1.0%	80%	80%	25	$6,876
New	Restaurant	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	2.90	20.0%	1%	75%	10	$1,074
New	Restaurant	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	2.90	7.5%	100%	25%	10	$6,829
New	Restaurant	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	2.90	3.8%	85%	81%	10	$247

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Restaurant	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	2.90	33.8%	85%	75%	20	$1,066
New	Restaurant	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	2.90	8.8%	20%	77%	10	$1,918
New	Restaurant	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2.90	1.6%	0%	94%	10	$1,791
New	Restaurant	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.28	16.8%	NA	NA	15	$3,086
New	Restaurant	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.28	30.2%	NA	NA	15	$6,607
New	Restaurant	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.94	12.5%	90%	80%	3	$3,835
New	Restaurant	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.94	10.0%	75%	100%	5	$2,829
New	Restaurant	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.94	2.5%	5%	94%	10	$9,035
New	Restaurant	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.94	4.5%	100%	85%	10	$5,726
New	Restaurant	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.94	1.3%	15%	98%	30	$53216
New	Restaurant	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.94	21.1%	45%	92%	20	$35790
New	Restaurant	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.94	45.0%	45%	92%	20	$67238
New	Restaurant	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.94	17.6%	0%	90%	20	$7,199
New	Restaurant	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.94	31.2%	0%	90%	20	$9,508
New	Restaurant	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.94	5.9%	75%	95%	25	$2,732
New	Restaurant	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.94	8.9%	75%	98%	25	$3,625
New	Restaurant	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.94	5.0%	95%	95%	25	$1,753
New	Restaurant	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.94	3.7%	35%	90%	25	$473
New	Restaurant	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.94	10.0%	40%	98%	25	$814
New	Restaurant	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.94	6.8%	80%	80%	25	$6,876
New	Restaurant	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	3.29	2.0%	10%	75%	9	$414
New	Restaurant	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	3.29	6.0%	60%	98%	9	$681
New	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.43	3.29	15.0%	90%	70%	14	$851

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.43	3.29	20.0%	75%	85%	14	$2,269
New	Restaurant	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.43	3.29	25.0%	70%	90%	14	$3,719
New	Restaurant	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	3.29	1.9%	50%	80%	13	$630
New	Restaurant	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	3.29	1.5%	10%	95%	14	$36
New	Restaurant	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	3.29	4.0%	45%	100%	10	$98
New	Restaurant	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	2.25	0.4%	95%	90%	7	$2
New	Restaurant	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	2.25	13.6%	64%	25%	4	$1
New	Restaurant	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	2.25	10.3%	5%	45%	6	$165
New	Restaurant	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	2.25	1.8%	75%	55%	4	$1
New	Restaurant	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	2.25	18.4%	64%	15%	4	$158
New	Restaurant	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	2.25	1.3%	75%	40%	5	$16
New	Restaurant	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	2.25	0.9%	75%	45%	4	$1
New	Restaurant	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	2.25	3.3%	35%	75%	10	$1
New	Restaurant	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	2.25	1.8%	95%	30%	3	$310
New	Restaurant	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	2.25	1.0%	95%	86%	7	$1
New	Restaurant	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	2.25	1.2%	75%	95%	10	$86
New	Restaurant	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	2.25	0.7%	35%	65%	13	$126
New	Restaurant	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	2.25	8.7%	25%	35%	7	$578
New	Restaurant	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	2.25	16.0%	5%	80%	14	$189
New	Restaurant	Refrigeration	Anti-Sweat (Humidistat) Controls	Variable Temp. Controls (Humidistat)	Constant Controls	5.60	35.4%	25%	45%	12	$954
New	Restaurant	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	5.60	17.3%	95%	100%	12	$345
New	Restaurant	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	5.60	3.6%	85%	65%	10	$9,595
New	Restaurant	Refrigeration	Display Cases	High-Efficiency Display Cases	Display Cases - Standard	5.60	3.6%	40%	90%	15	$1,[illegible]78
New	Restaurant	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	5.60	8.4%	85%	72%	10	$1,578
New	Restaurant	Refrigeration	High-Efficiency Evaporator Fans - Walk-ins	High-Efficiency Evaporator Fans, Walk-in Refrigerators	Standard Evaporator Fans	5.60	1.0%	92%	75%	15	$203
New	Restaurant	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	5.60	5.8%	85%	86%	9	$376
New	Restaurant	Refrigeration	Motor - Case Fans with ECM motors	ECM motors on evaporator fan, on display cases	48 cf 2-door reach-in commercial refrigerator	5.60	0.5%	95%	50%	20	$229

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Restaurant	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	5.60	6.0%	75%	70%	10	$76
New	Restaurant	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	5.60	5.0%	80%	90%	3	$94
New	Restaurant	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	5.60	3.2%	95%	77%	16	$315
New	Restaurant	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	5.60	2.0%	95%	20%	4	$189
New	Restaurant	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.32	12.5%	90%	80%	3	$3,835
New	Restaurant	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.32	10.0%	75%	100%	5	$2,829
New	Restaurant	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.32	15.0%	5%	94%	10	$9,035
New	Restaurant	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.32	4.5%	100%	85%	10	$5,726
New	Restaurant	Space Heat	Insulation (Ceiling)	R-49	R-30	0.32	8.0%	75%	98%	25	$2,732
New	Restaurant	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.32	6.0%	95%	95%	25	$1,753
New	Restaurant	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.32	5.0%	35%	90%	25	$473
New	Restaurant	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.32	10.0%	40%	98%	25	$814
New	Restaurant	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.32	25.0%	50%	98%	10	$11084
New	Restaurant	Space Heat	Windows	U = 0.35	U = 0.40	0.32	3.3%	80%	80%	25	$1,719
New	Restaurant	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	8.76	3.3%	NA	NA	20	$420
New	Restaurant	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	8.61	15.1%	5%	95%	10	$8,704
New	Restaurant	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	8.61	0.6%	5%	80%	11	$305
New	Restaurant	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	8.61	5.0%	90%	94%	15	$1,459
New	Restaurant	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	8.61	2.1%	100%	80%	10	$2,700
New	Restaurant	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	8.61	5.6%	100%	95%	10	$841
New	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	8.61	0.3%	85%	25%	13	$32
New	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	8.61	0.4%	85%	55%	13	$630
New	Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	8.61	20.0%	25%	92%	25	$2,276
New	Restaurant	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	8.61	4.0%	95%	25%	10	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Restaurant	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	8.61	58.9%	50%	94%	15	$9,059
New	Restaurant	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	8.61	2.3%	95%	25%	5	$5
New	Restaurant	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	8.61	1.1%	15%	75%	10	$6
New	Restaurant	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	8.61	40.3%	20%	95%	20	107164
New	Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	8.61	3.3%	95%	75%	10	$206
New	Restaurant	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	8.61	7.7%	75%	75%	11	$108
Existing	School	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.22	2.5%	35%	70%	12	$4,948
Existing	School	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.22	8.4%	75%	85%	12	$1,800
Existing	School	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.22	3.4%	85%	40%	15	$1,736
Existing	School	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.22	2.3%	35%	75%	10	$0
Existing	School	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.29	20.0%	NA	NA	20	$7,619
Existing	School	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.29	27.3%	NA	NA	20	$9,496
Existing	School	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.29	9.5%	NA	NA	20	$2,730
Existing	School	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.32	10.0%	25%	94%	15	$37066
Existing	School	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	0.32	40.0%	43%	45%	10	$14209
Existing	School	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.32	7.6%	25%	70%	10	$17233
Existing	School	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.32	5.0%	95%	85%	10	$40084
Existing	School	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	0.32	5.0%	45%	90%	10	$40025
Existing	School	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.32	12.5%	90%	40%	3	$11596
Existing	School	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.32	8.0%	50%	94%	15	$1,706
Existing	School	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	0.32	14.0%	95%	35%	10	$188

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	0.32	4.0%	95%	75%	10	$1,541
Existing	School	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.32	15.0%	5%	34%	5	$56576
Existing	School	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.32	10.0%	75%	80%	5	$31683
Existing	School	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.32	15.0%	50%	80%	5	$22863
Existing	School	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.32	2.5%	45%	45%	18	$23534
Existing	School	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.32	4.5%	73%	85%	10	$5,725
Existing	School	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.32	5.0%	15%	98%	30	298005
Existing	School	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.32	1.0%	75%	45%	25	$15297
Existing	School	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.32	1.5%	75%	85%	25	$20298
Existing	School	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.32	1.2%	75%	15%	25	$17945
Existing	School	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.32	3.0%	75%	0%	25	$17945
Existing	School	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.32	4.4%	10%	15%	25	$6,578
Existing	School	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.32	2.4%	10%	15%	25	$6,854
Existing	School	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.32	3.0%	10%	95%	25	$8,296
Existing	School	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.32	8.4%	10%	35%	25	$9,090
Existing	School	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.32	10.0%	10%	0%	25	$8,990
Existing	School	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.32	0.5%	35%	35%	25	$2,648
Existing	School	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.32	1.5%	35%	35%	25	$15297
Existing	School	Cooling Chillers	Pipe Insulation	R-4	R-0	0.32	1.0%	65%	45%	15	$1,206

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.32	25.0%	25%	98%	10	124142
Existing	School	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.32	44.8%	60%	99%	20	$46674
Existing	School	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.32	2.2%	80%	60%	25	$49751
Existing	School	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.32	1.1%	10%	60%	25	140474
Existing	School	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.32	14.2%	NA	NA	15	$19910
Existing	School	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.32	6.4%	NA	NA	15	$10602
Existing	School	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.32	10.4%	NA	NA	15	$16433
Existing	School	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.35	10.0%	25%	94%	15	$37066
Existing	School	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.35	12.5%	90%	40%	3	$11596
Existing	School	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	0.35	15.0%	10%	30%	15	$13809
Existing	School	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.35	25.0%	50%	85%	15	122577
Existing	School	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.35	15.0%	5%	34%	5	$56576
Existing	School	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.35	10.0%	75%	80%	5	$31683
Existing	School	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.35	15.0%	50%	80%	5	$22863
Existing	School	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.35	2.5%	45%	45%	18	$23534
Existing	School	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.35	4.5%	73%	85%	10	$5,725
Existing	School	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.35	5.0%	15%	98%	30	298005
Existing	School	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.35	1.0%	75%	45%	25	$15297
Existing	School	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.35	1.5%	75%	85%	25	$20298
Existing	School	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.35	1.2%	75%	15%	25	$17945
Existing	School	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.35	3.0%	75%	0%	25	$17945
Existing	School	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.35	4.4%	10%	15%	25	$6,578

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.35	2.4%	10%	15%	25	$6,854
Existing	School	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.35	3.0%	10%	95%	25	$8,296
Existing	School	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.35	8.4%	10%	35%	25	$9,090
Existing	School	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.35	10.0%	10%	0%	25	$8,990
Existing	School	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.35	0.5%	35%	35%	25	$2,648
Existing	School	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.35	1.5%	35%	35%	25	$15297
Existing	School	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.35	3.0%	95%	79%	15	$147
Existing	School	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.35	2.2%	80%	60%	25	$49751
Existing	School	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.35	1.1%	10%	60%	25	140474
Existing	School	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	1.34	20.0%	1%	85%	10	$12026
Existing	School	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	1.34	7.5%	60%	85%	10	$13132
Existing	School	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	1.34	3.8%	85%	81%	10	$1,536
Existing	School	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	1.34	33.8%	85%	75%	20	$11938
Existing	School	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	1.34	8.8%	50%	77%	10	$21487
Existing	School	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	1.34	1.6%	50%	94%	10	$1,789
Existing	School	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.62	16.8%	NA	NA	15	$14115
Existing	School	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.62	30.2%	NA	NA	15	$30224
Existing	School	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	2.78	10.0%	25%	94%	15	$37066
Existing	School	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.78	12.5%	90%	40%	3	$11596
Existing	School	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.78	15.0%	5%	34%	5	$56576
Existing	School	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.78	10.0%	75%	80%	5	$30683
Existing	School	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.78	15.0%	50%	80%	5	$22863
Existing	School	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.78	2.5%	45%	45%	18	$23534
Existing	School	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.78	13.2%	5%	94%	10	$53363

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	2.78	4.5%	73%	85%	10	$5,725
Existing	School	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	2.78	0.2%	15%	98%	30	298005
Existing	School	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	2.78	5.7%	5%	92%	20	163708
Existing	School	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	2.78	25.8%	5%	92%	20	307566
Existing	School	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	2.78	24.9%	5%	90%	20	$32930
Existing	School	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	2.78	34.8%	5%	90%	20	$43491
Existing	School	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	2.78	3.0%	75%	45%	25	$15297
Existing	School	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	2.78	4.4%	75%	85%	25	$20298
Existing	School	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	2.78	2.8%	75%	15%	25	$17945
Existing	School	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	2.78	6.9%	75%	0%	25	$17945
Existing	School	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.78	4.4%	10%	15%	25	$6,578
Existing	School	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.78	2.4%	10%	15%	25	$6,854
Existing	School	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.78	5.0%	10%	95%	25	$8,296
Existing	School	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.78	16.6%	10%	35%	25	$9,090
Existing	School	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.78	19.8%	10%	0%	25	$8,990
Existing	School	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.78	1.9%	35%	35%	25	$2,648
Existing	School	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.78	5.6%	35%	35%	25	$15297
Existing	School	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.78	3.0%	95%	79%	15	$147
Existing	School	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	2.78	14.9%	80%	60%	25	$49751
Existing	School	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	2.78	9.8%	10%	60%	25	140474
Existing	School	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.75	2.0%	50%	75%	9	$4,636
Existing	School	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.75	15.0%	20%	81%	9	$17651
Existing	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.2	2.75	15.0%	90%	70%	14	$8,931
Existing	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.2	2.75	20.0%	75%	85%	14	$22522

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.2	2.75	25.0%	70%	90%	14	$35725
Existing	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.2	2.75	5.3%	65%	95%	14	$28347
Existing	School	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.2	Existing Lighting Design	2.75	36.0%	95%	45%	14	$54881
Existing	School	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	2.75	1.6%	95%	65%	11	$53
Existing	School	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.75	0.1%	50%	80%	13	$630
Existing	School	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.75	0.8%	10%	95%	14	$35
Existing	School	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.75	4.0%	90%	65%	9	$1,100
Existing	School	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	2.75	4.9%	85%	98%	9	$218
Existing	School	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	1.57	0.4%	95%	90%	7	$0
Existing	School	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	1.57	13.6%	64%	25%	4	$0
Existing	School	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	1.57	1.3%	90%	45%	6	$165
Existing	School	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	1.57	1.8%	75%	55%	4	$0
Existing	School	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	1.57	18.4%	64%	15%	4	$159
Existing	School	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	1.57	1.3%	75%	40%	5	$18
Existing	School	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	1.57	0.9%	75%	45%	4	$0
Existing	School	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	1.57	0.4%	10%	75%	10	$0
Existing	School	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	1.57	1.8%	95%	30%	3	$312
Existing	School	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	1.57	1.0%	95%	86%	7	$0
Existing	School	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	1.57	1.2%	75%	95%	10	$171
Existing	School	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	1.57	0.1%	75%	65%	13	$124
Existing	School	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	1.57	1.1%	25%	35%	7	$577
Existing	School	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	1.57	2.1%	75%	80%	14	$188
Existing	School	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	1.57	2.1%	75%	25%	3	$300
Existing	School	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.50	12.8%	95%	100%	12	$347
Existing	School	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.50	3.6%	85%	65%	10	$9,596
Existing	School	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.50	1.1%	85%	86%	9	$377

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.50	6.0%	75%	70%	10	$76
Existing	School	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	0.50	5.0%	80%	90%	3	$94
Existing	School	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.50	3.2%	95%	77%	16	$318
Existing	School	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.50	2.0%	95%	20%	4	$188
Existing	School	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	5.72	10.0%	25%	94%	15	$37066
Existing	School	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	5.72	12.5%	90%	40%	3	$11596
Existing	School	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	5.72	15.0%	5%	34%	5	$56576
Existing	School	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	5.72	10.0%	75%	80%	5	$31683
Existing	School	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	5.72	15.0%	50%	80%	5	$22863
Existing	School	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	5.72	2.5%	45%	45%	18	$23534
Existing	School	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	5.72	15.0%	5%	94%	10	$53363
Existing	School	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	5.72	4.5%	73%	85%	10	$5,725
Existing	School	Space Heat	Insulation (Ceiling)	R-49	R-30	5.72	4.0%	75%	85%	25	$15297
Existing	School	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	5.72	6.3%	75%	15%	25	$17945
Existing	School	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	5.72	12.5%	75%	0%	25	$17945
Existing	School	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	5.72	4.4%	10%	15%	25	$6,578
Existing	School	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	5.72	2.4%	10%	15%	25	$6,854
Existing	School	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	5.72	6.0%	10%	95%	25	$8,296
Existing	School	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	5.72	21.1%	10%	35%	25	$9,090
Existing	School	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	5.72	25.0%	10%	0%	25	$8,990
Existing	School	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	5.72	2.5%	35%	35%	25	$2,648
Existing	School	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	5.72	7.5%	35%	35%	25	$15297
Existing	School	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	5.72	25.0%	25%	98%	10	124142
Existing	School	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	5.72	3.0%	95%	79%	15	$147

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Space Heat	Windows	U = 0.35	U = 0.40	5.72	7.3%	80%	60%	25	$12438
Existing	School	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	5.72	21.8%	10%	60%	25	177788
Existing	School	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.44	3.3%	NA	NA	20	$1,294
Existing	School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.44	15.1%	35%	95%	10	$8,702
Existing	School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.44	0.8%	35%	80%	11	$306
Existing	School	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.44	5.0%	55%	94%	15	$16344
Existing	School	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.44	2.1%	85%	80%	10	$2,701
Existing	School	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.44	5.6%	85%	95%	10	$841
Existing	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.44	0.2%	65%	25%	13	$29
Existing	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.44	0.2%	65%	55%	13	$630
Existing	School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.44	20.0%	5%	92%	25	$7,001
Existing	School	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.44	4.0%	95%	25%	10	$0
Existing	School	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	1.44	3.8%	95%	15%	10	$0
Existing	School	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.44	58.9%	40%	94%	15	$7,143
Existing	School	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	1.44	1.0%	80%	8%	15	$624
Existing	School	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.44	2.3%	95%	25%	5	$6
Existing	School	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.44	3.4%	45%	75%	10	$6
Existing	School	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	1.44	7.5%	45%	20%	10	$12
Existing	School	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.44	7.2%	20%	95%	20	$17862
Existing	School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.44	3.3%	95%	75%	10	$206
Existing	School	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.44	7.7%	75%	15%	11	$106
New	School	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.22	2.5%	35%	70%	12	$4,948
New	School	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.22	8.3%	75%	85%	12	$1,800
New	School	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.22	3.4%	85%	40%	15	$1,736
New	School	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.22	2.3%	35%	75%	10	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.16	20.0%	NA	NA	20	$7,619
New	School	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.16	27.3%	NA	NA	20	$9,496
New	School	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.16	9.5%	NA	NA	20	$2,730
New	School	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.14	10.0%	25%	94%	15	$37066
New	School	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.14	7.6%	25%	70%	10	$17233
New	School	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.14	5.0%	95%	85%	10	$40084
New	School	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.14	12.5%	90%	80%	3	$42950
New	School	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.14	8.0%	50%	94%	15	$1,706
New	School	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.14	10.0%	75%	80%	5	$31683
New	School	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.14	4.5%	73%	85%	10	$5,725
New	School	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.14	5.0%	15%	98%	30	298005
New	School	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.14	1.0%	75%	45%	25	$15297
New	School	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.14	1.5%	75%	85%	25	$20298
New	School	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.14	3.0%	95%	95%	25	$8,296
New	School	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.14	0.5%	35%	35%	25	$2,648
New	School	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.14	10.0%	40%	98%	25	$9,119
New	School	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.14	25.0%	50%	98%	10	120142
New	School	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.14	44.8%	95%	99%	20	$43991

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.14	8.5%	75%	75%	30	$15603
New	School	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.14	2.2%	80%	60%	25	$49751
New	School	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.17	14.2%	NA	NA	15	$19910
New	School	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.17	6.4%	NA	NA	15	$10602
New	School	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.17	10.4%	NA	NA	15	$16433
New	School	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.16	10.0%	25%	94%	15	$37066
New	School	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.16	12.5%	90%	80%	3	$42950
New	School	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.16	25.0%	50%	85%	15	122577
New	School	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.16	10.0%	75%	80%	5	$31683
New	School	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.16	4.5%	73%	85%	10	$5,725
New	School	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.16	5.0%	15%	98%	30	298005
New	School	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.16	1.0%	75%	45%	25	$15297
New	School	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.16	1.5%	75%	85%	25	$20298
New	School	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.16	3.0%	95%	95%	25	$8,296
New	School	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.16	0.5%	35%	35%	25	$2,648
New	School	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.16	10.0%	40%	98%	25	$9,119
New	School	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.16	8.5%	75%	75%	30	$15603
New	School	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.16	2.2%	80%	60%	25	$49751
New	School	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	0.90	20.0%	1%	75%	10	$12026
New	School	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	0.90	7.5%	60%	85%	10	$6,831
New	School	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	0.90	3.8%	85%	81%	10	$1,536
New	School	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	0.90	33.8%	85%	75%	20	$11938

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	0.90	8.8%	65%	77%	10	$21487
New	School	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	0.90	1.6%	50%	94%	10	$1,789
New	School	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.24	16.8%	NA	NA	15	$14115
New	School	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.24	30.2%	NA	NA	15	$30224
New	School	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.13	10.0%	25%	94%	15	$37066
New	School	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.13	12.5%	90%	80%	3	$42950
New	School	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.13	10.0%	75%	80%	5	$31683
New	School	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.13	13.2%	5%	94%	10	$53363
New	School	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.13	4.5%	73%	85%	10	$5,725
New	School	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.13	0.2%	15%	98%	30	298005
New	School	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.13	5.7%	45%	92%	20	163708
New	School	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.13	25.8%	45%	92%	20	307566
New	School	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.13	24.9%	10%	90%	20	$32930
New	School	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.13	34.8%	10%	90%	20	$43491
New	School	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.13	3.0%	75%	45%	25	$15297
New	School	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.13	4.4%	75%	85%	25	$20298
New	School	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.13	5.0%	95%	95%	25	$8,296
New	School	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.13	1.9%	35%	35%	25	$2,648
New	School	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.13	10.0%	40%	98%	25	$9,119
New	School	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.13	14.9%	80%	60%	25	$49751
New	School	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	1.98	2.0%	50%	75%	9	$4,636
New	School	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	1.98	15.0%	45%	81%	9	$17651
New	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.2	1.98	15.0%	90%	70%	14	$5,295

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.2	1.98	20.0%	75%	85%	14	$17651
New	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.2	1.98	25.0%	70%	90%	14	$29653
New	School	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.2	1.98	5.3%	65%	95%	14	$22946
New	School	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	1.98	0.1%	50%	80%	13	$630
New	School	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	1.98	0.8%	10%	95%	14	$35
New	School	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	1.98	4.0%	90%	65%	10	$1,100
New	School	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	1.57	0.4%	95%	90%	7	$0
New	School	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	1.57	13.6%	64%	25%	4	$0
New	School	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	1.57	1.3%	90%	45%	6	$165
New	School	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	1.57	1.8%	75%	55%	4	$0
New	School	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	1.57	18.4%	64%	15%	4	$159
New	School	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	1.57	1.3%	75%	40%	5	$18
New	School	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	1.57	0.9%	75%	45%	4	$0
New	School	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	1.57	0.4%	10%	75%	10	$0
New	School	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	1.57	1.8%	95%	30%	3	$312
New	School	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	1.57	1.0%	95%	86%	7	$0
New	School	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	1.57	1.2%	75%	95%	10	$171
New	School	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	1.57	0.1%	75%	65%	13	$124
New	School	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	1.57	1.1%	25%	35%	7	$577
New	School	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	1.57	2.0%	75%	80%	14	$188
New	School	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.50	8.5%	95%	100%	12	$347
New	School	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.50	3.6%	85%	65%	10	$9,596
New	School	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.50	1.1%	85%	86%	9	$377
New	School	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.50	6.0%	75%	70%	10	$76
New	School	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	0.50	5.0%	80%	90%	3	$94

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.50	3.2%	95%	77%	16	$318
New	School	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.50	2.0%	95%	20%	4	$188
New	School	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.85	10.0%	25%	94%	15	$37066
New	School	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.85	12.5%	90%	80%	3	$42950
New	School	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.85	10.0%	75%	80%	5	$31683
New	School	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.85	15.0%	5%	94%	10	$53363
New	School	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.85	4.5%	73%	85%	10	$5,725
New	School	Space Heat	Insulation (Ceiling)	R-49	R-30	1.85	4.0%	75%	85%	25	$15297
New	School	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.85	6.0%	95%	95%	25	$8,296
New	School	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.85	2.5%	35%	35%	25	$2,648
New	School	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.85	10.0%	40%	98%	25	$9,119
New	School	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.85	25.0%	50%	98%	10	124142
New	School	Space Heat	Windows	U = 0.35	U = 0.40	1.85	7.3%	80%	60%	25	$12438
New	School	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.44	3.3%	NA	NA	20	$1,294
New	School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.42	15.1%	35%	95%	10	$8,702
New	School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.42	0.8%	35%	80%	11	$306
New	School	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.42	5.0%	55%	94%	15	$16344
New	School	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.42	2.1%	85%	80%	10	$2,701
New	School	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.42	5.6%	85%	95%	10	$841
New	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.42	0.2%	65%	25%	13	$[illegible]29
New	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.42	0.2%	65%	55%	13	$630
New	School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.42	20.0%	25%	92%	25	$7,001
New	School	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.42	4.0%	95%	25%	10	$0
New	School	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.42	58.9%	50%	94%	15	$7,143

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.42	2.3%	95%	25%	5	$6
New	School	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.42	3.4%	45%	75%	10	$6
New	School	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.42	7.2%	20%	95%	20	$17862
New	School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.42	3.3%	95%	75%	10	$206
New	School	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.42	7.7%	75%	15%	11	$106
Existing	University	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.42	2.5%	35%	70%	12	$4,944
Existing	University	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.42	8.4%	75%	85%	12	$1,800
Existing	University	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.42	3.4%	85%	40%	15	$1,734
Existing	University	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.42	2.3%	35%	75%	10	$0
Existing	University	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.29	20.0%	NA	NA	20	$8,572
Existing	University	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.29	27.3%	NA	NA	20	$10683
Existing	University	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.29	9.5%	NA	NA	20	$3,071
Existing	University	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.32	10.0%	25%	94%	15	$41699
Existing	University	Cooling Chillers	Centrifugal Chiller - VSD Remodel for Existing	VSD motor	Constant Speed Motor	0.32	40.0%	43%	45%	10	$15985
Existing	University	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.32	7.6%	25%	70%	10	$19387
Existing	University	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.32	5.0%	95%	85%	10	$45095
Existing	University	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	0.32	5.0%	45%	90%	10	$45029
Existing	University	Cooling Chillers	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.32	12.5%	90%	40%	3	$13046
Existing	University	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.32	8.0%	50%	94%	15	$1,9[illegible]9
Existing	University	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Two-Speed Tower Fans replace Single-Speed	Cooling Tower-One-Speed Fan Motor	0.32	14.0%	95%	35%	10	$212
Existing	University	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	0.32	4.0%	95%	75%	10	$1,734

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.32	15.0%	5%	34%	5	$63648
Existing	University	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.32	10.0%	75%	80%	5	$35643
Existing	University	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.32	15.0%	50%	80%	5	$25721
Existing	University	Cooling Chillers	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.32	2.5%	45%	45%	18	$26476
Existing	University	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.32	4.5%	73%	85%	10	$5,725
Existing	University	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.32	10.0%	15%	98%	30	335256
Existing	University	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.32	1.0%	75%	45%	25	$17209
Existing	University	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.32	1.5%	75%	85%	25	$22835
Existing	University	Cooling Chillers	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.32	1.2%	75%	13%	25	$20188
Existing	University	Cooling Chillers	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.32	3.0%	75%	0%	25	$20188
Existing	University	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.32	4.4%	10%	15%	25	$7,400
Existing	University	Cooling Chillers	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.32	2.4%	10%	15%	25	$7,711
Existing	University	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.32	3.0%	10%	95%	25	$8,803
Existing	University	Cooling Chillers	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.32	8.4%	10%	35%	25	$9,644
Existing	University	Cooling Chillers	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.32	10.0%	10%	0%	25	$9,531
Existing	University	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.32	0.5%	35%	35%	25	$2,979
Existing	University	Cooling Chillers	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.32	1.5%	35%	35%	25	$10209
Existing	University	Cooling Chillers	Pipe Insulation	R-4	R-0	0.32	1.0%	65%	45%	15	$1,357

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.32	25.0%	25%	98%	10	139660
Existing	University	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.32	44.8%	60%	99%	20	$52508
Existing	University	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.32	2.2%	80%	60%	25	$55970
Existing	University	Cooling Chillers	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.32	1.1%	10%	60%	25	158034
Existing	University	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.32	14.2%	NA	NA	15	$22398
Existing	University	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.32	6.4%	NA	NA	15	$11927
Existing	University	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.32	10.4%	NA	NA	15	$18487
Existing	University	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.35	10.0%	25%	94%	15	$41699
Existing	University	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.35	12.5%	90%	40%	3	$13046
Existing	University	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	0.35	15.0%	10%	90%	15	$15535
Existing	University	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.35	25.0%	50%	85%	15	137899
Existing	University	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.35	15.0%	5%	34%	5	$63648
Existing	University	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.35	10.0%	75%	80%	5	$35643
Existing	University	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.35	15.0%	50%	80%	5	$25721
Existing	University	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.35	2.5%	45%	45%	18	$26476
Existing	University	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.35	4.5%	73%	85%	10	$5,725
Existing	University	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.35	10.0%	15%	98%	30	335256
Existing	University	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.35	1.0%	75%	45%	25	$17299
Existing	University	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.35	1.5%	75%	85%	25	$22835
Existing	University	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.35	1.2%	75%	13%	25	$20188
Existing	University	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.35	3.0%	75%	0%	25	$20188
Existing	University	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.35	4.4%	10%	15%	25	$7,400

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.35	2.4%	10%	15%	25	$7,711
Existing	University	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.35	3.0%	10%	95%	25	$8,803
Existing	University	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.35	8.4%	10%	35%	25	$9,644
Existing	University	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.35	10.0%	10%	0%	25	$9,531
Existing	University	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.35	0.5%	35%	35%	25	$2,979
Existing	University	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.35	1.5%	35%	35%	25	$17209
Existing	University	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.35	3.0%	95%	66%	15	$146
Existing	University	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.35	2.2%	80%	60%	25	$55970
Existing	University	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.35	1.1%	10%	60%	25	158034
Existing	University	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	1.34	20.0%	20%	85%	10	$13529
Existing	University	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	1.34	7.5%	60%	85%	10	$13132
Existing	University	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	1.34	3.8%	85%	81%	10	$1,728
Existing	University	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	1.34	33.8%	85%	75%	20	$13430
Existing	University	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	1.34	8.8%	50%	77%	10	$24172
Existing	University	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	1.34	1.6%	75%	94%	10	$1,794
Existing	University	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	2.63	16.8%	NA	NA	15	$15879
Existing	University	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	2.63	30.2%	NA	NA	15	$34001
Existing	University	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	2.79	10.0%	25%	94%	15	$41699
Existing	University	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	2.79	12.5%	90%	40%	3	$13046
Existing	University	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	2.79	15.0%	5%	34%	5	$63648
Existing	University	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	2.79	10.0%	75%	80%	5	$36643
Existing	University	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	2.79	15.0%	50%	80%	5	$25721
Existing	University	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	2.79	2.5%	45%	45%	18	$26476
Existing	University	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	2.79	13.2%	5%	94%	10	$60034

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	2.79	4.5%	73%	85%	10	$5,725
Existing	University	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	2.79	0.4%	15%	98%	30	335256
Existing	University	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	2.79	5.7%	5%	92%	20	184172
Existing	University	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	2.79	25.8%	5%	92%	20	346012
Existing	University	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	2.79	24.9%	5%	90%	20	$37046
Existing	University	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	2.79	34.8%	5%	90%	20	$48927
Existing	University	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	2.79	3.0%	75%	45%	25	$17209
Existing	University	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	2.79	4.4%	75%	85%	25	$22835
Existing	University	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	2.79	2.8%	75%	13%	25	$20188
Existing	University	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	2.79	6.9%	75%	0%	25	$20188
Existing	University	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	2.79	4.4%	10%	15%	25	$7,400
Existing	University	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	2.79	2.4%	10%	15%	25	$7,711
Existing	University	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	2.79	5.0%	10%	95%	25	$8,803
Existing	University	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	2.79	16.6%	10%	35%	25	$9,644
Existing	University	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	2.79	19.8%	10%	0%	25	$9,531
Existing	University	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	2.79	1.9%	35%	35%	25	$2,979
Existing	University	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	2.79	5.6%	35%	35%	25	$17209
Existing	University	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	2.79	3.0%	95%	66%	15	$146
Existing	University	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	2.79	14.9%	80%	60%	25	$55970
Existing	University	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	2.79	9.8%	10%	60%	25	158034
Existing	University	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	3.83	2.0%	50%	75%	9	$5,216
Existing	University	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	3.83	15.0%	30%	63%	9	$19857
Existing	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.2	3.83	15.0%	90%	70%	14	$10648
Existing	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.2	3.83	20.0%	75%	85%	14	$25337

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.2	3.83	25.0%	70%	90%	14	$40190
Existing	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.2	3.83	5.3%	65%	95%	14	$31890
Existing	University	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 1.2	Existing Lighting Design	3.83	36.0%	95%	45%	14	$61741
Existing	University	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	3.83	1.6%	95%	65%	11	$53
Existing	University	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	3.83	0.2%	50%	80%	13	$629
Existing	University	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	3.83	0.8%	10%	95%	14	$40
Existing	University	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	3.83	4.0%	90%	37%	9	$1,238
Existing	University	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	3.83	4.9%	85%	92%	9	$218
Existing	University	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	1.16	0.4%	95%	90%	7	$0
Existing	University	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	1.16	13.6%	64%	25%	4	$0
Existing	University	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	1.16	1.6%	90%	45%	6	$165
Existing	University	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	1.16	1.8%	75%	55%	4	$0
Existing	University	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	1.16	18.4%	64%	15%	4	$159
Existing	University	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	1.16	1.3%	75%	40%	5	$13
Existing	University	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	1.16	0.9%	75%	45%	4	$0
Existing	University	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	1.16	0.5%	10%	75%	10	$0
Existing	University	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	1.16	1.8%	95%	30%	3	$311
Existing	University	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	1.16	1.0%	95%	86%	7	$0
Existing	University	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	1.16	1.2%	75%	95%	10	$172
Existing	University	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	1.16	0.1%	75%	65%	13	$126
Existing	University	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	1.16	1.4%	25%	35%	7	$576
Existing	University	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	1.16	2.5%	90%	80%	14	$192
Existing	University	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	1.16	2.6%	90%	25%	3	$298
Existing	University	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.51	7.6%	95%	100%	12	$344
Existing	University	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.51	3.6%	85%	65%	10	$9,597
Existing	University	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.51	1.1%	85%	86%	9	$377

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.51	6.0%	75%	70%	10	$86
Existing	University	Refrigeration	Refrigeration - Retro Commissioning	Refrigeration Retro Commissioning (Refrigeration System Diagnostics / Operations And Maintenance)	No Re-commissioning	0.51	5.0%	80%	90%	3	$106
Existing	University	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.51	3.2%	95%	77%	16	$357
Existing	University	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.51	2.0%	95%	20%	4	$192
Existing	University	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	5.74	10.0%	25%	94%	15	$41699
Existing	University	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	5.74	12.5%	90%	40%	3	$13046
Existing	University	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	5.74	15.0%	5%	34%	5	$63648
Existing	University	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	5.74	10.0%	75%	80%	5	$35643
Existing	University	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	5.74	15.0%	50%	80%	5	$25721
Existing	University	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	5.74	2.5%	45%	45%	18	$26476
Existing	University	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	5.74	15.0%	5%	94%	10	$60034
Existing	University	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	5.74	4.5%	73%	85%	10	$5,725
Existing	University	Space Heat	Insulation (Ceiling)	R-49	R-30	5.74	4.0%	75%	85%	25	$17209
Existing	University	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	5.74	6.3%	75%	13%	25	$20188
Existing	University	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	5.74	12.5%	75%	0%	25	$20188
Existing	University	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	5.74	4.4%	10%	15%	25	$7,400
Existing	University	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	5.74	2.4%	10%	15%	25	$7,711
Existing	University	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	5.74	6.0%	10%	95%	25	$8,803
Existing	University	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	5.74	21.1%	10%	35%	25	$9,644
Existing	University	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	5.74	25.0%	10%	0%	25	$9,531
Existing	University	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	5.74	2.5%	35%	35%	25	$2,979
Existing	University	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	5.74	7.5%	35%	35%	25	$17209
Existing	University	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	5.74	25.0%	25%	98%	10	139660
Existing	University	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	5.74	3.0%	95%	66%	15	$146

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Space Heat	Windows	U = 0.35	U = 0.40	5.74	7.3%	80%	60%	25	$13992
Existing	University	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	5.74	21.8%	10%	60%	25	200011
Existing	University	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.45	3.3%	NA	NA	20	$2,264
Existing	University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.45	15.1%	35%	95%	10	$8,704
Existing	University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.45	0.7%	35%	80%	11	$304
Existing	University	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.45	5.0%	55%	94%	15	$18387
Existing	University	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.45	2.1%	85%	80%	10	$2,701
Existing	University	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.45	5.6%	85%	95%	10	$841
Existing	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.45	0.2%	65%	25%	13	$33
Existing	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.45	0.2%	65%	55%	13	$629
Existing	University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.45	20.0%	5%	92%	25	$12258
Existing	University	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.45	4.0%	95%	25%	10	$0
Existing	University	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	1.45	3.8%	95%	15%	10	$0
Existing	University	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.45	58.9%	40%	94%	15	$5,017
Existing	University	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	1.45	1.0%	80%	70%	15	$702
Existing	University	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.45	2.3%	95%	45%	5	$7
Existing	University	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.45	3.4%	45%	75%	10	$7
Existing	University	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	1.45	7.5%	45%	20%	10	$13
Existing	University	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.45	6.9%	20%	95%	20	$26793
Existing	University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.45	3.3%	95%	75%	10	$205
Existing	University	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.45	7.7%	75%	15%	11	$106
New	University	Cooking	Cooking Fryers - Commercial	Energy Star Commercial Fryer	Non-Energy Star Fryer	0.42	2.5%	35%	70%	12	$4,944
New	University	Cooking	Hot Food Holding Cabinets - Commercial	Energy Star Commercial Hot Food Holding Cabinets	Non-Energy Star Commercial Hot Food Holding Cabinets	0.42	8.3%	75%	85%	12	$1,800
New	University	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.42	3.4%	85%	40%	15	$1,734
New	University	Cooking	Steam Cookers - Commercial	Energy Star Commercial Steam Cookers (50% efficiency)	Non-Energy Star Commercial Steam Cooker (35% efficiency)	0.42	2.3%	35%	75%	10	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.16	20.0%	NA	NA	20	$8,572
New	University	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.16	27.3%	NA	NA	20	$10683
New	University	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.16	9.5%	NA	NA	20	$3,071
New	University	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.14	10.0%	25%	94%	15	$41699
New	University	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for Secondary Chilled Water Loop	Primary Loop Only w/ Constant Speed Pump	0.14	7.6%	25%	70%	10	$19387
New	University	Cooling Chillers	Chilled Water Reset	Install Chilled Water Reset	No Chilled Water Reset	0.14	5.0%	95%	85%	10	$45095
New	University	Cooling Chillers	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.14	12.5%	90%	80%	3	$48318
New	University	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	0.14	8.0%	50%	94%	15	$1,919
New	University	Cooling Chillers	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.14	10.0%	75%	80%	5	$35643
New	University	Cooling Chillers	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.14	4.5%	73%	85%	10	$5,725
New	University	Cooling Chillers	Green Roof	Vegetation on Roof	Standard roofing techniques	0.14	10.0%	15%	98%	30	335256
New	University	Cooling Chillers	Insulation (Ceiling)	R-38	R-21 (Code)	0.14	1.0%	75%	45%	25	$17209
New	University	Cooling Chillers	Insulation (Ceiling)	R-49	R-21 (Code)	0.14	1.5%	75%	85%	25	$22835
New	University	Cooling Chillers	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.14	3.0%	95%	95%	25	$8,803
New	University	Cooling Chillers	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.14	0.5%	35%	35%	25	$2,979
New	University	Cooling Chillers	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.14	10.0%	40%	98%	25	$10259
New	University	Cooling Chillers	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.14	25.0%	50%	98%	10	139660
New	University	Cooling Chillers	Turbocor Compressor	0.35 kW/Ton Turbocor oil-free refrigerant compressor with variable frequency drive (VFD)	0.634 kW/ton (Code) chiller water cooled	0.14	44.8%	95%	99%	20	$49490

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.14	8.5%	75%	75%	30	$17553
New	University	Cooling Chillers	Windows	U = 0.35	U = 0.55 (Code)	0.14	2.2%	80%	60%	25	$55970
New	University	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.17	14.2%	NA	NA	15	$22398
New	University	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.17	6.4%	NA	NA	15	$11927
New	University	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.17	10.4%	NA	NA	15	$18487
New	University	Cooling DX	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	0.16	10.0%	25%	94%	15	$41699
New	University	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.16	12.5%	90%	80%	3	$48318
New	University	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.16	25.0%	50%	85%	15	137899
New	University	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.16	10.0%	75%	80%	5	$35643
New	University	Cooling DX	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.16	4.5%	73%	85%	10	$5,725
New	University	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.16	10.0%	15%	98%	30	335256
New	University	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.16	1.0%	75%	45%	25	$17209
New	University	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.16	1.5%	75%	85%	25	$22835
New	University	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.16	3.0%	95%	95%	25	$8,803
New	University	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.16	0.5%	35%	35%	25	$2,979
New	University	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.16	10.0%	40%	98%	25	$10259
New	University	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.16	8.5%	75%	75%	30	$17553
New	University	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.16	2.2%	80%	60%	25	$55970
New	University	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	0.90	20.0%	20%	75%	10	$13529
New	University	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	0.90	7.5%	60%	85%	10	$6,[illegible]31
New	University	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	0.90	3.8%	85%	81%	10	$1,728
New	University	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	0.90	33.8%	85%	75%	20	$13430

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	0.90	8.8%	65%	77%	10	$24172
New	University	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	0.90	1.6%	75%	94%	10	$1,794
New	University	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	1.24	16.8%	NA	NA	15	$15879
New	University	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	1.24	30.2%	NA	NA	15	$34001
New	University	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.13	10.0%	25%	94%	15	$41699
New	University	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.13	12.5%	90%	80%	3	$48318
New	University	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.13	10.0%	75%	80%	5	$35643
New	University	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.13	13.2%	5%	94%	10	$60034
New	University	Heat Pump	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.13	4.5%	73%	85%	10	$5,725
New	University	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	1.13	0.4%	15%	98%	30	335256
New	University	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.13	5.7%	45%	92%	20	184172
New	University	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	1.13	25.8%	45%	92%	20	346012
New	University	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.13	24.9%	10%	90%	20	$37046
New	University	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	1.13	34.8%	10%	90%	20	$48927
New	University	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	1.13	3.0%	75%	45%	25	$17209
New	University	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	1.13	4.4%	75%	85%	25	$22835
New	University	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.13	5.0%	95%	95%	25	$8,803
New	University	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.13	1.9%	35%	35%	25	$2,979
New	University	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.13	10.0%	40%	98%	25	$10259
New	University	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	1.13	14.9%	80%	60%	25	$55970
New	University	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.76	2.0%	50%	75%	9	$5,216
New	University	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.76	15.0%	60%	63%	9	$19857
New	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 1.2	2.76	15.0%	90%	70%	14	$5,937

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 1.2	2.76	20.0%	75%	85%	14	$19857
New	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 1.2	2.76	25.0%	70%	90%	14	$33359
New	University	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 1.2	2.76	5.3%	65%	95%	14	$25814
New	University	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.76	0.2%	50%	80%	13	$629
New	University	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.76	0.8%	10%	95%	14	$40
New	University	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.76	4.0%	90%	37%	10	$1,238
New	University	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	1.16	0.4%	95%	90%	7	$0
New	University	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	1.16	13.6%	64%	25%	4	$0
New	University	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	1.16	1.6%	90%	45%	6	$165
New	University	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	1.16	1.8%	75%	55%	4	$0
New	University	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	1.16	18.4%	64%	15%	4	$159
New	University	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	1.16	1.3%	75%	40%	5	$13
New	University	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	1.16	0.9%	75%	45%	4	$0
New	University	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	1.16	0.5%	10%	75%	10	$0
New	University	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	1.16	1.8%	95%	30%	3	$311
New	University	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	1.16	1.0%	95%	86%	7	$0
New	University	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	1.16	1.2%	75%	95%	10	$172
New	University	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	1.16	0.1%	75%	65%	13	$126
New	University	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	1.16	1.3%	25%	35%	7	$576
New	University	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	1.16	2.5%	90%	80%	14	$192
New	University	Refrigeration	Commercial Reach-In Refrigerator	Energy Star Commercial Reach-In Refrigerator	Commercial-Size Refrigerator - Standard	0.51	7.6%	95%	100%	12	$344
New	University	Refrigeration	Custom Refrigeration System	High-Efficiency Custom Refrigeration System (Walk-in) includes compressors	Custom Refrigeration System - Standard	0.51	3.6%	85%	65%	10	$9,597
New	University	Refrigeration	Ice Maker	Energy Star Ice Maker - High-Efficiency	Standard Ice Maker	0.51	1.1%	85%	86%	9	$377
New	University	Refrigeration	Reduced Speed or Cycling of Evaporator Fans	VFD on Evaporator Fans (Evap Fan Control on Walk-In)	Constant Speed Evaporator Fans	0.51	6.0%	75%	70%	10	$86
New	University	Refrigeration	Refrigeration - Commissioning	Commissioning (Refrigeration System Diagnostics / Operations and Maintenance for a new unit)	No Commissioning	0.51	5.0%	80%	90%	3	$106

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Refrigeration	Special Glass Doors for Refrigerated Reach-in Cases	Do Not Require Anti-Sweat Heating	Standard Glass Doors	0.51	3.2%	95%	77%	16	$357
New	University	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-Ins	0.51	2.0%	95%	20%	4	$192
New	University	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1.86	10.0%	25%	94%	15	$41699
New	University	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	1.86	12.5%	90%	80%	3	$48318
New	University	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.86	10.0%	75%	80%	5	$35643
New	University	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.86	15.0%	5%	94%	10	$60034
New	University	Space Heat	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	1.86	4.5%	73%	85%	10	$5,725
New	University	Space Heat	Insulation (Ceiling)	R-49	R-30	1.86	4.0%	75%	85%	25	$17209
New	University	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.86	6.0%	95%	95%	25	$8,803
New	University	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.86	2.5%	35%	35%	25	$2,979
New	University	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	1.86	10.0%	40%	98%	25	$10259
New	University	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.86	25.0%	50%	98%	10	139660
New	University	Space Heat	Windows	U = 0.35	U = 0.40	1.86	7.3%	80%	60%	25	$13992
New	University	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	1.45	3.3%	NA	NA	20	$2,264
New	University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	1.42	15.1%	35%	95%	10	$8,704
New	University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	1.42	0.7%	35%	80%	11	$304
New	University	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	1.42	5.0%	55%	94%	15	$18387
New	University	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	1.42	2.1%	85%	80%	10	$2,701
New	University	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	1.42	5.6%	85%	95%	10	$841
New	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	1.42	0.2%	65%	25%	13	$[illegible]33
New	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	1.42	0.2%	65%	55%	13	$629
New	University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	1.42	20.0%	25%	92%	25	$12258
New	University	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	1.42	4.0%	95%	25%	10	$0
New	University	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	1.42	58.9%	50%	94%	15	$5,017

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	1.42	2.3%	95%	45%	5	$7
New	University	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	1.42	3.4%	45%	75%	10	$7
New	University	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	1.42	6.9%	20%	95%	20	$26793
New	University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	1.42	3.3%	95%	75%	10	$205
New	University	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	1.42	7.7%	75%	15%	11	$106
Existing	Warehouse	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.17	20.0%	NA	NA	20	$3,055
Existing	Warehouse	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.17	27.3%	NA	NA	20	$3,811
Existing	Warehouse	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.17	9.5%	NA	NA	20	$1,094
Existing	Warehouse	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.18	14.2%	NA	NA	15	$6,830
Existing	Warehouse	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.18	6.4%	NA	NA	15	$3,635
Existing	Warehouse	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.18	10.4%	NA	NA	15	$5,635
Existing	Warehouse	Cooling DX	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.19	12.5%	90%	40%	3	$6,419
Existing	Warehouse	Cooling DX	Cooling DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	0.19	15.0%	10%	40%	15	$5,540
Existing	Warehouse	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.19	25.0%	50%	85%	15	$67855
Existing	Warehouse	Cooling DX	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.19	15.0%	5%	93%	5	$31319
Existing	Warehouse	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.19	10.0%	75%	98%	5	$17539
Existing	Warehouse	Cooling DX	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.19	15.0%	50%	98%	5	$12656
Existing	Warehouse	Cooling DX	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.19	2.5%	45%	45%	18	$13028
Existing	Warehouse	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.19	10.0%	15%	98%	30	329938
Existing	Warehouse	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.19	2.0%	75%	45%	25	$16936
Existing	Warehouse	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.19	3.0%	75%	85%	25	$20473
Existing	Warehouse	Cooling DX	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.19	2.4%	75%	10%	25	$19867
Existing	Warehouse	Cooling DX	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.19	6.0%	75%	0%	25	$19867
Existing	Warehouse	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.19	4.4%	10%	15%	25	$3,641

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Cooling DX	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.19	2.4%	10%	15%	25	$3,794
Existing	Warehouse	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.19	3.0%	10%	95%	25	$4,364
Existing	Warehouse	Cooling DX	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.19	8.4%	10%	35%	25	$4,781
Existing	Warehouse	Cooling DX	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.19	10.0%	10%	0%	25	$4,729
Existing	Warehouse	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.19	1.0%	35%	45%	25	$2,931
Existing	Warehouse	Cooling DX	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.19	3.0%	35%	45%	25	$16936
Existing	Warehouse	Cooling DX	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.19	3.0%	95%	20%	15	$147
Existing	Warehouse	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.19	0.3%	80%	98%	25	$7,364
Existing	Warehouse	Cooling DX	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.19	0.2%	10%	98%	25	$20789
Existing	Warehouse	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	0.59	20.0%	1%	85%	10	$6,657
Existing	Warehouse	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	0.59	7.5%	0%	85%	10	$13132
Existing	Warehouse	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	0.59	3.8%	85%	81%	10	$850
Existing	Warehouse	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	0.59	33.8%	85%	75%	20	$6,608
Existing	Warehouse	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	0.59	8.8%	10%	77%	10	$11894
Existing	Warehouse	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	0.59	1.6%	0%	94%	10	$1,791
Existing	Warehouse	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	0.72	16.8%	NA	NA	15	$4,840
Existing	Warehouse	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	0.72	30.2%	NA	NA	15	$10367
Existing	Warehouse	Heat Pump	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.76	12.5%	90%	40%	3	$6,419
Existing	Warehouse	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	0.76	15.0%	5%	93%	5	$31319
Existing	Warehouse	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.76	10.0%	75%	98%	5	$17539
Existing	Warehouse	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.76	15.0%	50%	98%	5	$12656
Existing	Warehouse	Heat Pump	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.76	2.5%	45%	45%	18	$13028
Existing	Warehouse	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.76	11.2%	5%	94%	10	$29540
Existing	Warehouse	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	0.76	0.8%	15%	98%	30	329938

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	0.76	8.6%	5%	92%	20	$56150
Existing	Warehouse	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	0.76	29.3%	5%	92%	20	105492
Existing	Warehouse	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	0.76	23.6%	20%	90%	20	$11295
Existing	Warehouse	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	0.76	34.1%	20%	90%	20	$14917
Existing	Warehouse	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	0.76	5.9%	75%	45%	25	$16936
Existing	Warehouse	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	0.76	8.9%	75%	85%	25	$22473
Existing	Warehouse	Heat Pump	Insulation (Ceiling) - Existing to Code	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.76	5.5%	75%	10%	25	$19867
Existing	Warehouse	Heat Pump	Insulation (Ceiling) - Zero to Code	R-21 (Code)	R-0	0.76	13.8%	75%	0%	25	$19867
Existing	Warehouse	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.76	4.4%	10%	15%	25	$3,641
Existing	Warehouse	Heat Pump	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.76	2.4%	10%	15%	25	$3,794
Existing	Warehouse	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.76	5.0%	10%	95%	25	$4,364
Existing	Warehouse	Heat Pump	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.76	16.6%	10%	35%	25	$4,781
Existing	Warehouse	Heat Pump	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.76	19.8%	10%	0%	25	$4,729
Existing	Warehouse	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.76	3.7%	35%	45%	25	$2,931
Existing	Warehouse	Heat Pump	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	0.76	11.1%	35%	45%	25	$16936
Existing	Warehouse	Heat Pump	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.76	3.0%	95%	20%	15	$147
Existing	Warehouse	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	0.76	2.1%	80%	98%	25	$7,364
Existing	Warehouse	Heat Pump	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.76	1.4%	10%	98%	25	$20789
Existing	Warehouse	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	2.54	2.0%	10%	75%	9	$2,566
Existing	Warehouse	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	2.54	6.0%	30%	98%	9	$3,908
Existing	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 0.80	2.54	15.0%	90%	70%	14	$2,775
Existing	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 0.80	2.54	20.0%	75%	85%	14	$7,074
Existing	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 0.80	2.54	25.0%	70%	90%	14	$11588
Existing	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 0.80	2.54	35.0%	65%	95%	14	$15887

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Lighting	HE Fixtures/Design - Existing to Code	Code Required LPD And Control Strategies: LPD = 0.80	Existing Lighting Design	2.54	33.0%	95%	45%	14	$18643
Existing	Warehouse	Lighting	LED Exit Lighting	5 Watts	CFL Exit Sign (26 Watts)	2.54	1.6%	95%	65%	11	$52
Existing	Warehouse	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	2.54	0.4%	0%	80%	13	$632
Existing	Warehouse	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	2.54	0.8%	10%	95%	14	$36
Existing	Warehouse	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	2.54	4.0%	90%	83%	9	$609
Existing	Warehouse	Lighting	Time Clocks And Timers	Install Time Clock Lighting	No Time Clock	2.54	4.9%	85%	100%	9	$215
Existing	Warehouse	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	0.53	0.4%	95%	90%	7	$3
Existing	Warehouse	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	0.53	13.6%	64%	25%	4	$0
Existing	Warehouse	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	0.53	7.3%	5%	45%	6	$166
Existing	Warehouse	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	0.53	1.8%	75%	55%	4	$0
Existing	Warehouse	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	0.53	18.4%	64%	15%	4	$156
Existing	Warehouse	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	0.53	1.3%	75%	40%	5	$16
Existing	Warehouse	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	0.53	0.9%	75%	45%	4	$0
Existing	Warehouse	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	0.53	2.3%	75%	75%	10	$0
Existing	Warehouse	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	0.53	1.8%	95%	30%	3	$309
Existing	Warehouse	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	0.53	1.0%	95%	86%	7	$0
Existing	Warehouse	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	0.53	1.2%	75%	95%	10	$85
Existing	Warehouse	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	0.53	0.5%	65%	65%	13	$127
Existing	Warehouse	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	0.53	6.1%	25%	35%	7	$576
Existing	Warehouse	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	0.53	11.3%	10%	80%	14	$189
Existing	Warehouse	Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	0.53	11.6%	10%	25%	3	$296
Existing	Warehouse	Space Heat	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	1.15	12.5%	90%	40%	3	$6,419
Existing	Warehouse	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	1.15	15.0%	5%	93%	5	$31319
Existing	Warehouse	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	1.15	10.0%	75%	98%	5	$17539
Existing	Warehouse	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	1.15	15.0%	50%	98%	5	$12656
Existing	Warehouse	Space Heat	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	1.15	2.5%	45%	45%	18	$13028
Existing	Warehouse	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	1.15	15.0%	5%	94%	10	$29540

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Space Heat	Insulation (Ceiling)	R-49	R-30	1.15	8.0%	75%	85%	25	$16936
Existing	Warehouse	Space Heat	Insulation (Ceiling) - Existing to Code	R-30	Existing Ceiling Insulation (Average R-9)	1.15	12.5%	75%	10%	25	$19867
Existing	Warehouse	Space Heat	Insulation (Ceiling) - Zero to Code	R-30	R-0	1.15	25.0%	75%	0%	25	$19867
Existing	Warehouse	Space Heat	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	1.15	4.4%	10%	15%	25	$3,641
Existing	Warehouse	Space Heat	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	1.15	2.4%	10%	15%	25	$3,794
Existing	Warehouse	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	1.15	6.0%	10%	95%	25	$4,364
Existing	Warehouse	Space Heat	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	1.15	21.1%	10%	35%	25	$4,781
Existing	Warehouse	Space Heat	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	1.15	25.0%	10%	0%	25	$4,729
Existing	Warehouse	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	1.15	5.0%	35%	45%	25	$2,931
Existing	Warehouse	Space Heat	Insulation - Floor (Non-Slab) - Existing to Code	R-10 (Code)	R-0	1.15	15.0%	35%	45%	25	$16936
Existing	Warehouse	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	1.15	25.0%	25%	98%	10	$68721
Existing	Warehouse	Space Heat	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	1.15	3.0%	95%	20%	15	$147
Existing	Warehouse	Space Heat	Windows	U = 0.35	U = 0.40	1.15	1.0%	80%	98%	25	$1,840
Existing	Warehouse	Space Heat	Windows - Existing to Code	U = 0.40	Existing Windows (U=0.65)	1.15	3.0%	10%	98%	25	$26313
Existing	Warehouse	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.19	3.3%	NA	NA	20	$114
Existing	Warehouse	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.20	15.1%	5%	95%	10	$8,706
Existing	Warehouse	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.20	4.3%	5%	80%	11	$306
Existing	Warehouse	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.20	5.0%	55%	94%	15	$9,048
Existing	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.20	2.3%	5%	25%	13	$33
Existing	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.20	3.1%	5%	55%	13	$632
Existing	Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.20	20.0%	5%	92%	25	$612
Existing	Warehouse	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.20	4.0%	95%	25%	10	$0
Existing	Warehouse	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.20	3.8%	95%	15%	10	$3
Existing	Warehouse	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.20	58.9%	40%	94%	15	$9,732
Existing	Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.20	1.0%	80%	90%	15	$173
Existing	Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.20	1.1%	15%	75%	10	$7

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.20	2.5%	15%	20%	10	$13
Existing	Warehouse	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.20	32.7%	20%	95%	20	$8,931
Existing	Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.20	3.3%	95%	95%	10	$205
Existing	Warehouse	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.20	7.7%	75%	45%	11	$107
New	Warehouse	Cooling Chillers	Chiller - Premium Efficiency	0.507 kW/ton	0.634 kW/ton	0.22	20.0%	NA	NA	20	$3,055
New	Warehouse	Cooling Chillers	Chiller - Advanced Technology	0.461 kW/ton	0.634 kW/ton	0.22	27.3%	NA	NA	20	$3,811
New	Warehouse	Cooling Chillers	Chiller - High Efficiency	0.574 kW/ton	0.634 kW/ton	0.22	9.5%	NA	NA	20	$1,094
New	Warehouse	Cooling Chillers	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.20	4.9%	75%	75%	30	$2,309
New	Warehouse	Cooling DX	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	Advanced-Efficiency 12.0 EER Rooftop Unit (CEE Tier 3)	10.3 EER Rooftop Unit (State Code)	0.24	14.2%	NA	NA	15	$6,830
New	Warehouse	Cooling DX	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	High-Efficiency 11.0 EER Rooftop Unit, (CEE Tier 1)	10.3 EER Rooftop Unit (State Code)	0.24	6.4%	NA	NA	15	$3,635
New	Warehouse	Cooling DX	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	Premium-Efficiency 11.5 EER Rooftop Unit (CEE Tier 2)	10.3 EER Rooftop Unit (State Code)	0.24	10.4%	NA	NA	15	$5,635
New	Warehouse	Cooling DX	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.22	12.5%	90%	80%	3	$23776
New	Warehouse	Cooling DX	Direct / Indirect Evaporative Cooling, Pre-Cooling	Direct / Indirect Evaporative Cooling, Pre-Cooling	No modification to DX system	0.22	25.0%	50%	85%	15	$67855
New	Warehouse	Cooling DX	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.22	10.0%	75%	98%	5	$17539
New	Warehouse	Cooling DX	Green Roof	Vegetation on Roof	Standard roofing techniques	0.22	10.0%	15%	98%	30	329938
New	Warehouse	Cooling DX	Insulation (Ceiling)	R-38	R-21 (Code)	0.22	2.0%	75%	45%	25	$16936
New	Warehouse	Cooling DX	Insulation (Ceiling)	R-49	R-21 (Code)	0.22	3.0%	75%	85%	25	$22473
New	Warehouse	Cooling DX	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.22	3.0%	95%	95%	25	$4,364
New	Warehouse	Cooling DX	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.22	1.0%	35%	45%	25	$2,931
New	Warehouse	Cooling DX	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.22	10.0%	40%	98%	25	$5,048
New	Warehouse	Cooling DX	Window RE - Window Overhangs	Overhangs over windows for shading	No window overhangs	0.22	4.9%	75%	75%	30	$2,309
New	Warehouse	Cooling DX	Windows	U = 0.35	U = 0.55 (Code)	0.22	0.3%	80%	98%	25	$7,364
New	Warehouse	HVAC Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	0.57	20.0%	1%	75%	10	$6,657

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Warehouse	HVAC Aux	Cooking Hood Controls	Demand Controlled Ventilation - Cooking Hood Controls, with Sensors, Variable Speed Control, And Direct Make-up Air	No Cooking Hood Controls	0.57	7.5%	0%	85%	10	$6,830
New	Warehouse	HVAC Aux	Motor - Premium-Efficiency	PE Motors for HVAC Applications	Standard Efficiency Motors	0.57	3.8%	85%	81%	10	$850
New	Warehouse	HVAC Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	0.57	33.8%	85%	75%	20	$6,608
New	Warehouse	HVAC Aux	Motor - VAV Box High-Efficiency	ECM Motors	Standard Efficiency - Induction Motors with Silicon Controlled Rectifier (SCR) Speed Control	0.57	8.8%	20%	77%	10	$11894
New	Warehouse	HVAC Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	0.57	1.6%	0%	94%	10	$1,791
New	Warehouse	Heat Pump	High-Efficiency EER=11.0, COP=3.5	High-Efficiency EER=11.0, COP=3.5	EER=10.1, COP=3.2	0.57	16.8%	NA	NA	15	$4,840
New	Warehouse	Heat Pump	Premium-Efficiency EER=11.8, COP=3.8	Premium-Efficiency EER=11.8, COP=3.8	EER=10.1, COP=3.2	0.57	30.2%	NA	NA	15	$10367
New	Warehouse	Heat Pump	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.52	12.5%	90%	80%	3	$23776
New	Warehouse	Heat Pump	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.52	10.0%	75%	98%	5	$17539
New	Warehouse	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.52	11.2%	5%	94%	10	$29540
New	Warehouse	Heat Pump	Green Roof	Vegetation on Roof	Standard roofing techniques	0.52	0.8%	15%	98%	30	329938
New	Warehouse	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=3.1, EER=13.4	Stnd. Air Source HP 'EER=10.1, COP=3.2	0.52	8.6%	45%	92%	20	$56150
New	Warehouse	Heat Pump	Heat Pump - Ground Source (Closed Loop)	GSHP: COP=4.0, EER=20	Stnd. Air Source HP 'EER=10.1, COP=3.2	0.52	29.3%	45%	92%	20	105492
New	Warehouse	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.2, EER=12.0	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	0.52	23.6%	40%	90%	20	$11295
New	Warehouse	Heat Pump	Heat Pump - Water Source (Closed Loop)	WSHP: COP=4.8, EER=14.5	Stnd. Air Source Heat Pump'EER=10.1, COP=3.2	0.52	34.1%	40%	90%	20	$14917
New	Warehouse	Heat Pump	Insulation (Ceiling)	R-38	R-21 (Code)	0.52	5.9%	75%	45%	25	$16936
New	Warehouse	Heat Pump	Insulation (Ceiling)	R-49	R-21 (Code)	0.52	8.9%	75%	85%	25	$22473
New	Warehouse	Heat Pump	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.52	5.0%	95%	95%	25	$4,364
New	Warehouse	Heat Pump	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.52	3.7%	35%	45%	25	$2,931
New	Warehouse	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.52	10.0%	40%	98%	25	$5,048
New	Warehouse	Heat Pump	Windows	U = 0.35	U = 0.55 (Code)	0.52	2.1%	80%	98%	25	$7,354
New	Warehouse	Lighting	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	1.70	2.0%	10%	75%	9	$2,566
New	Warehouse	Lighting	Daylighting Controls - Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	1.70	6.0%	60%	98%	9	$3,908

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 15%	Code Required LPD And Control Strategies: LPD = 0.80	1.70	15.0%	90%	70%	14	$1,563
New	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 20%	Code Required LPD And Control Strategies: LPD = 0.80	1.70	20.0%	75%	85%	14	$5,472
New	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 25%	Code Required LPD And Control Strategies: LPD = 0.80	1.70	25.0%	70%	90%	14	$9,575
New	Warehouse	Lighting	HE Fixtures/Design	Lighting Power Densities Above Code Requirements by 35% - Only High Bay Applications	Code Required LPD And Control Strategies: LPD = 0.80	1.70	35.0%	65%	95%	14	$13484
New	Warehouse	Lighting	LED Refrigeration Case Lights	LED Refrigeration Case Lights (28W)	Fluorescent Refrigeration Case Lights (60W)	1.70	0.6%	0%	80%	13	$632
New	Warehouse	Lighting	LED Solid State White Lighting Package	Landscape, mercandise, signage, structure & task lighting	50W 10hrs/day, 365 day/yr	1.70	0.8%	10%	95%	14	$36
New	Warehouse	Lighting	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	1.70	4.0%	90%	83%	10	$609
New	Warehouse	Plug Load	Energy Star - Battery Charging System	Energy Star Battery Charging System	Non-Energy Star Battery Chargers	0.53	0.4%	95%	90%	7	$3
New	Warehouse	Plug Load	Energy Star - Computer	Energy Star Features Enabled	Non-Energy Star Features	0.53	13.6%	64%	25%	4	$0
New	Warehouse	Plug Load	Energy Star - Copiers	Energy Star or Better Office Equipment: Copiers,	Office Equipment: Copiers, Standard	0.53	7.1%	5%	45%	6	$166
New	Warehouse	Plug Load	Energy Star - Fax	Energy Star Features Enabled	Non-Energy Star Features	0.53	1.8%	75%	55%	4	$0
New	Warehouse	Plug Load	Energy Star - Monitors	Energy Star Features Enabled	Non-Energy Star Features	0.53	18.4%	64%	15%	4	$156
New	Warehouse	Plug Load	Energy Star - Printers	Energy Star Features Enabled	Non-Energy Star Features	0.53	1.3%	75%	40%	5	$16
New	Warehouse	Plug Load	Energy Star - Scanners	Energy Star Features Enabled	Non-Energy Star Features	0.53	0.9%	75%	45%	4	$0
New	Warehouse	Plug Load	Energy Star - Water Cooler	Energy Star Water Cooler (Hot/Cold Water)	Non-Energy Star Water Cooler	0.53	2.3%	75%	75%	10	$0
New	Warehouse	Plug Load	Office Computer Network Energy Management	Office Computer Network Energy Management	No Network Management	0.53	1.8%	95%	30%	3	$309
New	Warehouse	Plug Load	Power Supply 80+ Office Measure	80% Efficient Power supply	No 80+	0.53	1.0%	95%	86%	7	$0
New	Warehouse	Plug Load	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	0.53	1.2%	75%	95%	10	$85
New	Warehouse	Plug Load	Residential-Size Refrigerator	Energy Star Residential-Size Refrigerator	Residential-Size Refrigerator - Standard	0.53	0.5%	65%	65%	13	$127
New	Warehouse	Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	0.53	5.9%	25%	35%	7	$576
New	Warehouse	Plug Load	Vending Machine	Energy Star Vending Machines - High-Efficiency	Vending Machines - Standard	0.53	10.9%	10%	80%	14	$189
New	Warehouse	Space Heat	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.38	12.5%	90%	80%	3	$23776
New	Warehouse	Space Heat	Direct Digital Control System-Optimization	DDC System (Optimized)	DDC System (Basic)	0.38	10.0%	75%	98%	5	$17539
New	Warehouse	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.38	15.0%	5%	94%	10	$29540
New	Warehouse	Space Heat	Insulation (Ceiling)	R-49	R-30	0.38	8.0%	75%	85%	25	$16986
New	Warehouse	Space Heat	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.38	6.0%	95%	95%	25	$4,364

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline kWh (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Warehouse	Space Heat	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.38	5.0%	35%	45%	25	$2,931
New	Warehouse	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.38	10.0%	40%	98%	25	$5,048
New	Warehouse	Space Heat	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 50% sensible and latent recovery effectiveness	No Heat Recovery	0.38	25.0%	50%	98%	10	$68721
New	Warehouse	Space Heat	Windows	U = 0.35	U = 0.40	0.38	1.0%	80%	98%	25	$1,840
New	Warehouse	Water Heat	Water_Heater (40 Gallon Electric) - Residential Sized	EF = 0.95	EF = 0.92	0.20	3.3%	NA	NA	20	$114
New	Warehouse	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.20	15.1%	5%	95%	10	$8,706
New	Warehouse	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.72	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.20	4.2%	5%	80%	11	$306
New	Warehouse	Water Heat	Demand controlled Circulating Systems	Install demand-based control system (VFD Control by Demand)	No demand control systems in place	0.20	5.0%	55%	94%	15	$9,048
New	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Standard Dishwasher (FED Std. EF=0.46)	0.20	2.2%	5%	25%	13	$33
New	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Standard Dishwasher (FED Std. EF=0.46)	0.20	3.1%	5%	55%	13	$632
New	Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	0.20	20.0%	25%	92%	25	$612
New	Warehouse	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.20	4.0%	95%	25%	10	$0
New	Warehouse	Water Heat	Heat Pump Water Heater	EF = 2.9	EF=0.93 Baseline Electric Water Heater	0.20	58.9%	50%	94%	15	$9,732
New	Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.20	1.1%	15%	75%	10	$7
New	Warehouse	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Non-solar hot water heater	0.20	32.7%	20%	95%	20	$8,931
New	Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.20	3.3%	95%	95%	10	$205
New	Warehouse	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.20	7.7%	75%	45%	11	$107

Commercial Gas Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.07	5.9%	NA	NA	20	$3,796
Existing	Dry Goods Retail	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.07	11.1%	NA	NA	20	$7,744
Existing	Dry Goods Retail	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.07	5.5%	40%	90%	20	$15356
Existing	Dry Goods Retail	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.07	12.5%	90%	40%	3	$9,319
Existing	Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.07	5.0%	75%	59%	15	$13134
Existing	Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.07	10.0%	75%	80%	5	$25459
Existing	Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.07	15.0%	50%	80%	5	$18372
Existing	Dry Goods Retail	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.07	2.5%	45%	45%	18	$18911
Existing	Dry Goods Retail	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.07	15.0%	5%	94%	10	$42881
Existing	Dry Goods Retail	Space Heat Boiler	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.07	10.0%	40%	10%	10	$11068
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.07	7.2%	75%	85%	25	$28840
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.07	20.0%	75%	0%	25	$28840
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.07	8.0%	75%	95%	25	$24585
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.07	12.0%	75%	98%	25	$32622
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.07	4.4%	10%	15%	25	$5,236
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.07	2.4%	10%	15%	25	$5,508
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.07	6.0%	10%	95%	25	$5,262

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.07	21.1%	10%	35%	25	$5,697
Existing	Dry Goods Retail	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.07	25.0%	10%	0%	25	$5,697
Existing	Dry Goods Retail	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.07	15.0%	35%	90%	25	$24585
Existing	Dry Goods Retail	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.07	5.0%	35%	90%	25	$4,255
Existing	Dry Goods Retail	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.07	25.0%	25%	98%	10	$99757
Existing	Dry Goods Retail	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.07	12.1%	75%	65%	20	$3,229
Existing	Dry Goods Retail	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.07	17.0%	90%	45%	3	$6,383
Existing	Dry Goods Retail	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.07	3.0%	95%	54%	15	$147
Existing	Dry Goods Retail	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.07	4.7%	80%	80%	25	$42460
Existing	Dry Goods Retail	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.07	3.1%	10%	80%	25	119878
Existing	Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.11	11.1%	NA	NA	18	$3,943
Existing	Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.11	14.9%	NA	NA	18	$3,943
Existing	Dry Goods Retail	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.10	12.5%	90%	80%	3	$9,319
Existing	Dry Goods Retail	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.10	2.5%	45%	45%	18	$18911
Existing	Dry Goods Retail	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.10	15.0%	5%	94%	10	$42881
Existing	Dry Goods Retail	Space Heat Furnace	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.10	10.0%	40%	10%	10	$11068
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.10	7.2%	75%	85%	25	$28840
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.10	20.0%	75%	0%	25	$28840
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.10	8.0%	75%	95%	25	$24585

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.10	12.0%	75%	98%	25	$32622
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.10	4.4%	10%	15%	25	$5,286
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.10	2.4%	10%	15%	25	$5,508
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.10	6.0%	10%	95%	25	$5,262
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.10	21.1%	10%	35%	25	$5,697
Existing	Dry Goods Retail	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.10	25.0%	10%	0%	25	$5,697
Existing	Dry Goods Retail	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.10	15.0%	35%	90%	25	$24585
Existing	Dry Goods Retail	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.10	5.0%	35%	90%	25	$4,255
Existing	Dry Goods Retail	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.10	3.0%	95%	54%	15	$147
Existing	Dry Goods Retail	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.10	4.7%	80%	80%	25	$42460
Existing	Dry Goods Retail	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.10	3.1%	10%	80%	25	119878
Existing	Dry Goods Retail	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.03	34.4%	NA	NA	13	$3,626
Existing	Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.03	15.1%	5%	95%	10	$8,704
Existing	Dry Goods Retail	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.03	0.9%	5%	75%	10	$303
Existing	Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.03	5.0%	75%	94%	15	$13134
Existing	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.03	0.6%	45%	25%	13	$33
Existing	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.03	0.8%	45%	55%	13	$629
Existing	Dry Goods Retail	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.03	20.0%	5%	92%	25	$2,804
Existing	Dry Goods Retail	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.03	4.0%	95%	25%	10	$0

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Dry Goods Retail	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.03	3.8%	95%	15%	10	$0
Existing	Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.03	1.0%	75%	90%	15	$501
Existing	Dry Goods Retail	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.03	2.3%	10%	45%	5	$5
Existing	Dry Goods Retail	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.03	1.1%	15%	75%	10	$5
Existing	Dry Goods Retail	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.03	2.5%	15%	20%	10	$9
Existing	Dry Goods Retail	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.03	28.0%	75%	74%	16	$43023
Existing	Dry Goods Retail	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.03	55.6%	20%	95%	20	$62587
Existing	Dry Goods Retail	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.03	30.0%	25%	90%	14	$2,265
Existing	Dry Goods Retail	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.03	28.0%	25%	90%	20	$695
Existing	Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.03	3.3%	95%	95%	10	$208
Existing	Dry Goods Retail	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.03	7.7%	75%	45%	11	$539
New	Dry Goods Retail	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.04	5.9%	NA	NA	20	$3,796
New	Dry Goods Retail	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.04	11.1%	NA	NA	20	$7,744
New	Dry Goods Retail	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.04	5.5%	40%	90%	20	$15356
New	Dry Goods Retail	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.04	12.5%	90%	40%	3	$34513
New	Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.04	10.0%	75%	80%	5	$25459
New	Dry Goods Retail	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.04	2.5%	45%	45%	18	$16911
New	Dry Goods Retail	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.04	15.0%	5%	94%	10	$42881
New	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.04	8.0%	75%	95%	25	$24585

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.04	12.0%	75%	98%	25	$32622
New	Dry Goods Retail	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.04	6.0%	95%	95%	25	$5,262
New	Dry Goods Retail	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.04	5.0%	35%	90%	25	$4,255
New	Dry Goods Retail	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.04	5.0%	50%	95%	15	$10865
New	Dry Goods Retail	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.04	10.0%	40%	98%	25	$7,328
New	Dry Goods Retail	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.04	25.0%	50%	98%	10	$99757
New	Dry Goods Retail	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.04	3.0%	95%	54%	15	$147
New	Dry Goods Retail	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.04	4.7%	80%	80%	25	$42460
New	Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.06	11.1%	NA	NA	18	$3,943
New	Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.06	14.9%	NA	NA	18	$3,943
New	Dry Goods Retail	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.06	12.5%	90%	80%	3	$34513
New	Dry Goods Retail	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.06	2.5%	45%	45%	18	$18911
New	Dry Goods Retail	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.06	15.0%	5%	94%	10	$42881
New	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.06	8.0%	75%	95%	25	$24585
New	Dry Goods Retail	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.06	12.0%	75%	98%	25	$32622
New	Dry Goods Retail	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.06	6.0%	95%	95%	25	$5,262
New	Dry Goods Retail	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.06	5.0%	35%	90%	25	$4,255
New	Dry Goods Retail	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.06	10.0%	40%	98%	25	$7,328
New	Dry Goods Retail	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.06	3.0%	95%	54%	15	$147

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Dry Goods Retail	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.06	4.7%	80%	80%	25	$42460
New	Dry Goods Retail	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.03	34.4%	NA	NA	13	$3,626
New	Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.03	15.1%	5%	95%	10	$8,704
New	Dry Goods Retail	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.03	0.9%	5%	75%	10	$303
New	Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.03	5.0%	90%	94%	15	$13134
New	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.03	0.6%	45%	25%	13	$33
New	Dry Goods Retail	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.03	0.8%	45%	55%	13	$629
New	Dry Goods Retail	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.03	20.0%	25%	92%	25	$2,804
New	Dry Goods Retail	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.03	4.0%	95%	25%	10	$0
New	Dry Goods Retail	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.03	5.0%	50%	95%	15	$10865
New	Dry Goods Retail	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.03	2.3%	10%	45%	5	$5
New	Dry Goods Retail	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.03	1.1%	15%	75%	10	$5
New	Dry Goods Retail	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.03	28.0%	75%	74%	16	$24112
New	Dry Goods Retail	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.03	55.6%	20%	95%	20	$62587
New	Dry Goods Retail	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.03	30.0%	25%	90%	14	$2,265
New	Dry Goods Retail	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.03	28.0%	25%	90%	20	$695
New	Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.03	3.3%	95%	95%	10	$208
New	Dry Goods Retail	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.03	7.7%	75%	45%	11	$539
Existing	Grocery	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.20	1.9%	95%	75%	10	$210

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.20	3.1%	45%	65%	8	$1,112
Existing	Grocery	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.20	0.3%	45%	75%	12	$1,223
Existing	Grocery	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.20	1.2%	85%	85%	12	$420
Existing	Grocery	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.20	10.4%	5%	85%	10	$3,541
Existing	Grocery	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.20	3.8%	25%	90%	12	$5,358
Existing	Grocery	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.20	6.9%	25%	75%	10	$2,181
Existing	Grocery	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.24	5.9%	NA	NA	20	$2,080
Existing	Grocery	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.24	11.1%	NA	NA	20	$4,242
Existing	Grocery	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.24	5.5%	40%	90%	20	$8,413
Existing	Grocery	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.24	12.5%	90%	40%	3	$4,142
Existing	Grocery	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.24	5.0%	75%	61%	15	$5,837
Existing	Grocery	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.24	10.0%	75%	80%	5	$11315
Existing	Grocery	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.24	15.0%	50%	80%	5	$8,165
Existing	Grocery	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.24	2.5%	45%	45%	18	$8,405
Existing	Grocery	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.24	15.0%	5%	94%	10	$19058
Existing	Grocery	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.24	4.5%	64%	85%	10	$5,726
Existing	Grocery	Space Heat Boiler	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.24	10.0%	40%	10%	10	$4,919
Existing	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.24	7.2%	75%	10%	25	$12818
Existing	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.24	20.0%	75%	0%	25	$12818
Existing	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.24	8.0%	75%	45%	25	$10927

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.24	12.0%	75%	85%	25	$14499
Existing	Grocery	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.24	4.4%	10%	15%	25	$2,349
Existing	Grocery	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.24	2.4%	10%	15%	25	$2,448
Existing	Grocery	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.24	6.0%	10%	95%	25	$3,507
Existing	Grocery	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.24	21.1%	10%	35%	25	$3,799
Existing	Grocery	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.24	25.0%	10%	0%	25	$3,799
Existing	Grocery	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.24	15.0%	35%	45%	25	$10927
Existing	Grocery	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.24	5.0%	35%	45%	25	$1,891
Existing	Grocery	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.24	25.0%	25%	98%	10	$44336
Existing	Grocery	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.24	12.1%	75%	65%	20	$2,152
Existing	Grocery	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.24	17.0%	90%	45%	3	$2,837
Existing	Grocery	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.24	3.0%	95%	46%	15	$145
Existing	Grocery	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.24	3.7%	80%	85%	25	$13402
Existing	Grocery	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.24	2.4%	10%	85%	25	$37841
Existing	Grocery	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.35	11.1%	NA	NA	18	$2,160
Existing	Grocery	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.35	14.9%	NA	NA	18	$2,160
Existing	Grocery	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.35	12.5%	90%	80%	3	$4,142
Existing	Grocery	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.35	2.5%	45%	45%	18	$8,405
Existing	Grocery	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.35	15.0%	5%	94%	10	$19058

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.35	4.5%	64%	85%	10	$5,726
Existing	Grocery	Space Heat Furnace	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.35	10.0%	40%	10%	10	$4,919
Existing	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.35	7.2%	75%	10%	25	$12818
Existing	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.35	20.0%	75%	0%	25	$12818
Existing	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.35	8.0%	75%	45%	25	$10927
Existing	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.35	12.0%	75%	85%	25	$14499
Existing	Grocery	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.35	4.4%	10%	15%	25	$2,349
Existing	Grocery	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.35	2.4%	10%	15%	25	$2,448
Existing	Grocery	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.35	6.0%	10%	95%	25	$3,507
Existing	Grocery	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.35	21.1%	10%	35%	25	$3,799
Existing	Grocery	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.35	25.0%	10%	0%	25	$3,799
Existing	Grocery	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.35	15.0%	35%	45%	25	$10927
Existing	Grocery	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.35	5.0%	35%	45%	25	$1,891
Existing	Grocery	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.35	3.0%	95%	46%	15	$145
Existing	Grocery	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.35	3.7%	80%	85%	25	$13402
Existing	Grocery	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.35	2.4%	10%	85%	25	$37841
Existing	Grocery	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.12	34.4%	NA	NA	13	$3,625
Existing	Grocery	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.12	15.1%	5%	95%	10	$8,705
Existing	Grocery	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.12	0.5%	5%	75%	10	$305

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Grocery	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.12	5.0%	75%	94%	15	$5,837
Existing	Grocery	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.12	3.0%	75%	80%	13	$2,700
Existing	Grocery	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.12	6.0%	75%	95%	10	$841
Existing	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.12	0.3%	45%	25%	13	$32
Existing	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.12	0.4%	45%	55%	13	$630
Existing	Grocery	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.12	20.0%	5%	92%	25	$2,801
Existing	Grocery	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.12	4.0%	95%	25%	10	$0
Existing	Grocery	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.12	3.8%	95%	15%	10	$2
Existing	Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.12	1.0%	75%	90%	15	$223
Existing	Grocery	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.12	2.3%	95%	40%	5	$6
Existing	Grocery	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.12	1.1%	15%	75%	10	$6
Existing	Grocery	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.12	2.5%	15%	20%	10	$11
Existing	Grocery	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.12	28.0%	75%	55%	16	$19121
Existing	Grocery	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.12	38.6%	20%	95%	20	$20678
Existing	Grocery	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.12	30.0%	25%	90%	14	$2,265
Existing	Grocery	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.12	28.0%	25%	90%	20	$696
Existing	Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.12	3.3%	95%	95%	10	$206
Existing	Grocery	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.12	7.7%	75%	50%	11	$538
New	Grocery	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.20	1.9%	95%	75%	10	$210
New	Grocery	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.20	3.1%	45%	65%	8	$1,112
New	Grocery	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.20	0.3%	45%	75%	12	$1,223
New	Grocery	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.20	1.2%	85%	85%	12	$420
New	Grocery	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.20	10.4%	5%	85%	10	$2,832
New	Grocery	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.20	3.8%	25%	90%	12	$5,358
New	Grocery	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.20	6.9%	25%	75%	10	$2,181

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.05	5.9%	NA	NA	20	$2,080
New	Grocery	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.05	11.1%	NA	NA	20	$4,242
New	Grocery	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.05	5.5%	40%	90%	20	$8,413
New	Grocery	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.05	12.5%	90%	40%	3	$15339
New	Grocery	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.05	10.0%	75%	80%	5	$11315
New	Grocery	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.05	2.5%	45%	45%	18	$8,405
New	Grocery	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.05	15.0%	5%	94%	10	$19058
New	Grocery	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.05	4.5%	64%	85%	10	$5,726
New	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.05	8.0%	75%	45%	25	$10927
New	Grocery	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.05	12.0%	75%	85%	25	$14499
New	Grocery	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.05	6.0%	95%	95%	25	$3,507
New	Grocery	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.05	5.0%	35%	45%	25	$1,891
New	Grocery	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.05	5.0%	50%	95%	15	$5,953
New	Grocery	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.05	10.0%	40%	98%	25	$3,257
New	Grocery	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.05	25.0%	50%	98%	10	$44336
New	Grocery	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.05	3.0%	95%	46%	15	$145
New	Grocery	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.05	3.7%	80%	85%	25	$10402
New	Grocery	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.08	11.1%	NA	NA	18	$2,180
New	Grocery	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.08	14.9%	NA	NA	18	$2,160

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.08	12.5%	90%	80%	3	$15339
New	Grocery	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.08	2.5%	45%	45%	18	$8,405
New	Grocery	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.08	15.0%	5%	94%	10	$19058
New	Grocery	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.08	4.5%	64%	85%	10	$5,726
New	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.08	8.0%	75%	45%	25	$10927
New	Grocery	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.08	12.0%	75%	85%	25	$14499
New	Grocery	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.08	6.0%	95%	95%	25	$3,507
New	Grocery	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.08	5.0%	35%	45%	25	$1,891
New	Grocery	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.08	10.0%	40%	98%	25	$3,257
New	Grocery	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.08	3.0%	95%	46%	15	$145
New	Grocery	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.08	3.7%	80%	85%	25	$13402
New	Grocery	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.13	34.4%	NA	NA	13	$3,625
New	Grocery	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.12	15.1%	5%	95%	10	$8,705
New	Grocery	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.12	0.4%	5%	75%	10	$305
New	Grocery	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.12	5.0%	90%	94%	15	$5,837
New	Grocery	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.12	3.0%	75%	80%	13	$2,700
New	Grocery	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.12	6.0%	75%	95%	10	$841
New	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.12	0.3%	45%	25%	13	$[illegible]32
New	Grocery	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.12	0.4%	45%	55%	13	$630
New	Grocery	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.12	20.0%	25%	92%	25	$2,[illegible]01

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Grocery	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.12	4.0%	95%	25%	10	$0
New	Grocery	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.12	5.0%	50%	95%	15	$5,953
New	Grocery	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.12	2.3%	95%	40%	5	$6
New	Grocery	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.12	1.1%	15%	75%	10	$6
New	Grocery	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.12	28.0%	75%	55%	16	$10716
New	Grocery	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.12	38.6%	20%	95%	20	$20678
New	Grocery	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.12	30.0%	25%	90%	14	$2,265
New	Grocery	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.12	28.0%	25%	90%	20	$696
New	Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.12	3.3%	95%	95%	10	$206
New	Grocery	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.12	7.7%	75%	50%	11	$538
Existing	Hospital	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.04	1.9%	95%	75%	10	$210
Existing	Hospital	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.04	3.1%	45%	65%	8	$1,112
Existing	Hospital	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.04	0.3%	45%	75%	12	$1,223
Existing	Hospital	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.04	1.2%	85%	55%	12	$420
Existing	Hospital	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.04	10.4%	5%	85%	10	$3,541
Existing	Hospital	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.04	3.8%	25%	90%	12	$5,358
Existing	Hospital	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.04	6.9%	25%	75%	10	$2,181
Existing	Hospital	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.32	5.9%	NA	NA	20	$4,453
Existing	Hospital	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.32	11.1%	NA	NA	20	$9,084
Existing	Hospital	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.33	10.0%	5%	94%	15	$13238
Existing	Hospital	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.33	5.5%	40%	90%	20	$18008
Existing	Hospital	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.33	12.5%	90%	40%	3	$4,142
Existing	Hospital	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.33	5.0%	35%	26%	15	$5,837

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.33	10.0%	75%	80%	5	$11315
Existing	Hospital	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.33	15.0%	75%	80%	5	$8,165
Existing	Hospital	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.33	2.5%	45%	45%	18	$8,405
Existing	Hospital	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.33	15.0%	5%	94%	10	$19058
Existing	Hospital	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.33	4.5%	62%	85%	10	$5,726
Existing	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.33	3.6%	75%	13%	25	$6,409
Existing	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.33	10.0%	75%	0%	25	$6,409
Existing	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.33	4.0%	75%	45%	25	$5,463
Existing	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.33	6.0%	75%	85%	25	$7,249
Existing	Hospital	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.33	4.4%	10%	15%	25	$2,349
Existing	Hospital	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.33	2.4%	10%	15%	25	$2,448
Existing	Hospital	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.33	6.0%	10%	95%	25	$4,959
Existing	Hospital	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.33	21.1%	10%	35%	25	$5,371
Existing	Hospital	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.33	25.0%	10%	0%	25	$5,371
Existing	Hospital	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.33	7.5%	35%	35%	25	$5,463
Existing	Hospital	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.33	2.5%	35%	35%	25	$946
Existing	Hospital	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.33	25.0%	25%	98%	10	$40386
Existing	Hospital	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.33	12.1%	75%	65%	20	$2,152
Existing	Hospital	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.33	17.0%	90%	45%	3	$2,837

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.33	3.0%	95%	71%	15	$145
Existing	Hospital	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.33	6.2%	80%	60%	25	$17468
Existing	Hospital	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.33	4.1%	10%	60%	25	$49321
Existing	Hospital	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.48	11.1%	NA	NA	18	$4,623
Existing	Hospital	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.48	14.9%	NA	NA	18	$4,623
Existing	Hospital	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.48	10.0%	5%	94%	15	$13238
Existing	Hospital	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.48	12.5%	90%	80%	3	$4,142
Existing	Hospital	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.48	2.5%	45%	45%	18	$8,405
Existing	Hospital	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.48	15.0%	5%	94%	10	$19058
Existing	Hospital	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.48	4.5%	62%	85%	10	$5,726
Existing	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.48	3.6%	75%	13%	25	$6,409
Existing	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.48	10.0%	75%	0%	25	$6,409
Existing	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.48	4.0%	75%	45%	25	$5,463
Existing	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.48	6.0%	75%	85%	25	$7,249
Existing	Hospital	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.48	4.4%	10%	15%	25	$2,349
Existing	Hospital	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.48	2.4%	10%	15%	25	$2,448
Existing	Hospital	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.48	6.0%	10%	95%	25	$4,959
Existing	Hospital	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.48	21.1%	10%	35%	25	$5,371
Existing	Hospital	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.48	25.0%	10%	0%	25	$5,371

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.48	7.5%	35%	35%	25	$5,463
Existing	Hospital	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.48	2.5%	35%	35%	25	$946
Existing	Hospital	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.48	3.0%	95%	71%	15	$145
Existing	Hospital	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.48	6.2%	80%	60%	25	$17468
Existing	Hospital	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.48	4.1%	10%	60%	25	$49321
Existing	Hospital	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.40	34.4%	NA	NA	13	$12324
Existing	Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.41	15.1%	15%	95%	10	$8,705
Existing	Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.41	0.3%	15%	75%	10	$305
Existing	Hospital	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.41	5.0%	55%	94%	15	$5,837
Existing	Hospital	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.41	3.0%	25%	80%	13	$2,700
Existing	Hospital	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.41	6.0%	25%	95%	10	$841
Existing	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.41	0.1%	20%	25%	13	$32
Existing	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.41	0.1%	20%	55%	13	$630
Existing	Hospital	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.41	20.0%	5%	92%	25	$9,525
Existing	Hospital	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.41	4.0%	95%	25%	10	$0
Existing	Hospital	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.41	3.8%	95%	15%	10	$2
Existing	Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.41	1.0%	75%	70%	15	$223
Existing	Hospital	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.41	2.3%	50%	45%	5	$6
Existing	Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.41	2.6%	35%	75%	10	$6
Existing	Hospital	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.41	5.8%	35%	20%	10	$11
Existing	Hospital	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.41	28.0%	75%	50%	16	$19,121
Existing	Hospital	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.41	66.6%	20%	95%	20	120656
Existing	Hospital	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.41	30.0%	10%	90%	14	$2,267

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hospital	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.41	28.0%	10%	90%	20	$696
Existing	Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.41	3.3%	95%	90%	10	$206
Existing	Hospital	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.41	7.7%	75%	80%	11	$1,828
New	Hospital	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.04	1.9%	95%	75%	10	$210
New	Hospital	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.04	3.1%	45%	65%	8	$1,112
New	Hospital	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.04	0.3%	45%	75%	12	$1,223
New	Hospital	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.04	1.2%	85%	55%	12	$420
New	Hospital	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.04	10.4%	5%	85%	10	$2,832
New	Hospital	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.04	3.8%	25%	90%	12	$5,358
New	Hospital	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.04	6.9%	25%	75%	10	$2,181
New	Hospital	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.32	5.9%	NA	NA	20	$4,453
New	Hospital	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.32	11.1%	NA	NA	20	$9,084
New	Hospital	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.32	10.0%	5%	94%	15	$13238
New	Hospital	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.32	5.5%	40%	90%	20	$18008
New	Hospital	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.32	12.5%	90%	40%	3	$15339
New	Hospital	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.32	10.0%	75%	80%	5	$11315
New	Hospital	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.32	2.5%	45%	45%	18	$8,405
New	Hospital	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.32	15.0%	5%	94%	10	$19058
New	Hospital	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.32	4.5%	62%	85%	10	$5,726
New	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.32	4.0%	75%	45%	25	$5,463
New	Hospital	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.32	6.0%	75%	85%	25	$7,249

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.32	6.0%	95%	95%	25	$4,959
New	Hospital	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.32	2.5%	35%	35%	25	$946
New	Hospital	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.32	5.0%	50%	95%	15	$12742
New	Hospital	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.32	10.0%	40%	98%	25	$3,257
New	Hospital	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.32	25.0%	50%	98%	10	$44336
New	Hospital	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.32	3.0%	95%	71%	15	$145
New	Hospital	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.32	6.2%	80%	60%	25	$17468
New	Hospital	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.47	11.1%	NA	NA	18	$4,623
New	Hospital	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.47	14.9%	NA	NA	18	$4,623
New	Hospital	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.47	10.0%	5%	94%	15	$13238
New	Hospital	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.47	12.5%	90%	80%	3	$15339
New	Hospital	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.47	2.5%	45%	45%	18	$8,405
New	Hospital	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.47	15.0%	5%	94%	10	$19058
New	Hospital	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.47	4.5%	62%	85%	10	$5,726
New	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.47	4.0%	75%	45%	25	$5,463
New	Hospital	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.47	6.0%	75%	85%	25	$7,249
New	Hospital	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.47	6.0%	95%	95%	25	$4,959
New	Hospital	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.47	2.5%	35%	35%	25	$946
New	Hospital	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.47	10.0%	40%	98%	25	$3,257

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hospital	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.47	3.0%	95%	71%	15	$145
New	Hospital	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.47	6.2%	80%	60%	25	$17468
New	Hospital	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.43	34.4%	NA	NA	13	$12324
New	Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.41	15.1%	15%	95%	10	$8,705
New	Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.41	0.3%	15%	75%	10	$305
New	Hospital	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.41	5.0%	55%	94%	15	$5,837
New	Hospital	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.41	3.0%	25%	80%	13	$2,700
New	Hospital	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.41	6.0%	25%	95%	10	$841
New	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.41	0.1%	20%	25%	13	$32
New	Hospital	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.41	0.1%	20%	55%	13	$630
New	Hospital	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.41	20.0%	25%	92%	25	$9,525
New	Hospital	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.41	4.0%	95%	25%	10	$0
New	Hospital	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.41	5.0%	50%	95%	15	$12742
New	Hospital	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.41	2.3%	50%	45%	5	$6
New	Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.41	2.6%	35%	75%	10	$6
New	Hospital	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.41	28.0%	75%	50%	16	$10716
New	Hospital	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.41	66.6%	20%	95%	20	120656
New	Hospital	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.41	30.0%	10%	90%	14	$2,267
New	Hospital	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.41	28.0%	10%	90%	20	$696
New	Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.41	3.3%	95%	90%	10	$206
New	Hospital	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.41	7.7%	75%	80%	11	$1,028
Existing	Hotel Motel	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.08	1.9%	95%	75%	10	$210
Existing	Hotel Motel	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.08	3.1%	35%	65%	8	$1,112

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.08	0.3%	45%	75%	12	$1,225
Existing	Hotel Motel	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.08	1.2%	85%	55%	12	$421
Existing	Hotel Motel	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.08	10.4%	5%	85%	10	$3,541
Existing	Hotel Motel	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.08	3.8%	15%	90%	12	$5,358
Existing	Hotel Motel	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.08	6.9%	25%	75%	10	$2,180
Existing	Hotel Motel	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.11	10.1%	30%	90%	12	$16506
Existing	Hotel Motel	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.11	50.0%	95%	35%	10	$2,237
Existing	Hotel Motel	Space Heat Boiler	Gas Boiler - Less than 300 kBTUH	AFUE=85%	AFUE=80%	0.17	5.9%	NA	NA	20	$3,421
Existing	Hotel Motel	Space Heat Boiler	Gas Boiler - Less than 300 kBTUH	AFUE=90%	AFUE=80%	0.17	11.1%	NA	NA	20	$6,842
Existing	Hotel Motel	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.17	2.0%	50%	94%	15	$3,120
Existing	Hotel Motel	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.17	5.5%	40%	30%	20	$3,338
Existing	Hotel Motel	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.17	12.5%	90%	40%	3	$4,556
Existing	Hotel Motel	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.17	5.0%	5%	52%	15	$6,421
Existing	Hotel Motel	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.17	10.0%	75%	80%	5	$12447
Existing	Hotel Motel	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.17	15.0%	50%	80%	5	$8,982
Existing	Hotel Motel	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.17	2.5%	45%	45%	18	$9,246
Existing	Hotel Motel	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.17	15.0%	5%	94%	10	$20964
Existing	Hotel Motel	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.17	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.17	3.6%	75%	25%	25	$7,050
Existing	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.17	10.0%	75%	0%	25	$7,050
Existing	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.17	4.0%	75%	45%	25	$6,010

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.17	6.0%	75%	85%	25	$7,974
Existing	Hotel Motel	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.17	4.4%	10%	15%	25	$2,584
Existing	Hotel Motel	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.17	2.4%	10%	15%	25	$2,693
Existing	Hotel Motel	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.17	6.0%	10%	95%	25	$5,201
Existing	Hotel Motel	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.17	21.1%	10%	35%	25	$5,633
Existing	Hotel Motel	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.17	25.0%	10%	0%	25	$5,633
Existing	Hotel Motel	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.17	7.5%	35%	45%	25	$6,010
Existing	Hotel Motel	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.17	2.5%	35%	45%	25	$1,040
Existing	Hotel Motel	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.17	25.0%	25%	98%	10	$48770
Existing	Hotel Motel	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.17	12.1%	75%	65%	20	$2,258
Existing	Hotel Motel	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.17	17.0%	90%	45%	3	$3,120
Existing	Hotel Motel	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.17	3.0%	95%	78%	15	$146
Existing	Hotel Motel	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.17	8.3%	80%	50%	25	$39564
Existing	Hotel Motel	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.17	5.5%	10%	50%	25	111702
Existing	Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.25	11.1%	NA	NA	18	$2,570
Existing	Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.25	14.9%	NA	NA	18	$2,570
Existing	Hotel Motel	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.25	2.0%	50%	94%	15	$3,120
Existing	Hotel Motel	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.25	12.5%	90%	80%	3	$4,536
Existing	Hotel Motel	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.25	2.5%	45%	45%	18	$9,246

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.25	15.0%	5%	94%	10	$20964
Existing	Hotel Motel	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.25	4.5%	58%	85%	10	$5,725
Existing	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.25	3.6%	75%	25%	25	$7,050
Existing	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.25	10.0%	75%	0%	25	$7,050
Existing	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.25	4.0%	75%	45%	25	$6,010
Existing	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.25	6.0%	75%	85%	25	$7,974
Existing	Hotel Motel	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.25	4.4%	10%	15%	25	$2,584
Existing	Hotel Motel	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.25	2.4%	10%	15%	25	$2,693
Existing	Hotel Motel	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.25	6.0%	10%	95%	25	$5,201
Existing	Hotel Motel	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.25	21.1%	10%	35%	25	$5,633
Existing	Hotel Motel	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.25	25.0%	10%	0%	25	$5,633
Existing	Hotel Motel	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.25	7.5%	35%	45%	25	$6,010
Existing	Hotel Motel	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.25	2.5%	35%	45%	25	$1,040
Existing	Hotel Motel	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.25	3.0%	95%	78%	15	$146
Existing	Hotel Motel	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.25	8.3%	80%	50%	25	$39564
Existing	Hotel Motel	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.25	5.5%	10%	50%	25	111702
Existing	Hotel Motel	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.30	34.4%	NA	NA	13	$10324
Existing	Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.31	15.1%	35%	95%	10	$8,705
Existing	Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.31	0.4%	35%	75%	10	$305

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Hotel Motel	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.31	5.0%	55%	80%	15	$6,421
Existing	Hotel Motel	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.31	3.0%	45%	80%	13	$2,700
Existing	Hotel Motel	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.31	6.0%	45%	95%	10	$841
Existing	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.31	0.1%	45%	25%	13	$32
Existing	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.31	0.1%	45%	55%	13	$631
Existing	Hotel Motel	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.31	20.0%	5%	92%	25	$9,525
Existing	Hotel Motel	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.31	4.0%	95%	25%	10	$0
Existing	Hotel Motel	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.31	3.8%	95%	15%	10	$2
Existing	Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.31	1.0%	75%	90%	15	$245
Existing	Hotel Motel	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.31	2.3%	85%	50%	5	$5
Existing	Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.31	7.5%	100%	75%	10	$7
Existing	Hotel Motel	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.31	16.7%	100%	20%	10	$12
Existing	Hotel Motel	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.31	28.0%	75%	35%	16	$21034
Existing	Hotel Motel	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.31	56.1%	20%	95%	20	153827
Existing	Hotel Motel	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.31	30.0%	10%	90%	14	$2,265
Existing	Hotel Motel	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.31	28.0%	10%	90%	20	$696
Existing	Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.31	3.3%	95%	85%	10	$206
Existing	Hotel Motel	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.31	7.7%	75%	5%	11	$1,828
New	Hotel Motel	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.08	1.9%	95%	75%	10	$210
New	Hotel Motel	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.08	3.1%	35%	65%	8	$1,112
New	Hotel Motel	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.08	0.3%	45%	75%	12	$1,225
New	Hotel Motel	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.08	1.2%	85%	55%	12	$421
New	Hotel Motel	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.08	10.4%	5%	85%	10	$2,834
New	Hotel Motel	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.08	3.8%	15%	90%	12	$5,358
New	Hotel Motel	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.08	6.9%	25%	75%	10	$2,180

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.06	10.1%	30%	90%	12	$16506
New	Hotel Motel	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.06	50.0%	95%	35%	10	$2,237
New	Hotel Motel	Space Heat Boiler	Gas Boiler - Less than 300 kBTUH	AFUE=85%	AFUE=80%	0.12	5.9%	NA	NA	20	$3,421
New	Hotel Motel	Space Heat Boiler	Gas Boiler - Less than 300 kBTUH	AFUE=90%	AFUE=80%	0.12	11.1%	NA	NA	20	$6,842
New	Hotel Motel	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.12	2.0%	50%	94%	15	$3,120
New	Hotel Motel	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.12	5.5%	40%	30%	20	$3,338
New	Hotel Motel	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.12	12.5%	90%	40%	3	$16873
New	Hotel Motel	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.12	10.0%	75%	80%	5	$12447
New	Hotel Motel	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.12	2.5%	45%	45%	18	$9,246
New	Hotel Motel	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.12	15.0%	5%	94%	10	$20964
New	Hotel Motel	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.12	4.5%	58%	85%	10	$5,725
New	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.12	4.0%	75%	45%	25	$6,010
New	Hotel Motel	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.12	6.0%	75%	85%	25	$7,974
New	Hotel Motel	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.12	6.0%	95%	95%	25	$5,201
New	Hotel Motel	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.12	2.5%	35%	45%	25	$1,040
New	Hotel Motel	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.12	5.0%	50%	95%	15	$2,362
New	Hotel Motel	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.12	10.0%	40%	98%	25	$3,583
New	Hotel Motel	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.12	25.0%	50%	98%	10	$48770
New	Hotel Motel	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.12	3.0%	95%	78%	15	$146

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.12	8.3%	80%	50%	25	$39564
New	Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.18	11.1%	NA	NA	18	$2,570
New	Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.18	14.9%	NA	NA	18	$2,570
New	Hotel Motel	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.18	2.0%	50%	94%	15	$3,120
New	Hotel Motel	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.18	12.5%	90%	80%	3	$16873
New	Hotel Motel	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.18	2.5%	45%	45%	18	$9,246
New	Hotel Motel	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.18	15.0%	5%	94%	10	$20964
New	Hotel Motel	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.18	4.5%	58%	85%	10	$5,725
New	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.18	4.0%	75%	45%	25	$6,010
New	Hotel Motel	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.18	6.0%	75%	85%	25	$7,974
New	Hotel Motel	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.18	6.0%	95%	95%	25	$5,201
New	Hotel Motel	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.18	2.5%	35%	45%	25	$1,040
New	Hotel Motel	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.18	10.0%	40%	98%	25	$3,583
New	Hotel Motel	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.18	3.0%	95%	78%	15	$146
New	Hotel Motel	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.18	8.3%	80%	50%	25	$39564
New	Hotel Motel	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.33	34.4%	NA	NA	13	$12324
New	Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.31	15.1%	35%	95%	10	$8,705
New	Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.31	0.4%	35%	75%	10	$305
New	Hotel Motel	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.31	5.0%	55%	80%	15	$6,421
New	Hotel Motel	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.31	3.0%	45%	80%	13	$2,700

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Hotel Motel	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.31	6.0%	45%	95%	10	$841
New	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.31	0.1%	45%	25%	13	$32
New	Hotel Motel	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.31	0.1%	45%	55%	13	$631
New	Hotel Motel	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.31	20.0%	25%	92%	25	$9,525
New	Hotel Motel	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.31	4.0%	95%	25%	10	$0
New	Hotel Motel	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.31	5.0%	50%	95%	15	$2,362
New	Hotel Motel	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.31	2.3%	85%	50%	5	$5
New	Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.31	7.5%	100%	75%	10	$7
New	Hotel Motel	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.31	28.0%	75%	35%	16	$11788
New	Hotel Motel	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.31	56.1%	20%	95%	20	153827
New	Hotel Motel	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.31	30.0%	10%	90%	14	$2,265
New	Hotel Motel	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.31	28.0%	10%	90%	20	$696
New	Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.31	3.3%	95%	85%	10	$206
New	Hotel Motel	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.31	7.7%	75%	5%	11	$1,828
Existing	Office	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.23	5.9%	NA	NA	20	$10979
Existing	Office	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.23	11.1%	NA	NA	20	$22399
Existing	Office	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.23	10.0%	75%	94%	15	$33095
Existing	Office	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.23	5.5%	40%	45%	20	$39813
Existing	Office	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.23	12.5%	90%	40%	3	$10354
Existing	Office	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.23	5.0%	5%	28%	15	$14593
Existing	Office	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.23	10.0%	75%	80%	5	$28288

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.23	15.0%	75%	80%	5	$20414
Existing	Office	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.23	2.5%	45%	45%	18	$21013
Existing	Office	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.23	15.0%	5%	94%	10	$47646
Existing	Office	Space Heat Boiler	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.23	10.0%	40%	10%	10	$12298
Existing	Office	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.23	1.8%	75%	4%	25	$8,011
Existing	Office	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.23	5.0%	75%	0%	25	$8,011
Existing	Office	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.23	2.0%	75%	25%	25	$6,829
Existing	Office	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.23	3.0%	75%	65%	25	$9,062
Existing	Office	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.23	4.4%	10%	15%	25	$5,873
Existing	Office	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.23	2.4%	10%	15%	25	$6,120
Existing	Office	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.23	6.0%	10%	95%	25	$11089
Existing	Office	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.23	21.1%	10%	35%	25	$12009
Existing	Office	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.23	25.0%	10%	0%	25	$12009
Existing	Office	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.23	3.8%	35%	15%	25	$6,829
Existing	Office	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.23	1.3%	35%	15%	25	$1,182
Existing	Office	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.23	25.0%	25%	98%	10	110841
Existing	Office	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.23	12.1%	75%	65%	20	$3,404
Existing	Office	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.23	17.0%	90%	45%	3	$7,092
Existing	Office	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.23	3.0%	95%	67%	15	$147

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.23	4.8%	80%	95%	25	$54732
Existing	Office	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.23	3.2%	10%	95%	25	154536
Existing	Office	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.34	11.1%	NA	NA	18	$11399
Existing	Office	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.34	14.9%	NA	NA	18	$11399
Existing	Office	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.34	10.0%	75%	94%	15	$33095
Existing	Office	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.34	12.5%	90%	80%	3	$10354
Existing	Office	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.34	2.5%	45%	45%	18	$21013
Existing	Office	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.34	15.0%	5%	94%	10	$47646
Existing	Office	Space Heat Furnace	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.34	10.0%	40%	10%	10	$12298
Existing	Office	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.34	1.8%	75%	4%	25	$8,011
Existing	Office	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.34	5.0%	75%	0%	25	$8,011
Existing	Office	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.34	2.0%	75%	25%	25	$6,829
Existing	Office	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.34	3.0%	75%	65%	25	$9,062
Existing	Office	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.34	4.4%	10%	15%	25	$5,873
Existing	Office	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.34	2.4%	10%	15%	25	$6,120
Existing	Office	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.34	6.0%	10%	95%	25	$11089
Existing	Office	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.34	21.1%	10%	35%	25	$10009
Existing	Office	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.34	25.0%	10%	0%	25	$12009
Existing	Office	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.34	3.8%	35%	15%	25	$6,829

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.34	1.3%	35%	15%	25	$1,182
Existing	Office	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.34	3.0%	95%	67%	15	$147
Existing	Office	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.34	4.8%	80%	95%	25	$54732
Existing	Office	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.34	3.2%	10%	95%	25	154536
Existing	Office	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.04	34.4%	NA	NA	13	$5,437
Existing	Office	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.04	15.1%	5%	95%	10	$8,704
Existing	Office	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.04	0.6%	5%	75%	10	$305
Existing	Office	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.04	5.0%	55%	80%	15	$14593
Existing	Office	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.04	3.0%	10%	80%	13	$2,700
Existing	Office	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.04	6.0%	10%	95%	10	$841
Existing	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.04	0.4%	15%	25%	13	$32
Existing	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.04	0.6%	15%	55%	13	$630
Existing	Office	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.04	20.0%	5%	92%	25	$4,203
Existing	Office	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.04	4.0%	95%	25%	10	$0
Existing	Office	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.04	3.8%	95%	15%	10	$0
Existing	Office	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.04	1.0%	75%	30%	15	$557
Existing	Office	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.04	1.1%	15%	75%	10	$5
Existing	Office	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.04	2.5%	15%	20%	10	$11
Existing	Office	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.04	28.0%	75%	92%	16	$47803
Existing	Office	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.04	55.8%	20%	95%	20	$93758
Existing	Office	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.04	30.0%	25%	90%	14	$2,264
Existing	Office	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.04	28.0%	25%	90%	20	$699
Existing	Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.04	3.3%	95%	85%	10	$205

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Office	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.04	7.7%	75%	40%	11	$809
New	Office	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.11	5.9%	NA	NA	20	$10979
New	Office	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.11	11.1%	NA	NA	20	$22399
New	Office	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.11	10.0%	75%	94%	15	$33095
New	Office	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.11	5.5%	40%	45%	20	$39813
New	Office	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.11	12.5%	90%	40%	3	$38348
New	Office	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.11	10.0%	75%	80%	5	$28288
New	Office	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.11	2.5%	45%	45%	18	$21013
New	Office	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.11	15.0%	5%	94%	10	$47646
New	Office	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.11	2.0%	75%	25%	25	$6,829
New	Office	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.11	3.0%	75%	65%	25	$9,062
New	Office	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.11	6.0%	95%	95%	25	$11089
New	Office	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.11	1.3%	35%	15%	25	$1,182
New	Office	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.11	5.0%	50%	95%	15	$31419
New	Office	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.11	10.0%	40%	98%	25	$8,142
New	Office	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.11	25.0%	50%	98%	10	110841
New	Office	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.11	3.0%	95%	67%	15	$147
New	Office	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.11	4.8%	80%	95%	25	$54732
New	Office	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.17	11.1%	NA	NA	18	$11399

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.17	14.9%	NA	NA	18	$11399
New	Office	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.17	10.0%	75%	94%	15	$33095
New	Office	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.17	12.5%	90%	80%	3	$38348
New	Office	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.17	2.5%	45%	45%	18	$21013
New	Office	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.17	15.0%	5%	94%	10	$47646
New	Office	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.17	2.0%	75%	25%	25	$6,829
New	Office	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.17	3.0%	75%	65%	25	$9,062
New	Office	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.17	6.0%	95%	95%	25	$11089
New	Office	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.17	1.3%	35%	15%	25	$1,182
New	Office	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.17	10.0%	40%	98%	25	$8,142
New	Office	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.17	3.0%	95%	67%	15	$147
New	Office	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.17	4.8%	80%	95%	25	$54732
New	Office	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.04	34.4%	NA	NA	13	$5,437
New	Office	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.04	15.1%	5%	95%	10	$8,704
New	Office	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.04	0.6%	5%	75%	10	$305
New	Office	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.04	5.0%	55%	80%	15	$14593
New	Office	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.04	3.0%	10%	80%	13	$2,700
New	Office	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.04	6.0%	10%	95%	10	$841
New	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.04	0.4%	15%	25%	13	$32
New	Office	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.04	0.5%	15%	55%	13	$630

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Office	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.04	20.0%	25%	92%	25	$4,203
New	Office	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.04	4.0%	95%	25%	10	$0
New	Office	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.04	5.0%	50%	95%	15	$31419
New	Office	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.04	1.1%	15%	75%	10	$5
New	Office	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.04	28.0%	75%	92%	16	$26791
New	Office	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.04	55.8%	20%	95%	20	$93758
New	Office	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.04	30.0%	25%	90%	14	$2,264
New	Office	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.04	28.0%	25%	90%	20	$699
New	Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.04	3.3%	95%	85%	10	$205
New	Office	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.04	7.7%	75%	40%	11	$809
Existing	Other	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.04	1.9%	95%	75%	10	$210
Existing	Other	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.04	3.1%	20%	65%	8	$1,112
Existing	Other	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.04	0.3%	20%	75%	12	$1,225
Existing	Other	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.04	1.2%	85%	85%	12	$419
Existing	Other	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.04	10.4%	5%	85%	10	$3,541
Existing	Other	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.04	3.8%	5%	90%	12	$5,359
Existing	Other	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.04	6.9%	15%	75%	10	$2,180
Existing	Other	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.15	5.9%	NA	NA	20	$1,902
Existing	Other	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.15	11.1%	NA	NA	20	$3,881
Existing	Other	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.15	10.0%	50%	94%	15	$13900
Existing	Other	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.15	5.5%	40%	90%	20	$7,696
Existing	Other	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.15	12.5%	90%	40%	3	$4,349
Existing	Other	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.15	5.0%	45%	66%	15	$6,129

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.15	10.0%	75%	80%	5	$11881
Existing	Other	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.15	15.0%	50%	80%	5	$8,574
Existing	Other	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.15	2.5%	45%	45%	18	$8,825
Existing	Other	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.15	15.0%	5%	94%	10	$20011
Existing	Other	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.15	4.5%	5%	85%	10	$5,725
Existing	Other	Space Heat Boiler	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.15	10.0%	40%	10%	10	$5,165
Existing	Other	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.15	7.2%	75%	30%	25	$13459
Existing	Other	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.15	20.0%	75%	0%	25	$13459
Existing	Other	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.15	8.0%	75%	45%	25	$11473
Existing	Other	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.15	12.0%	75%	85%	25	$15224
Existing	Other	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.15	4.4%	10%	15%	25	$2,467
Existing	Other	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.15	2.4%	10%	15%	25	$2,570
Existing	Other	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.15	6.0%	10%	95%	25	$3,594
Existing	Other	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.15	21.1%	10%	35%	25	$3,892
Existing	Other	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.15	25.0%	10%	0%	25	$3,892
Existing	Other	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.15	15.0%	35%	50%	25	$11473
Existing	Other	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.15	5.0%	35%	50%	25	$1,986
Existing	Other	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.15	25.0%	25%	98%	10	$46533
Existing	Other	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.15	12.1%	75%	65%	20	$2,206

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.15	17.0%	90%	45%	3	$2,979
Existing	Other	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.15	3.0%	95%	63%	15	$146
Existing	Other	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.15	3.5%	80%	70%	25	$10884
Existing	Other	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.15	2.3%	10%	70%	25	$30732
Existing	Other	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.22	11.1%	NA	NA	18	$1,975
Existing	Other	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.22	14.9%	NA	NA	18	$1,975
Existing	Other	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.21	10.0%	50%	94%	15	$13900
Existing	Other	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.21	12.5%	90%	80%	3	$4,349
Existing	Other	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.21	2.5%	45%	45%	18	$8,825
Existing	Other	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.21	15.0%	5%	94%	10	$20011
Existing	Other	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.21	4.5%	5%	85%	10	$5,725
Existing	Other	Space Heat Furnace	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.21	10.0%	40%	10%	10	$5,165
Existing	Other	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.21	7.2%	75%	30%	25	$13459
Existing	Other	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.21	20.0%	75%	0%	25	$13459
Existing	Other	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.21	8.0%	75%	45%	25	$11473
Existing	Other	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.21	12.0%	75%	85%	25	$15224
Existing	Other	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.21	4.4%	10%	15%	25	$2,467
Existing	Other	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.21	2.4%	10%	15%	25	$2,570
Existing	Other	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.21	6.0%	10%	95%	25	$3,594

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.21	21.1%	10%	35%	25	$3,892
Existing	Other	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.21	25.0%	10%	0%	25	$3,892
Existing	Other	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.21	15.0%	35%	50%	25	$11473
Existing	Other	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.21	5.0%	35%	50%	25	$1,986
Existing	Other	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.21	3.0%	95%	63%	15	$146
Existing	Other	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.21	3.5%	80%	70%	25	$10884
Existing	Other	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.21	2.3%	10%	70%	25	$30732
Existing	Other	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.03	34.4%	NA	NA	13	$3,444
Existing	Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.03	15.1%	5%	95%	10	$8,704
Existing	Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.03	1.7%	5%	75%	10	$304
Existing	Other	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.03	5.0%	75%	94%	15	$6,129
Existing	Other	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.03	3.0%	10%	80%	13	$2,701
Existing	Other	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.03	6.0%	10%	95%	10	$841
Existing	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.03	1.1%	10%	25%	13	$31
Existing	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.03	1.5%	10%	55%	13	$631
Existing	Other	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.03	20.0%	5%	92%	25	$2,661
Existing	Other	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.03	4.0%	95%	25%	10	$0
Existing	Other	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.03	3.8%	95%	15%	10	$2
Existing	Other	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.03	1.0%	75%	90%	15	$34
Existing	Other	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.03	2.3%	50%	50%	5	$4
Existing	Other	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.03	1.1%	15%	75%	10	$7
Existing	Other	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.03	2.5%	15%	20%	10	$11

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Other	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.03	28.0%	75%	100%	16	$20077
Existing	Other	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.03	62.3%	20%	95%	20	$35056
Existing	Other	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.03	30.0%	25%	90%	14	$2,266
Existing	Other	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.03	28.0%	25%	90%	20	$697
Existing	Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.03	3.3%	95%	95%	10	$207
Existing	Other	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.03	7.7%	75%	55%	11	$510
New	Other	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.04	1.9%	95%	75%	10	$210
New	Other	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.04	3.1%	20%	65%	8	$1,112
New	Other	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.04	0.3%	20%	75%	12	$1,225
New	Other	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.04	1.2%	85%	85%	12	$419
New	Other	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.04	10.4%	5%	85%	10	$2,833
New	Other	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.04	3.8%	5%	90%	12	$5,359
New	Other	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.04	6.9%	15%	75%	10	$2,180
New	Other	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.08	5.9%	NA	NA	20	$1,902
New	Other	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.08	11.1%	NA	NA	20	$3,881
New	Other	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.07	10.0%	50%	94%	15	$13900
New	Other	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.07	5.5%	40%	90%	20	$7,696
New	Other	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.07	12.5%	90%	40%	3	$16106
New	Other	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.07	10.0%	75%	80%	5	$11881
New	Other	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.07	2.5%	45%	45%	18	$8,825
New	Other	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.07	15.0%	5%	94%	10	$20011
New	Other	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.07	4.5%	5%	85%	10	$5,725

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.07	8.0%	75%	45%	25	$11473
New	Other	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.07	12.0%	75%	85%	25	$15224
New	Other	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.07	6.0%	95%	95%	25	$3,594
New	Other	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.07	5.0%	35%	50%	25	$1,986
New	Other	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.07	5.0%	50%	95%	15	$5,445
New	Other	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.07	10.0%	40%	98%	25	$3,420
New	Other	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.07	25.0%	50%	98%	10	$46553
New	Other	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.07	3.0%	95%	63%	15	$146
New	Other	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.07	3.5%	80%	70%	25	$10884
New	Other	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.11	11.1%	NA	NA	18	$1,975
New	Other	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.11	14.9%	NA	NA	18	$1,975
New	Other	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.11	10.0%	50%	94%	15	$13900
New	Other	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.11	12.5%	90%	80%	3	$16106
New	Other	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.11	2.5%	45%	45%	18	$8,825
New	Other	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.11	15.0%	5%	94%	10	$20011
New	Other	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.11	4.5%	5%	85%	10	$5,725
New	Other	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.11	8.0%	75%	45%	25	$10[illegible]73
New	Other	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.11	12.0%	75%	85%	25	$15[illegible]24
New	Other	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.11	6.0%	95%	95%	25	$3,[illegible]94

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Other	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.11	5.0%	35%	50%	25	$1,986
New	Other	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.11	10.0%	40%	98%	25	$3,420
New	Other	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.11	3.0%	95%	63%	15	$146
New	Other	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.11	3.5%	80%	70%	25	$10884
New	Other	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.03	34.4%	NA	NA	13	$3,444
New	Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.03	15.1%	5%	95%	10	$8,704
New	Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.03	1.7%	5%	75%	10	$304
New	Other	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.03	5.0%	90%	94%	15	$6,129
New	Other	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.03	3.0%	10%	80%	13	$2,701
New	Other	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.03	6.0%	10%	95%	10	$841
New	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.03	1.1%	10%	25%	13	$31
New	Other	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.03	1.5%	10%	55%	13	$631
New	Other	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.03	20.0%	25%	92%	25	$2,661
New	Other	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.03	4.0%	95%	25%	10	$0
New	Other	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.03	5.0%	50%	95%	15	$5,445
New	Other	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.03	2.3%	50%	50%	5	$4
New	Other	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.03	1.1%	15%	75%	10	$7
New	Other	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.03	28.0%	75%	100%	16	$11252
New	Other	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.03	62.3%	20%	95%	20	$35056
New	Other	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.03	30.0%	25%	90%	14	$2,266
New	Other	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.03	28.0%	25%	90%	20	$697
New	Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.03	3.3%	95%	95%	10	$207
New	Other	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.03	7.7%	75%	55%	11	$510

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	1.61	1.9%	95%	75%	10	$210
Existing	Restaurant	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	1.61	6.2%	65%	65%	8	$1,111
Existing	Restaurant	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	1.61	0.5%	75%	75%	12	$1,224
Existing	Restaurant	Cooking	Oven - Convection	Convection Oven	Standard Oven	1.61	1.2%	85%	85%	12	$420
Existing	Restaurant	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	1.61	10.4%	35%	85%	10	$3,541
Existing	Restaurant	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	1.61	3.8%	45%	80%	12	$5,358
Existing	Restaurant	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	1.61	6.9%	65%	75%	10	$2,180
Existing	Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.06	11.1%	NA	NA	18	$1,414
Existing	Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.06	14.9%	NA	NA	18	$1,414
Existing	Restaurant	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.06	12.5%	90%	80%	3	$663
Existing	Restaurant	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.06	2.5%	45%	45%	18	$1,345
Existing	Restaurant	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.06	15.0%	5%	94%	10	$5,783
Existing	Restaurant	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.06	4.5%	100%	85%	10	$5,726
Existing	Restaurant	Space Heat Furnace	Infiltration Control (Caulking, Weather Stripping, etc.)	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	0.06	10.0%	40%	10%	10	$787
Existing	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.06	7.2%	75%	85%	25	$2,051
Existing	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.06	20.0%	75%	0%	25	$2,051
Existing	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.06	8.0%	75%	95%	25	$1,748
Existing	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.06	12.0%	75%	98%	25	$2,320
Existing	Restaurant	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.06	4.4%	10%	15%	25	$376
Existing	Restaurant	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.06	2.4%	10%	15%	25	$392
Existing	Restaurant	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.06	6.0%	10%	95%	25	$1,403

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.06	21.1%	10%	35%	25	$1,519
Existing	Restaurant	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.06	25.0%	10%	0%	25	$1,519
Existing	Restaurant	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.06	15.0%	35%	90%	25	$1,748
Existing	Restaurant	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.06	5.0%	35%	90%	25	$303
Existing	Restaurant	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.06	3.0%	95%	42%	15	$146
Existing	Restaurant	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.06	5.0%	80%	80%	25	$4,401
Existing	Restaurant	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.06	3.3%	10%	80%	25	$12425
Existing	Restaurant	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.41	34.4%	NA	NA	13	$2,356
Existing	Restaurant	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.42	15.1%	5%	95%	10	$8,705
Existing	Restaurant	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.42	0.8%	5%	75%	10	$305
Existing	Restaurant	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.42	5.0%	75%	94%	15	$934
Existing	Restaurant	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.42	3.0%	100%	80%	13	$2,700
Existing	Restaurant	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.42	6.0%	100%	95%	10	$841
Existing	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.42	0.5%	85%	25%	13	$32
Existing	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.42	0.7%	85%	55%	13	$630
Existing	Restaurant	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.42	20.0%	5%	92%	25	$1,821
Existing	Restaurant	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.42	4.0%	95%	25%	10	$0
Existing	Restaurant	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.42	3.8%	95%	15%	10	$2
Existing	Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.42	1.0%	75%	90%	15	$36
Existing	Restaurant	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.42	2.3%	95%	25%	5	$5
Existing	Restaurant	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.42	1.1%	15%	75%	10	$6
Existing	Restaurant	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.42	2.5%	15%	20%	10	$41

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Restaurant	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.42	28.0%	75%	100%	16	$3,059
Existing	Restaurant	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.42	39.5%	20%	95%	20	$72978
Existing	Restaurant	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.42	30.0%	25%	90%	14	$2,266
Existing	Restaurant	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.42	28.0%	25%	90%	20	$697
Existing	Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.42	3.3%	95%	75%	10	$206
Existing	Restaurant	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.42	7.7%	75%	75%	11	$349
New	Restaurant	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	1.61	1.9%	95%	75%	10	$210
New	Restaurant	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	1.61	6.2%	65%	65%	8	$1,111
New	Restaurant	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	1.61	0.5%	75%	75%	12	$1,224
New	Restaurant	Cooking	Oven - Convection	Convection Oven	Standard Oven	1.61	1.2%	85%	85%	12	$420
New	Restaurant	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	1.61	10.4%	35%	85%	10	$2,833
New	Restaurant	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	1.61	3.8%	45%	80%	12	$5,358
New	Restaurant	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	1.61	6.9%	65%	75%	10	$2,180
New	Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.05	11.1%	NA	NA	18	$1,414
New	Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.05	14.9%	NA	NA	18	$1,414
New	Restaurant	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.05	12.5%	90%	80%	3	$2,454
New	Restaurant	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.05	2.5%	45%	45%	18	$1,345
New	Restaurant	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.05	15.0%	5%	94%	10	$5,783
New	Restaurant	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.05	4.5%	100%	85%	10	$5,726
New	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.05	8.0%	75%	95%	25	$1,748
New	Restaurant	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.05	12.0%	75%	98%	25	$2,320
New	Restaurant	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.05	6.0%	95%	95%	25	$1,403

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Restaurant	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.05	5.0%	35%	90%	25	$303
New	Restaurant	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.05	10.0%	40%	98%	25	$521
New	Restaurant	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.05	3.0%	95%	42%	15	$146
New	Restaurant	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.05	5.0%	80%	80%	25	$4,401
New	Restaurant	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.44	34.4%	NA	NA	13	$2,356
New	Restaurant	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.42	15.1%	5%	95%	10	$8,705
New	Restaurant	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.42	0.8%	5%	75%	10	$305
New	Restaurant	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.42	5.0%	90%	94%	15	$934
New	Restaurant	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.42	3.0%	100%	80%	13	$2,700
New	Restaurant	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.42	6.0%	100%	95%	10	$841
New	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.42	0.5%	85%	25%	13	$32
New	Restaurant	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.42	0.7%	85%	55%	13	$630
New	Restaurant	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.42	20.0%	25%	92%	25	$1,821
New	Restaurant	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.42	4.0%	95%	25%	10	$0
New	Restaurant	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.42	5.0%	50%	95%	15	$1,299
New	Restaurant	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.42	2.3%	95%	25%	5	$5
New	Restaurant	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.42	1.1%	15%	75%	10	$6
New	Restaurant	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.42	28.0%	75%	100%	16	$1,715
New	Restaurant	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.42	39.5%	20%	95%	20	$72,978
New	Restaurant	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.42	30.0%	25%	90%	14	$2,266
New	Restaurant	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.42	28.0%	25%	90%	20	$697
New	Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.42	3.3%	95%	75%	10	$206
New	Restaurant	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.42	7.7%	75%	75%	11	$349

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.02	1.9%	95%	75%	10	$209
Existing	School	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.02	3.1%	45%	65%	8	$1,107
Existing	School	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.02	0.3%	65%	75%	12	$1,221
Existing	School	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.02	1.2%	85%	40%	12	$419
Existing	School	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.02	10.4%	5%	85%	10	$3,540
Existing	School	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.02	3.8%	25%	90%	12	$5,354
Existing	School	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.02	6.9%	25%	75%	10	$2,180
Existing	School	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.17	10.1%	5%	90%	12	$35761
Existing	School	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.17	50.0%	95%	35%	10	$2,241
Existing	School	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.11	5.9%	NA	NA	20	$12705
Existing	School	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.11	11.1%	NA	NA	20	$25916
Existing	School	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.11	10.0%	25%	94%	15	$54937
Existing	School	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.11	5.5%	40%	65%	20	$46077
Existing	School	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.11	12.5%	90%	40%	3	$17187
Existing	School	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.11	5.0%	5%	34%	15	$24225
Existing	School	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.11	10.0%	75%	80%	5	$46958
Existing	School	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.11	15.0%	50%	80%	5	$33887
Existing	School	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.11	2.5%	45%	45%	18	$34881
Existing	School	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.11	15.0%	5%	94%	10	$790[illegible]2
Existing	School	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.11	4.5%	73%	85%	10	$5,729
Existing	School	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.11	3.6%	75%	15%	25	$26[illegible]7

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.11	10.0%	75%	0%	25	$26597
Existing	School	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.11	4.0%	75%	45%	25	$22672
Existing	School	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.11	6.0%	75%	85%	25	$30085
Existing	School	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.11	4.4%	10%	15%	25	$9,749
Existing	School	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.11	2.4%	10%	15%	25	$10159
Existing	School	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.11	6.0%	10%	95%	25	$10098
Existing	School	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.11	21.1%	10%	35%	25	$10944
Existing	School	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.11	25.0%	10%	0%	25	$10944
Existing	School	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.11	7.5%	35%	35%	25	$22672
Existing	School	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.11	2.5%	35%	35%	25	$3,924
Existing	School	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.11	25.0%	25%	98%	10	183996
Existing	School	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.11	12.1%	75%	65%	20	$4,386
Existing	School	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.11	17.0%	90%	45%	3	$11772
Existing	School	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.11	3.0%	95%	79%	15	$148
Existing	School	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.11	10.9%	80%	60%	25	$73738
Existing	School	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.11	7.3%	10%	60%	25	208203
Existing	School	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.17	11.1%	NA	NA	18	$10194
Existing	School	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.17	14.9%	NA	NA	18	$13194
Existing	School	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.17	10.0%	25%	94%	15	$54937

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.17	12.5%	90%	80%	3	$17187
Existing	School	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.17	2.5%	45%	45%	18	$34881
Existing	School	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.17	15.0%	5%	94%	10	$79092
Existing	School	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.17	4.5%	73%	85%	10	$5,729
Existing	School	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.17	3.6%	75%	15%	25	$26597
Existing	School	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.17	10.0%	75%	0%	25	$26597
Existing	School	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.17	4.0%	75%	45%	25	$22672
Existing	School	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.17	6.0%	75%	85%	25	$30085
Existing	School	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.17	4.4%	10%	15%	25	$9,749
Existing	School	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.17	2.4%	10%	15%	25	$10159
Existing	School	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.17	6.0%	10%	95%	25	$10098
Existing	School	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.17	21.1%	10%	35%	25	$10944
Existing	School	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.17	25.0%	10%	0%	25	$10944
Existing	School	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.17	7.5%	35%	35%	25	$22672
Existing	School	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.17	2.5%	35%	35%	25	$3,924
Existing	School	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.17	3.0%	95%	79%	15	$148
Existing	School	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.17	10.9%	80%	60%	25	$70788
Existing	School	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.17	7.3%	10%	60%	25	208203
Existing	School	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.05	34.4%	NA	NA	13	$10891

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.06	15.1%	35%	95%	10	$8,703
Existing	School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.06	0.6%	35%	75%	10	$305
Existing	School	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.06	5.0%	55%	94%	15	$24225
Existing	School	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.06	3.0%	85%	80%	13	$2,703
Existing	School	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.06	6.0%	85%	95%	10	$837
Existing	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.06	0.1%	65%	25%	13	$35
Existing	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.06	0.2%	65%	55%	13	$628
Existing	School	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.06	20.0%	5%	92%	25	$8,267
Existing	School	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.06	4.0%	95%	25%	10	$0
Existing	School	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.06	3.8%	95%	15%	10	$0
Existing	School	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.06	1.0%	75%	70%	15	$924
Existing	School	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.06	2.3%	95%	25%	5	$9
Existing	School	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.06	3.4%	45%	75%	10	$9
Existing	School	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.06	7.5%	45%	20%	10	$9
Existing	School	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.06	28.0%	75%	93%	16	$79354
Existing	School	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.06	7.2%	20%	95%	20	$66657
Existing	School	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.06	30.0%	10%	90%	14	$2,267
Existing	School	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.06	28.0%	10%	90%	20	$698
Existing	School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.06	3.3%	95%	75%	10	$209
Existing	School	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.06	7.7%	75%	15%	11	$1,587
New	School	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.02	1.9%	95%	75%	10	$209
New	School	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.02	3.1%	45%	65%	8	$1,107
New	School	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.02	0.3%	65%	75%	12	$1,221
New	School	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.02	1.2%	85%	40%	12	$419

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.02	10.4%	5%	85%	10	$2,834
New	School	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.02	3.8%	25%	90%	12	$5,354
New	School	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.02	6.9%	25%	75%	10	$2,180
New	School	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.03	10.1%	5%	90%	12	$35761
New	School	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.03	50.0%	95%	35%	10	$2,241
New	School	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.10	5.9%	NA	NA	20	$12705
New	School	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.10	11.1%	NA	NA	20	$25916
New	School	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.10	10.0%	25%	94%	15	$54937
New	School	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.10	5.5%	40%	65%	20	$46077
New	School	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.10	12.5%	90%	40%	3	$63657
New	School	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.10	10.0%	75%	80%	5	$46958
New	School	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.10	2.5%	45%	45%	18	$34881
New	School	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.10	15.0%	5%	94%	10	$79092
New	School	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.10	4.5%	73%	85%	10	$5,729
New	School	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.10	4.0%	75%	45%	25	$22672
New	School	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.10	6.0%	75%	85%	25	$30085
New	School	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.10	6.0%	95%	95%	25	$10098
New	School	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.10	2.5%	35%	35%	25	$3,924
New	School	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.10	5.0%	50%	95%	15	$36363
New	School	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.10	10.0%	40%	98%	25	$13516

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.10	25.0%	50%	98%	10	183996
New	School	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.10	3.0%	95%	79%	15	$148
New	School	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.10	10.9%	80%	60%	25	$73738
New	School	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.14	11.1%	NA	NA	18	$13194
New	School	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.14	14.9%	NA	NA	18	$13194
New	School	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.14	10.0%	25%	94%	15	$54937
New	School	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.14	12.5%	90%	80%	3	$63657
New	School	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.14	2.5%	45%	45%	18	$34881
New	School	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.14	15.0%	5%	94%	10	$79092
New	School	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.14	4.5%	73%	85%	10	$5,729
New	School	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.14	4.0%	75%	45%	25	$22672
New	School	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.14	6.0%	75%	85%	25	$30085
New	School	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.14	6.0%	95%	95%	25	$10098
New	School	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.14	2.5%	35%	35%	25	$3,924
New	School	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.14	10.0%	40%	98%	25	$13516
New	School	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.14	3.0%	95%	79%	15	$148
New	School	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.14	10.9%	80%	60%	25	$73738
New	School	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.06	34.4%	NA	NA	13	$10691
New	School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.06	15.1%	35%	95%	10	$8,703

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.06	0.6%	35%	75%	10	$305
New	School	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.06	5.0%	55%	94%	15	$24225
New	School	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.06	3.0%	85%	80%	13	$2,703
New	School	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.06	6.0%	85%	95%	10	$837
New	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.06	0.1%	65%	25%	13	$35
New	School	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.06	0.2%	65%	55%	13	$628
New	School	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.06	20.0%	25%	92%	25	$8,267
New	School	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.06	4.0%	95%	25%	10	$0
New	School	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.06	5.0%	50%	95%	15	$36363
New	School	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.06	2.3%	95%	25%	5	$9
New	School	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.06	3.4%	45%	75%	10	$9
New	School	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.06	28.0%	75%	93%	16	$44473
New	School	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.06	7.2%	20%	95%	20	$66657
New	School	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.06	30.0%	10%	90%	14	$2,267
New	School	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.06	28.0%	10%	90%	20	$698
New	School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.06	3.3%	95%	75%	10	$209
New	School	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.06	7.7%	75%	15%	11	$1,587
Existing	University	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.05	1.9%	95%	75%	10	$214
Existing	University	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.05	3.1%	45%	65%	8	$1,109
Existing	University	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.05	0.3%	65%	75%	12	$1,223
Existing	University	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.05	1.2%	85%	40%	12	$416
Existing	University	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.05	10.4%	5%	85%	10	$3,543
Existing	University	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.05	3.8%	25%	90%	12	$5,358
Existing	University	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.05	6.9%	25%	75%	10	$2,181

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.13	10.1%	50%	90%	12	$35503
Existing	University	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.13	50.0%	95%	35%	10	$2,232
Existing	University	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.22	5.9%	NA	NA	20	$18369
Existing	University	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.22	11.1%	NA	NA	20	$37469
Existing	University	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.23	10.0%	25%	94%	15	$79427
Existing	University	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.23	5.5%	40%	90%	20	$66618
Existing	University	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.23	12.5%	90%	40%	3	$24849
Existing	University	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.23	5.0%	5%	34%	15	$35024
Existing	University	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.23	10.0%	75%	80%	5	$67891
Existing	University	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.23	15.0%	50%	80%	5	$48993
Existing	University	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.23	2.5%	45%	45%	18	$50430
Existing	University	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.23	15.0%	5%	94%	10	114350
Existing	University	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.23	4.5%	73%	85%	10	$5,724
Existing	University	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.23	3.6%	75%	13%	25	$38453
Existing	University	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.23	10.0%	75%	0%	25	$38453
Existing	University	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.23	4.0%	75%	45%	25	$32780
Existing	University	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.23	6.0%	75%	85%	25	$43496
Existing	University	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.23	4.4%	10%	15%	25	$14095
Existing	University	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.23	2.4%	10%	15%	25	$14688

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.23	6.0%	10%	95%	25	$12141
Existing	University	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.23	21.1%	10%	35%	25	$13162
Existing	University	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.23	25.0%	10%	0%	25	$13162
Existing	University	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.23	7.5%	35%	35%	25	$32780
Existing	University	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.23	2.5%	35%	35%	25	$5,673
Existing	University	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.23	25.0%	25%	98%	10	266018
Existing	University	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.23	12.1%	75%	65%	20	$5,270
Existing	University	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.23	17.0%	90%	45%	3	$17020
Existing	University	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.23	3.0%	95%	66%	15	$151
Existing	University	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.23	10.9%	80%	60%	25	106609
Existing	University	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.23	7.3%	10%	60%	25	301017
Existing	University	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.33	11.1%	NA	NA	18	$19075
Existing	University	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.33	14.9%	NA	NA	18	$19075
Existing	University	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.33	10.0%	25%	94%	15	$79427
Existing	University	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.33	12.5%	90%	80%	3	$24849
Existing	University	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.33	2.5%	45%	45%	18	$50430
Existing	University	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.33	15.0%	5%	94%	10	110350
Existing	University	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.33	4.5%	73%	85%	10	$5,724
Existing	University	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.33	3.6%	75%	13%	25	$38453

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.33	10.0%	75%	0%	25	$38453
Existing	University	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.33	4.0%	75%	45%	25	$32780
Existing	University	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.33	6.0%	75%	85%	25	$43496
Existing	University	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.33	4.4%	10%	15%	25	$14095
Existing	University	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.33	2.4%	10%	15%	25	$14688
Existing	University	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.33	6.0%	10%	95%	25	$12141
Existing	University	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.33	21.1%	10%	35%	25	$13162
Existing	University	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.33	25.0%	10%	0%	25	$13162
Existing	University	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.33	7.5%	35%	35%	25	$32780
Existing	University	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.33	2.5%	35%	35%	25	$5,673
Existing	University	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.33	3.0%	95%	66%	15	$151
Existing	University	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.33	10.9%	80%	60%	25	106609
Existing	University	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.33	7.3%	10%	60%	25	301017
Existing	University	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.09	34.4%	NA	NA	13	$18117
Existing	University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.09	15.1%	35%	95%	10	$8,699
Existing	University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.09	0.2%	35%	75%	10	$303
Existing	University	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.09	5.0%	55%	94%	15	$35,024
Existing	University	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.09	3.0%	85%	80%	13	$2,698
Existing	University	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.09	6.0%	85%	95%	10	$845
Existing	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.09	0.1%	65%	25%	13	$25

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.09	0.1%	65%	55%	13	$630
Existing	University	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.09	20.0%	5%	92%	25	$14007
Existing	University	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.09	4.0%	95%	25%	10	$0
Existing	University	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.09	3.8%	95%	15%	10	$0
Existing	University	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.09	1.0%	75%	70%	15	$1,336
Existing	University	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.09	2.3%	95%	45%	5	$0
Existing	University	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.09	3.4%	45%	75%	10	$0
Existing	University	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.09	7.5%	45%	20%	10	$13
Existing	University	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.09	28.0%	75%	100%	16	114728
Existing	University	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.09	6.9%	20%	95%	20	$99246
Existing	University	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.09	30.0%	10%	90%	14	$2,269
Existing	University	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.09	28.0%	10%	90%	20	$693
Existing	University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.09	3.3%	95%	75%	10	$202
Existing	University	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.09	7.7%	75%	15%	11	$2,685
New	University	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	0.05	1.9%	95%	75%	10	$214
New	University	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	0.05	3.1%	45%	65%	8	$1,109
New	University	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	0.05	0.3%	65%	75%	12	$1,223
New	University	Cooking	Oven - Convection	Convection Oven	Standard Oven	0.05	1.2%	85%	40%	12	$416
New	University	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	0.05	10.4%	5%	85%	10	$2,837
New	University	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	0.05	3.8%	25%	90%	12	$5,358
New	University	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	0.05	6.9%	25%	75%	10	$2,181
New	University	Pool Heat	Solar RE - Installation of Solar Pool/Spa Heating Systems	Solar Pool/Spa Heating Systems	No Solar Pool Heating System	0.04	10.1%	50%	90%	12	$35503
New	University	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	0.04	50.0%	95%	35%	10	$2,432
New	University	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.19	5.9%	NA	NA	20	$18369
New	University	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.19	11.1%	NA	NA	20	$37469

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.19	10.0%	25%	94%	15	$79427
New	University	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.19	5.5%	40%	90%	20	$66618
New	University	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.19	12.5%	90%	40%	3	$92035
New	University	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.19	10.0%	75%	80%	5	$67891
New	University	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.19	2.5%	45%	45%	18	$50430
New	University	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.19	15.0%	5%	94%	10	114350
New	University	Space Heat Boiler	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.19	4.5%	73%	85%	10	$5,724
New	University	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.19	4.0%	75%	45%	25	$32780
New	University	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.19	6.0%	75%	85%	25	$43496
New	University	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.19	6.0%	95%	95%	25	$12141
New	University	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.19	2.5%	35%	35%	25	$5,673
New	University	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.19	5.0%	50%	95%	15	$52573
New	University	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.19	10.0%	40%	98%	25	$19542
New	University	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.19	25.0%	50%	98%	10	266018
New	University	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.19	3.0%	95%	66%	15	$151
New	University	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.19	10.9%	80%	60%	25	106609
New	University	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.28	11.1%	NA	NA	18	$19075
New	University	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.28	14.9%	NA	NA	18	$19075
New	University	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	0.28	10.0%	25%	94%	15	$79427

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.28	12.5%	90%	80%	3	$92035
New	University	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.28	2.5%	45%	45%	18	$50430
New	University	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.28	15.0%	5%	94%	10	114350
New	University	Space Heat Furnace	Exhaust Hood Makeup Air	Provide Makeup Air Directly at Exhaust Hood Instead of Pulling Conditioned Air	Hood Pulls Conditioned Air (No Make-up Air)	0.28	4.5%	73%	85%	10	$5,724
New	University	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.28	4.0%	75%	45%	25	$32780
New	University	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.28	6.0%	75%	85%	25	$43496
New	University	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.28	6.0%	95%	95%	25	$12141
New	University	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.28	2.5%	35%	35%	25	$5,673
New	University	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.28	10.0%	40%	98%	25	$19542
New	University	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.28	3.0%	95%	66%	15	$151
New	University	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.28	10.9%	80%	60%	25	106609
New	University	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.10	34.4%	NA	NA	13	$18117
New	University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.09	15.1%	35%	95%	10	$8,699
New	University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.09	0.2%	35%	75%	10	$303
New	University	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.09	5.0%	55%	94%	15	$35024
New	University	Water Heat	Dishwashing - Commercial - High Efficeincy	High Efficiency Dishwasher	Standard Dishwasher	0.09	3.0%	85%	80%	13	$2,698
New	University	Water Heat	Dishwashing - Commercial Chemical System	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	0.09	6.0%	85%	95%	10	$845
New	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.09	0.1%	65%	25%	13	$625
New	University	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.09	0.1%	65%	55%	13	$630
New	University	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.09	20.0%	25%	92%	25	$14007

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	University	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.09	4.0%	95%	25%	10	$0
New	University	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.09	5.0%	50%	95%	15	$52573
New	University	Water Heat	Low Flow Spray Heads	1.6 GPM	3.0 GPM	0.09	2.3%	95%	45%	5	$0
New	University	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.09	3.4%	45%	75%	10	$0
New	University	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.09	28.0%	75%	100%	16	$64298
New	University	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.09	6.9%	20%	95%	20	$99246
New	University	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.09	30.0%	10%	90%	14	$2,269
New	University	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.09	28.0%	10%	90%	20	$693
New	University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.09	3.3%	95%	75%	10	$202
New	University	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.09	7.7%	75%	15%	11	$2,685
Existing	Warehouse	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.09	5.9%	NA	NA	20	$11670
Existing	Warehouse	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.09	11.1%	NA	NA	20	$23805
Existing	Warehouse	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.09	5.5%	40%	90%	20	$42306
Existing	Warehouse	Space Heat Boiler	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.09	12.5%	90%	40%	3	$15531
Existing	Warehouse	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	0.09	5.0%	5%	93%	15	$21890
Existing	Warehouse	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.09	10.0%	75%	98%	5	$42432
Existing	Warehouse	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	0.09	15.0%	75%	98%	5	$30620
Existing	Warehouse	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.09	2.5%	45%	45%	18	$31519
Existing	Warehouse	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.09	15.0%	5%	94%	10	$71469
Existing	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.09	7.2%	75%	10%	25	$48066
Existing	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-21 (Code)	R-0	0.09	20.0%	75%	0%	25	$48066

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.09	8.0%	75%	45%	25	$40974
Existing	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.09	12.0%	75%	85%	25	$54370
Existing	Warehouse	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.09	4.4%	10%	15%	25	$8,809
Existing	Warehouse	Space Heat Boiler	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.09	2.4%	10%	15%	25	$9,180
Existing	Warehouse	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.09	6.0%	10%	95%	25	$6,792
Existing	Warehouse	Space Heat Boiler	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.09	21.1%	10%	35%	25	$7,352
Existing	Warehouse	Space Heat Boiler	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.09	25.0%	10%	0%	25	$7,352
Existing	Warehouse	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.09	15.0%	35%	45%	25	$40974
Existing	Warehouse	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.09	5.0%	35%	45%	25	$7,092
Existing	Warehouse	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.09	25.0%	25%	98%	10	166261
Existing	Warehouse	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	0.09	12.1%	75%	65%	20	$4,168
Existing	Warehouse	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	0.09	17.0%	90%	45%	3	$10638
Existing	Warehouse	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.09	3.0%	95%	20%	15	$142
Existing	Warehouse	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.09	1.5%	80%	98%	25	$17816
Existing	Warehouse	Space Heat Boiler	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.09	1.0%	10%	98%	25	$50296
Existing	Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.13	11.1%	NA	NA	18	$12119
Existing	Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.13	14.9%	NA	NA	18	$12119
Existing	Warehouse	Space Heat Furnace	Commissioning - Retro Building Commissioning	Commissioning - Retro Building Commissioning	No Commisioning	0.13	12.5%	90%	80%	3	$15531
Existing	Warehouse	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.13	2.5%	45%	45%	18	$31519

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.13	15.0%	5%	94%	10	$71469
Existing	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	Existing Ceiling Insulation (Average R-9)	0.13	7.2%	75%	10%	25	$48066
Existing	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-21 (Code)	R-0	0.13	20.0%	75%	0%	25	$48066
Existing	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.13	8.0%	75%	45%	25	$40974
Existing	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.13	12.0%	75%	85%	25	$54370
Existing	Warehouse	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	Install New Duct Insulation (R-8)	R-0	0.13	4.4%	10%	15%	25	$8,809
Existing	Warehouse	Space Heat Furnace	Insulation (Duct) (Unconditioned Spaces)	R-4	R-0	0.13	2.4%	10%	15%	25	$9,180
Existing	Warehouse	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.13	6.0%	10%	95%	25	$6,792
Existing	Warehouse	Space Heat Furnace	Insulation (Wall) - Existing to Code	R-19 (2x6 Framing) - (Code)	Existing R-value (Average R-3)	0.13	21.1%	10%	35%	25	$7,352
Existing	Warehouse	Space Heat Furnace	Insulation (Wall) - Zero to Code	R-19 (2x6 Framing) - (Code)	R-0	0.13	25.0%	10%	0%	25	$7,352
Existing	Warehouse	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-10 (Code)	R-0	0.13	15.0%	35%	45%	25	$40974
Existing	Warehouse	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.13	5.0%	35%	45%	25	$7,092
Existing	Warehouse	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.13	3.0%	95%	20%	15	$142
Existing	Warehouse	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.13	1.5%	80%	98%	25	$17816
Existing	Warehouse	Space Heat Furnace	Windows - Existing to Code	U = 0.55 (Code)	Existing Windows (U=0.65)	0.13	1.0%	10%	98%	25	$50296
Existing	Warehouse	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.02	34.4%	NA	NA	13	$1,450
Existing	Warehouse	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.02	15.1%	5%	95%	10	$8,707
Existing	Warehouse	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.02	0.8%	5%	75%	10	$307
Existing	Warehouse	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.02	5.0%	55%	94%	15	$21890

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
Existing	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.02	0.5%	5%	25%	13	$32
Existing	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.02	0.7%	5%	55%	13	$630
Existing	Warehouse	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.02	20.0%	5%	92%	25	$1,119
Existing	Warehouse	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.02	4.0%	95%	25%	10	$0
Existing	Warehouse	Water Heat	Faucet Aerators - Existing to Code	2.5 GPM Aerator (Federal Code)	4.0 GPM Aerator	0.02	3.8%	95%	15%	10	$0
Existing	Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	Install Insulation (R-4)	No Pipe Insulation	0.02	1.0%	75%	90%	15	$835
Existing	Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.02	1.1%	15%	75%	10	$8
Existing	Warehouse	Water Heat	Low-Flow Showerheads - Existing to Code	2.5 GPM Showerhead (Federal Code)	4.5 GPM Showerhead	0.02	2.5%	15%	20%	10	$8
Existing	Warehouse	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.02	28.0%	75%	49%	16	$71705
Existing	Warehouse	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.02	32.7%	20%	95%	20	$43819
Existing	Warehouse	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.02	30.0%	25%	90%	14	$2,269
Existing	Warehouse	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.02	28.0%	25%	90%	20	$693
Existing	Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.02	3.3%	95%	95%	10	$205
Existing	Warehouse	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.02	7.7%	75%	45%	11	$213
New	Warehouse	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	85% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.05	5.9%	NA	NA	20	$11670
New	Warehouse	Space Heat Boiler	Gas Boiler - Greater than 300 kBTUH	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	0.05	11.1%	NA	NA	20	$23805
New	Warehouse	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	0.05	5.5%	40%	90%	20	$42306
New	Warehouse	Space Heat Boiler	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.05	12.5%	90%	40%	3	$57522
New	Warehouse	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	0.05	10.0%	75%	98%	5	$42432
New	Warehouse	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.05	2.5%	45%	45%	18	$31519
New	Warehouse	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.05	15.0%	5%	94%	10	$71469
New	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-38	R-21 (Code)	0.05	8.0%	75%	45%	25	$40974

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Warehouse	Space Heat Boiler	Insulation (Ceiling)	R-49	R-21 (Code)	0.05	12.0%	75%	85%	25	$54370
New	Warehouse	Space Heat Boiler	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.05	6.0%	95%	95%	25	$6,792
New	Warehouse	Space Heat Boiler	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.05	5.0%	35%	45%	25	$7,092
New	Warehouse	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.05	5.0%	50%	95%	15	$33386
New	Warehouse	Space Heat Boiler	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.05	10.0%	40%	98%	25	$12214
New	Warehouse	Space Heat Boiler	Sensible And Total Heat Recovery Devices	Install Heat Recovery Devices - rotary air-to-air enthalpy heat recovery- 70% sensible and latent recovery effectiveness	No Heat Recovery	0.05	25.0%	50%	98%	10	166261
New	Warehouse	Space Heat Boiler	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.05	3.0%	95%	20%	15	$142
New	Warehouse	Space Heat Boiler	Windows	U = 0.35	U = 0.55 (Code)	0.05	1.5%	80%	98%	25	$17816
New	Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	0.07	11.1%	NA	NA	18	$12119
New	Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	0.07	14.9%	NA	NA	18	$12119
New	Warehouse	Space Heat Furnace	Commissioning - New Building Commissioning	Commissioning - New Building Commissioning	No Commisioning	0.07	12.5%	90%	80%	3	$57522
New	Warehouse	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	0.07	2.5%	45%	45%	18	$31519
New	Warehouse	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	0.07	15.0%	5%	94%	10	$71469
New	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-38	R-21 (Code)	0.07	8.0%	75%	45%	25	$40974
New	Warehouse	Space Heat Furnace	Insulation (Ceiling)	R-49	R-21 (Code)	0.07	12.0%	75%	85%	25	$54370
New	Warehouse	Space Heat Furnace	Insulation (Wall)	R-25 (2x6 Framing) - Advanced	R-19 (2x6 Framing) - (Code)	0.07	6.0%	95%	95%	25	$6,792
New	Warehouse	Space Heat Furnace	Insulation - Floor (Non-Slab)	R-19	R-10 (Code)	0.07	5.0%	35%	45%	25	$7,092
New	Warehouse	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	0.07	10.0%	40%	98%	25	$12214
New	Warehouse	Space Heat Furnace	Thermostat - Programmable	Energy Star Programmable Thermostat	Manual Thermostat	0.07	3.0%	95%	20%	15	$142

Construction Vintage	Customer Segment	End Use	Measure Name	Measure Description	Base Equipment	Baseline therm (UEC or EUI)	Savings as Percent of End Use	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Measure Life	Measure Cost
New	Warehouse	Space Heat Furnace	Windows	U = 0.35	U = 0.55 (Code)	0.07	1.5%	80%	98%	25	$17816
New	Warehouse	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.59	0.02	34.4%	NA	NA	13	$1,450
New	Warehouse	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	0.02	15.1%	5%	95%	10	$8,707
New	Warehouse	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	0.02	0.8%	5%	75%	10	$307
New	Warehouse	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	0.02	5.0%	55%	94%	15	$21890
New	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.65 (ENERGY STAR)	Existing Dishwasher (FED Std. EF=0.46)	0.02	0.5%	5%	25%	13	$32
New	Warehouse	Water Heat	Dishwashing - Residential Sized System	EF = 0.77	Existing Dishwasher (FED Std. EF=0.46)	0.02	0.7%	5%	55%	13	$630
New	Warehouse	Water Heat	Drainwater Heat Recovery (Power-Pipe or GFX)	Install Power-Pipe or GFX System	No GFX or Power-Pipe System	0.02	20.0%	25%	92%	25	$1,119
New	Warehouse	Water Heat	Faucet Aerators	1.5 GPM Aerator	2.5 GPM Aerator (Federal Code)	0.02	4.0%	95%	25%	10	$0
New	Warehouse	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	0.02	5.0%	50%	95%	15	$33386
New	Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM Showerhead	2.5 GPM Showerhead (Federal Code)	0.02	1.1%	15%	75%	10	$8
New	Warehouse	Water Heat	Refrigeration with Heat Recovery	Heat Recovery from Refrigeration System. Applied to Water Heating	No Heat Recovery	0.02	28.0%	75%	49%	16	$40186
New	Warehouse	Water Heat	Solar RE - Solar Water Heater	Passive solar water heating	Standard Water Heater EF = 0.93	0.02	32.7%	20%	95%	20	$43819
New	Warehouse	Water Heat	Tankless Water Heater - Commercial	EF = 0.82	Thermal Efficiency = 80%	0.02	30.0%	25%	90%	14	$2,269
New	Warehouse	Water Heat	Tankless Water Heater - Residential	EF = 0.82	EF = 0.59 (40 Gal)	0.02	28.0%	25%	90%	20	$693
New	Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	0.02	3.3%	95%	95%	10	$205
New	Warehouse	Water Heat	Water Heater Thermostat Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	0.02	7.7%	75%	45%	11	$213

Industrial Electric Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Chemical Mfg	Fans	Motor Improvements	105,893	2.6%	15	$298
Existing	Chemical Mfg	Fans	Motor O&M	105,893	5.5%	2	$53
Existing	Chemical Mfg	HVAC	HVAC Improvements	89,911	12.1%	15	$415
Existing	Chemical Mfg	HVAC	HVAC O&M	89,911	12.0%	2	$432
Existing	Chemical Mfg	Lighting	Lighting Improvements	66,306	5.0%	10	$321
Existing	Chemical Mfg	Motors Other	Motor Improvements	237,600	2.6%	15	$669
Existing	Chemical Mfg	Motors Other	Motor O&M	237,600	5.5%	2	$120
Existing	Chemical Mfg	Other	Bldg Improvements	26,703	12.1%	15	$774
Existing	Chemical Mfg	Process AirComp	Air Comp Improvements	246,511	3.9%	15	$414
Existing	Chemical Mfg	Process AirComp	Air Comp O&M	246,511	4.6%	2	$231
Existing	Chemical Mfg	Process AirComp	Motor Improvements	246,511	2.6%	15	$694
Existing	Chemical Mfg	Process AirComp	Motor O&M	246,511	5.5%	2	$125
Existing	Chemical Mfg	Process Cool	Cool Improvements	130,817	9.2%	15	$1,380
Existing	Chemical Mfg	Process Heat	Heat Improvements	51,321	12.2%	15	$633
Existing	Chemical Mfg	Process Heat	Heat O&M	51,321	8.0%	2	$70
Existing	Chemical Mfg	Process Heat	Steam Distribution	51,321	29.1%	15	$981
Existing	Chemical Mfg	Process Other	Other Improvements	2,029	44.1%	15	$270
Existing	Chemical Mfg	Process Other	Other O&M	2,029	2.5%	2	$2
Existing	Chemical Mfg	Process Refrig	Motor Improvements	68,530	2.6%	15	$193
Existing	Chemical Mfg	Process Refrig	Motor O&M	68,530	5.5%	2	$35
Existing	Chemical Mfg	Pumps	Motor Improvements	231,373	2.6%	15	$651
Existing	Chemical Mfg	Pumps	Motor O&M	231,373	5.5%	2	$117
Existing	Computer Electronic Mfg	Fans	Motor Improvements	16,024	3.7%	15	$47
Existing	Computer Electronic Mfg	Fans	Motor O&M	16,024	0.3%	2	$11
Existing	Computer Electronic Mfg	HVAC	HVAC Improvements	101,509	11.7%	15	$1,065
Existing	Computer Electronic Mfg	HVAC	HVAC O&M	101,509	6.8%	2	$60
Existing	Computer Electronic Mfg	Lighting	Lighting Improvements	45,454	8.7%	10	$499
Existing	Computer Electronic Mfg	Motors Other	Motor Improvements	31,721	3.7%	15	$93
Existing	Computer Electronic Mfg	Motors Other	Motor O&M	31,721	0.3%	2	$21

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Computer Electronic Mfg	Other	Bldg Improvements	40,204	0.8%	15	$56
Existing	Computer Electronic Mfg	Process AirComp	Air Comp Improvements	3,723	23.6%	15	$52
Existing	Computer Electronic Mfg	Process AirComp	Air Comp O&M	3,723	31.7%	2	$42
Existing	Computer Electronic Mfg	Process AirComp	Motor Improvements	3,723	3.7%	15	$11
Existing	Computer Electronic Mfg	Process AirComp	Motor O&M	3,723	0.3%	2	$3
Existing	Computer Electronic Mfg	Process Cool	Cool Improvements	31,899	12.4%	15	$946
Existing	Computer Electronic Mfg	Process Heat	Heat Improvements	40,101	0.8%	15	$29
Existing	Computer Electronic Mfg	Process Heat	Heat O&M	40,101	32.9%	2	$87
Existing	Computer Electronic Mfg	Process Heat	Steam Distribution	40,101	1.1%	15	$30
Existing	Computer Electronic Mfg	Process Other	Other Improvements	9,811	12.4%	15	$115
Existing	Computer Electronic Mfg	Process Other	Other O&M	9,811	26.4%	2	$78
Existing	Computer Electronic Mfg	Process Refrig	Motor Improvements	4,046	3.7%	15	$12
Existing	Computer Electronic Mfg	Process Refrig	Motor O&M	4,046	0.3%	2	$3
Existing	Computer Electronic Mfg	Pumps	Motor Improvements	25,409	3.7%	15	$74
Existing	Computer Electronic Mfg	Pumps	Motor O&M	25,409	0.3%	2	$17
Existing	Electrical Equipment Mfg	Fans	Motor Improvements	5,860	2.4%	15	$11
Existing	Electrical Equipment Mfg	Fans	Motor O&M	5,860	2.9%	2	$6
Existing	Electrical Equipment Mfg	HVAC	HVAC Improvements	23,487	14.9%	15	$234
Existing	Electrical Equipment Mfg	HVAC	HVAC O&M	23,487	12.1%	2	$10
Existing	Electrical Equipment Mfg	Lighting	Lighting Improvements	17,790	6.2%	10	$104
Existing	Electrical Equipment Mfg	Motors Other	Motor Improvements	13,149	2.4%	15	$25
Existing	Electrical Equipment Mfg	Motors Other	Motor O&M	13,149	2.9%	2	$14
Existing	Electrical Equipment Mfg	Other	Bldg Improvements	10,432	1.4%	15	$7
Existing	Electrical Equipment Mfg	Process AirComp	Air Comp Improvements	13,642	8.8%	15	$67
Existing	Electrical Equipment Mfg	Process AirComp	Air Comp O&M	13,642	8.8%	2	$35
Existing	Electrical Equipment Mfg	Process AirComp	Motor Improvements	13,642	2.4%	15	$26
Existing	Electrical Equipment Mfg	Process AirComp	Motor O&M	13,642	2.9%	2	$14
Existing	Electrical Equipment Mfg	Process Cool	Cool Improvements	6,072	11.3%	15	$32
Existing	Electrical Equipment Mfg	Process Heat	Heat Improvements	25,682	5.4%	15	$30
Existing	Electrical Equipment Mfg	Process Heat	Heat O&M	25,682	2.4%	2	$9
Existing	Electrical Equipment Mfg	Process Heat	Steam Distribution	25,682	2.2%	15	$10

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Electrical Equipment Mfg	Process Other	Other Improvements	831	40.1%	15	$30
Existing	Electrical Equipment Mfg	Process Other	Other O&M	831	18.7%	2	$16
Existing	Electrical Equipment Mfg	Process Refrig	Motor Improvements	3,792	2.4%	15	$7
Existing	Electrical Equipment Mfg	Process Refrig	Motor O&M	3,792	2.9%	2	$4
Existing	Electrical Equipment Mfg	Process Refrig	Refrig Improvements	3,792	16.4%	15	$38
Existing	Electrical Equipment Mfg	Pumps	Motor Improvements	12,804	2.4%	15	$24
Existing	Electrical Equipment Mfg	Pumps	Motor O&M	12,804	2.9%	2	$14
Existing	Fabricated Metal Products	Fans	Motor Improvements	22,481	4.2%	15	$122
Existing	Fabricated Metal Products	Fans	Motor O&M	22,481	7.3%	2	$30
Existing	Fabricated Metal Products	HVAC	HVAC Improvements	37,690	10.0%	15	$528
Existing	Fabricated Metal Products	HVAC	HVAC O&M	37,690	11.2%	2	$281
Existing	Fabricated Metal Products	Lighting	Lighting Improvements	35,135	8.9%	10	$344
Existing	Fabricated Metal Products	Motors Other	Motor Improvements	63,998	4.2%	15	$347
Existing	Fabricated Metal Products	Motors Other	Motor O&M	63,998	7.3%	2	$87
Existing	Fabricated Metal Products	Other	Bldg Improvements	33,684	5.5%	15	$551
Existing	Fabricated Metal Products	Process AirComp	Air Comp Improvements	25,929	10.9%	15	$100
Existing	Fabricated Metal Products	Process AirComp	Air Comp O&M	25,929	14.2%	2	$62
Existing	Fabricated Metal Products	Process AirComp	Motor Improvements	25,929	4.2%	15	$141
Existing	Fabricated Metal Products	Process AirComp	Motor O&M	25,929	7.3%	2	$35
Existing	Fabricated Metal Products	Process Cool	Cool Improvements	12,899	12.1%	15	$182
Existing	Fabricated Metal Products	Process Heat	Heat Improvements	85,352	6.2%	15	$159
Existing	Fabricated Metal Products	Process Heat	Heat O&M	85,352	4.7%	2	$75
Existing	Fabricated Metal Products	Process Heat	Steam Distribution	85,352	33.3%	15	$245
Existing	Fabricated Metal Products	Process Other	Other Improvements	691	44.8%	15	$55
Existing	Fabricated Metal Products	Process Other	Other O&M	691	27.4%	2	$22
Existing	Fabricated Metal Products	Process Refrig	Motor Improvements	10,995	4.2%	15	$60
Existing	Fabricated Metal Products	Process Refrig	Motor O&M	10,995	7.3%	2	$15
Existing	Fabricated Metal Products	Process Refrig	Refrig Improvements	10,995	11.5%	15	$14
Existing	Fabricated Metal Products	Pumps	Motor Improvements	40,695	4.2%	15	$221
Existing	Fabricated Metal Products	Pumps	Motor O&M	40,695	7.3%	2	$55
Existing	Food Mfg	Fans	Motor Improvements	19,516	3.3%	15	$61

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Food Mfg	Fans	Motor O&M	19,516	1.6%	2	$5
Existing	Food Mfg	HVAC	HVAC Improvements	35,927	9.2%	15	$376
Existing	Food Mfg	HVAC	HVAC O&M	35,927	10.9%	2	$70
Existing	Food Mfg	Lighting	Lighting Improvements	34,421	7.8%	10	$263
Existing	Food Mfg	Motors Other	Motor Improvements	101,472	3.3%	15	$315
Existing	Food Mfg	Motors Other	Motor O&M	101,472	1.6%	2	$24
Existing	Food Mfg	Other	Bldg Improvements	37,401	0.6%	15	$27
Existing	Food Mfg	Process AirComp	Air Comp Improvements	20,032	10.2%	15	$84
Existing	Food Mfg	Process AirComp	Air Comp O&M	20,032	13.0%	2	$58
Existing	Food Mfg	Process AirComp	Motor Improvements	20,032	3.3%	15	$62
Existing	Food Mfg	Process AirComp	Motor O&M	20,032	1.6%	2	$5
Existing	Food Mfg	Process Cool	Cool Improvements	129,766	11.9%	15	$2,450
Existing	Food Mfg	Process Heat	Heat Improvements	15,900	33.0%	15	$906
Existing	Food Mfg	Process Heat	Heat O&M	15,900	8.9%	2	$67
Existing	Food Mfg	Process Heat	Steam Distribution	15,900	22.6%	15	$804
Existing	Food Mfg	Process Other	Other Improvements	1,334	29.5%	15	$37
Existing	Food Mfg	Process Other	Other O&M	1,334	28.1%	2	$100
Existing	Food Mfg	Process Refrig	Motor Improvements	76,496	3.3%	15	$238
Existing	Food Mfg	Process Refrig	Motor O&M	76,496	1.6%	2	$18
Existing	Food Mfg	Process Refrig	Refrig Improvements	76,496	15.6%	15	$855
Existing	Food Mfg	Pumps	Motor Improvements	42,668	3.3%	15	$133
Existing	Food Mfg	Pumps	Motor O&M	42,668	1.6%	2	$10
Existing	Industrial Machinery	Fans	Motor Improvements	10,864	3.1%	15	$29
Existing	Industrial Machinery	Fans	Motor O&M	10,864	1.0%	2	$5
Existing	Industrial Machinery	HVAC	HVAC Improvements	30,134	12.8%	15	$521
Existing	Industrial Machinery	HVAC	HVAC O&M	30,134	7.5%	2	$91
Existing	Industrial Machinery	Lighting	Lighting Improvements	22,418	6.9%	10	$166
Existing	Industrial Machinery	Motors Other	Motor Improvements	30,926	3.1%	15	$84
Existing	Industrial Machinery	Motors Other	Motor O&M	30,926	1.0%	2	$15
Existing	Industrial Machinery	Other	Bldg Improvements	11,525	9.3%	15	$225
Existing	Industrial Machinery	Process AirComp	Air Comp Improvements	12,529	11.9%	15	$129

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Industrial Machinery	Process AirComp	Air Comp O&M	12,529	15.5%	2	$48
Existing	Industrial Machinery	Process AirComp	Motor Improvements	12,529	3.1%	15	$34
Existing	Industrial Machinery	Process AirComp	Motor O&M	12,529	1.0%	2	$6
Existing	Industrial Machinery	Process Cool	Cool Improvements	5,338	31.5%	15	$190
Existing	Industrial Machinery	Process Heat	Heat Improvements	12,146	6.4%	15	$92
Existing	Industrial Machinery	Process Heat	Heat O&M	12,146	8.5%	2	$57
Existing	Industrial Machinery	Process Heat	Steam Distribution	12,146	6.7%	15	$11
Existing	Industrial Machinery	Process Other	Other Improvements	888	39.0%	15	$40
Existing	Industrial Machinery	Process Other	Other O&M	888	17.3%	2	$58
Existing	Industrial Machinery	Process Refrig	Motor Improvements	5,314	3.1%	15	$14
Existing	Industrial Machinery	Process Refrig	Motor O&M	5,314	1.0%	2	$3
Existing	Industrial Machinery	Process Refrig	Refrig Improvements	5,314	9.5%	15	$52
Existing	Industrial Machinery	Pumps	Motor Improvements	19,666	3.1%	15	$53
Existing	Industrial Machinery	Pumps	Motor O&M	19,666	1.0%	2	$10
Existing	Miscellaneous Mfg	Fans	Motor Improvements	9,058	4.4%	15	$71
Existing	Miscellaneous Mfg	Fans	Motor O&M	9,058	2.4%	2	$2
Existing	Miscellaneous Mfg	HVAC	HVAC Improvements	33,107	8.7%	15	$844
Existing	Miscellaneous Mfg	HVAC	HVAC O&M	33,107	9.5%	2	$18
Existing	Miscellaneous Mfg	Lighting	Lighting Improvements	23,729	6.3%	10	$145
Existing	Miscellaneous Mfg	Motors Other	Motor Improvements	36,470	4.4%	15	$285
Existing	Miscellaneous Mfg	Motors Other	Motor O&M	36,470	2.4%	2	$8
Existing	Miscellaneous Mfg	Other	Bldg Improvements	6,914	6.8%	15	$37
Existing	Miscellaneous Mfg	Process AirComp	Air Comp Improvements	8,466	11.8%	15	$102
Existing	Miscellaneous Mfg	Process AirComp	Air Comp O&M	8,466	13.3%	2	$27
Existing	Miscellaneous Mfg	Process AirComp	Motor Improvements	8,466	4.4%	15	$66
Existing	Miscellaneous Mfg	Process AirComp	Motor O&M	8,466	2.4%	2	$2
Existing	Miscellaneous Mfg	Process Cool	Cool Improvements	9,725	23.2%	15	$188
Existing	Miscellaneous Mfg	Process Heat	Heat O&M	15,045	4.9%	2	$38
Existing	Miscellaneous Mfg	Process Heat	Steam Distribution	15,045	15.3%	15	$41
Existing	Miscellaneous Mfg	Process Other	Other Improvements	710	22.5%	15	$20
Existing	Miscellaneous Mfg	Process Other	Other O&M	710	27.1%	2	$5

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Miscellaneous Mfg	Process Refrig	Motor Improvements	59	4.4%	15	$0
Existing	Miscellaneous Mfg	Process Refrig	Motor O&M	59	2.4%	2	$0
Existing	Miscellaneous Mfg	Pumps	Motor Improvements	5,150	4.4%	15	$40
Existing	Miscellaneous Mfg	Pumps	Motor O&M	5,150	2.4%	2	$1
Existing	Nonmetallic Mineral Products	Fans	Motor Improvements	34,135	3.0%	15	$106
Existing	Nonmetallic Mineral Products	Fans	Motor O&M	34,135	1.2%	2	$21
Existing	Nonmetallic Mineral Products	HVAC	HVAC Improvements	26,038	10.0%	15	$97
Existing	Nonmetallic Mineral Products	HVAC	HVAC O&M	26,038	8.5%	2	$145
Existing	Nonmetallic Mineral Products	Lighting	Lighting Improvements	20,223	8.0%	10	$160
Existing	Nonmetallic Mineral Products	Motors Other	Motor Improvements	97,170	3.0%	15	$302
Existing	Nonmetallic Mineral Products	Motors Other	Motor O&M	97,170	1.2%	2	$59
Existing	Nonmetallic Mineral Products	Other	Bldg Improvements	18,578	17.9%	15	$439
Existing	Nonmetallic Mineral Products	Process AirComp	Air Comp Improvements	39,367	10.0%	15	$245
Existing	Nonmetallic Mineral Products	Process AirComp	Air Comp O&M	39,367	5.7%	2	$41
Existing	Nonmetallic Mineral Products	Process AirComp	Motor Improvements	39,367	3.0%	15	$122
Existing	Nonmetallic Mineral Products	Process AirComp	Motor O&M	39,367	1.2%	2	$24
Existing	Nonmetallic Mineral Products	Process Cool	Cool Improvements	14,508	9.2%	15	$104
Existing	Nonmetallic Mineral Products	Process Heat	Heat Improvements	84,841	8.7%	15	$446
Existing	Nonmetallic Mineral Products	Process Heat	Heat O&M	84,841	4.8%	2	$138
Existing	Nonmetallic Mineral Products	Process Other	Other Improvements	2,539	18.0%	15	$13
Existing	Nonmetallic Mineral Products	Process Other	Other O&M	2,539	17.8%	2	$23
Existing	Nonmetallic Mineral Products	Process Refrig	Motor Improvements	16,695	3.0%	15	$52
Existing	Nonmetallic Mineral Products	Process Refrig	Motor O&M	16,695	1.2%	2	$10
Existing	Nonmetallic Mineral Products	Pumps	Motor Improvements	61,789	3.0%	15	$192
Existing	Nonmetallic Mineral Products	Pumps	Motor O&M	61,789	1.2%	2	$37
Existing	Paper Mfg	Fans	Motor Improvements	303,153	1.4%	15	$302
Existing	Paper Mfg	Fans	Motor O&M	303,153	1.2%	2	$127
Existing	Paper Mfg	HVAC	HVAC Improvements	77,029	6.0%	15	$482
Existing	Paper Mfg	HVAC	HVAC O&M	77,029	9.6%	2	$439
Existing	Paper Mfg	Indirect Boiler	Boiler Improvements	55,154	11.8%	15	$3,798
Existing	Paper Mfg	Lighting	Lighting Improvements	74,623	12.7%	10	$969

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Paper Mfg	Motors Other	Motor Improvements	600,185	1.4%	15	$597
Existing	Paper Mfg	Motors Other	Motor O&M	600,185	1.2%	2	$251
Existing	Paper Mfg	Other	Bldg Improvements	39,832	1.2%	15	$83
Existing	Paper Mfg	Process AirComp	Air Comp Improvements	70,435	14.1%	15	$382
Existing	Paper Mfg	Process AirComp	Air Comp O&M	70,435	11.6%	2	$188
Existing	Paper Mfg	Process AirComp	Motor Improvements	70,435	1.4%	15	$70
Existing	Paper Mfg	Process AirComp	Motor O&M	70,435	1.2%	2	$29
Existing	Paper Mfg	Process Cool	Cool Improvements	28,367	17.6%	15	$171
Existing	Paper Mfg	Process Heat	Heat Improvements	47,089	23.8%	15	$3,363
Existing	Paper Mfg	Process Heat	Heat O&M	47,089	14.0%	2	$207
Existing	Paper Mfg	Process Other	Other Improvements	9,151	33.3%	15	$103
Existing	Paper Mfg	Process Other	Other O&M	9,151	13.2%	2	$41
Existing	Paper Mfg	Process Refrig	Motor Improvements	76,556	1.4%	15	$76
Existing	Paper Mfg	Process Refrig	Motor O&M	76,556	1.2%	2	$32
Existing	Paper Mfg	Process Refrig	Refrig Improvements	76,556	18.8%	15	$256
Existing	Paper Mfg	Pumps	Motor Improvements	480,747	1.4%	15	$479
Existing	Paper Mfg	Pumps	Motor O&M	480,747	1.2%	2	$201
Existing	Petroleum Coal Products	Fans	Motor Improvements	3,387,337	1.5%	15	$5,993
Existing	Petroleum Coal Products	Fans	Motor O&M	3,387,337	10.8%	2	$4,166
Existing	Petroleum Coal Products	HVAC	HVAC Improvements	984,388	32.9%	15	$47772
Existing	Petroleum Coal Products	HVAC	HVAC O&M	984,388	11.7%	2	$4,658
Existing	Petroleum Coal Products	Lighting	Lighting Improvements	755,361	6.4%	10	$4,178
Existing	Petroleum Coal Products	Motors Other	Motor Improvements	9,642,720	1.5%	15	$17059
Existing	Petroleum Coal Products	Motors Other	Motor O&M	9,642,720	10.8%	2	$11860
Existing	Petroleum Coal Products	Process AirComp	Air Comp Improvements	3,906,629	23.2%	15	$41975
Existing	Petroleum Coal Products	Process AirComp	Air Comp O&M	3,906,629	13.7%	2	$9,559
Existing	Petroleum Coal Products	Process AirComp	Motor Improvements	3,906,629	1.5%	15	$6,911
Existing	Petroleum Coal Products	Process AirComp	Motor O&M	3,906,629	10.8%	2	$4,805
Existing	Petroleum Coal Products	Process Cool	Cool Improvements	1,710,356	3.8%	15	$4,717
Existing	Petroleum Coal Products	Process Refrig	Motor Improvements	1,656,467	1.5%	15	$2,931
Existing	Petroleum Coal Products	Process Refrig	Motor O&M	1,656,467	10.8%	2	$2,037

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Petroleum Coal Products	Pumps	Motor Improvements	6,131,683	1.5%	15	$10848
Existing	Petroleum Coal Products	Pumps	Motor O&M	6,131,683	10.8%	2	$7,542
Existing	Plastics Rubber Products	Fans	Motor Improvements	69,629	4.4%	15	$379
Existing	Plastics Rubber Products	Fans	Motor O&M	69,629	1.6%	2	$115
Existing	Plastics Rubber Products	HVAC	HVAC Improvements	93,747	10.6%	15	$831
Existing	Plastics Rubber Products	HVAC	HVAC O&M	93,747	7.0%	2	$323
Existing	Plastics Rubber Products	Lighting	Lighting Improvements	76,701	6.4%	10	$485
Existing	Plastics Rubber Products	Motors Other	Motor Improvements	198,215	4.4%	15	$1,080
Existing	Plastics Rubber Products	Motors Other	Motor O&M	198,215	1.6%	2	$327
Existing	Plastics Rubber Products	Other	Bldg Improvements	24,929	26.6%	15	$1,777
Existing	Plastics Rubber Products	Process AirComp	Air Comp Improvements	80,302	8.5%	15	$207
Existing	Plastics Rubber Products	Process AirComp	Air Comp O&M	80,302	10.6%	2	$166
Existing	Plastics Rubber Products	Process AirComp	Motor Improvements	80,302	4.4%	15	$438
Existing	Plastics Rubber Products	Process AirComp	Motor O&M	80,302	1.6%	2	$133
Existing	Plastics Rubber Products	Process Cool	Cool Improvements	78,021	15.5%	15	$779
Existing	Plastics Rubber Products	Process Heat	Heat Improvements	145,953	12.6%	15	$971
Existing	Plastics Rubber Products	Process Heat	Heat O&M	145,953	8.7%	2	$288
Existing	Plastics Rubber Products	Process Heat	Steam Distribution	145,953	1.4%	15	$41
Existing	Plastics Rubber Products	Process Other	Other Improvements	8,355	21.6%	15	$168
Existing	Plastics Rubber Products	Process Other	Other O&M	8,355	16.6%	2	$96
Existing	Plastics Rubber Products	Process Refrig	Motor Improvements	34,056	4.4%	15	$186
Existing	Plastics Rubber Products	Process Refrig	Motor O&M	34,056	1.6%	2	$56
Existing	Plastics Rubber Products	Pumps	Motor Improvements	126,049	4.4%	15	$687
Existing	Plastics Rubber Products	Pumps	Motor O&M	126,049	1.6%	2	$208
Existing	Primary Metal Mfg	Fans	Motor Improvements	17,015	3.5%	15	$112
Existing	Primary Metal Mfg	Fans	Motor O&M	17,015	3.0%	2	$34
Existing	Primary Metal Mfg	HVAC	HVAC Improvements	12,703	7.6%	15	$60
Existing	Primary Metal Mfg	HVAC	HVAC O&M	12,703	9.6%	2	$41
Existing	Primary Metal Mfg	Indirect Boiler	Boiler Improvements	623	25.0%	15	$1
Existing	Primary Metal Mfg	Lighting	Lighting Improvements	10,174	11.2%	10	$157
Existing	Primary Metal Mfg	Motors Other	Motor Improvements	68,504	3.5%	15	$453

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Primary Metal Mfg	Motors Other	Motor O&M	68,504	3.0%	2	$136
Existing	Primary Metal Mfg	Other	Bldg Improvements	4,554	2.9%	15	$22
Existing	Primary Metal Mfg	Process AirComp	Air Comp Improvements	15,904	11.3%	15	$31
Existing	Primary Metal Mfg	Process AirComp	Air Comp O&M	15,904	11.6%	2	$29
Existing	Primary Metal Mfg	Process AirComp	Motor Improvements	15,904	3.5%	15	$105
Existing	Primary Metal Mfg	Process AirComp	Motor O&M	15,904	3.0%	2	$32
Existing	Primary Metal Mfg	Process Cool	Cool Improvements	2,831	40.9%	15	$24
Existing	Primary Metal Mfg	Process Heat	Heat Improvements	97,170	12.7%	15	$531
Existing	Primary Metal Mfg	Process Heat	Heat O&M	97,170	6.0%	2	$304
Existing	Primary Metal Mfg	Process Heat	Steam Distribution	97,170	7.2%	15	$304
Existing	Primary Metal Mfg	Process Other	Other Improvements	467	45.7%	15	$88
Existing	Primary Metal Mfg	Process Other	Other O&M	467	35.1%	2	$9
Existing	Primary Metal Mfg	Process Refrig	Motor Improvements	111	3.5%	15	$1
Existing	Primary Metal Mfg	Process Refrig	Motor O&M	111	3.0%	2	$0
Existing	Primary Metal Mfg	Pumps	Motor Improvements	9,675	3.5%	15	$64
Existing	Primary Metal Mfg	Pumps	Motor O&M	9,675	3.0%	2	$19
Existing	Printing Related Support	Fans	Motor Improvements	5,617	3.2%	15	$17
Existing	Printing Related Support	Fans	Motor O&M	5,617	2.5%	2	$13
Existing	Printing Related Support	HVAC	HVAC Improvements	15,020	11.5%	15	$207
Existing	Printing Related Support	HVAC	HVAC O&M	15,020	11.8%	2	$123
Existing	Printing Related Support	Lighting	Lighting Improvements	9,395	10.5%	10	$107
Existing	Printing Related Support	Motors Other	Motor Improvements	15,991	3.2%	15	$47
Existing	Printing Related Support	Motors Other	Motor O&M	15,991	2.5%	2	$37
Existing	Printing Related Support	Other	Bldg Improvements	11,998	47.9%	15	$8
Existing	Printing Related Support	Process AirComp	Air Comp Improvements	6,478	9.3%	15	$23
Existing	Printing Related Support	Process AirComp	Air Comp O&M	6,478	12.7%	2	$14
Existing	Printing Related Support	Process AirComp	Motor Improvements	6,478	3.2%	15	$19
Existing	Printing Related Support	Process AirComp	Motor O&M	6,478	2.5%	2	$15
Existing	Printing Related Support	Process Cool	Cool Improvements	3,701	41.3%	15	$241
Existing	Printing Related Support	Process Heat	Heat Improvements	2,088	18.8%	15	$32
Existing	Printing Related Support	Process Heat	Heat O&M	2,088	18.7%	2	$57

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Printing Related Support	Process Other	Other Improvements	153	30.3%	15	$8
Existing	Printing Related Support	Process Refrig	Motor Improvements	2,747	3.2%	15	$8
Existing	Printing Related Support	Process Refrig	Motor O&M	2,747	2.5%	2	$6
Existing	Printing Related Support	Process Refrig	Refrig Improvements	2,747	20.4%	15	$120
Existing	Printing Related Support	Pumps	Motor Improvements	10,169	3.2%	15	$30
Existing	Printing Related Support	Pumps	Motor O&M	10,169	2.5%	2	$24
Existing	Transportation Equipment Mfg	Fans	Motor Improvements	60,863	2.4%	15	$161
Existing	Transportation Equipment Mfg	Fans	Motor O&M	60,863	2.4%	2	$86
Existing	Transportation Equipment Mfg	HVAC	HVAC Improvements	224,719	13.2%	15	$2,119
Existing	Transportation Equipment Mfg	HVAC	HVAC O&M	224,719	2.1%	2	$243
Existing	Transportation Equipment Mfg	Indirect Boiler	Boiler Improvements	2,307	33.4%	15	$472
Existing	Transportation Equipment Mfg	Lighting	Lighting Improvements	175,929	8.2%	10	$1,275
Existing	Transportation Equipment Mfg	Motors Other	Motor Improvements	136,552	2.4%	15	$361
Existing	Transportation Equipment Mfg	Motors Other	Motor O&M	136,552	2.4%	2	$193
Existing	Transportation Equipment Mfg	Other	Bldg Improvements	48,813	38.8%	15	$177
Existing	Transportation Equipment Mfg	Process AirComp	Air Comp Improvements	141,664	8.2%	15	$362
Existing	Transportation Equipment Mfg	Process AirComp	Air Comp O&M	141,664	9.6%	2	$378
Existing	Transportation Equipment Mfg	Process AirComp	Motor Improvements	141,664	2.4%	15	$374
Existing	Transportation Equipment Mfg	Process AirComp	Motor O&M	141,664	2.4%	2	$200
Existing	Transportation Equipment Mfg	Process Cool	Cool Improvements	53,115	15.2%	15	$973
Existing	Transportation Equipment Mfg	Process Heat	Heat Improvements	112,903	7.1%	15	$315
Existing	Transportation Equipment Mfg	Process Heat	Heat O&M	112,903	9.5%	2	$154
Existing	Transportation Equipment Mfg	Process Heat	Steam Distribution	112,903	8.6%	15	$293
Existing	Transportation Equipment Mfg	Process Other	Other Improvements	15,361	22.3%	15	$139
Existing	Transportation Equipment Mfg	Process Other	Other O&M	15,361	23.4%	2	$114
Existing	Transportation Equipment Mfg	Process Refrig	Motor Improvements	39,377	2.4%	15	$104
Existing	Transportation Equipment Mfg	Process Refrig	Motor O&M	39,377	2.4%	2	$56
Existing	Transportation Equipment Mfg	Process Refrig	Refrig Improvements	39,377	37.9%	15	$2,421
Existing	Transportation Equipment Mfg	Pumps	Motor Improvements	132,979	2.4%	15	$351
Existing	Transportation Equipment Mfg	Pumps	Motor O&M	132,979	2.4%	2	$187
Existing	Wood Product Mfg	Fans	Motor Improvements	39,578	3.4%	15	$122

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline MWh (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Wood Product Mfg	Fans	Motor O&M	39,578	2.0%	2	$27
Existing	Wood Product Mfg	HVAC	HVAC Improvements	27,116	19.0%	15	$1,468
Existing	Wood Product Mfg	HVAC	HVAC O&M	27,116	1.2%	2	$19
Existing	Wood Product Mfg	Lighting	Lighting Improvements	28,702	7.3%	10	$146
Existing	Wood Product Mfg	Motors Other	Motor Improvements	112,670	3.4%	15	$348
Existing	Wood Product Mfg	Motors Other	Motor O&M	112,670	0.4%	2	$514
Existing	Wood Product Mfg	Other	Bldg Improvements	31,237	32.2%	15	$241
Existing	Wood Product Mfg	Process AirComp	Air Comp Improvements	45,646	6.9%	15	$127
Existing	Wood Product Mfg	Process AirComp	Air Comp O&M	45,646	9.6%	2	$82
Existing	Wood Product Mfg	Process AirComp	Motor Improvements	45,646	3.4%	15	$141
Existing	Wood Product Mfg	Process AirComp	Motor O&M	45,646	2.0%	2	$31
Existing	Wood Product Mfg	Process Cool	Cool Improvements	2,535	34.9%	15	$8
Existing	Wood Product Mfg	Process Heat	Heat Improvements	21,024	27.0%	15	$39
Existing	Wood Product Mfg	Process Heat	Heat O&M	21,024	21.4%	2	$82
Existing	Wood Product Mfg	Process Heat	Steam Distribution	21,024	23.6%	15	$229
Existing	Wood Product Mfg	Process Other	Other Improvements	693	1.2%	15	$9
Existing	Wood Product Mfg	Process Other	Other O&M	693	26.8%	2	$22
Existing	Wood Product Mfg	Process Refrig	Motor Improvements	19,354	3.4%	15	$60
Existing	Wood Product Mfg	Process Refrig	Motor O&M	19,354	0.4%	2	$88
Existing	Wood Product Mfg	Pumps	Motor Improvements	71,648	3.4%	15	$221
Existing	Wood Product Mfg	Pumps	Motor O&M	71,648	2.0%	2	$49

Industrial Gas Measures

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline decatherms (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Chemical Mfg	HVAC	HVAC Improvements	294	20.5%	15	$60
Existing	Chemical Mfg	HVAC	HVAC O&M	294	13.7%	2	$47
Existing	Chemical Mfg	Indirect Boiler	Boiler Improvements	8,291	2.2%	15	$51
Existing	Chemical Mfg	Indirect Boiler	Boiler O&M	8,291	3.3%	2	$47
Existing	Chemical Mfg	Process Heat	Boiler Improvements	5,261	20.7%	15	$74
Existing	Chemical Mfg	Process Heat	Heat Improvements	5,261	10.5%	15	$210
Existing	Chemical Mfg	Process Heat	Heat O&M	5,261	0.6%	2	$17
Existing	Chemical Mfg	Process Heat	Steam Distribution	5,261	14.3%	15	$43
Existing	Chemical Mfg	Process Other	Other O&M	863	9.7%	2	$25
Existing	Computer Electronic Mfg	HVAC	HVAC Improvements	749	11.0%	15	$65
Existing	Computer Electronic Mfg	HVAC	HVAC O&M	749	13.7%	2	$41
Existing	Computer Electronic Mfg	Indirect Boiler	Boiler Improvements	974	11.7%	15	$140
Existing	Computer Electronic Mfg	Indirect Boiler	Boiler O&M	974	8.9%	2	$12
Existing	Computer Electronic Mfg	Process Heat	Boiler Improvements	337	4.4%	15	$26
Existing	Computer Electronic Mfg	Process Heat	Heat Improvements	337	23.9%	15	$31
Existing	Computer Electronic Mfg	Process Heat	Heat O&M	337	4.3%	2	$9
Existing	Computer Electronic Mfg	Process Heat	Steam Distribution	337	9.7%	15	$17
Existing	Electrical Equipment Mfg	HVAC	HVAC Improvements	439	10.4%	15	$29
Existing	Electrical Equipment Mfg	HVAC	HVAC O&M	439	4.6%	2	$4
Existing	Electrical Equipment Mfg	Indirect Boiler	Boiler Improvements	176	12.0%	15	$25
Existing	Electrical Equipment Mfg	Indirect Boiler	Boiler O&M	176	12.8%	2	$5
Existing	Electrical Equipment Mfg	Process Heat	Boiler Improvements	790	7.3%	15	$32
Existing	Electrical Equipment Mfg	Process Heat	Heat Improvements	790	17.1%	15	$80
Existing	Electrical Equipment Mfg	Process Heat	Heat O&M	790	2.5%	2	$9
Existing	Electrical Equipment Mfg	Process Heat	Steam Distribution	790	6.3%	15	$18
Existing	Fabricated Metal Products	HVAC	HVAC Improvements	1,158	14.5%	15	$216
Existing	Fabricated Metal Products	HVAC	HVAC O&M	1,158	13.0%	2	$109
Existing	Fabricated Metal Products	Indirect Boiler	Boiler Improvements	883	17.3%	15	$252
Existing	Fabricated Metal Products	Indirect Boiler	Boiler O&M	883	11.8%	2	$12

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline decatherms (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Fabricated Metal Products	Process Heat	Boiler Improvements	3,475	6.0%	15	$103
Existing	Fabricated Metal Products	Process Heat	Heat Improvements	3,475	6.8%	15	$227
Existing	Fabricated Metal Products	Process Heat	Heat O&M	3,475	3.5%	2	$61
Existing	Fabricated Metal Products	Process Heat	Steam Distribution	3,475	5.2%	15	$123
Existing	Fabricated Metal Products	Process Other	Other O&M	55	12.4%	2	$4
Existing	Food Mfg	HVAC	HVAC Improvements	856	20.4%	15	$107
Existing	Food Mfg	HVAC	HVAC O&M	856	5.6%	2	$11
Existing	Food Mfg	Indirect Boiler	Boiler Improvements	6,372	6.0%	15	$327
Existing	Food Mfg	Indirect Boiler	Boiler O&M	6,372	4.1%	2	$99
Existing	Food Mfg	Process Heat	Boiler Improvements	4,731	7.1%	15	$112
Existing	Food Mfg	Process Heat	Heat Improvements	4,731	12.9%	15	$324
Existing	Food Mfg	Process Heat	Heat O&M	4,731	3.5%	2	$61
Existing	Food Mfg	Process Heat	Steam Distribution	4,731	5.2%	15	$119
Existing	Food Mfg	Process Other	Other O&M	594	28.1%	2	$24
Existing	Industrial Machinery	HVAC	HVAC Improvements	1,327	14.4%	15	$164
Existing	Industrial Machinery	HVAC	HVAC O&M	1,327	14.6%	2	$70
Existing	Industrial Machinery	Indirect Boiler	Boiler Improvements	641	18.8%	15	$131
Existing	Industrial Machinery	Indirect Boiler	Boiler O&M	641	15.1%	2	$18
Existing	Industrial Machinery	Process Heat	Boiler Improvements	1,327	2.1%	15	$32
Existing	Industrial Machinery	Process Heat	Heat Improvements	1,327	13.2%	15	$94
Existing	Industrial Machinery	Process Heat	Heat O&M	1,327	9.7%	2	$77
Existing	Industrial Machinery	Process Heat	Steam Distribution	1,327	6.2%	15	$31
Existing	Miscellaneous Mfg	HVAC	HVAC Improvements	754	16.6%	15	$92
Existing	Miscellaneous Mfg	HVAC	HVAC O&M	754	20.2%	2	$7
Existing	Miscellaneous Mfg	Indirect Boiler	Boiler Improvements	679	14.3%	15	$60
Existing	Miscellaneous Mfg	Indirect Boiler	Boiler O&M	679	5.5%	2	$8
Existing	Miscellaneous Mfg	Process Heat	Boiler Improvements	603	4.4%	15	$29
Existing	Miscellaneous Mfg	Process Heat	Heat Improvements	603	8.1%	15	$24
Existing	Miscellaneous Mfg	Process Heat	Heat O&M	603	3.5%	2	$7
Existing	Miscellaneous Mfg	Process Heat	Steam Distribution	603	11.7%	15	$16
New	Miscellaneous Mfg	HVAC	HVAC Improvements	754	16.6%	15	$92

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline decatherms (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
New	Miscellaneous Mfg	HVAC	HVAC O&M	754	20.2%	2	$7
New	Miscellaneous Mfg	Indirect Boiler	Boiler Improvements	679	14.3%	15	$60
New	Miscellaneous Mfg	Indirect Boiler	Boiler O&M	679	5.5%	2	$8
New	Miscellaneous Mfg	Process Heat	Boiler Improvements	603	4.4%	15	$29
New	Miscellaneous Mfg	Process Heat	Heat Improvements	603	8.1%	15	$24
New	Miscellaneous Mfg	Process Heat	Heat O&M	603	3.5%	2	$7
New	Miscellaneous Mfg	Process Heat	Steam Distribution	603	11.7%	15	$16
Existing	Nonmetallic Mineral Products	HVAC	HVAC Improvements	3,832	10.8%	15	$502
Existing	Nonmetallic Mineral Products	HVAC	HVAC O&M	3,832	1.9%	2	$36
Existing	Nonmetallic Mineral Products	Indirect Boiler	Boiler O&M	2,299	4.5%	2	$7
Existing	Nonmetallic Mineral Products	Process Heat	Boiler Improvements	66,686	21.8%	15	$3,054
Existing	Nonmetallic Mineral Products	Process Heat	Heat Improvements	66,686	12.9%	15	$8,142
Existing	Nonmetallic Mineral Products	Process Heat	Heat O&M	66,686	3.0%	2	$642
Existing	Nonmetallic Mineral Products	Process Heat	Steam Distribution	66,686	4.6%	15	$1,330
Existing	Nonmetallic Mineral Products	Process Other	Other O&M	383	15.3%	2	$120
Existing	Paper Mfg	HVAC	HVAC Improvements	7,319	18.3%	15	$934
Existing	Paper Mfg	HVAC	HVAC O&M	7,319	22.0%	2	$232
Existing	Paper Mfg	Indirect Boiler	Boiler Improvements	114,806	7.8%	15	$4,456
Existing	Paper Mfg	Indirect Boiler	Boiler O&M	114,806	4.1%	2	$605
Existing	Paper Mfg	Process Heat	Boiler Improvements	48,543	6.2%	15	$1,544
Existing	Paper Mfg	Process Heat	Heat Improvements	48,543	10.4%	15	$3,596
Existing	Paper Mfg	Process Heat	Heat O&M	48,543	3.1%	2	$382
Existing	Paper Mfg	Process Heat	Steam Distribution	48,543	3.8%	15	$341
Existing	Paper Mfg	Process Other	Other O&M	8,861	20.0%	2	$1,235
Existing	Petroleum Coal Products	Indirect Boiler	Boiler Improvements	54,472	8.8%	15	$4,614
Existing	Petroleum Coal Products	Indirect Boiler	Boiler O&M	54,472	5.8%	2	$569
Existing	Petroleum Coal Products	Process Heat	Boiler Improvements	99,253	1.9%	15	$1,532
Existing	Petroleum Coal Products	Process Heat	Heat Improvements	99,253	4.8%	15	$3,757
Existing	Petroleum Coal Products	Process Heat	Heat O&M	99,253	2.3%	2	$457
Existing	Petroleum Coal Products	Process Heat	Steam Distribution	99,253	3.0%	15	$157
Existing	Plastics Rubber Products	HVAC	HVAC Improvements	1,322	9.3%	15	$81

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline decatherms (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Plastics Rubber Products	HVAC	HVAC O&M	1,322	12.4%	2	$5,385
Existing	Plastics Rubber Products	Indirect Boiler	Boiler Improvements	2,644	12.4%	15	$106
Existing	Plastics Rubber Products	Indirect Boiler	Boiler O&M	2,644	6.4%	2	$40
Existing	Plastics Rubber Products	Process Heat	Boiler Improvements	1,983	10.3%	15	$135
Existing	Plastics Rubber Products	Process Heat	Heat Improvements	1,983	13.1%	15	$172
Existing	Plastics Rubber Products	Process Heat	Heat O&M	1,983	8.4%	2	$109
Existing	Plastics Rubber Products	Process Heat	Steam Distribution	1,983	6.8%	15	$22
Existing	Plastics Rubber Products	Process Other	Other O&M	165	16.6%	2	$6
Existing	Primary Metal Mfg	HVAC	HVAC Improvements	9,682	13.9%	15	$655
Existing	Primary Metal Mfg	Indirect Boiler	Boiler Improvements	15,537	17.7%	15	$2,839
Existing	Primary Metal Mfg	Indirect Boiler	Boiler O&M	15,537	13.5%	2	$322
Existing	Primary Metal Mfg	Process Heat	Boiler Improvements	116,190	7.8%	15	$4,113
Existing	Primary Metal Mfg	Process Heat	Heat Improvements	116,190	8.3%	15	$7,569
Existing	Primary Metal Mfg	Process Heat	Heat O&M	116,190	1.6%	2	$978
Existing	Primary Metal Mfg	Process Heat	Steam Distribution	116,190	4.2%	15	$1,983
Existing	Printing Related Support	HVAC	HVAC Improvements	386	17.4%	15	$31
Existing	Printing Related Support	HVAC	HVAC O&M	386	30.9%	2	$41
Existing	Printing Related Support	Indirect Boiler	Boiler Improvements	232	12.4%	15	$31
Existing	Printing Related Support	Indirect Boiler	Boiler O&M	232	10.3%	2	$3
Existing	Printing Related Support	Process Heat	Boiler Improvements	463	16.3%	15	$138
Existing	Printing Related Support	Process Heat	Heat Improvements	463	4.7%	15	$10
Existing	Printing Related Support	Process Heat	Heat O&M	463	4.4%	2	$13
Existing	Printing Related Support	Process Heat	Steam Distribution	463	17.3%	15	$30
Existing	Printing Related Support	Process Other	Other O&M	26	16.6%	2	$5
Existing	Transportation Equipment Mfg	HVAC	HVAC Improvements	11,987	7.3%	15	$910
Existing	Transportation Equipment Mfg	HVAC	HVAC O&M	11,987	13.7%	2	$319
Existing	Transportation Equipment Mfg	Indirect Boiler	Boiler Improvements	9,826	18.9%	15	$1,935
Existing	Transportation Equipment Mfg	Indirect Boiler	Boiler O&M	9,826	6.2%	2	$458
Existing	Transportation Equipment Mfg	Process Heat	Boiler Improvements	11,987	15.1%	15	$469
Existing	Transportation Equipment Mfg	Process Heat	Heat Improvements	11,987	19.6%	15	$792
Existing	Transportation Equipment Mfg	Process Heat	Heat O&M	11,987	3.4%	2	$318

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline decatherms (UEC or EUI)	Savings as Percent of End Use	Measure Life	Measure Cost
Existing	Transportation Equipment Mfg	Process Heat	Steam Distribution	11,987	5.3%	15	$5,564
Existing	Transportation Equipment Mfg	Process Other	Other O&M	786	17.4%	2	$60
Existing	Wood Product Mfg	HVAC	HVAC Improvements	2,944	9.8%	15	$332
Existing	Wood Product Mfg	HVAC	HVAC O&M	2,944	4.5%	2	$24
Existing	Wood Product Mfg	Indirect Boiler	Boiler Improvements	6,308	12.1%	15	$384
Existing	Wood Product Mfg	Indirect Boiler	Boiler O&M	6,308	3.6%	2	$19
Existing	Wood Product Mfg	Process Heat	Boiler Improvements	11,354	11.4%	15	$463
Existing	Wood Product Mfg	Process Heat	Heat Improvements	11,354	8.0%	15	$2,113
Existing	Wood Product Mfg	Process Heat	Heat O&M	11,354	5.8%	2	$77
Existing	Wood Product Mfg	Process Heat	Steam Distribution	11,354	1.5%	15	$14
Existing	Wood Product Mfg	Process Other	Other O&M	841	6.9%	2	$10

Appendix C.3: Detailed Results

The following pie charts show how the technical and achievable technical potential are distributed by fuel, sector, segment, and end use.

Residential Electric

Technical Potential

Figure 1: Residential Technical Potential in 2029 by Segment

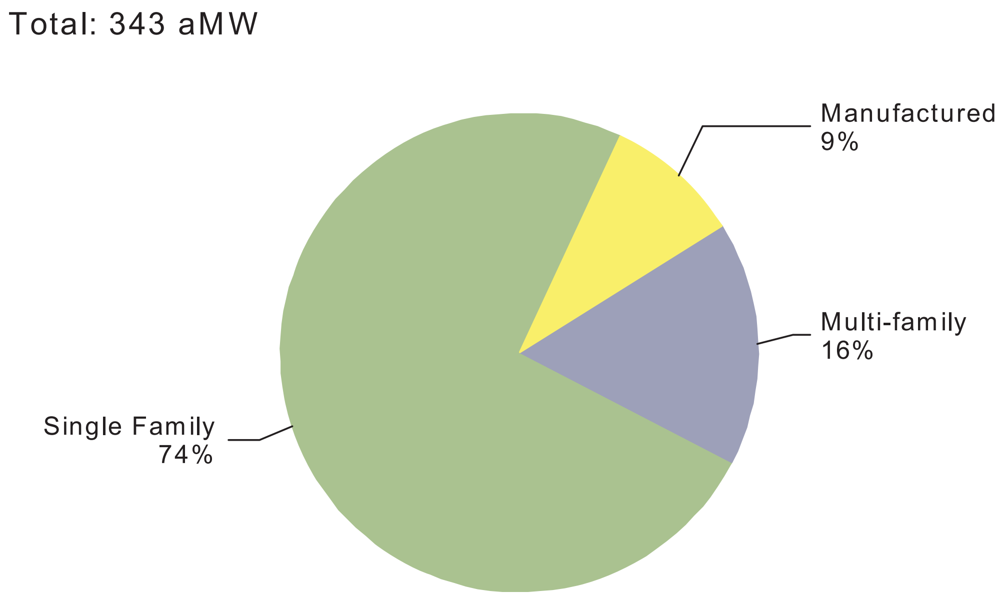
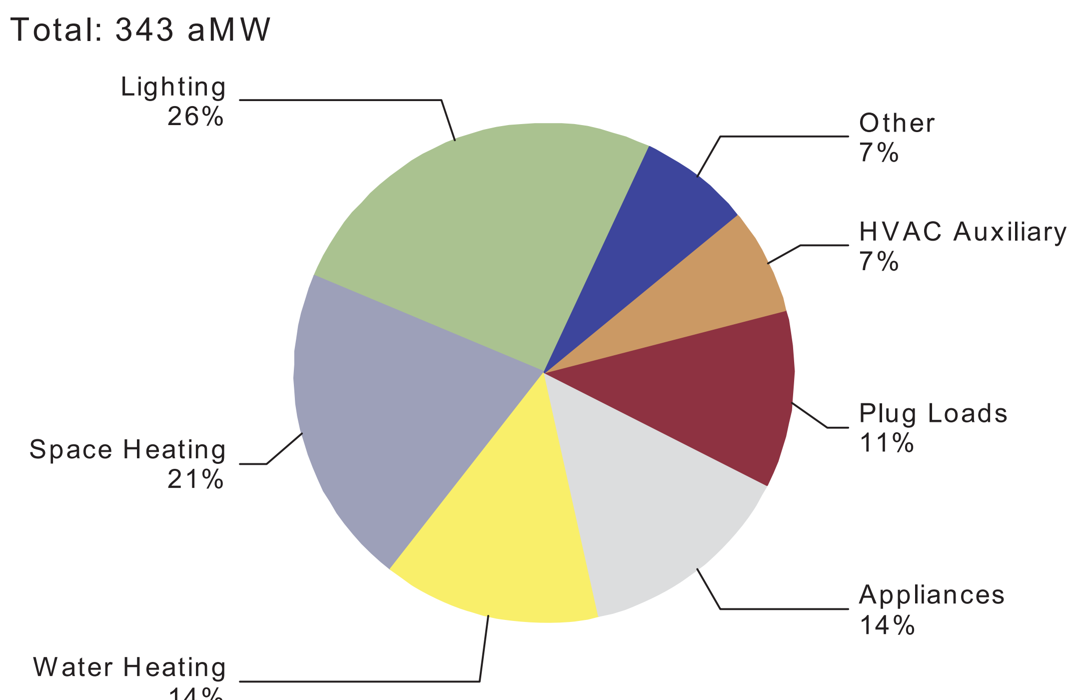
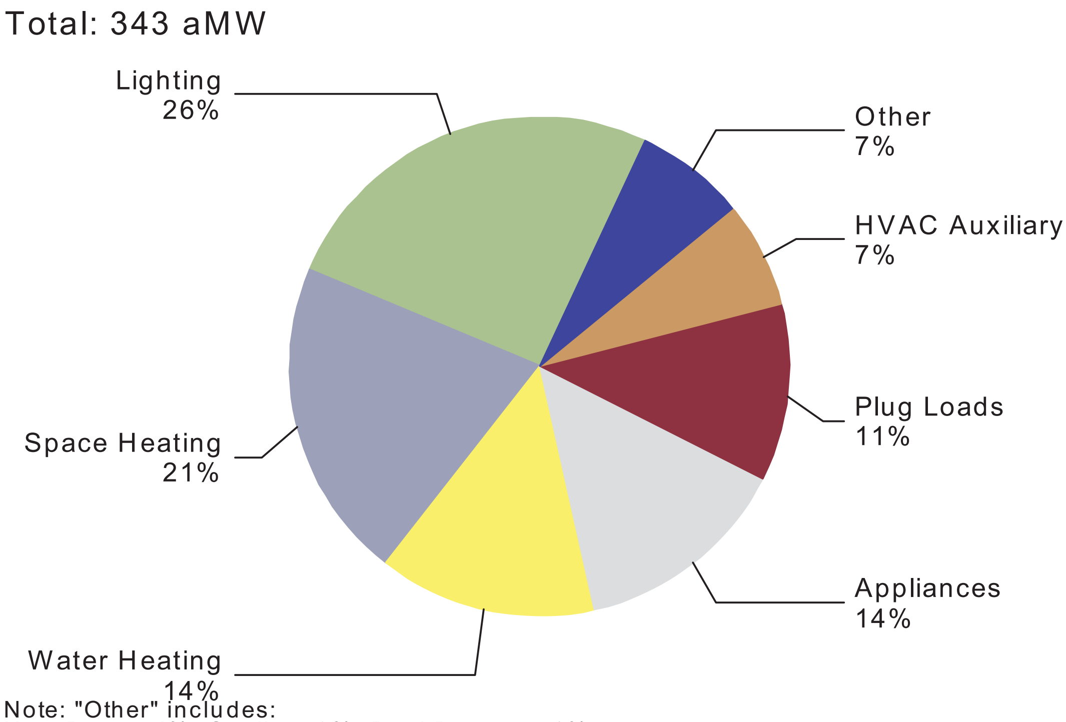


Figure 2: Residential Technical Potential in 2029 by End Use



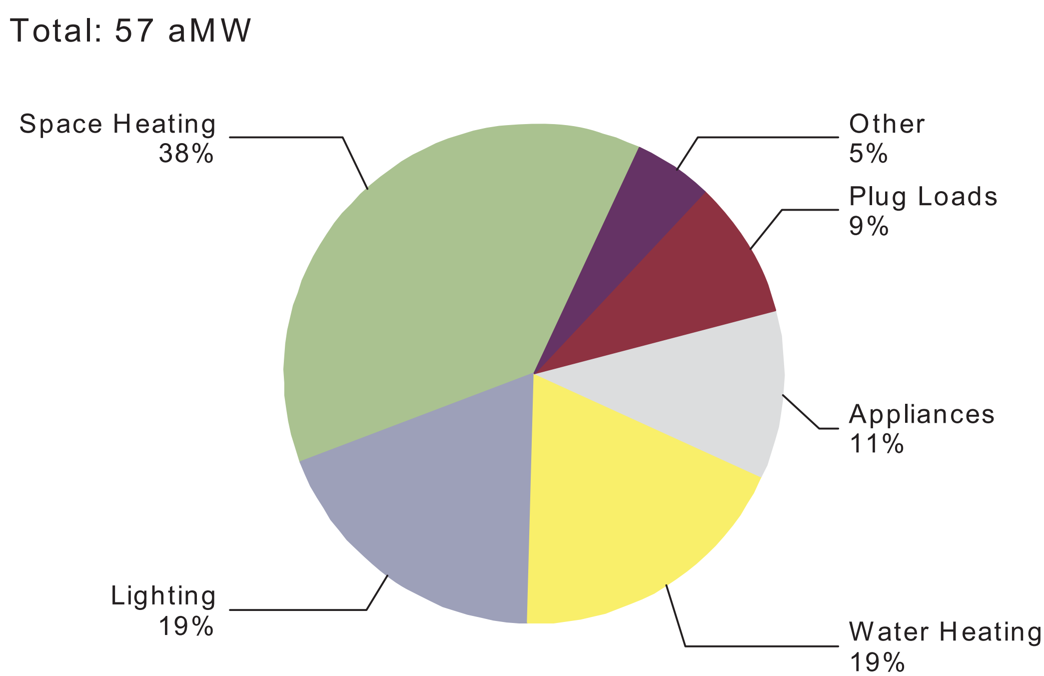
Note: "Other" includes:
Heat Pump: 4%, Cooling: 3%, Pool Pumps: <1%

Figure 3: Residential Technical Potential in 2029 by End Use, Manufactured



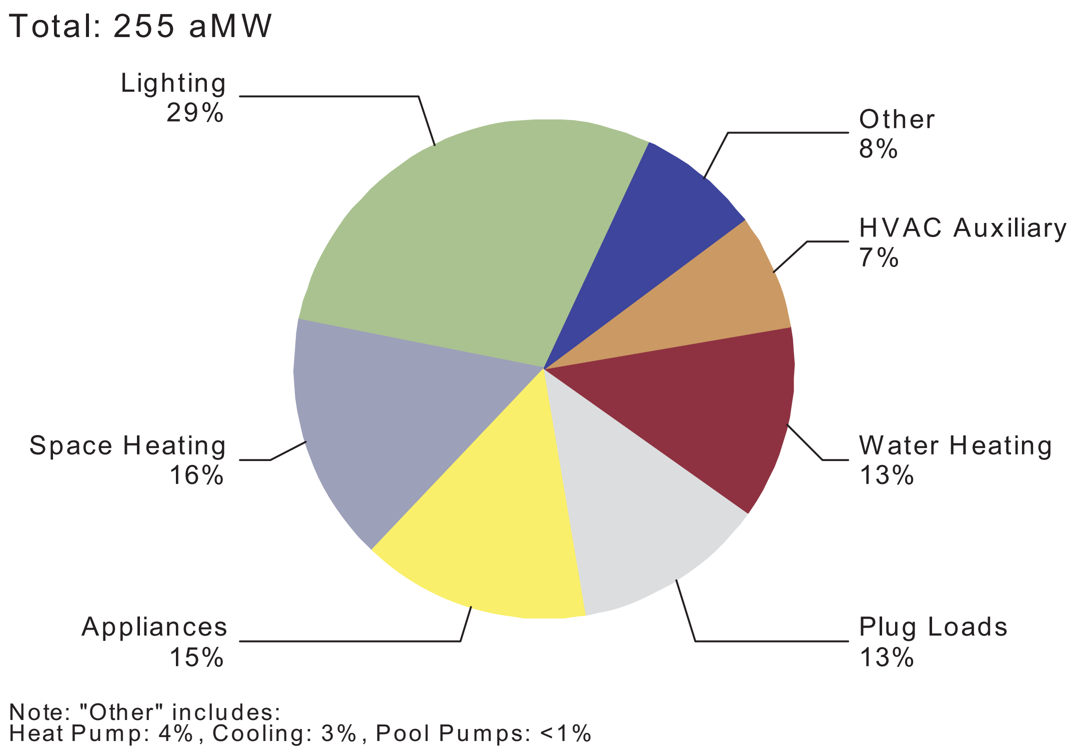
Note: "Other" includes:
Heat Pump: 4%, Cooling: 3%, Pool Pumps: <1%

Figure 4: Residential Technical Potential in 2029 by End Use, Multifamily



Note: "Other" includes:
HVAC Auxiliary: 5%, Cooling: <1%

Figure 5: Residential Technical Potential in 2029 by End Use, Single Family



Achievable Technical Potential

Figure 6: Residential Achievable Technical Potential in 2029 by Segment

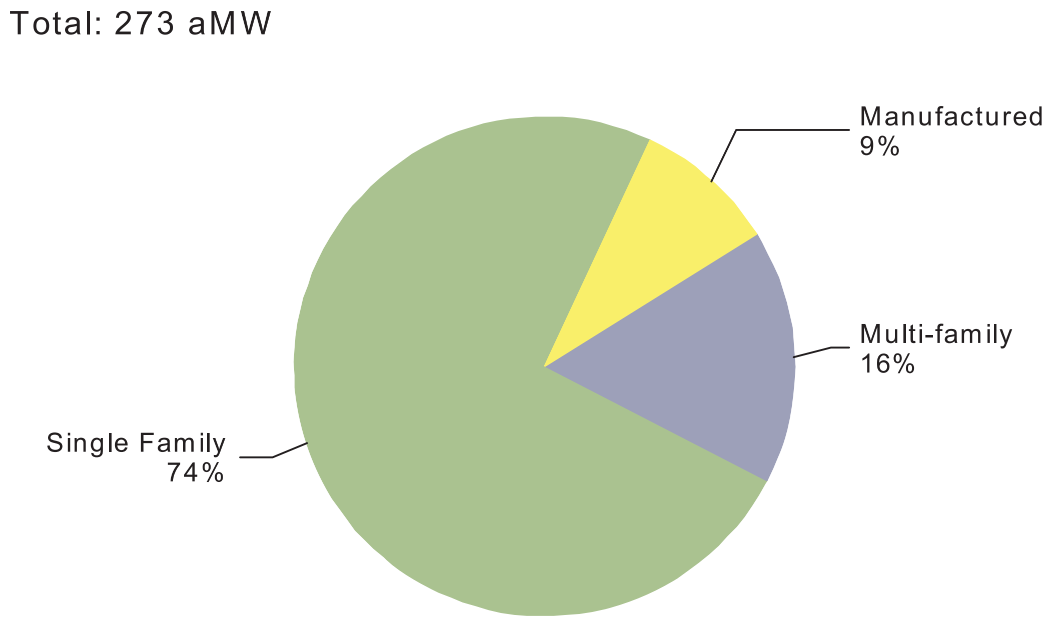
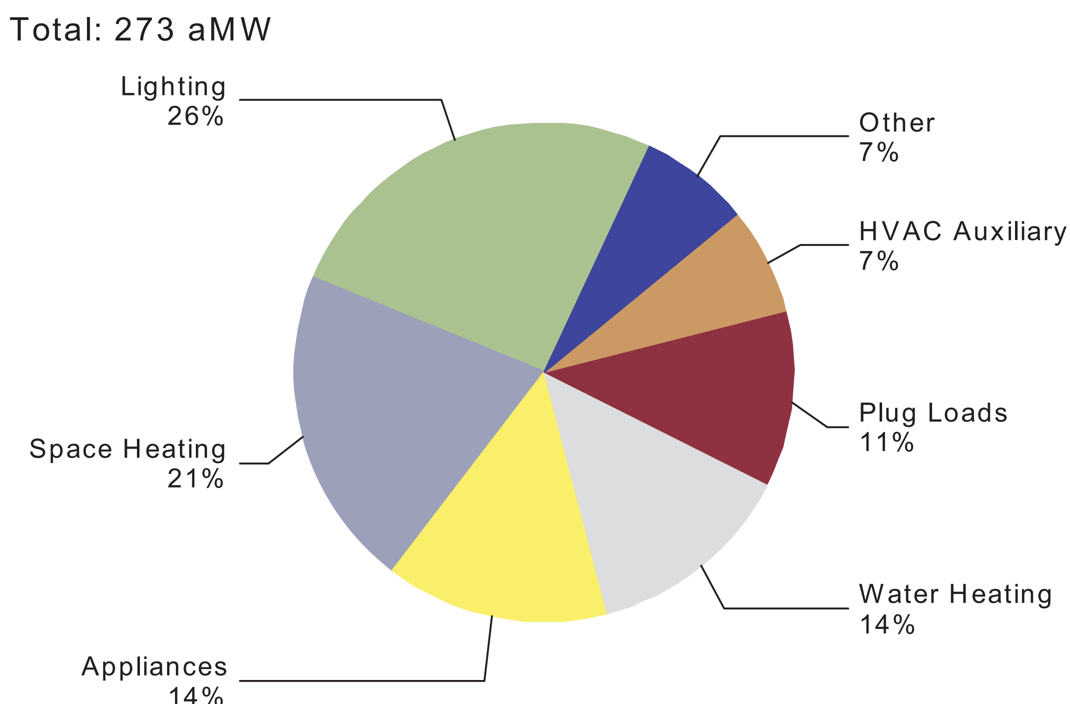
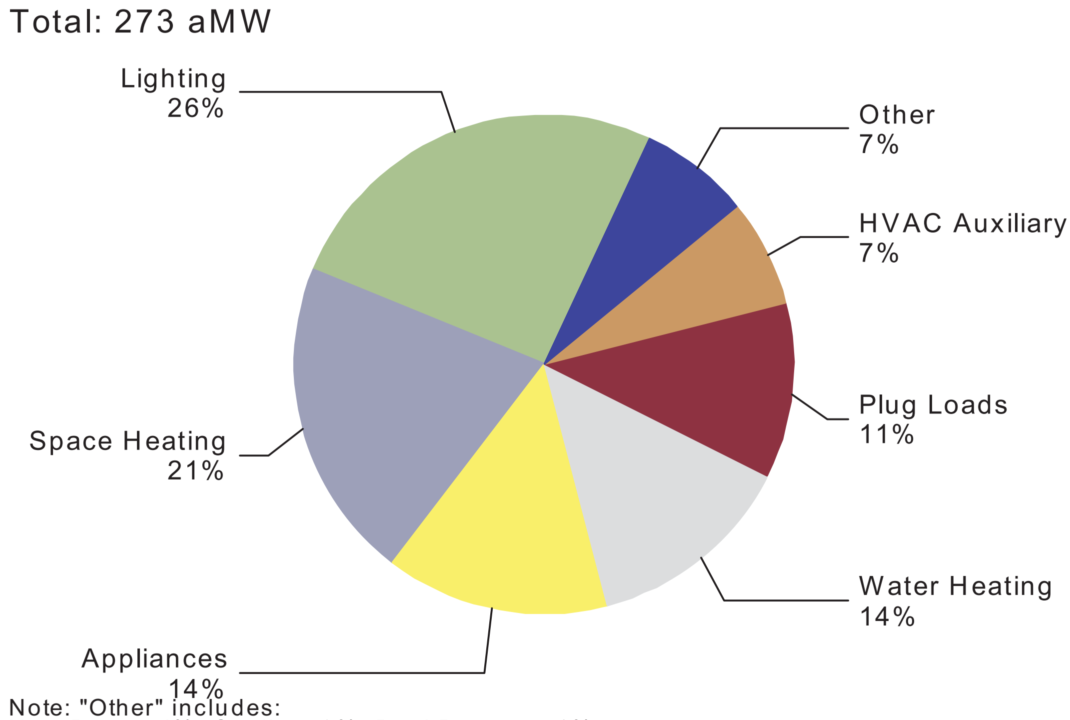


Figure 7: Residential Achievable Technical Potential in 2029 by End Use



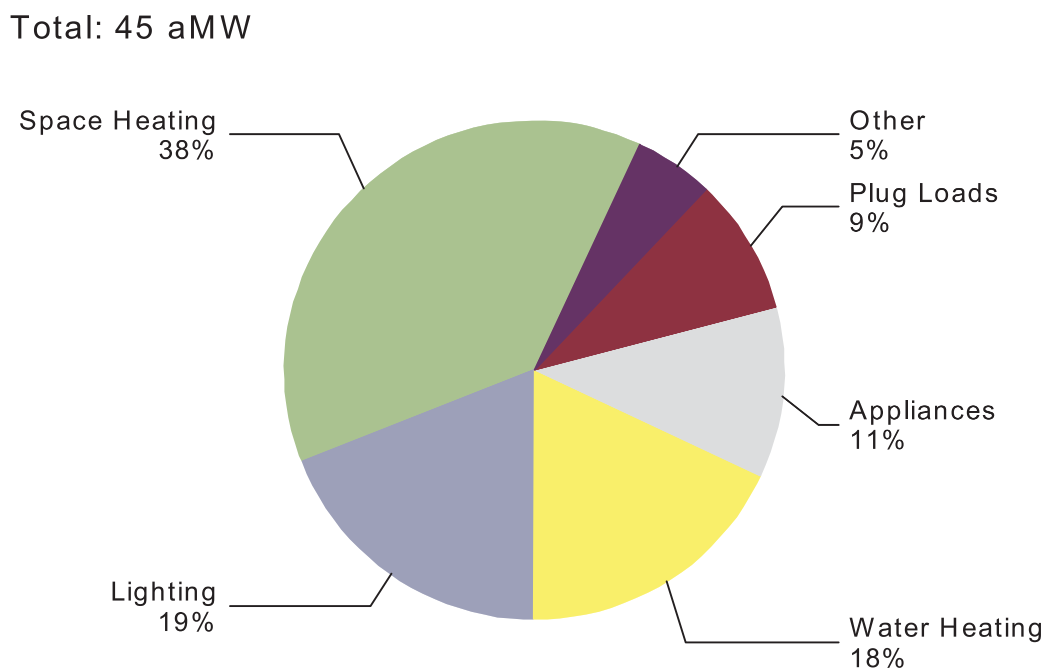
Note: "Other" includes:
Heat Pump: 4%, Cooling: 3%, Pool Pumps: <1%

Figure 8: Residential Achievable Technical Potential in 2029 by End Use, Manufactured



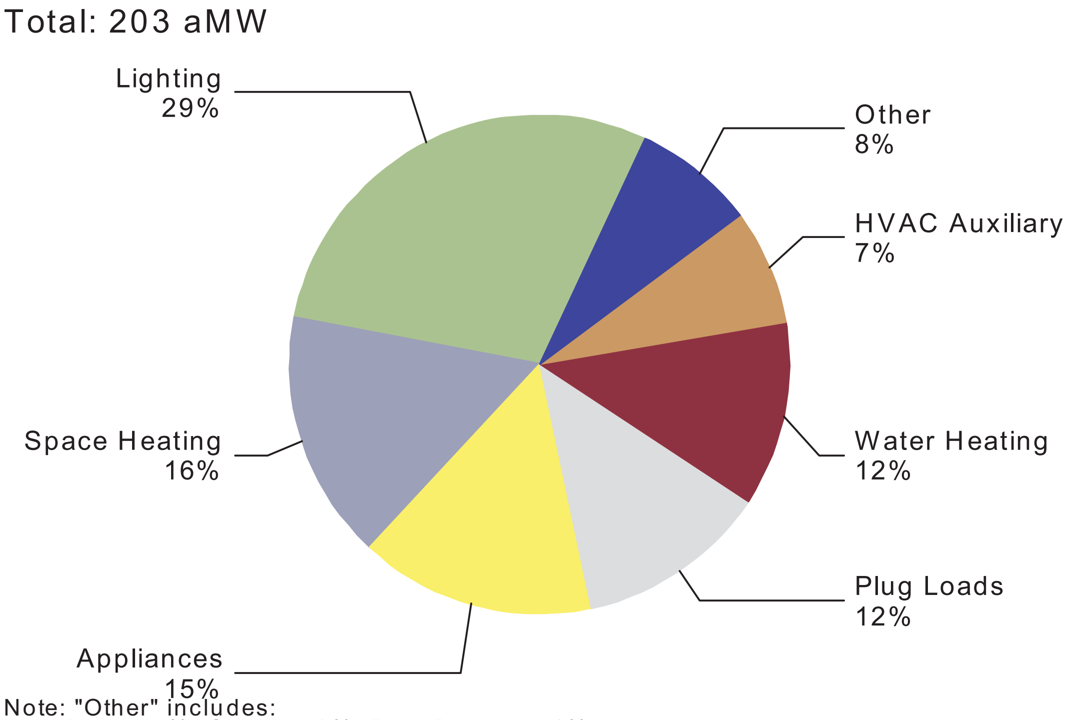
Note: "Other" includes:
Heat Pump: 4%, Cooling: 3%, Pool Pumps: <1%

Figure 9: Residential Achievable Technical Potential in 2029 by End Use, Multifamily



Note: "Other" includes:
HVAC Auxiliary: 5%, Cooling: <1%

Figure 10: Residential Achievable Technical Potential in 2029 by End Use, Single Family



Note: "Other" includes:
Heat Pump: 4%, Cooling: 3%, Pool Pumps: <1%

Residential Gas

Technical Potential

Figure 1: Residential Technical Potential in 2029 by Segment

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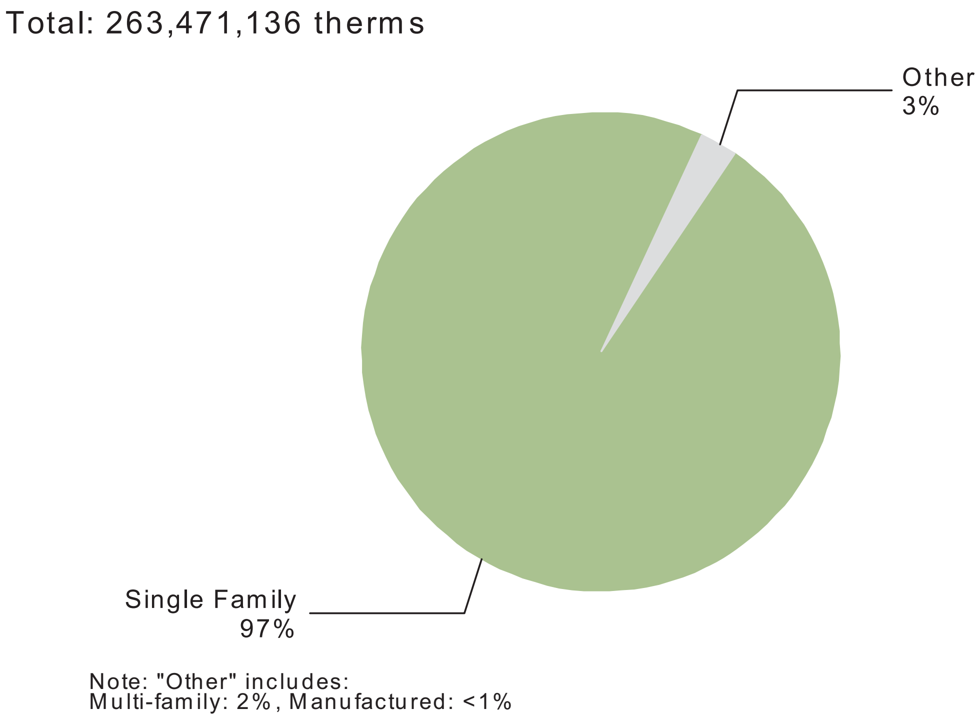


Figure 2: Residential Technical Potential in 2029 by End Use

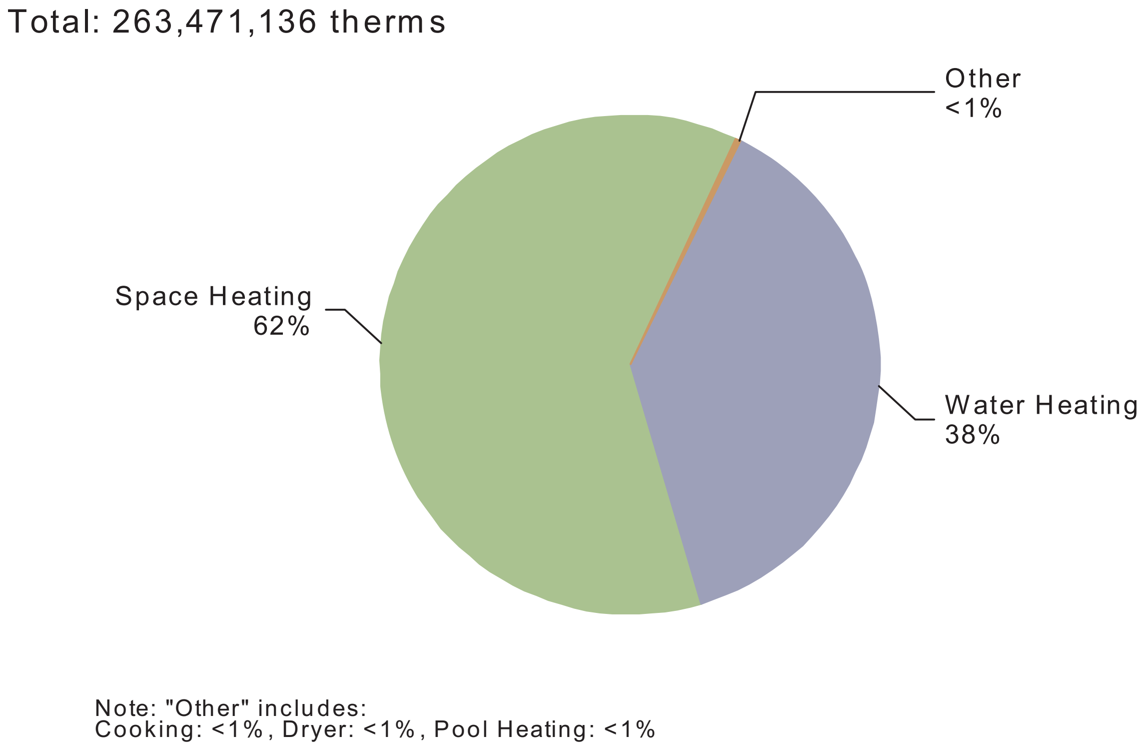


Figure 3: Residential Technical Potential in 2029 by End Use, Manufactured

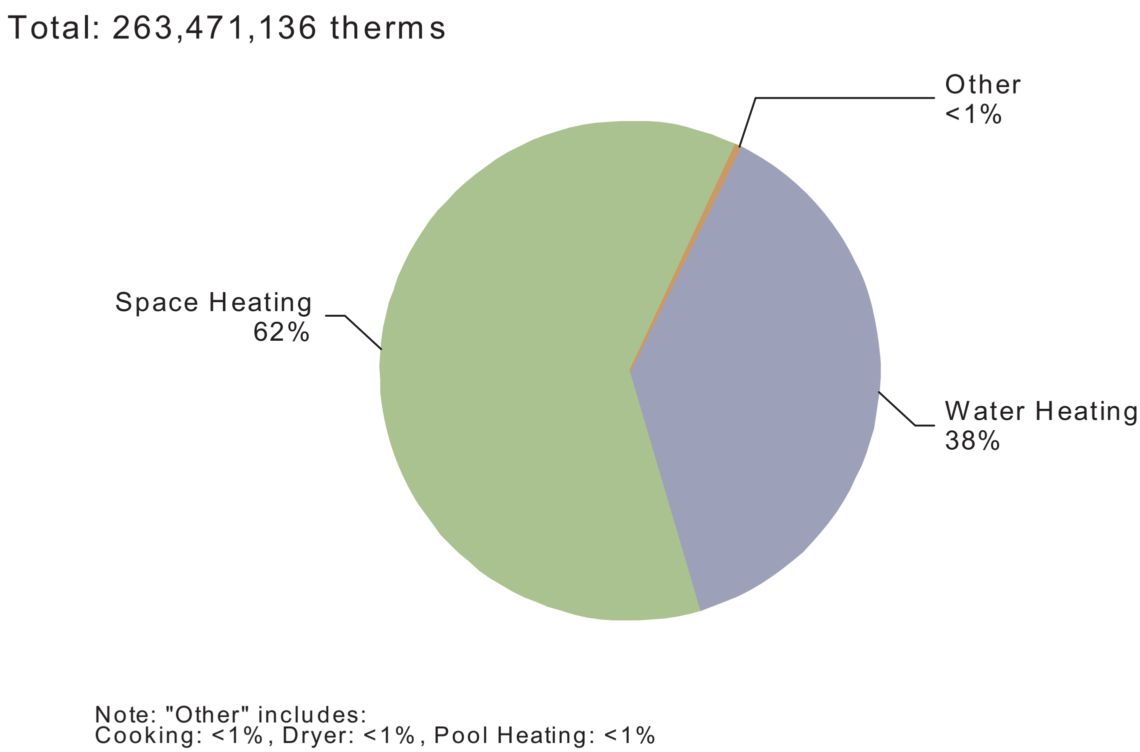


Figure 4: Residential Technical Potential in 2029 by End Use, Multifamily

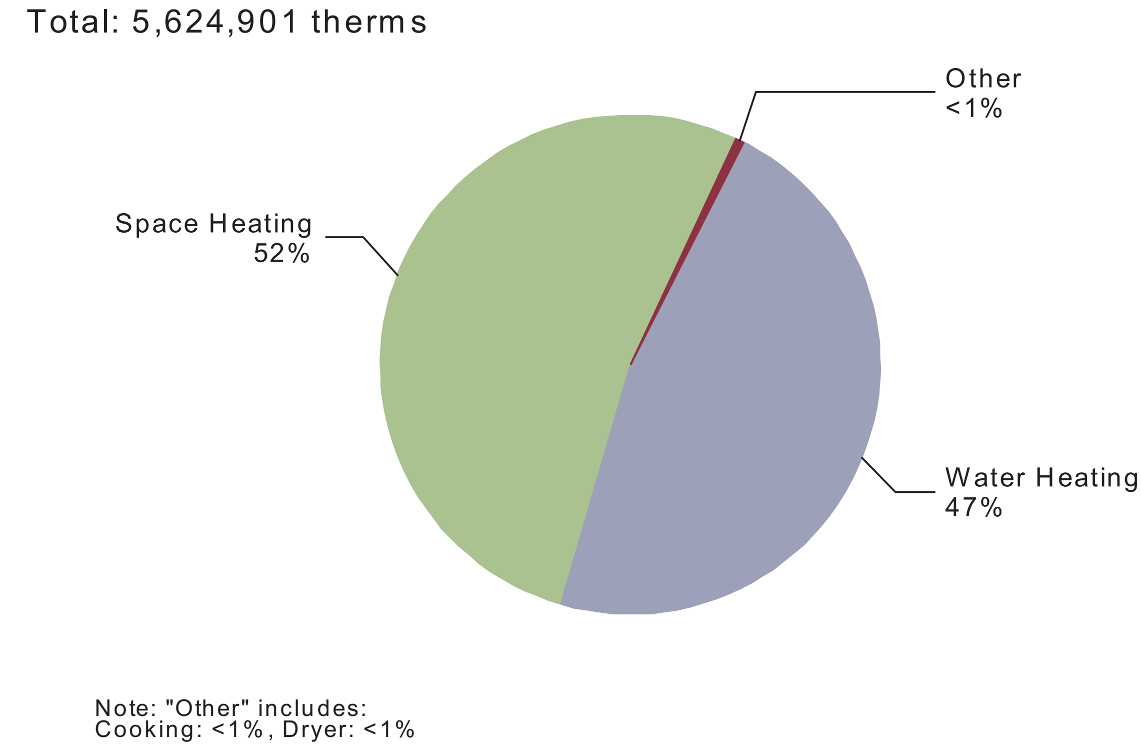
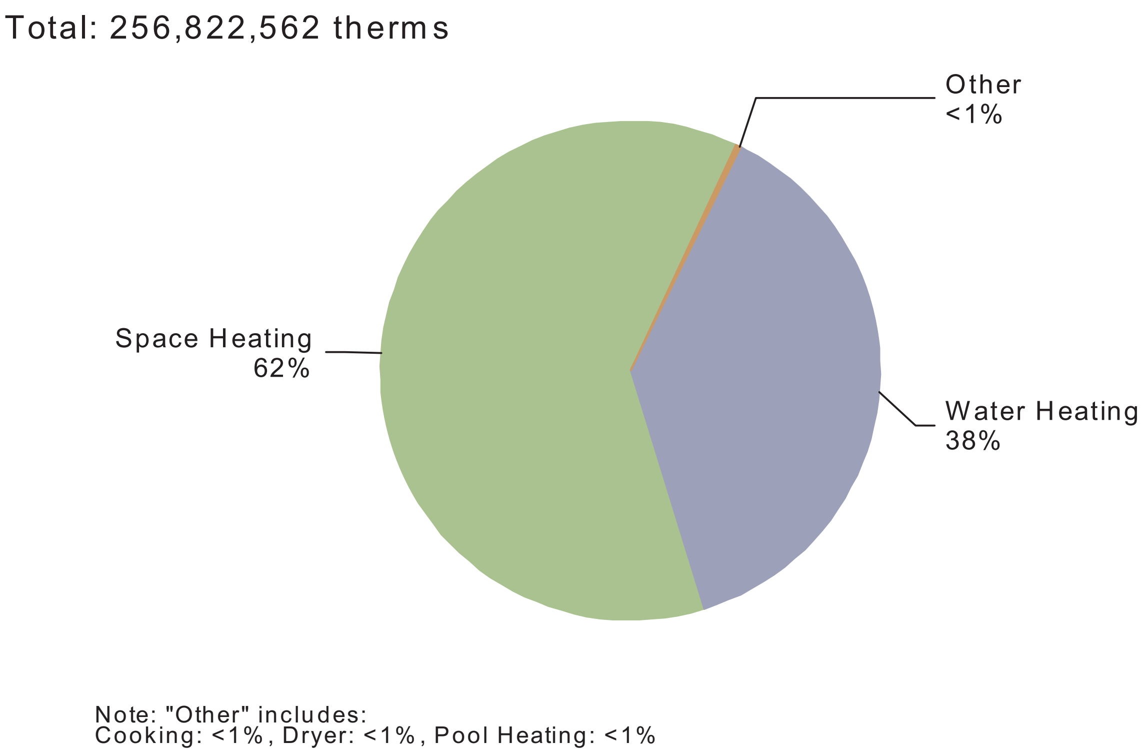


Figure 5: Residential Technical Potential in 2029 by End Use, Single Family



Achievable Technical Potential

Figure 6: Residential Achievable Technical Potential in 2029 by Segment

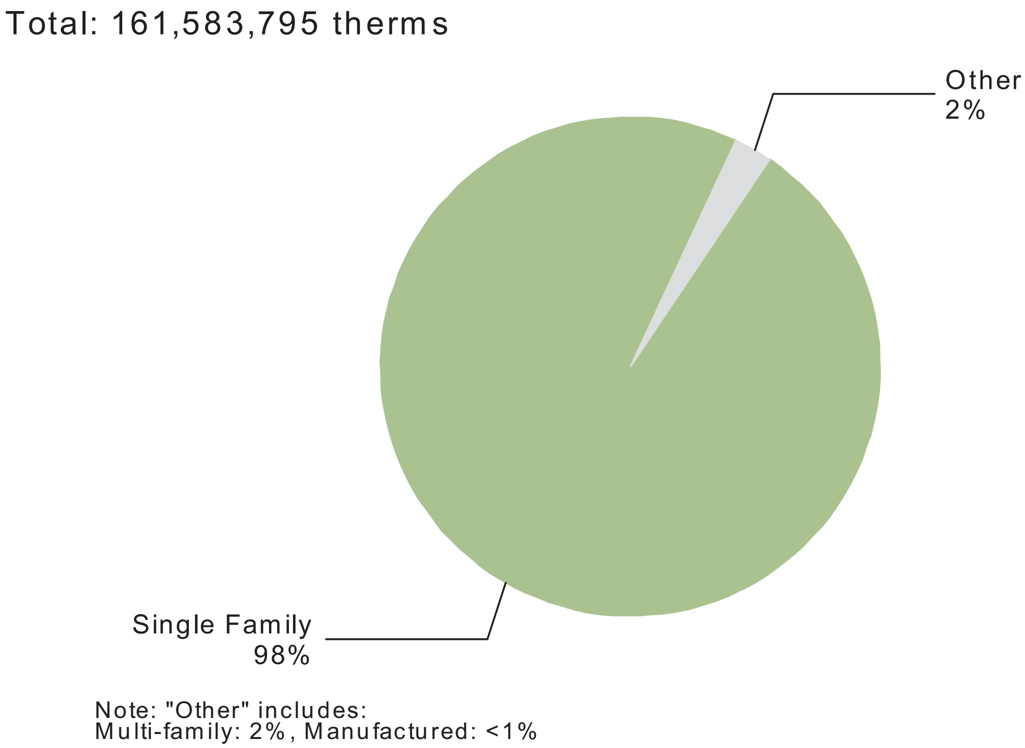


Figure 7: Residential Achievable Technical Potential in 2029 by End Use

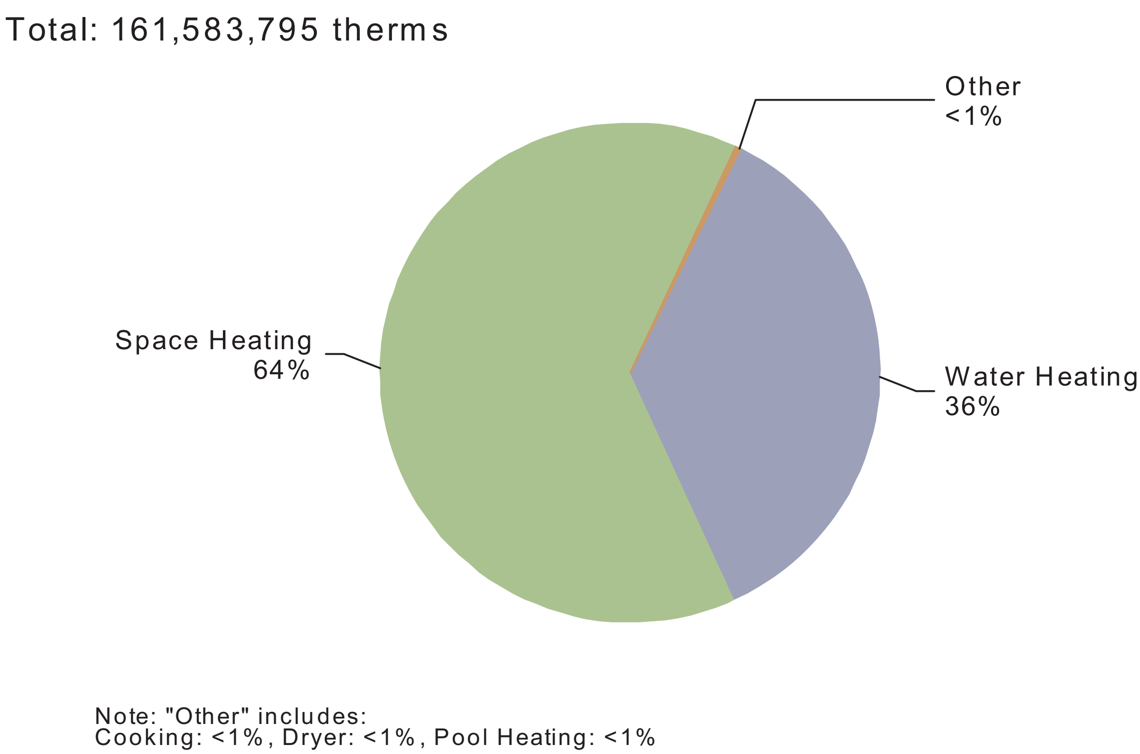


Figure 8: Residential Achievable Technical Potential in 2029 by End Use, Manufactured

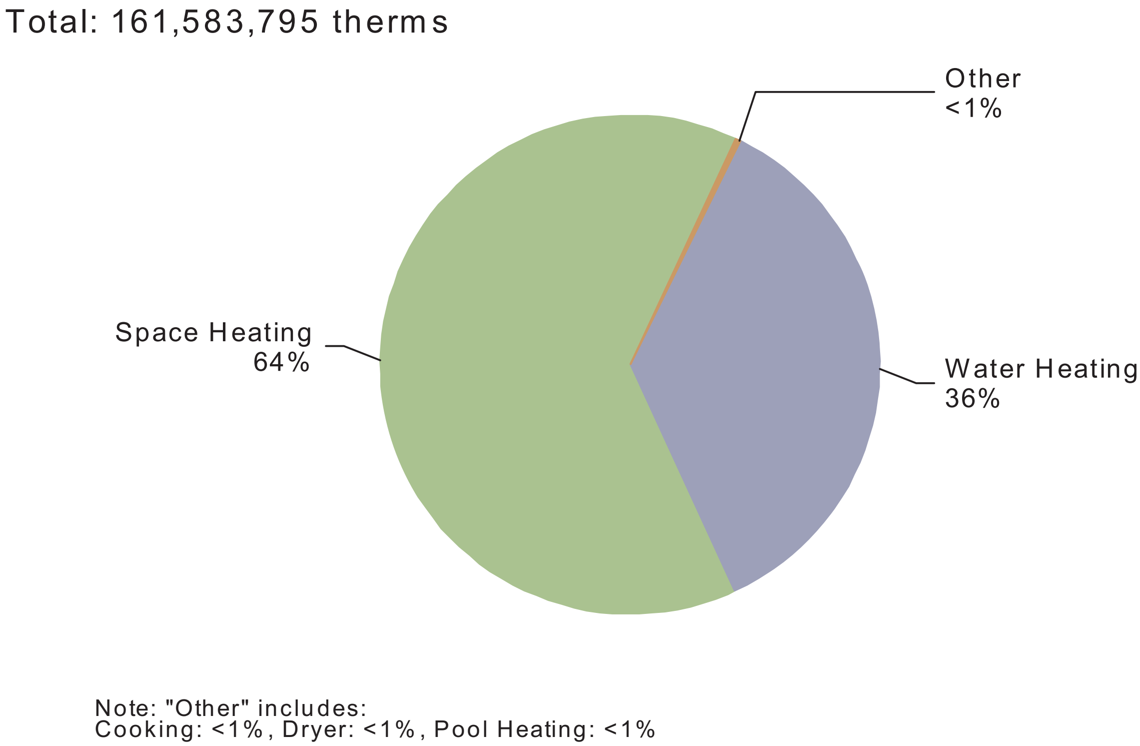


Figure 9: Residential Achievable Technical Potential in 2029 by End Use, Multifamily

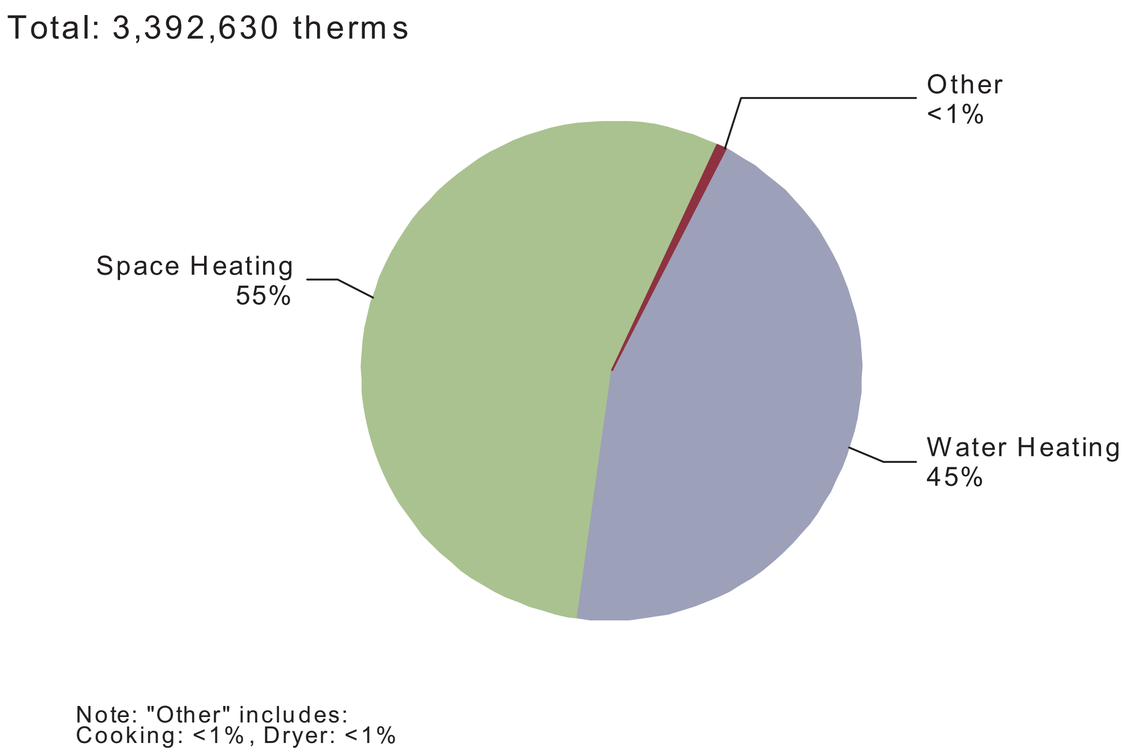
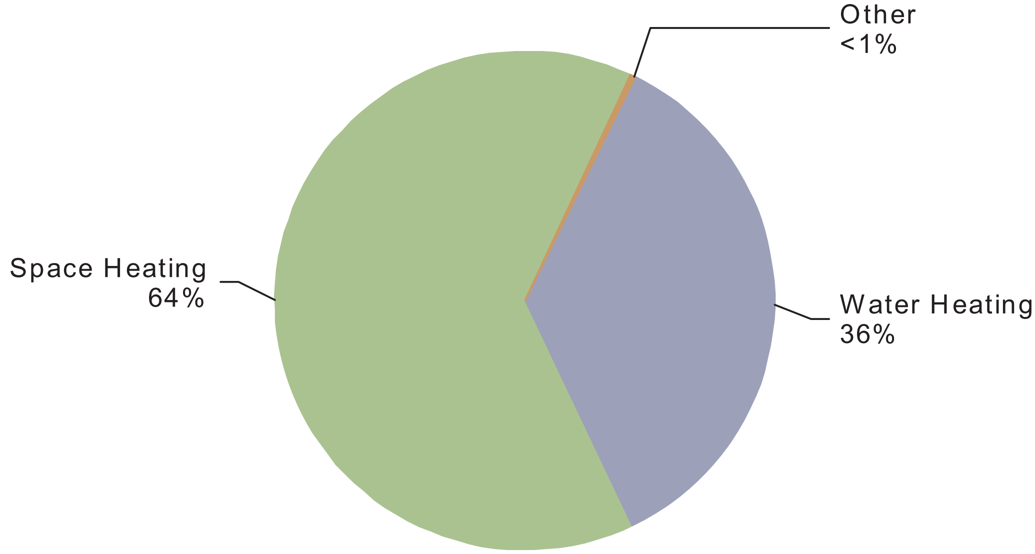


Figure 10: Residential Achievable Technical Potential in 2029 by End Use, Single Family

Total: 157,567,807 therms



Note: "Other" includes:
Cooking: <1%, Dryer: <1%, Pool Heating: <1%

Commercial Electric

Technical Potential

Figure 1: Commercial Technical Potential in 2029 by Segment

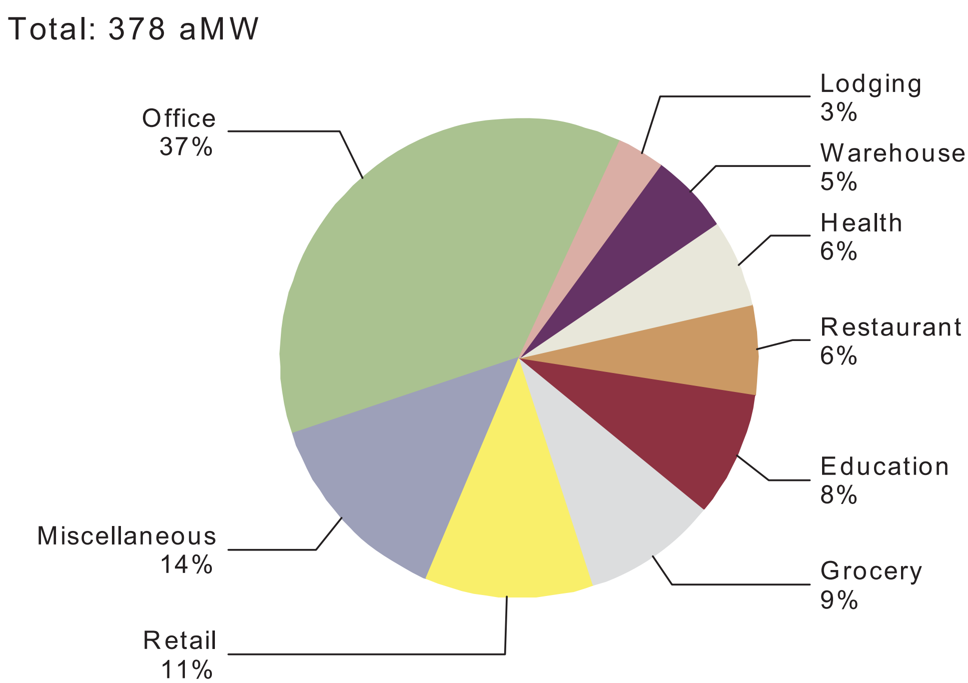
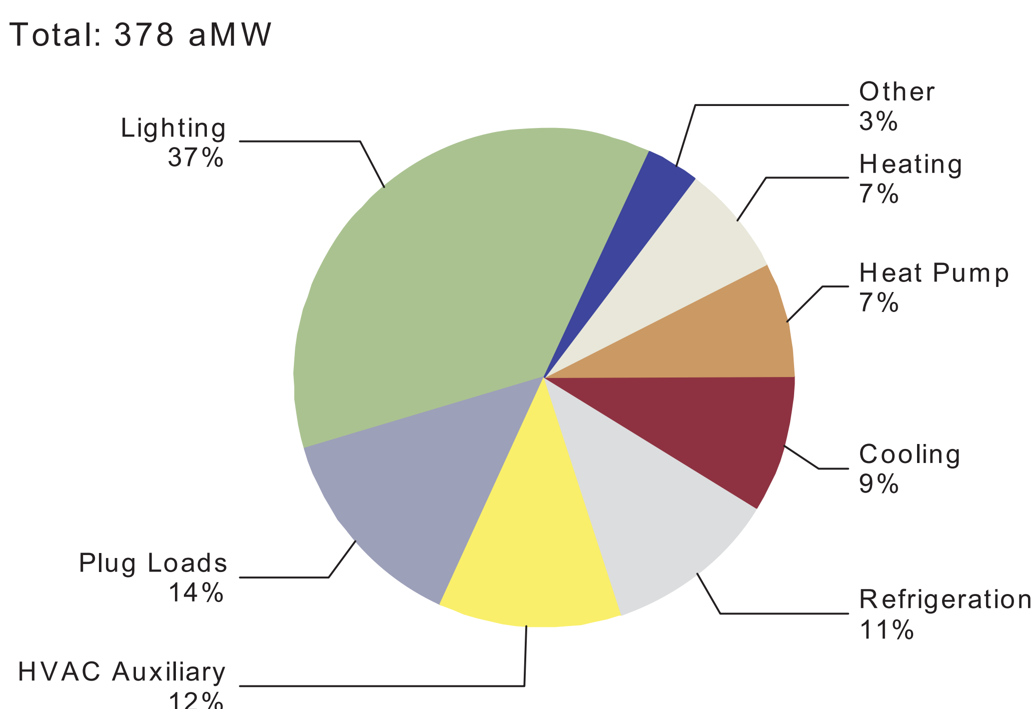


Figure 2: Commercial Technical Potential in 2029 by End Use



Note: "Other" includes:
Water Heating: 3%, Cooking: <1%

Figure 3: Commercial Technical Potential in 2029 by End Use, Education

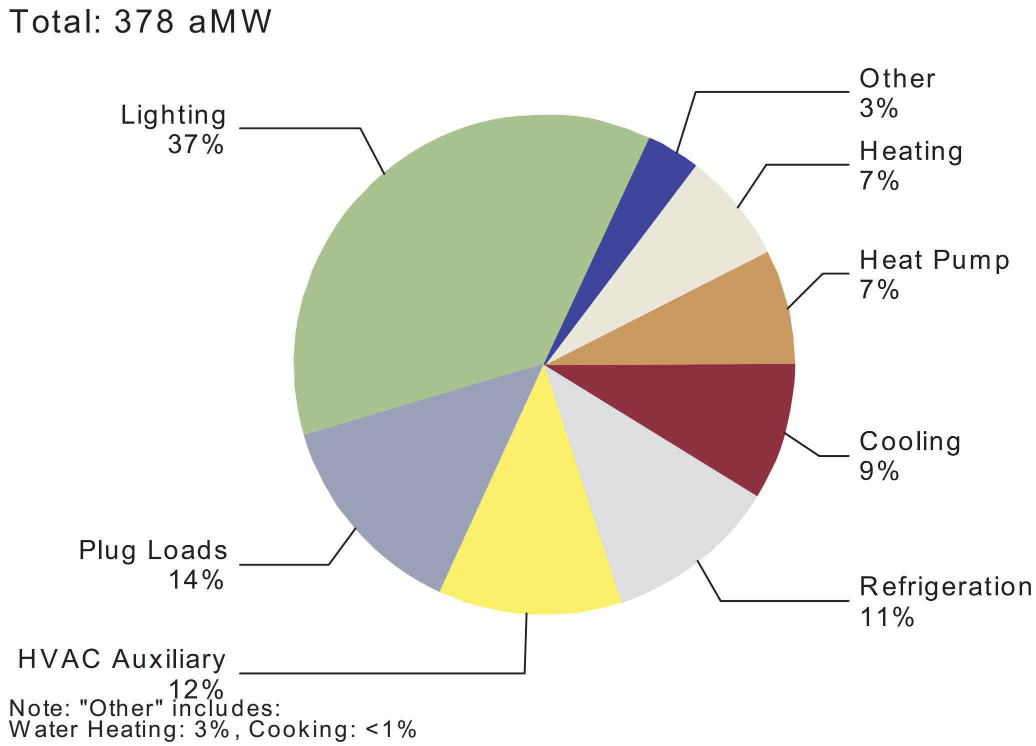


Figure 4: Commercial Technical Potential in 2029 by End Use, Grocery

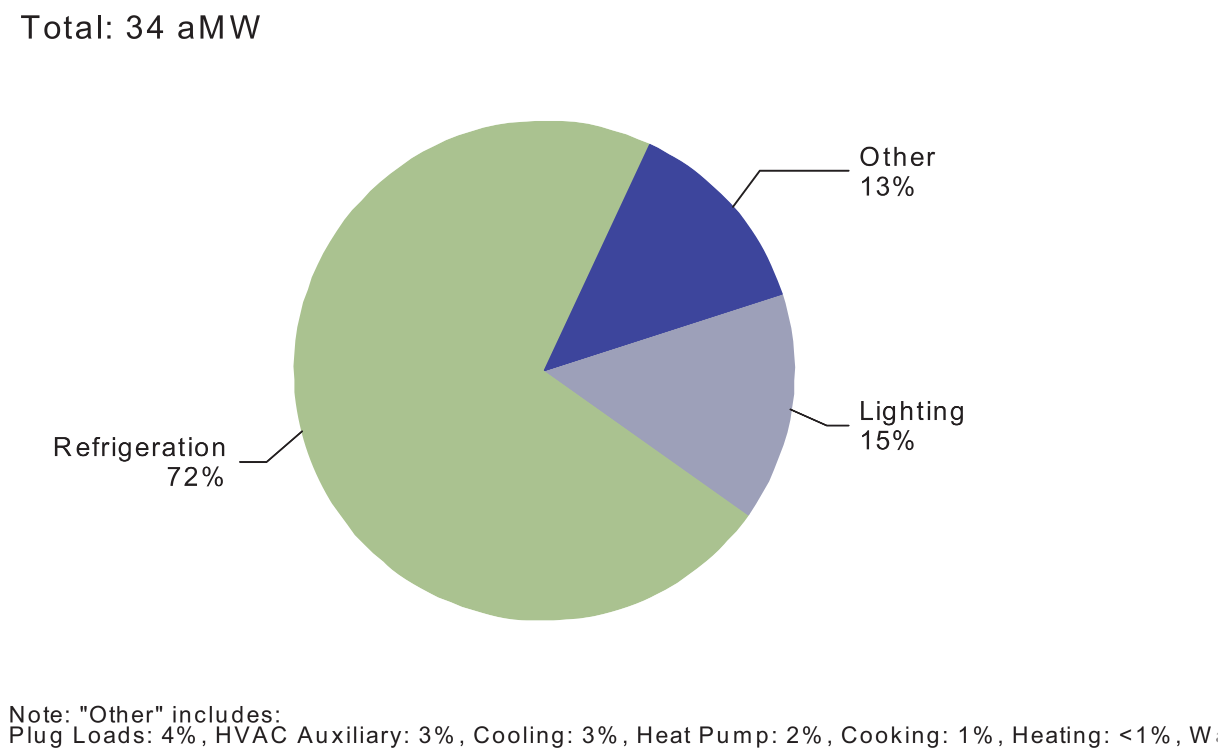
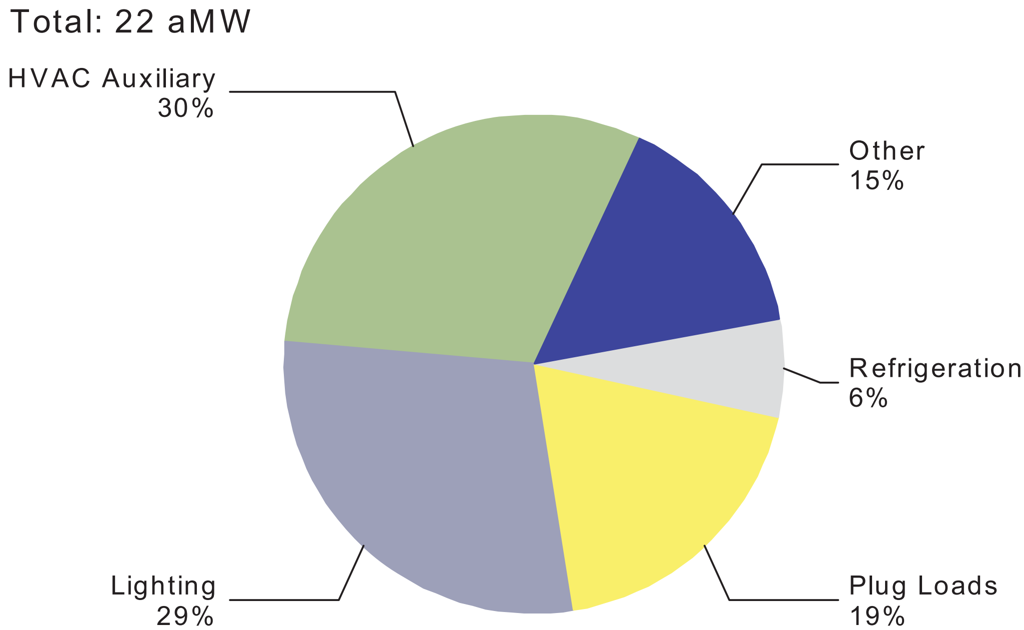
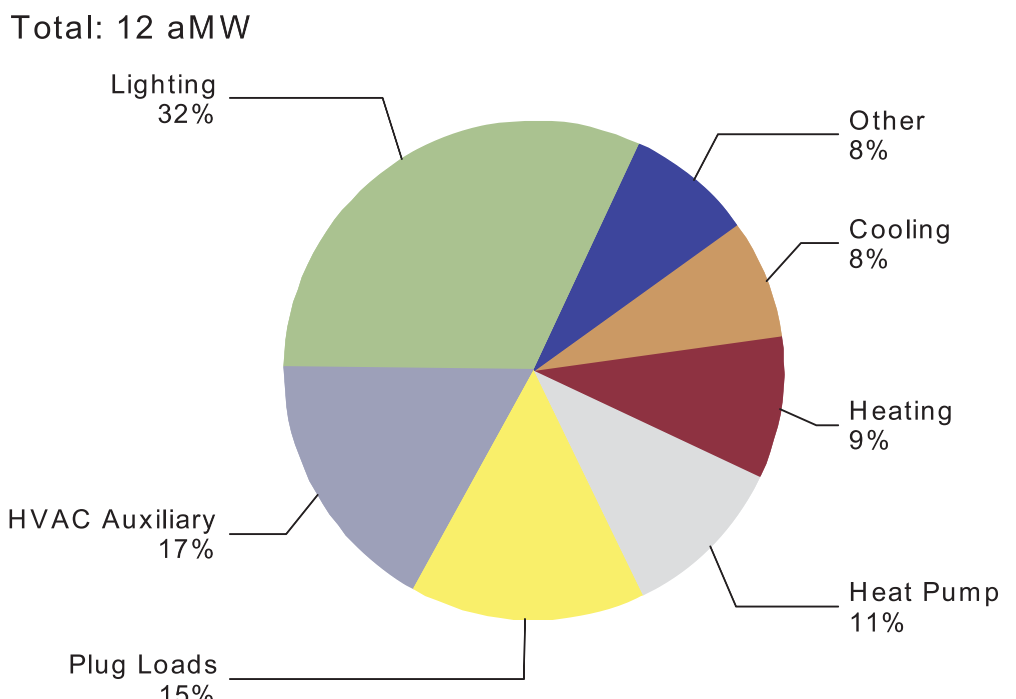


Figure 5: Commercial Technical Potential in 2029 by End Use, Health



Note: "Other" includes:
Heating: 4%, Water Heating: 4%, Cooling: 4%, Heat Pump: 2%, Cooking: <1%

Figure 6: Commercial Technical Potential in 2029 by End Use, Lodging



Note: "Other" includes:
Water Heating: 5%, Refrigeration: 3%, Cooking: <1%

Figure 7: Commercial Technical Potential in 2029 by End Use, Miscellaneous

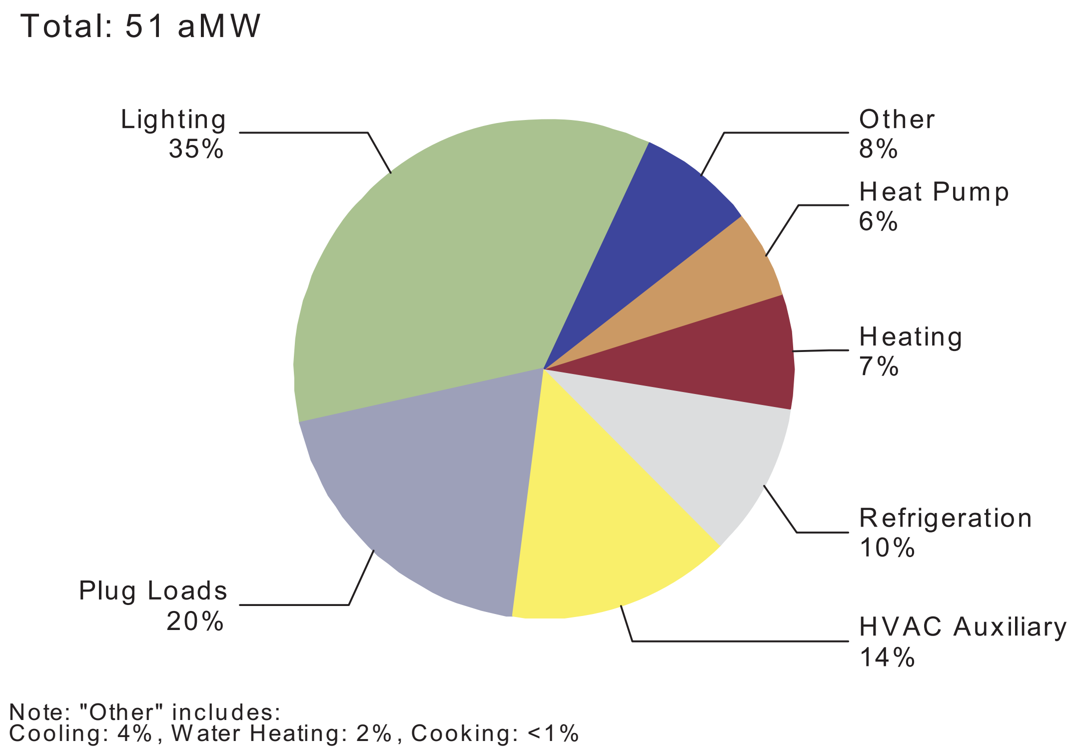


Figure 8: Commercial Technical Potential in 2029 by End Use, Office

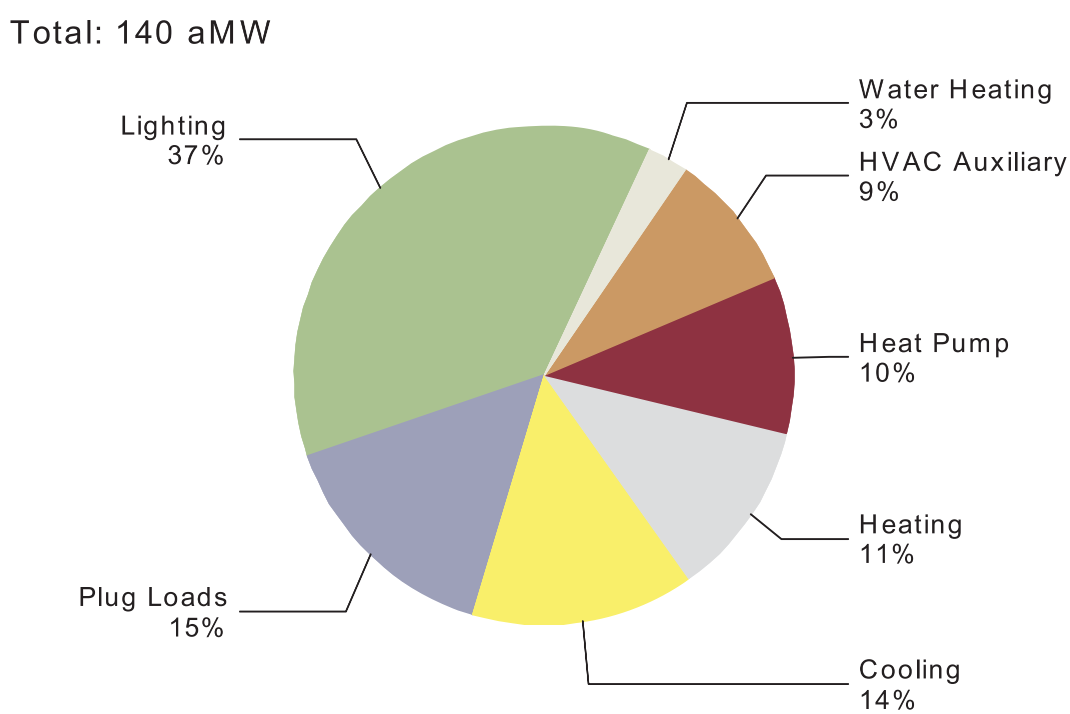


Figure 9: Commercial Technical Potential in 2029 by End Use, Restaurant

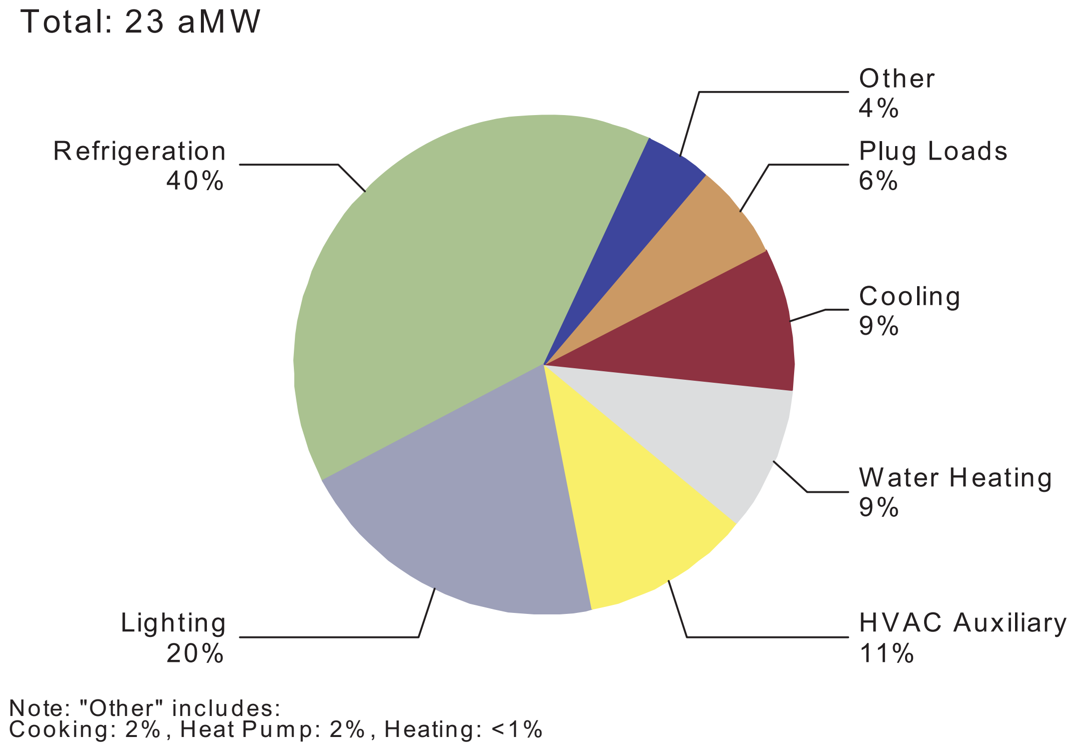


Figure 10: Commercial Technical Potential in 2029 by End Use, Retail

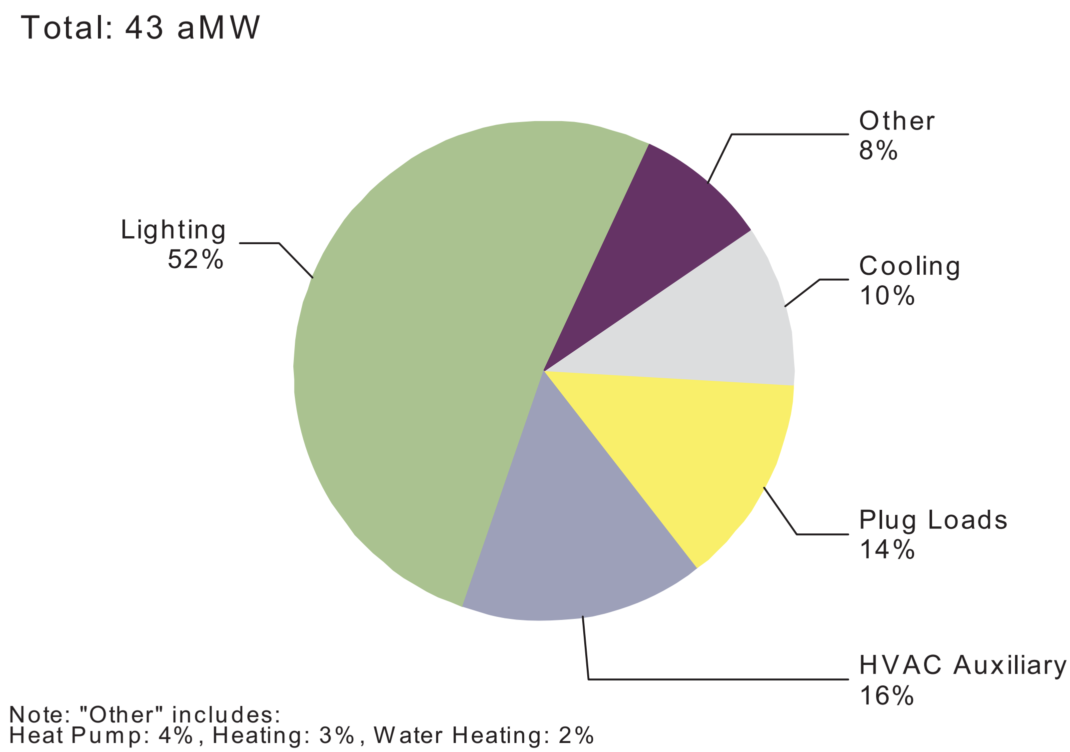
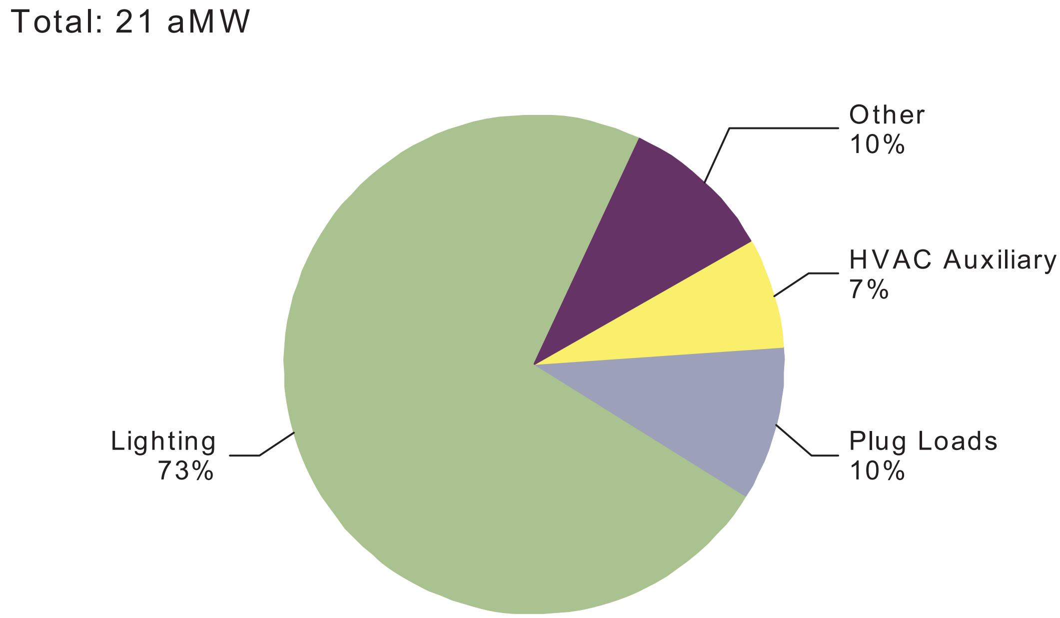


Figure 11: Commercial Technical Potential in 2029 by End Use, Warehouse



Note: "Other" includes:
Heating: 4%, Water Heating: 4%, Cooling: 1%, Heat Pump: 1%

Achievable Technical Potential

Figure 12: Commercial Achievable Technical Potential in 2029 by Segment

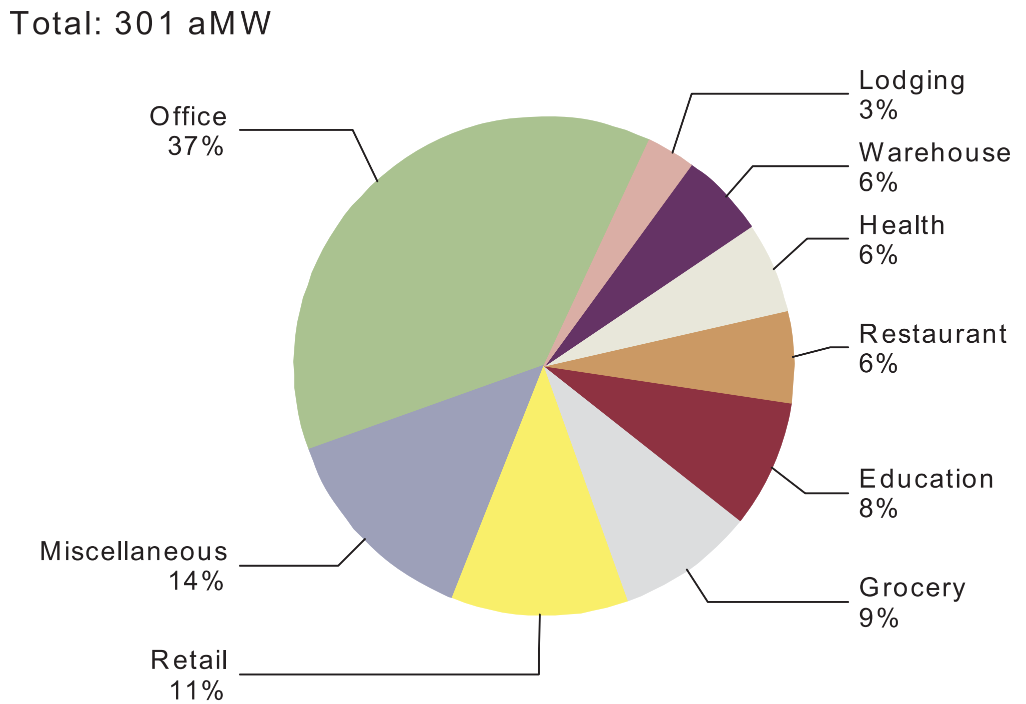


Figure 13: Commercial Achievable Technical Potential in 2029 by End Use

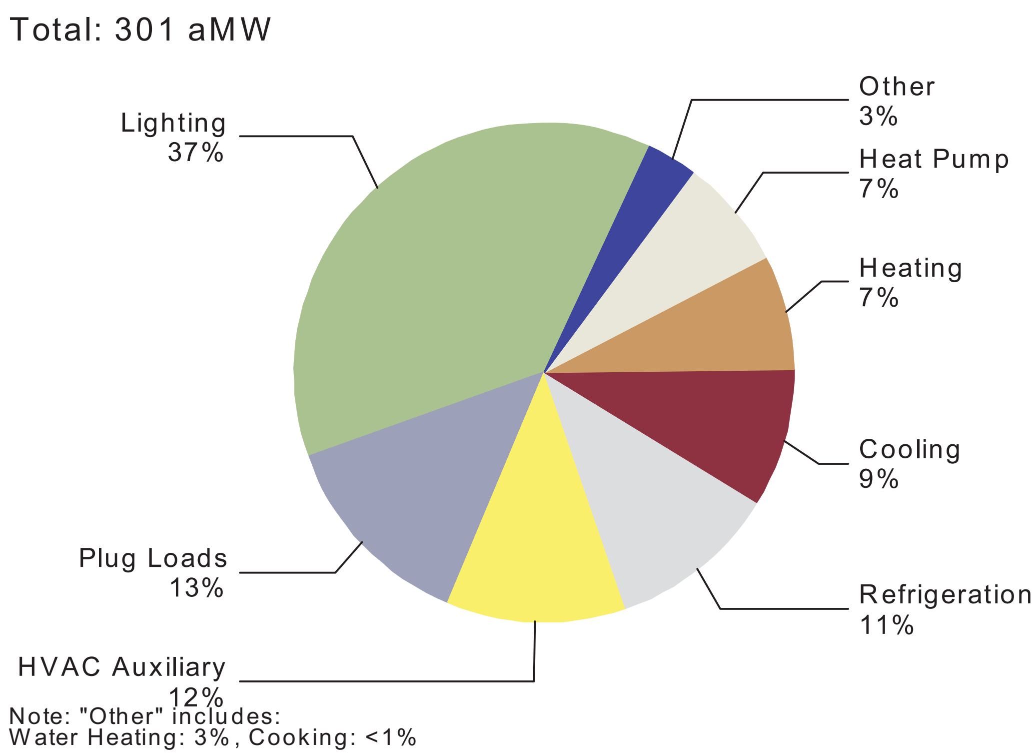


Figure 14: Commercial Achievable Technical Potential in 2029 by End Use, Education

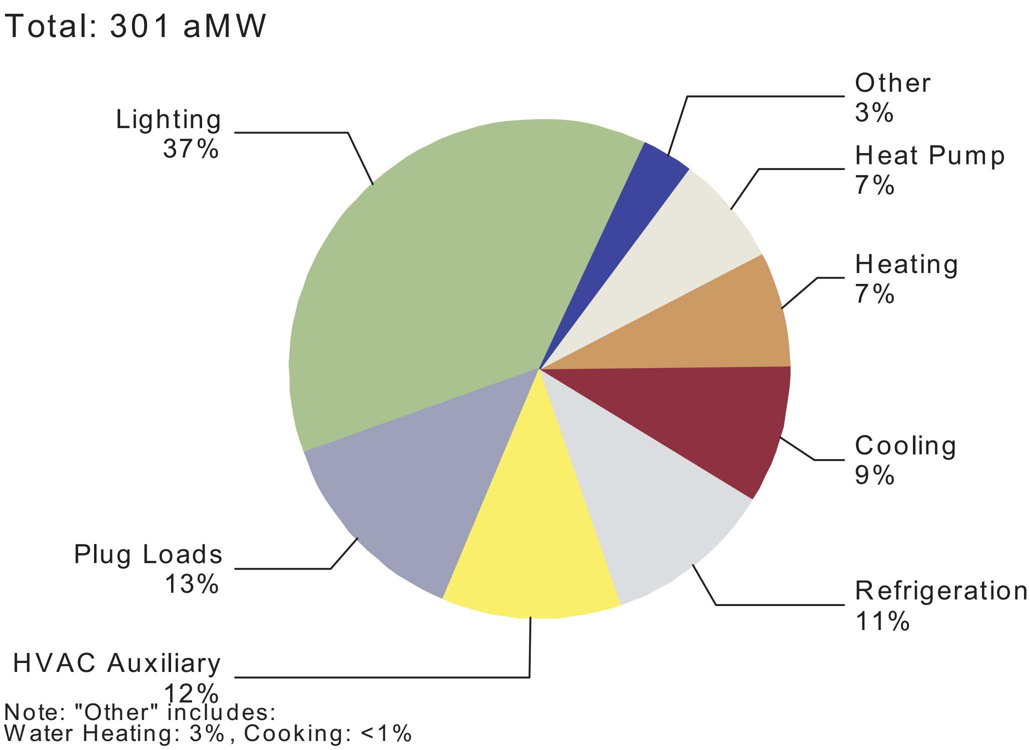


Figure 15: Commercial Achievable Technical Potential in 2029 by End Use, Grocery

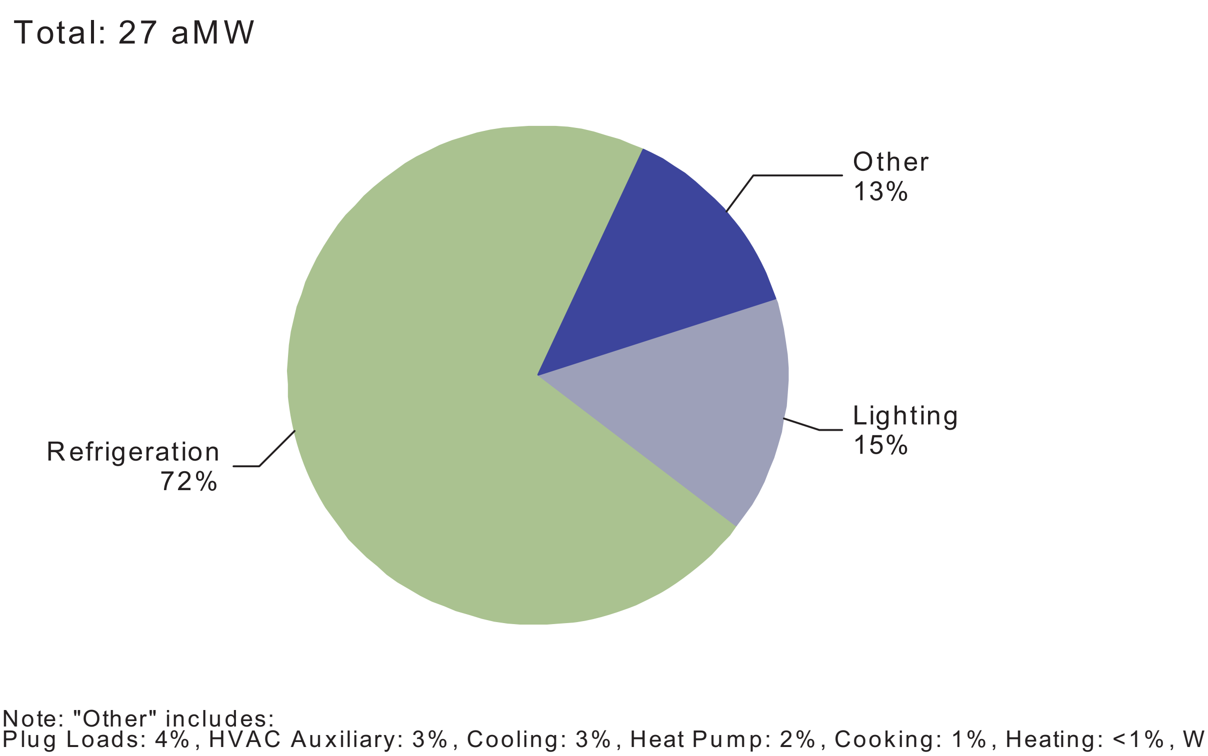


Figure 16: Commercial Achievable Technical Potential in 2029 by End Use, Health

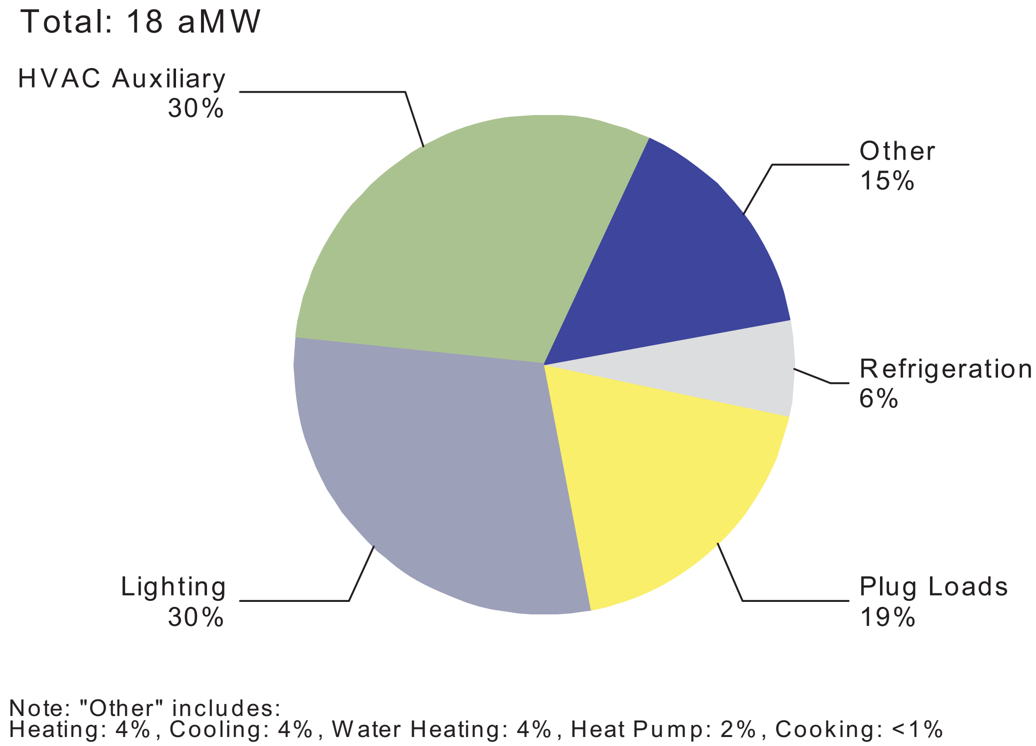


Figure 17: Commercial Achievable Technical Potential in 2029 by End Use, Lodging

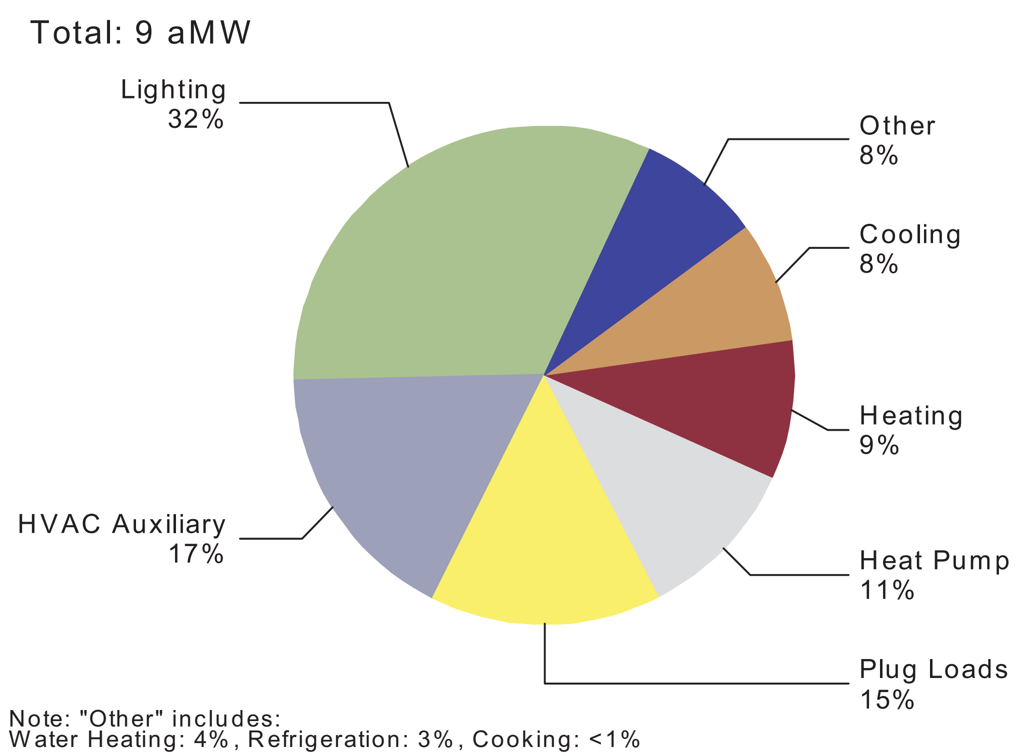


Figure 18: Commercial Achievable Technical Potential in 2029 by End Use, Miscellaneous

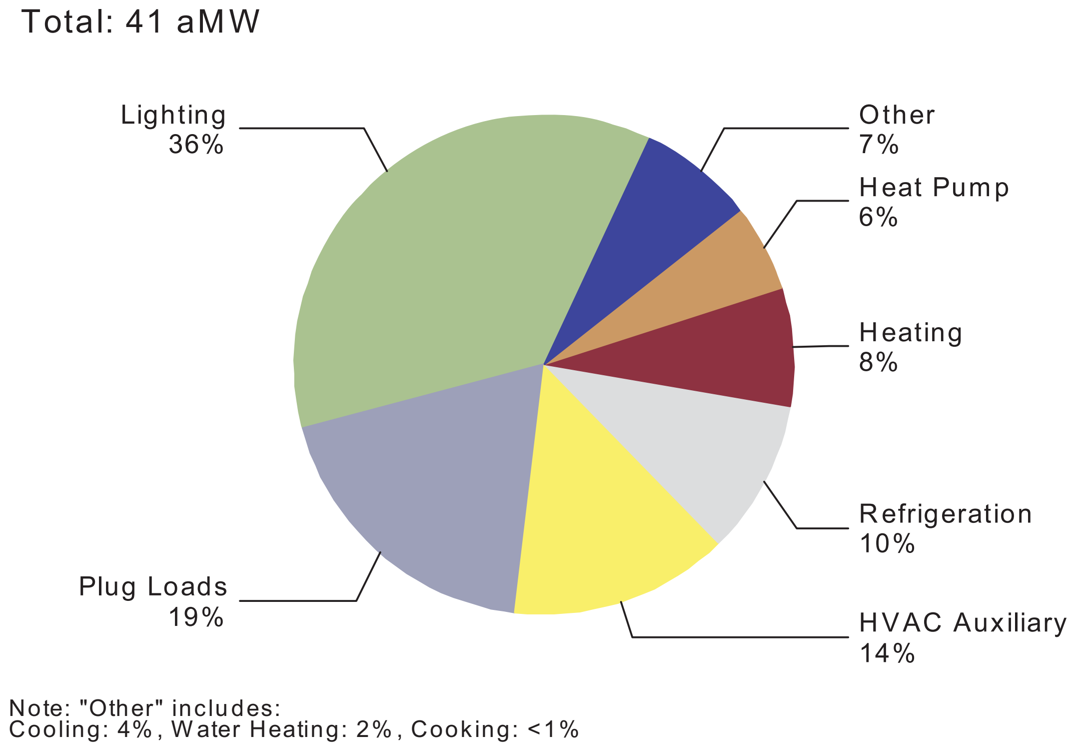


Figure 19: Commercial Achievable Technical Potential in 2029 by End Use, Office

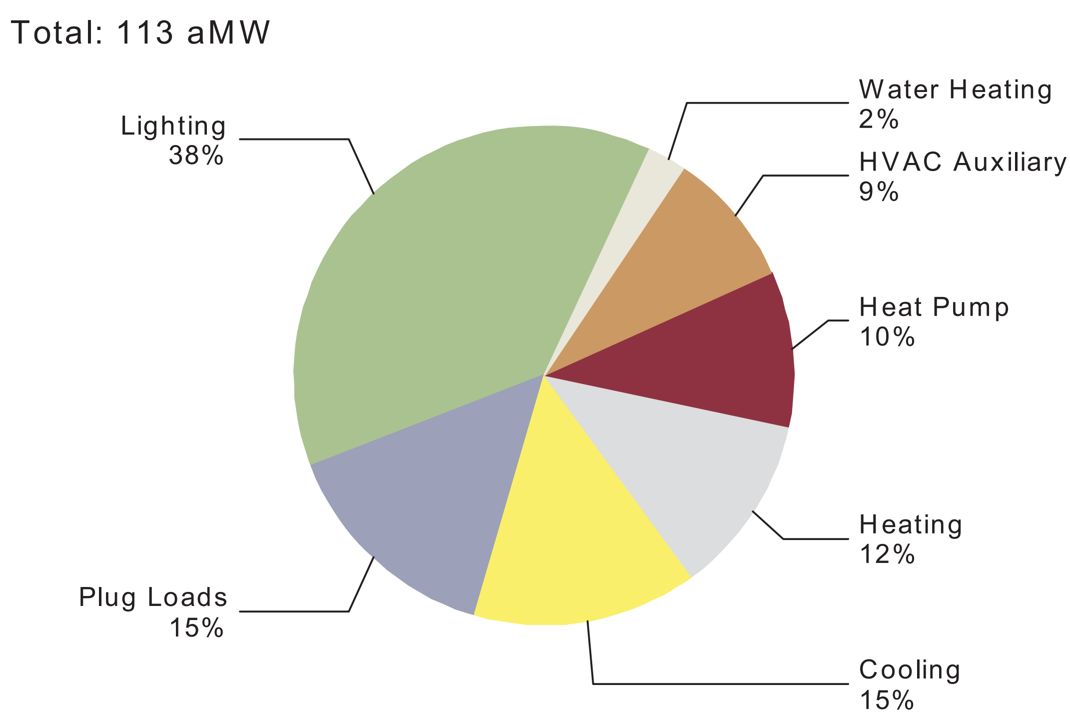


Figure 20: Commercial Achievable Technical Potential in 2029 by End Use, Restaurant

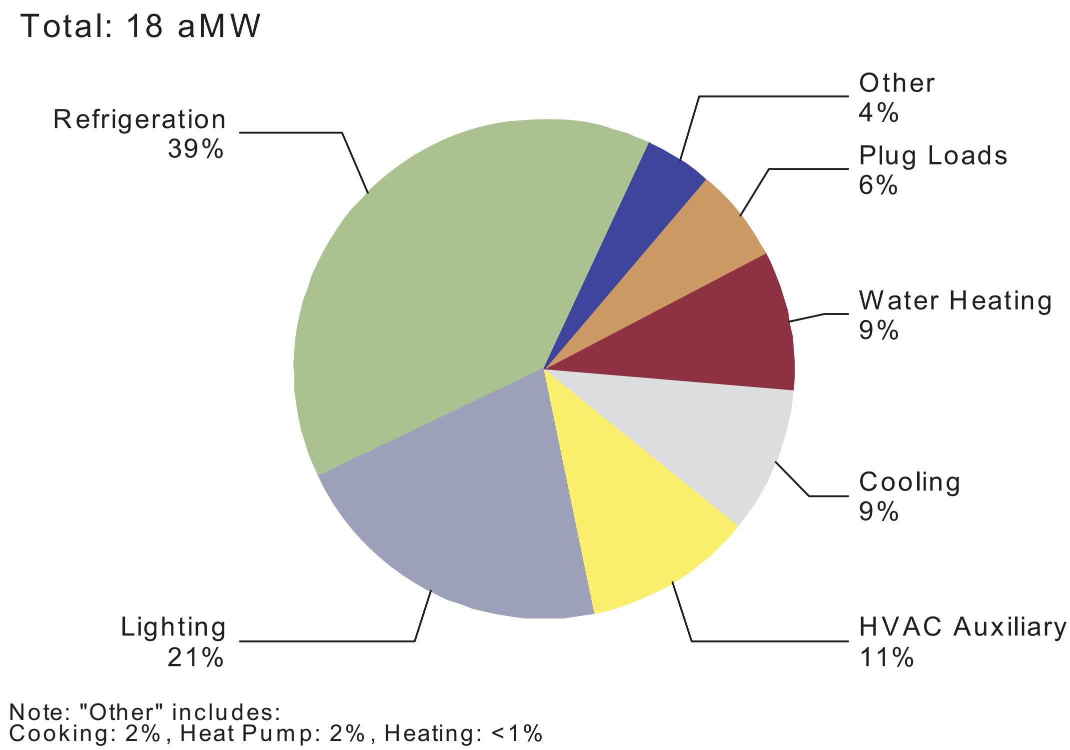


Figure 21: Commercial Achievable Technical Potential in 2029 by End Use, Retail

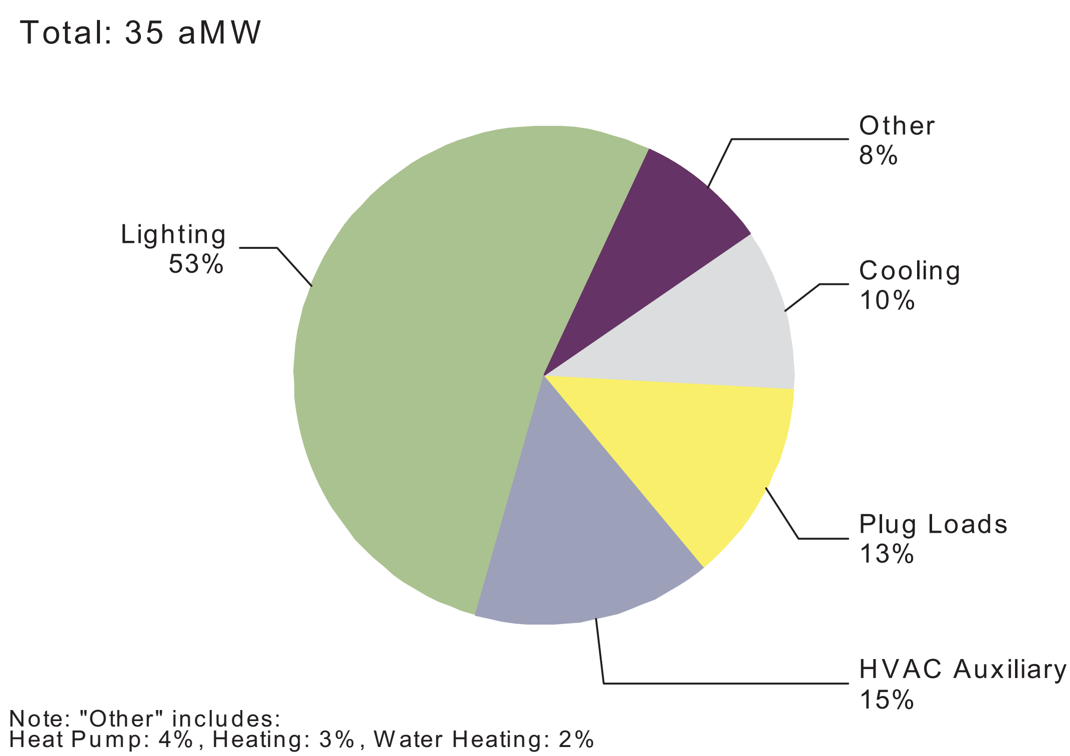
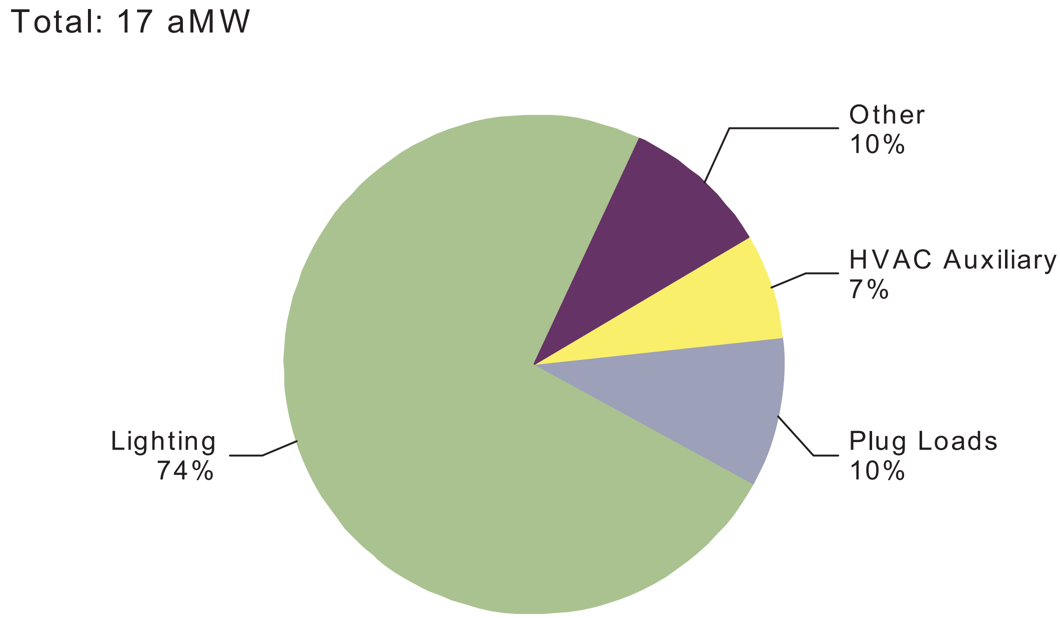


Figure 22: Commercial Achievable Technical Potential in 2029 by End Use, Warehouse



Note: "Other" includes:
Heating: 4%, Water Heating: 4%, Cooling: 1%, Heat Pump: <1%

Commercial Gas

Technical Potential

Com Gas Detailed Results
Figure 1: Commercial Technical Potential in 2029 by Segment

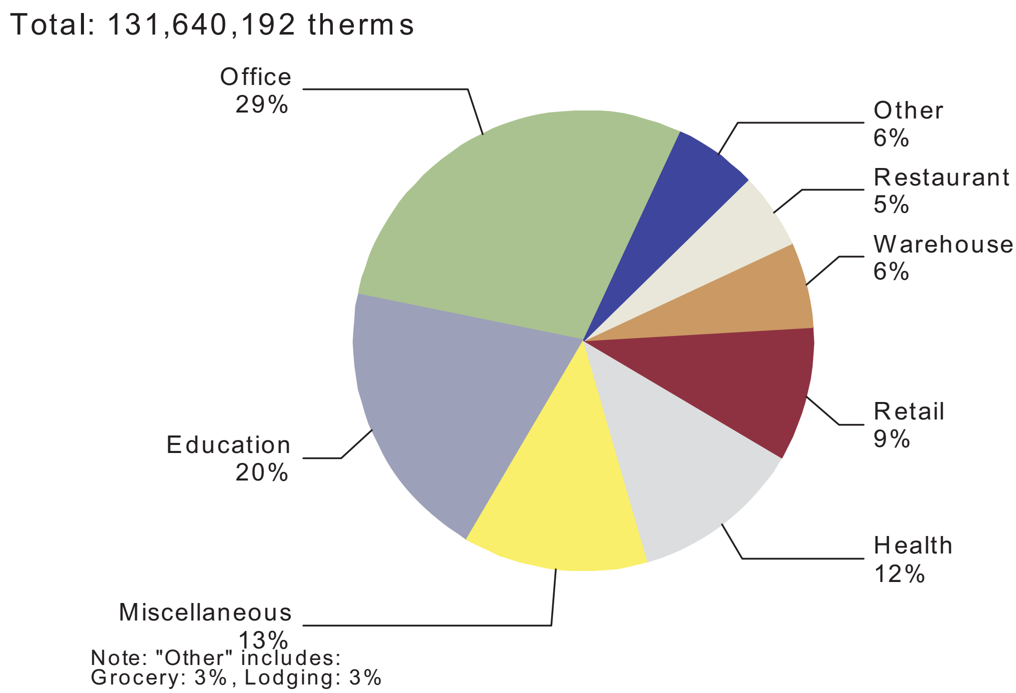


Figure 2: Commercial Technical Potential in 2029 by End Use

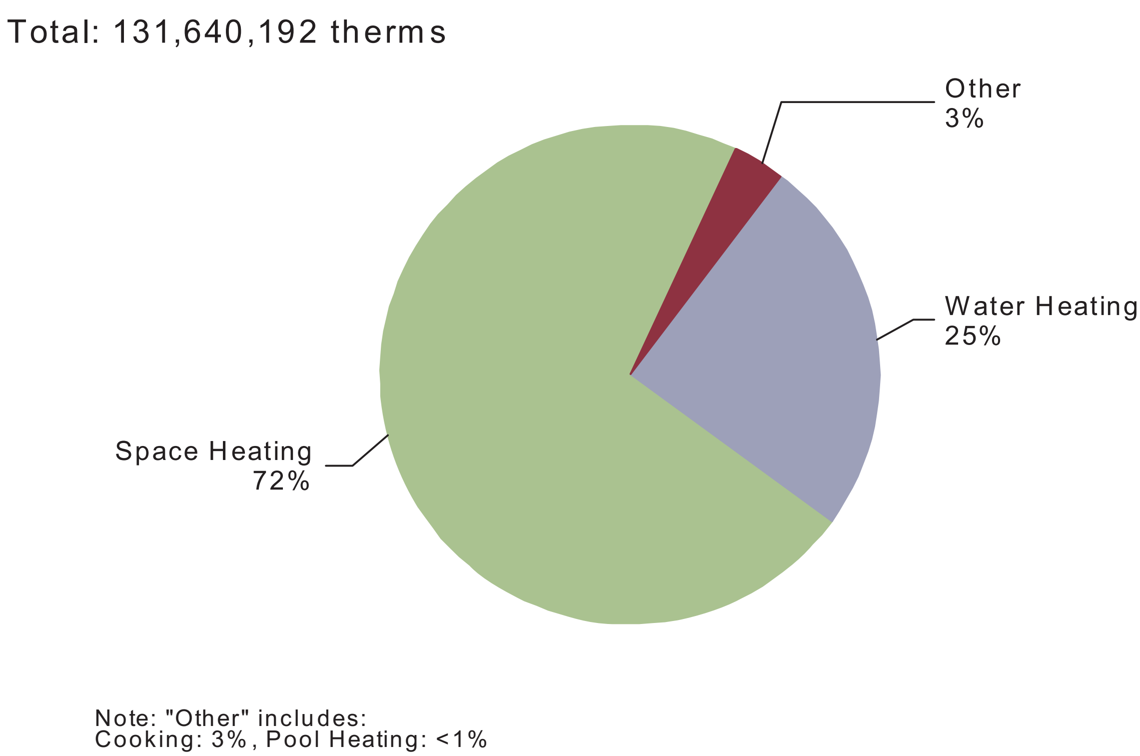


Figure 3: Commercial Technical Potential in 2029 by End Use, Education

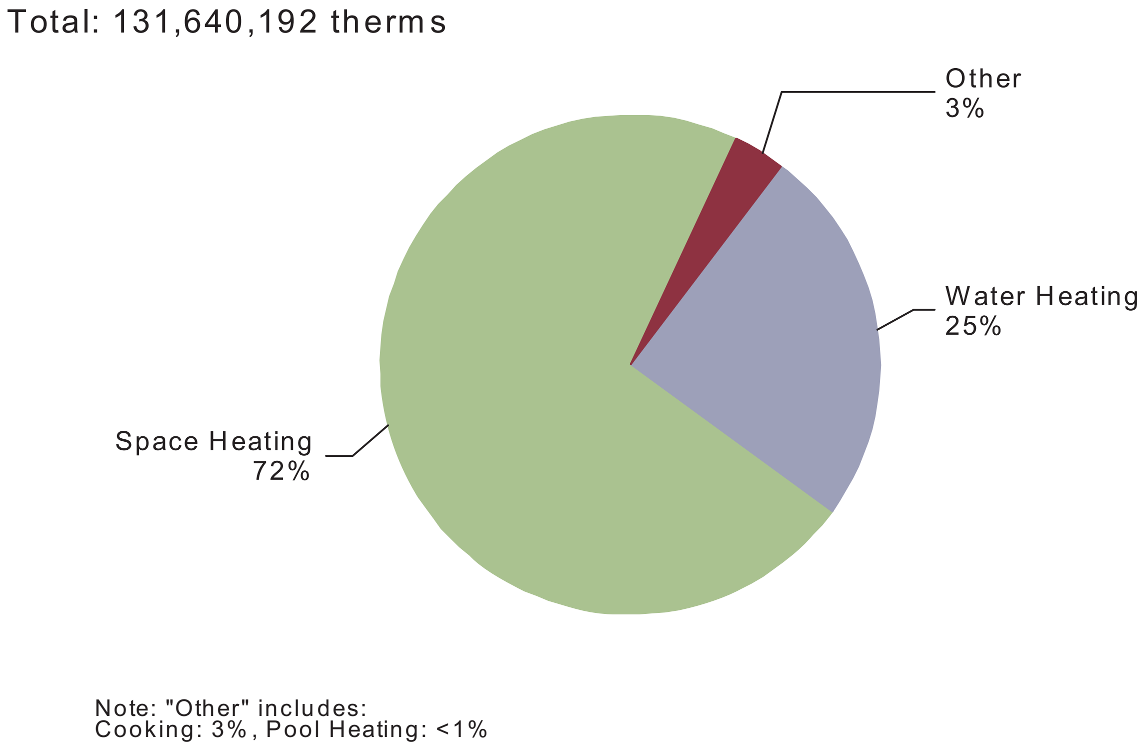


Figure 4: Commercial Technical Potential in 2029 by End Use, Grocery

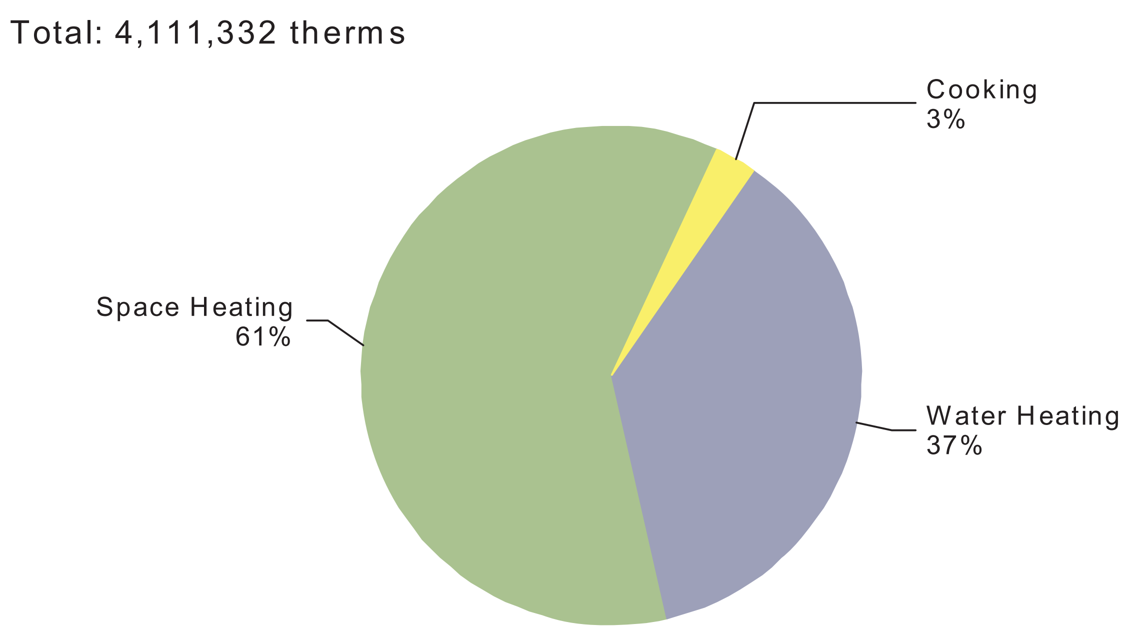


Figure 5: Commercial Technical Potential in 2029 by End Use, Health

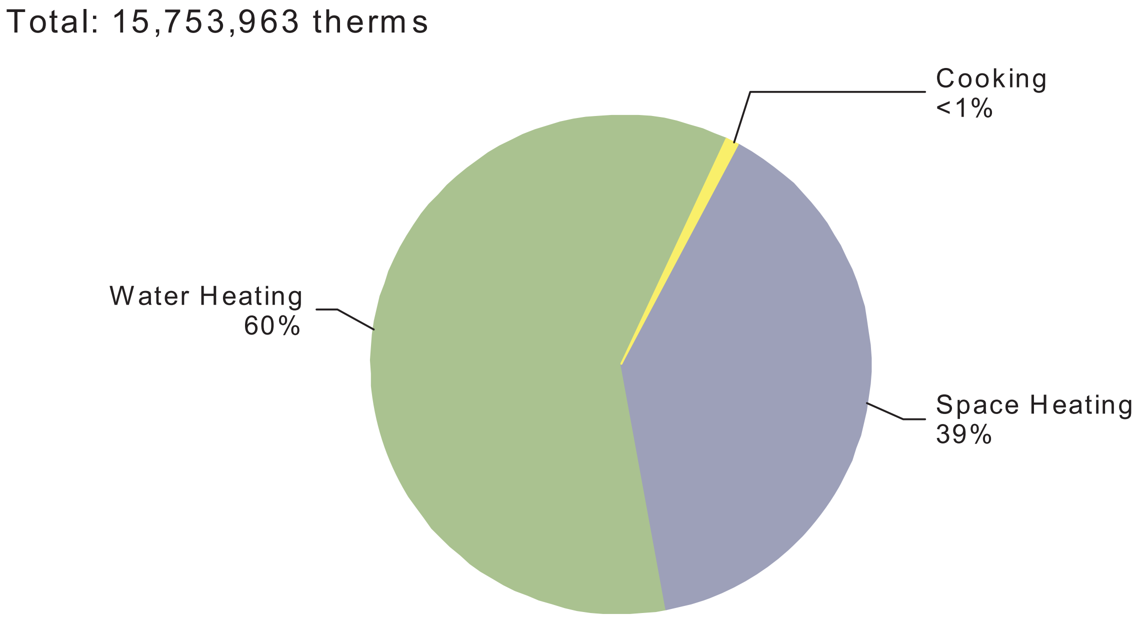


Figure 6: Commercial Technical Potential in 2029 by End Use, Lodging

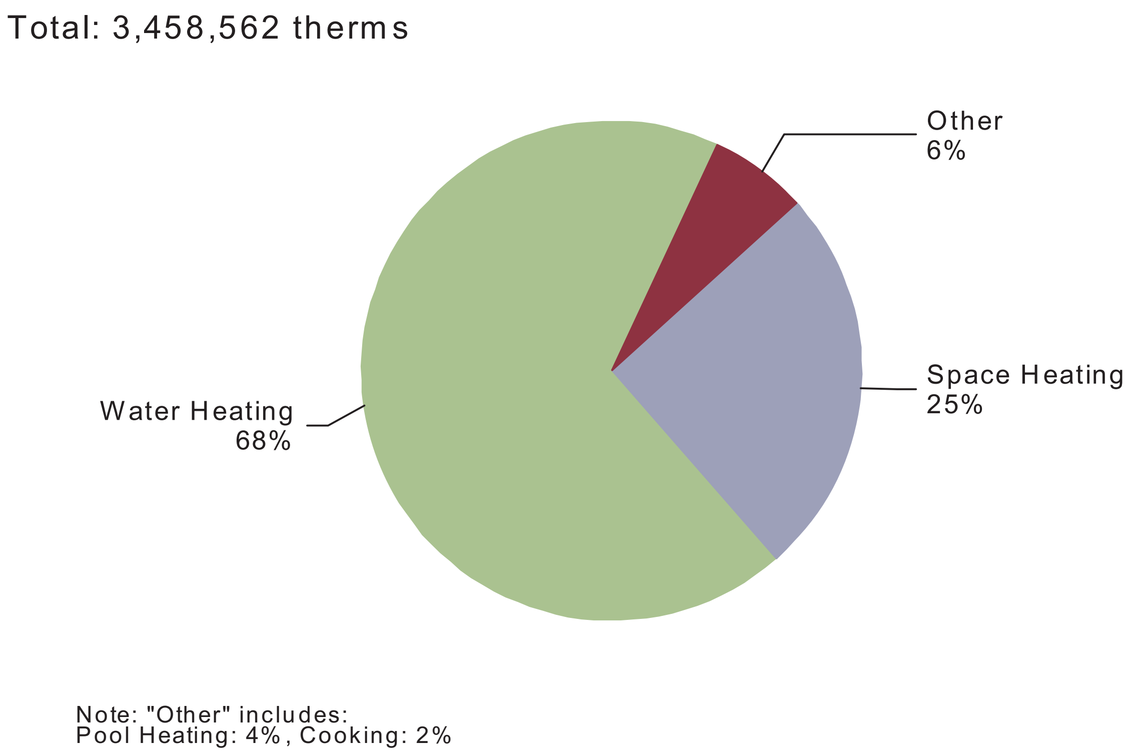


Figure 7: Commercial Technical Potential in 2029 by End Use, Miscellaneous

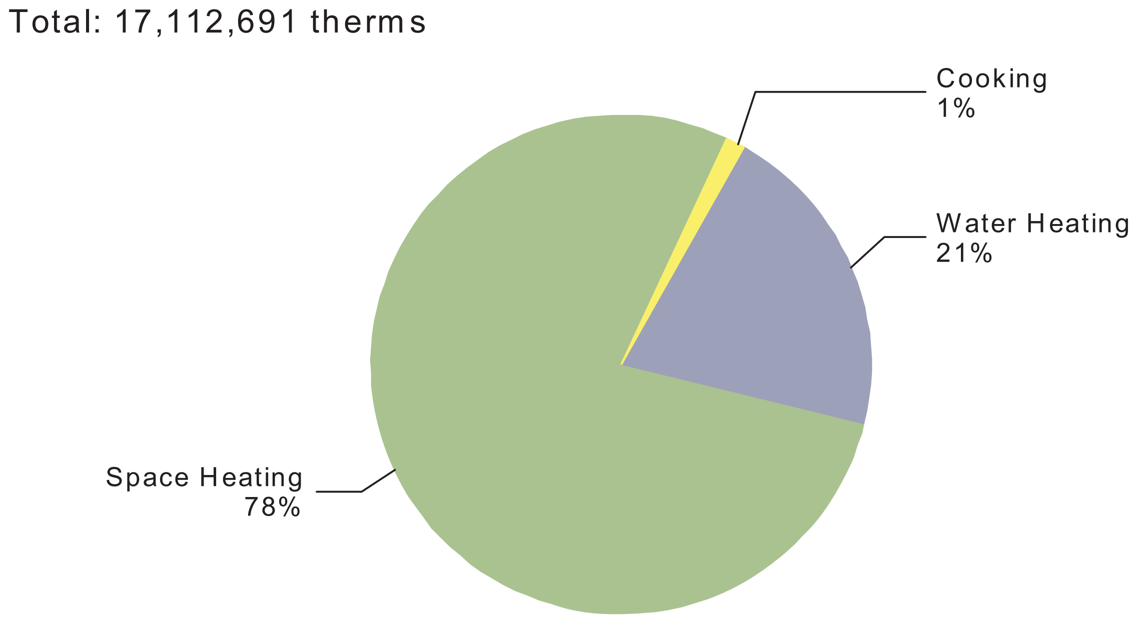


Figure 8: Commercial Technical Potential in 2029 by End Use, Office

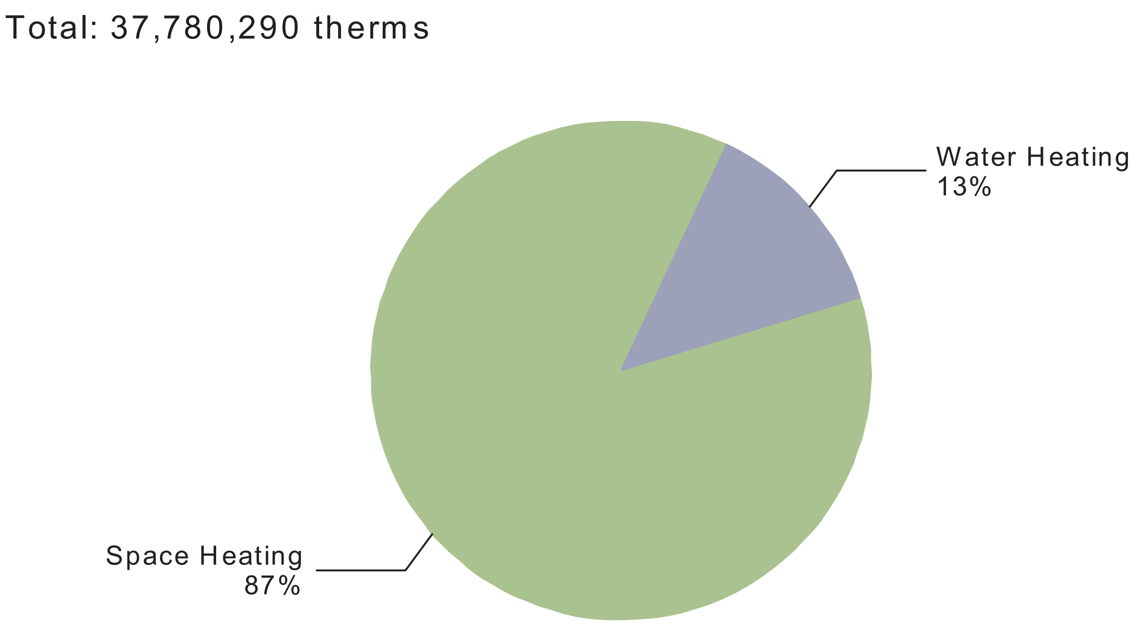


Figure 9: Commercial Technical Potential in 2029 by End Use, Restaurant

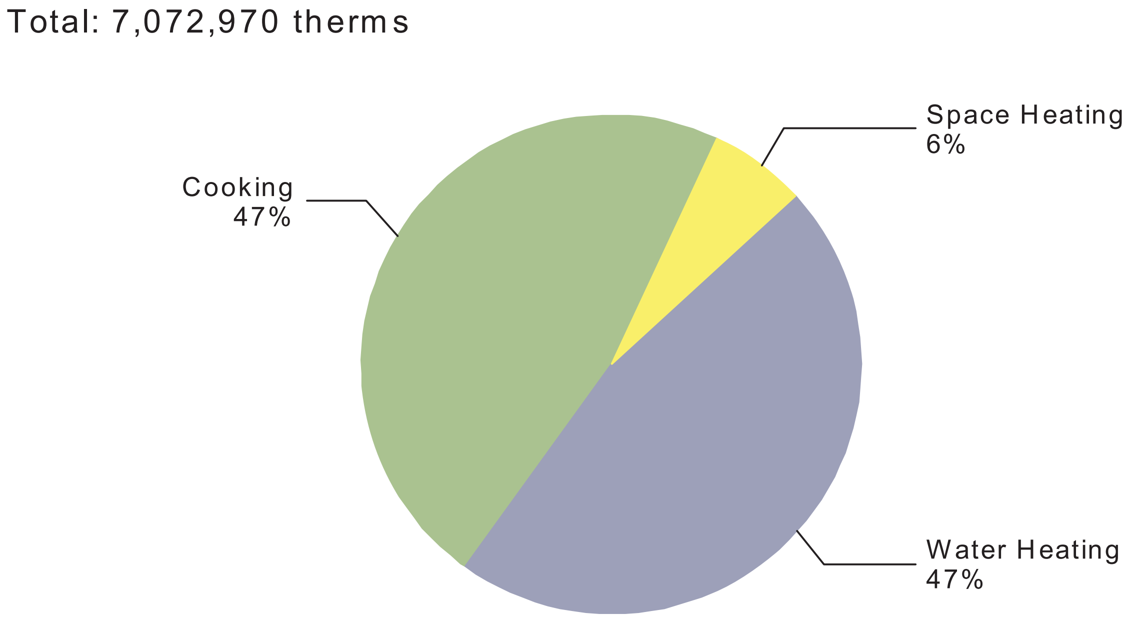


Figure 10: Commercial Technical Potential in 2029 by End Use, Retail

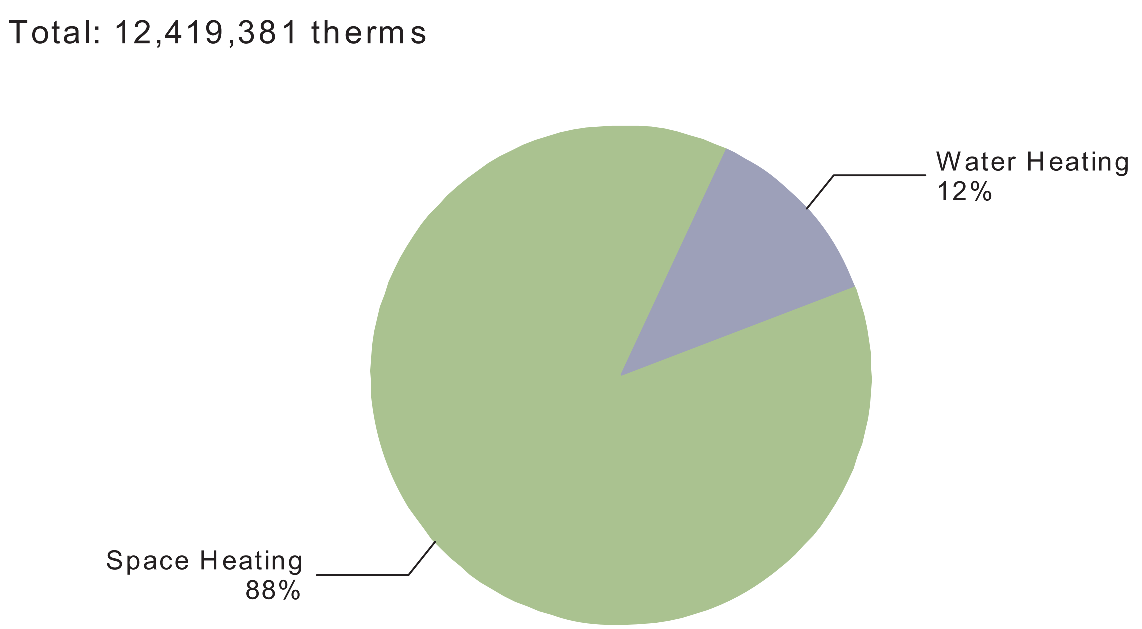
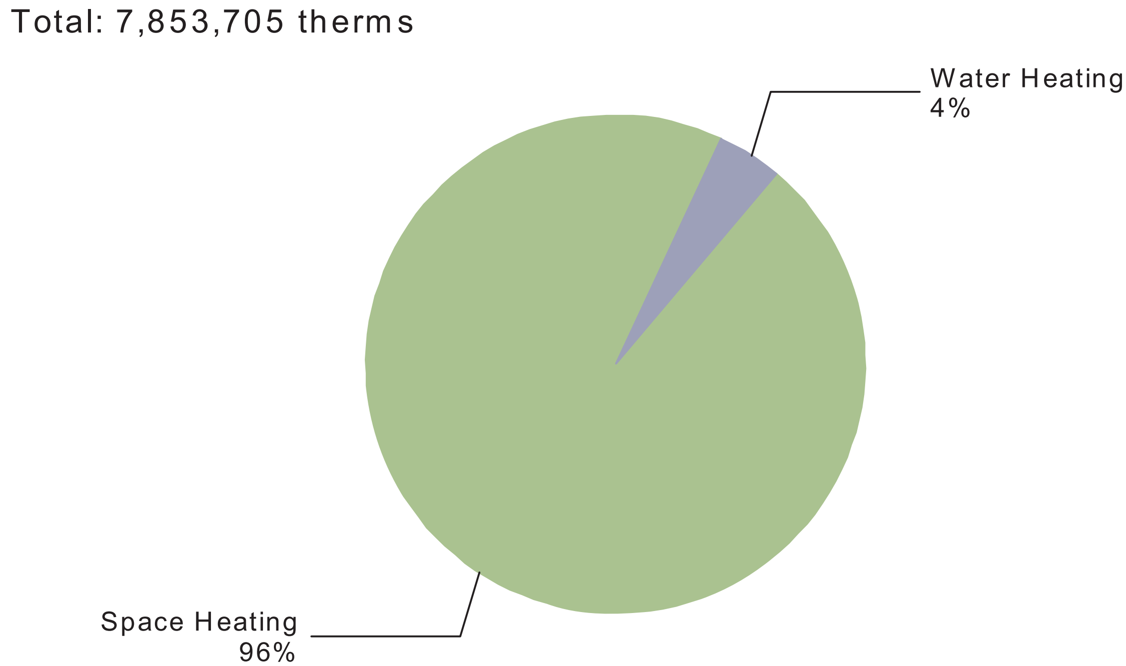


Figure 11: Commercial Technical Potential in 2029 by End Use, Warehouse



Achievable Technical Potential

Figure 12: Commercial Achievable Technical Potential in 2029 by Segment

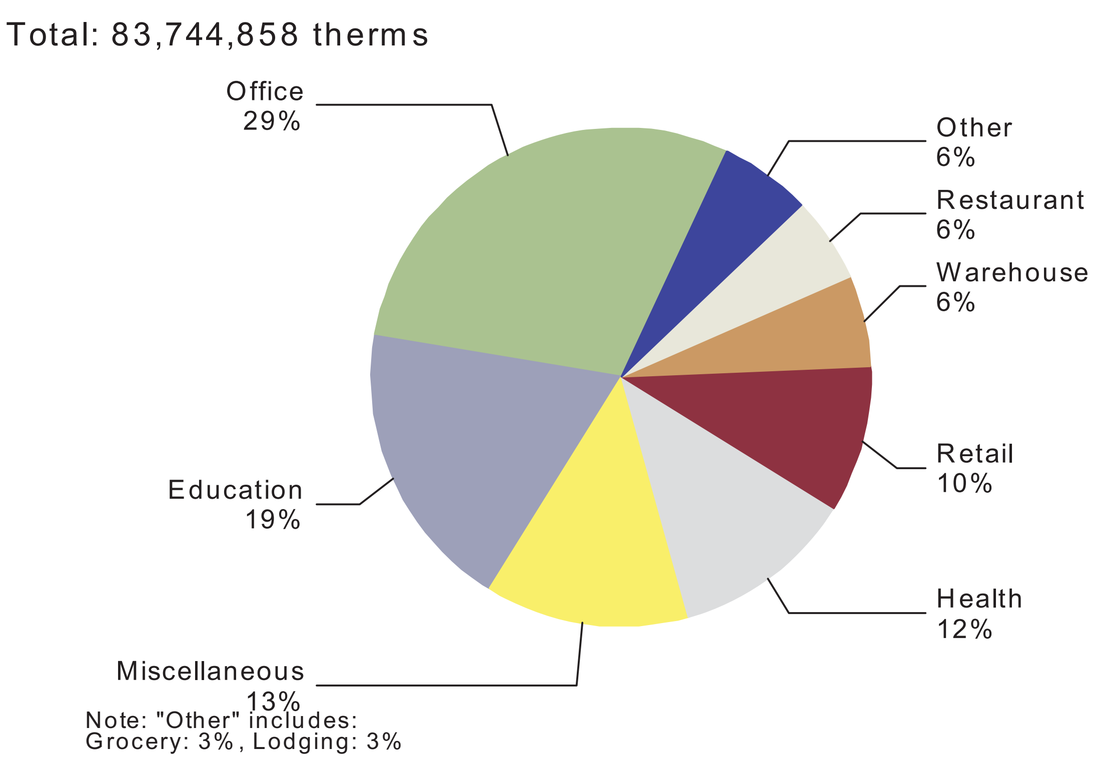


Figure 13: Commercial Achievable Technical Potential in 2029 by End Use

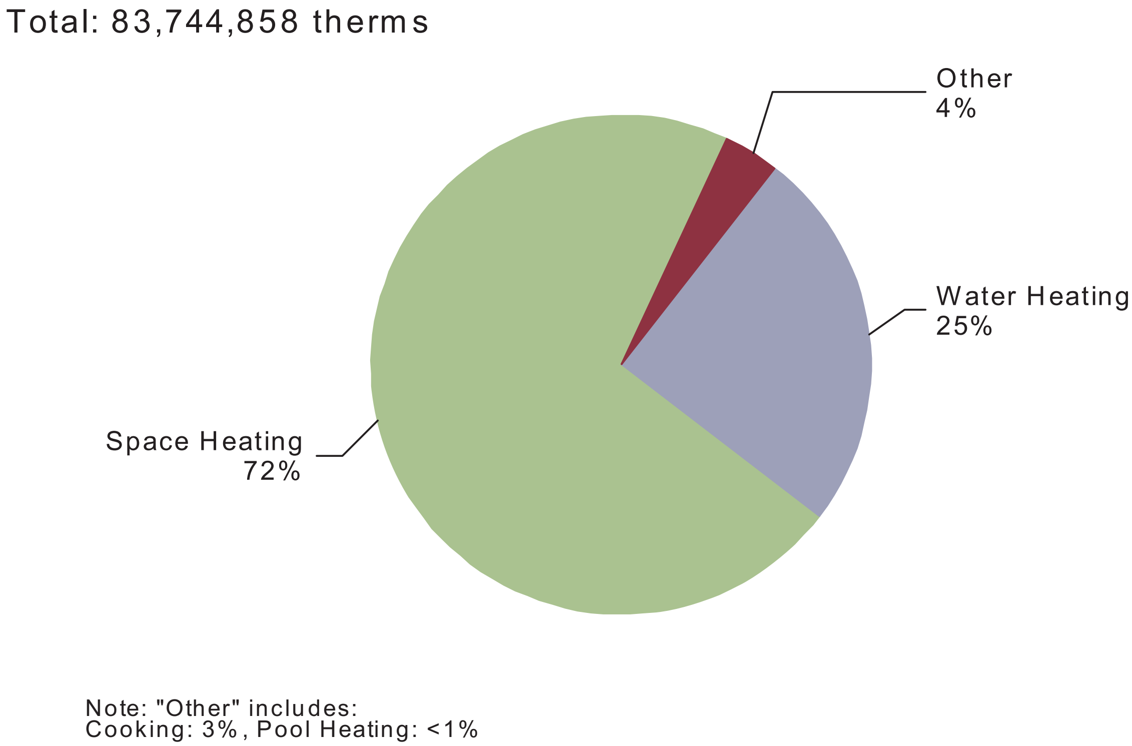


Figure 14: Commercial Achievable Technical Potential in 2029 by End Use, Education

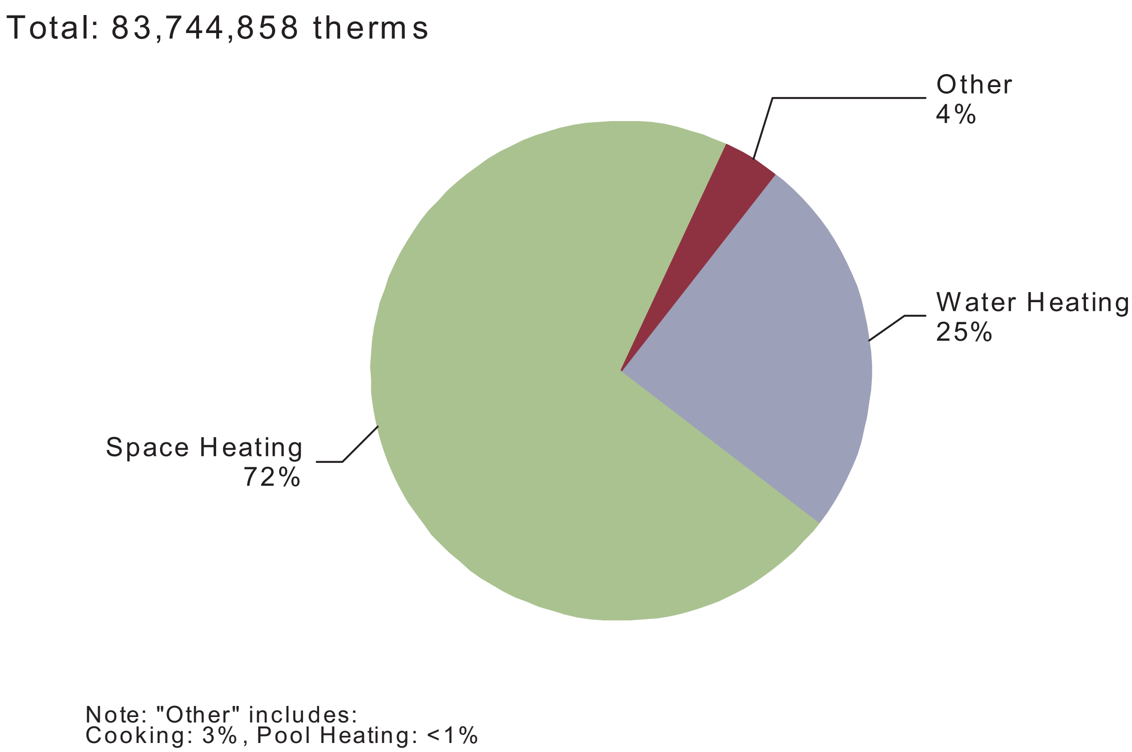


Figure 15: Commercial Achievable Technical Potential in 2029 by End Use, Grocery

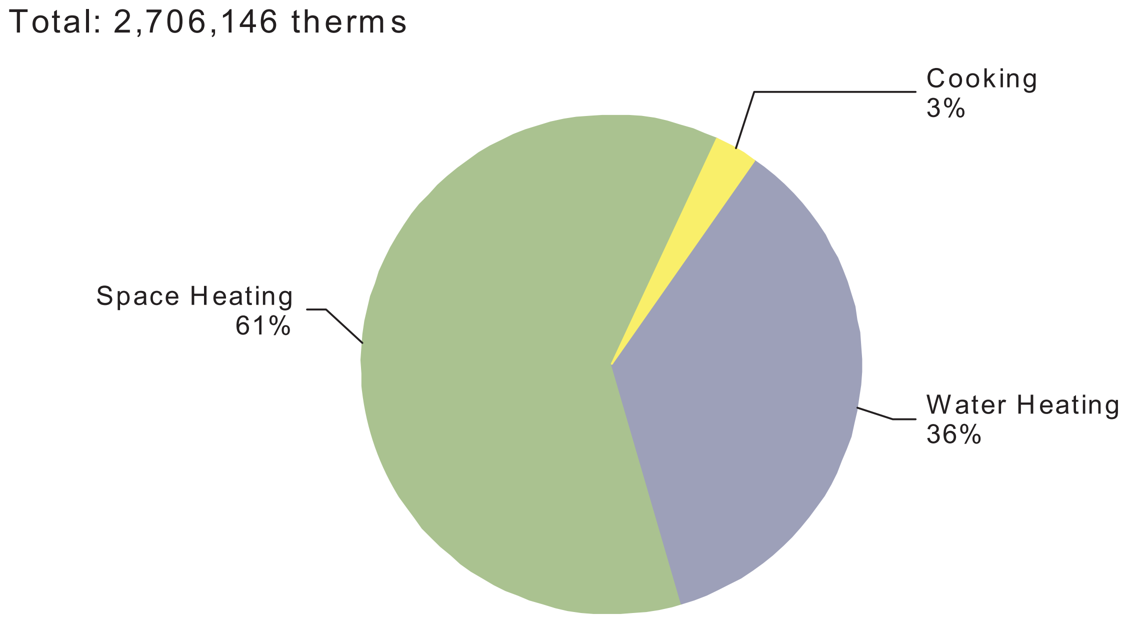


Figure 16: Commercial Achievable Technical Potential in 2029 by End Use, Health

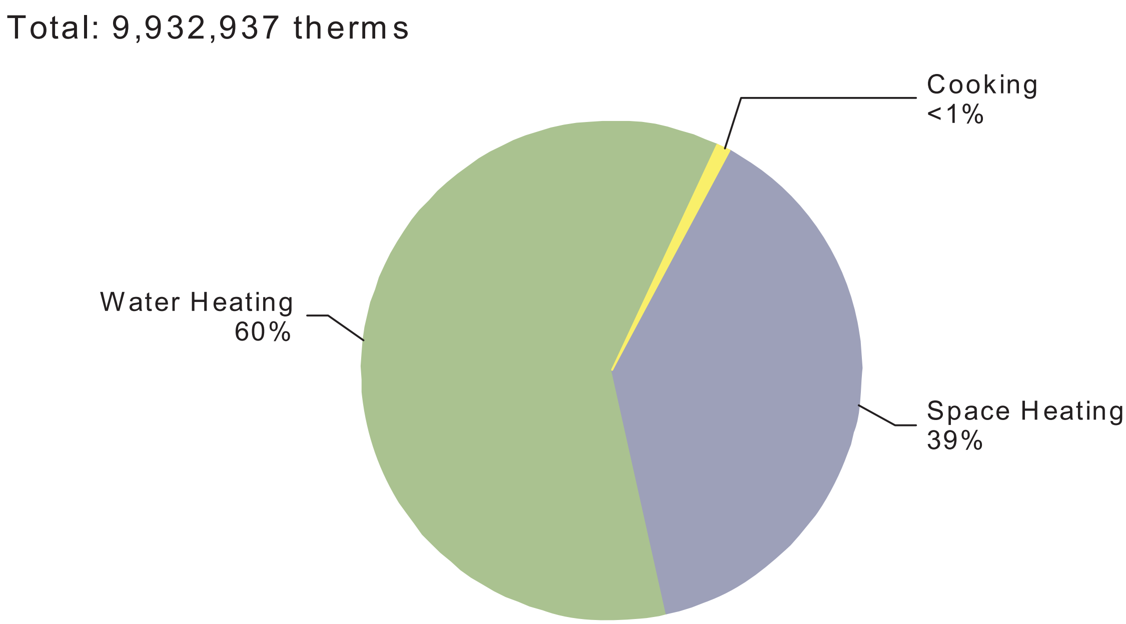
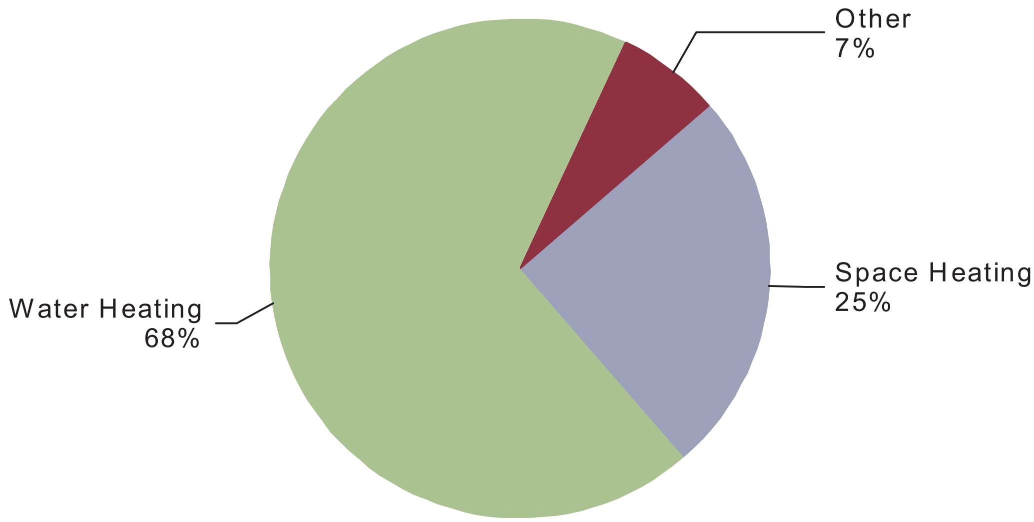


Figure 17: Commercial Achievable Technical Potential in 2029 by End Use, Lodging

Total: 2,226,227 therms



Note: "Other" includes:
Pool Heating: 4% , Cooking: 3%

Figure 18: Commercial Achievable Technical Potential in 2029 by End Use, Miscellaneous

Total: 11,038,940 therms

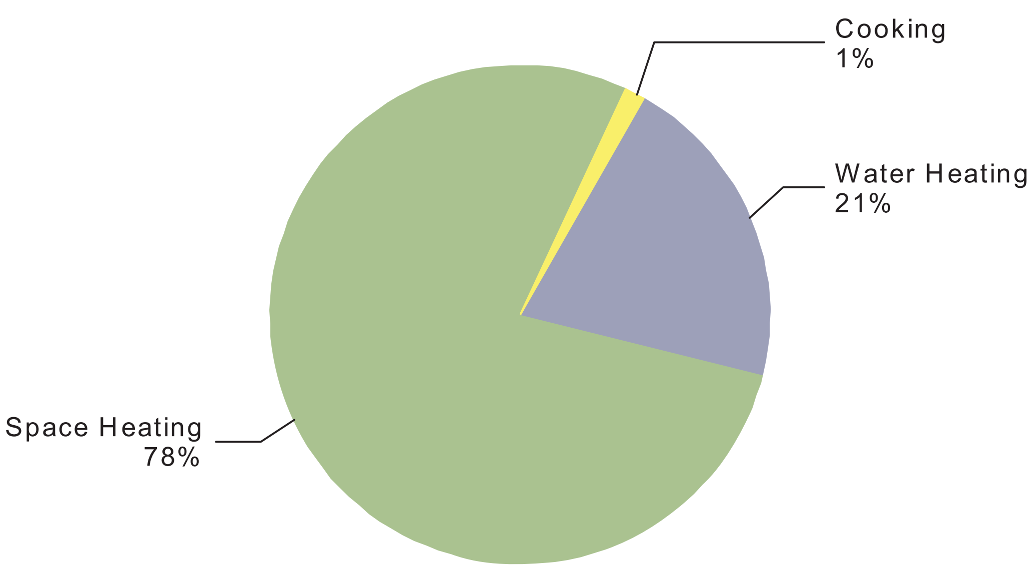


Figure 19: Commercial Achievable Technical Potential in 2029 by End Use, Office

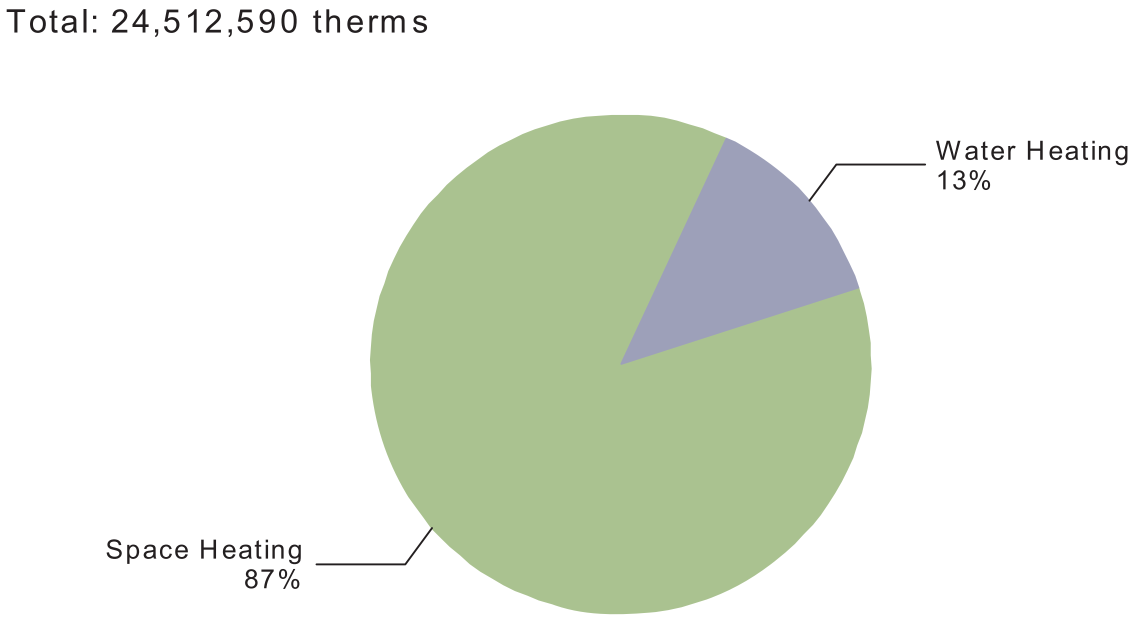


Figure 20: Commercial Achievable Technical Potential in 2029 by End Use, Restaurant

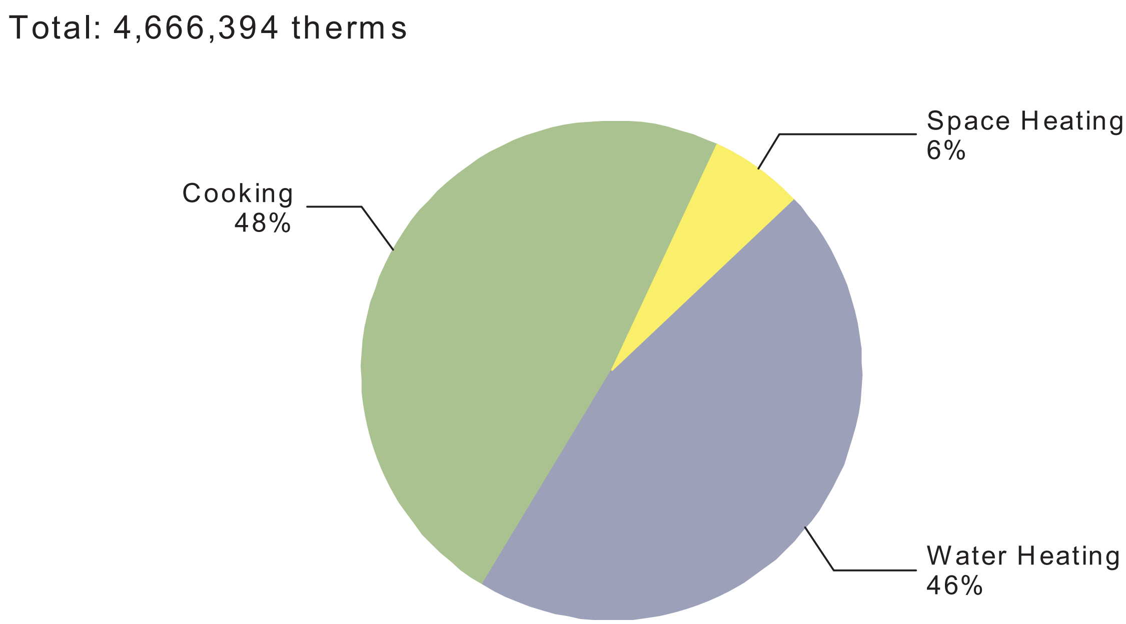


Figure 21: Commercial Achievable Technical Potential in 2029 by End Use, Retail

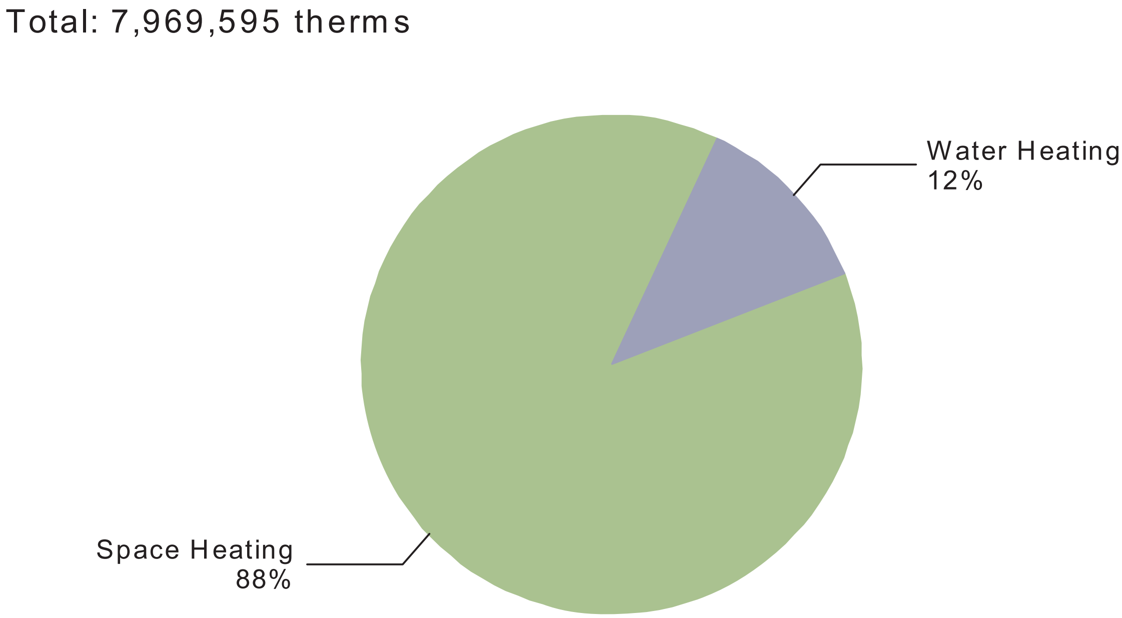
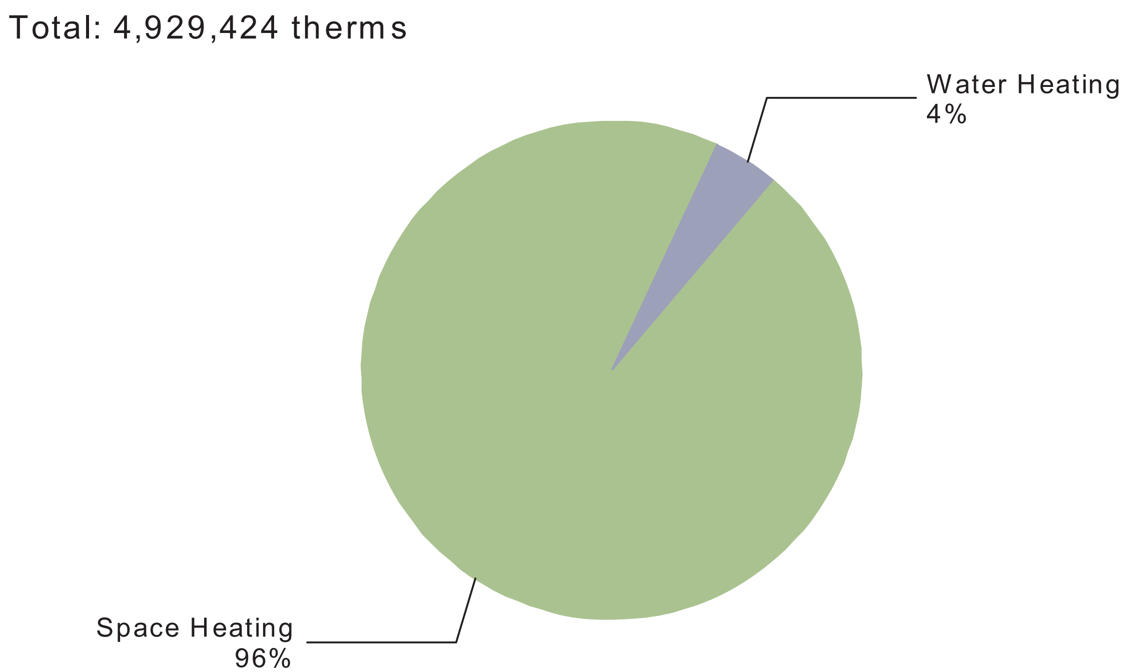


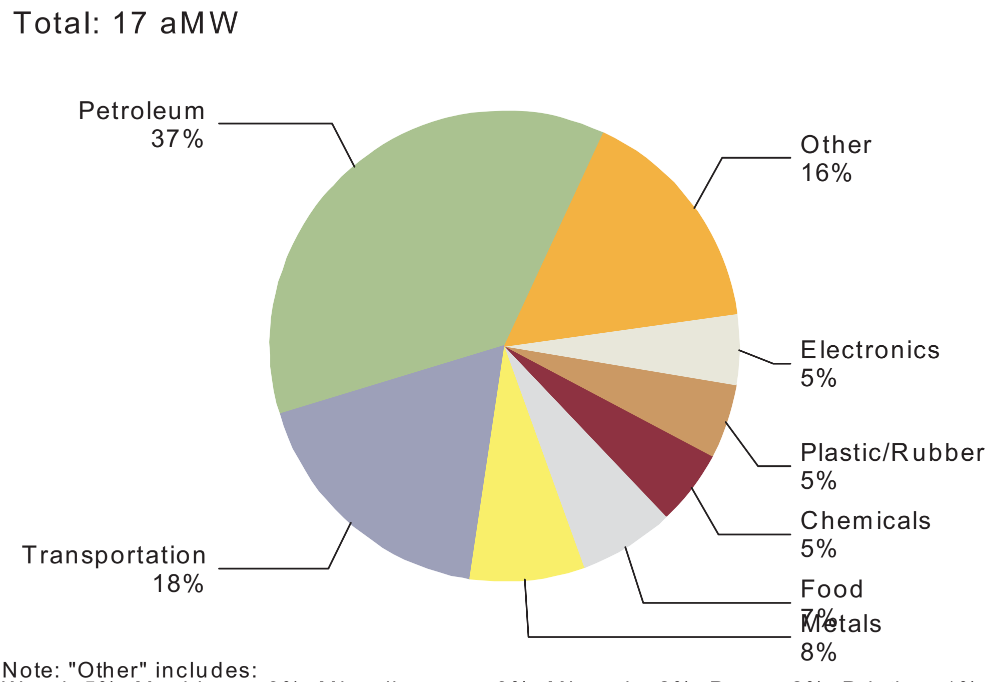
Figure 22: Commercial Achievable Technical Potential in 2029 by End Use, Warehouse



Industrial Electric

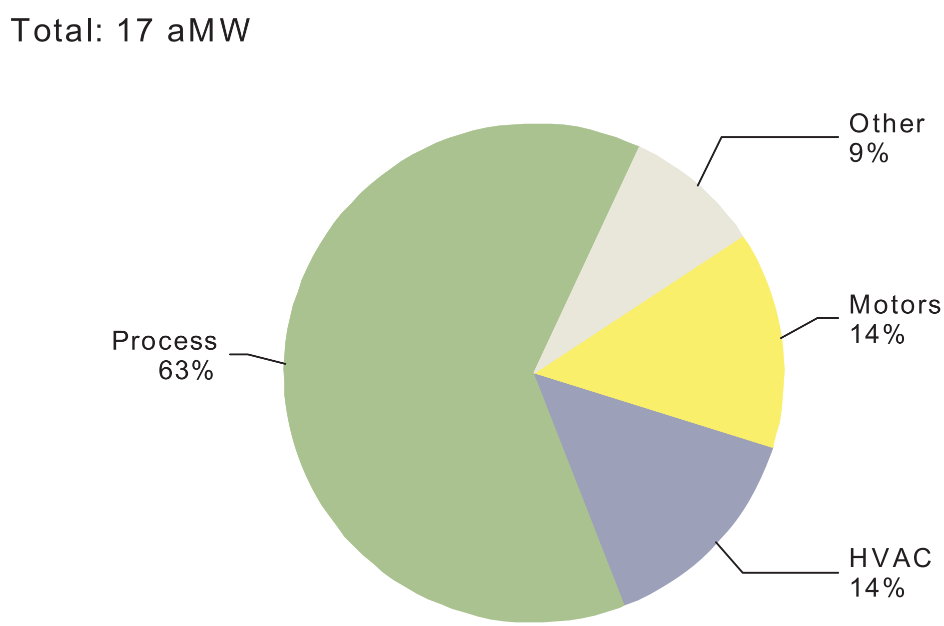
Technical Potential

Figure 1: Industrial Technical Potential in 2029 by Segment



Note: "Other" includes:
Wood: 5%, Machinery: 3%, Miscellaneous: 3%, Minerals: 2%, Paper: 2%, Printing: 1%

Figure 2: Industrial Technical Potential in 2029 by End Use



Note: "Other" includes:
Miscellaneous: 4%, Lighting: 4%, Boiler: <1%

Figure 3: Industrial Technical Potential in 2029 by End Use, Chemicals

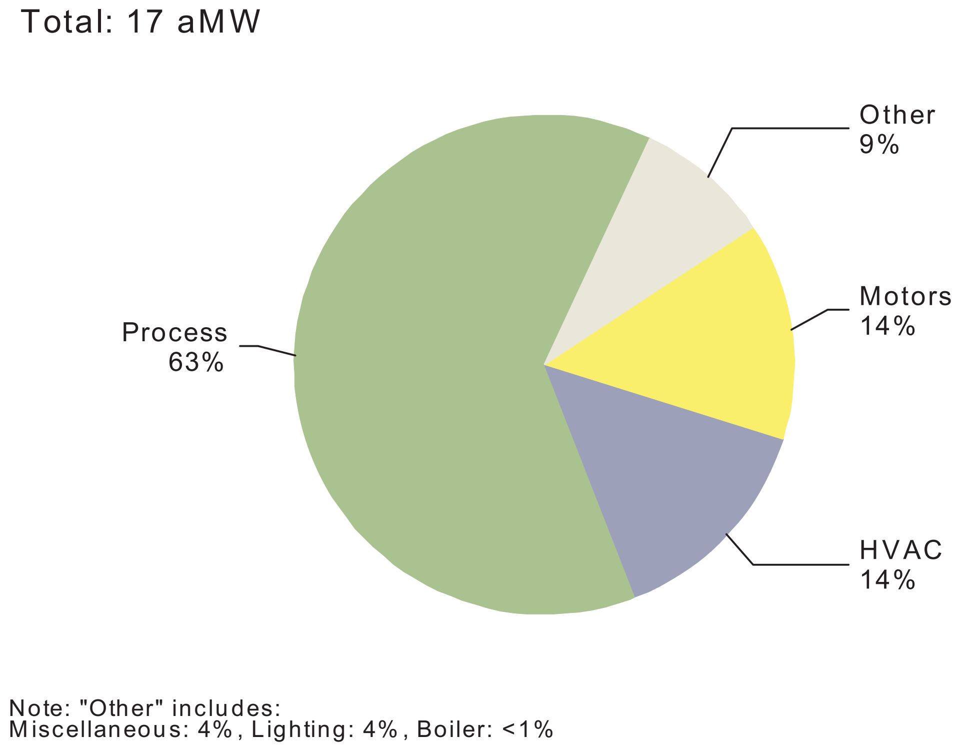


Figure 4: Industrial Technical Potential in 2029 by End Use, Electronics

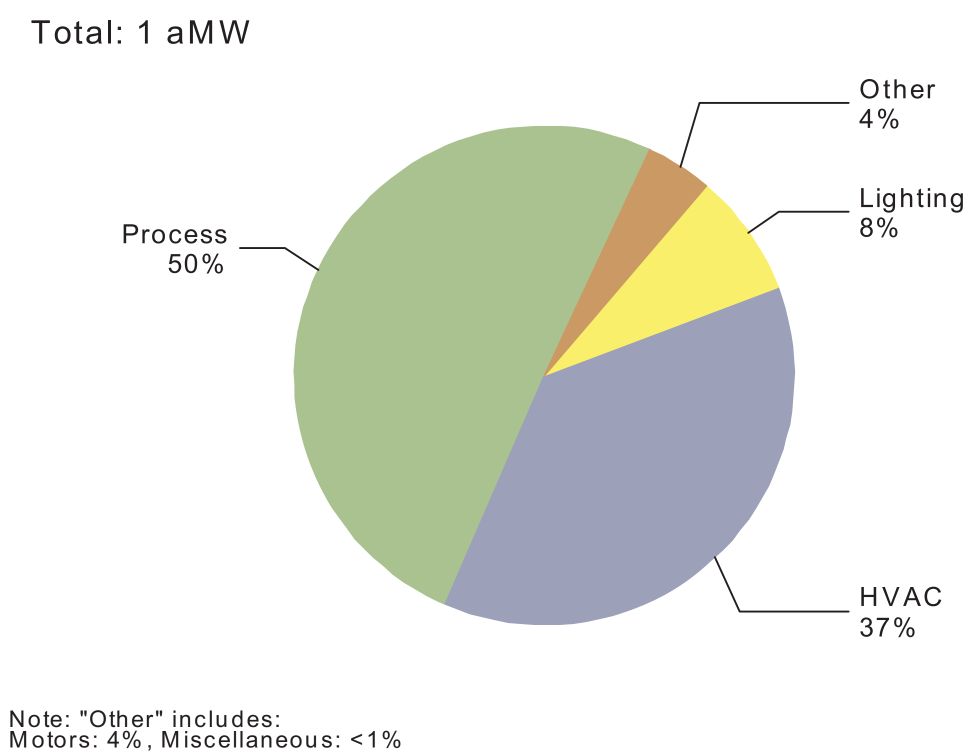
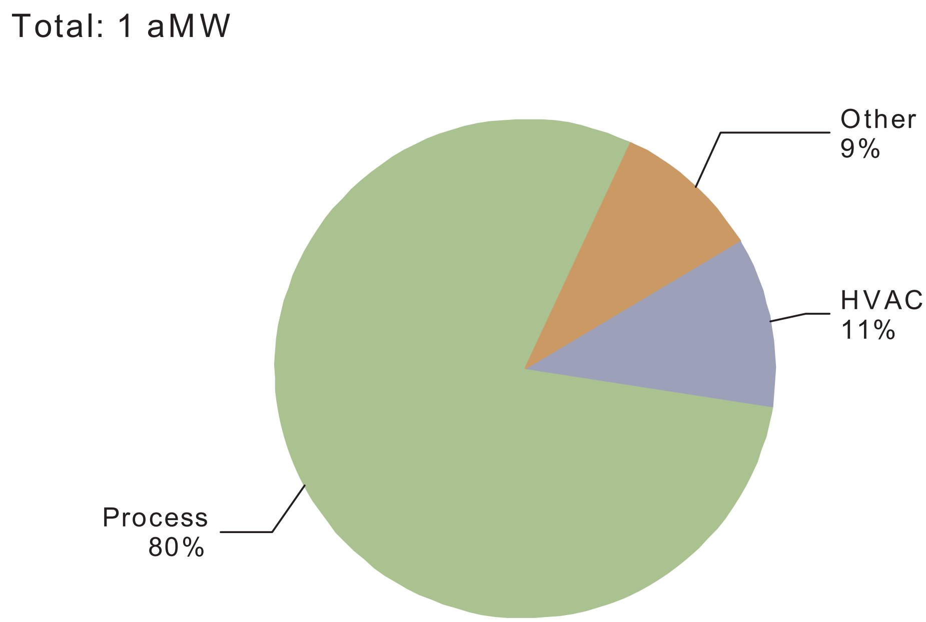


Figure 5: Industrial Technical Potential in 2029 by End Use, Food



Note: "Other" includes:
Motors: 5%, Lighting: 4%, Miscellaneous: <1%

Figure 6: Industrial Technical Potential in 2029 by End Use, Machinery

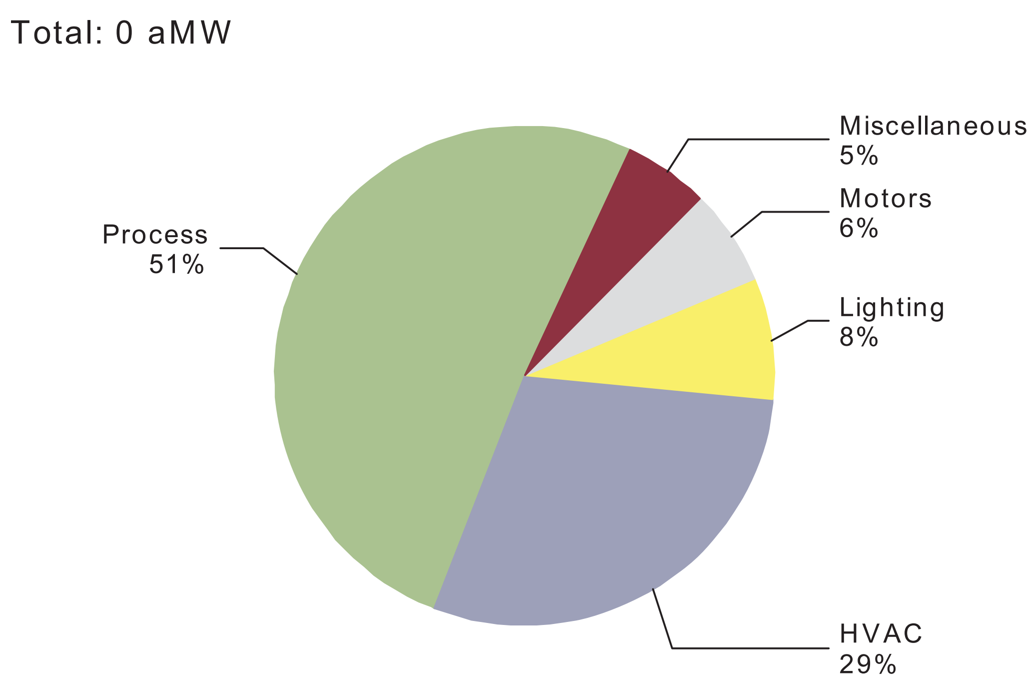


Figure 7: Industrial Technical Potential in 2029 by End Use, Metals

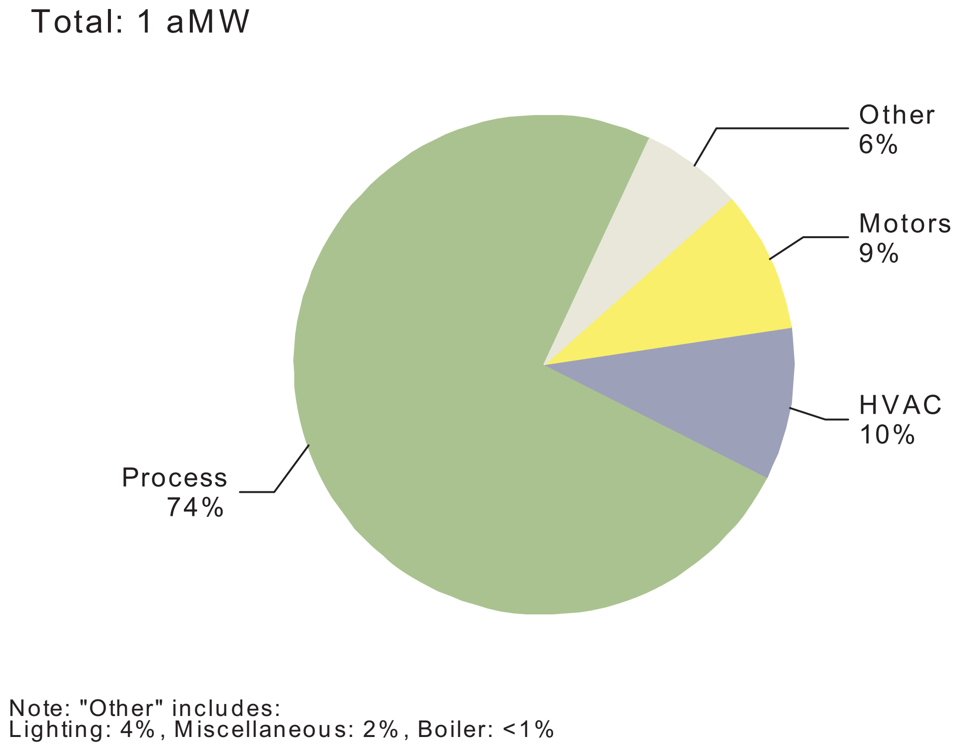


Figure 8: Industrial Technical Potential in 2029 by End Use, Minerals

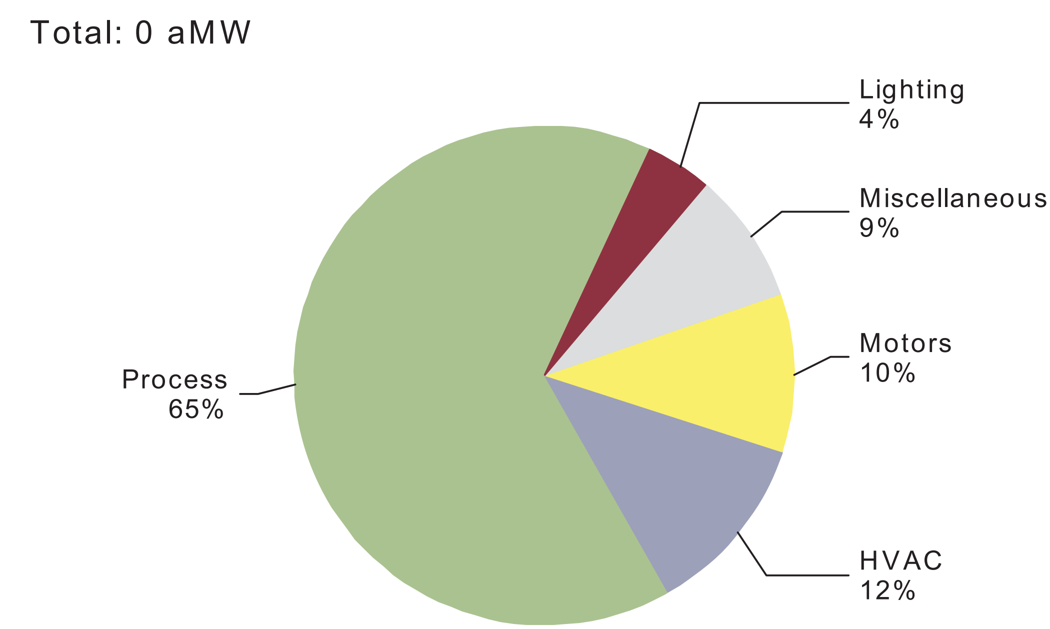


Figure 9: Industrial Technical Potential in 2029 by End Use, Miscellaneous

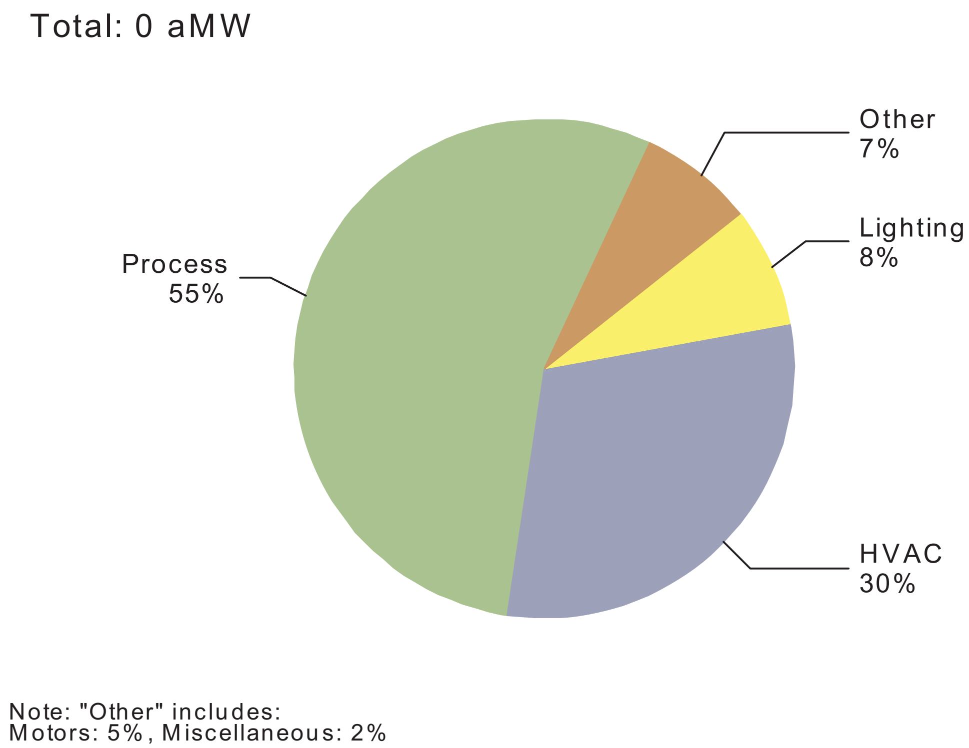


Figure 10: Industrial Technical Potential in 2029 by End Use, Paper

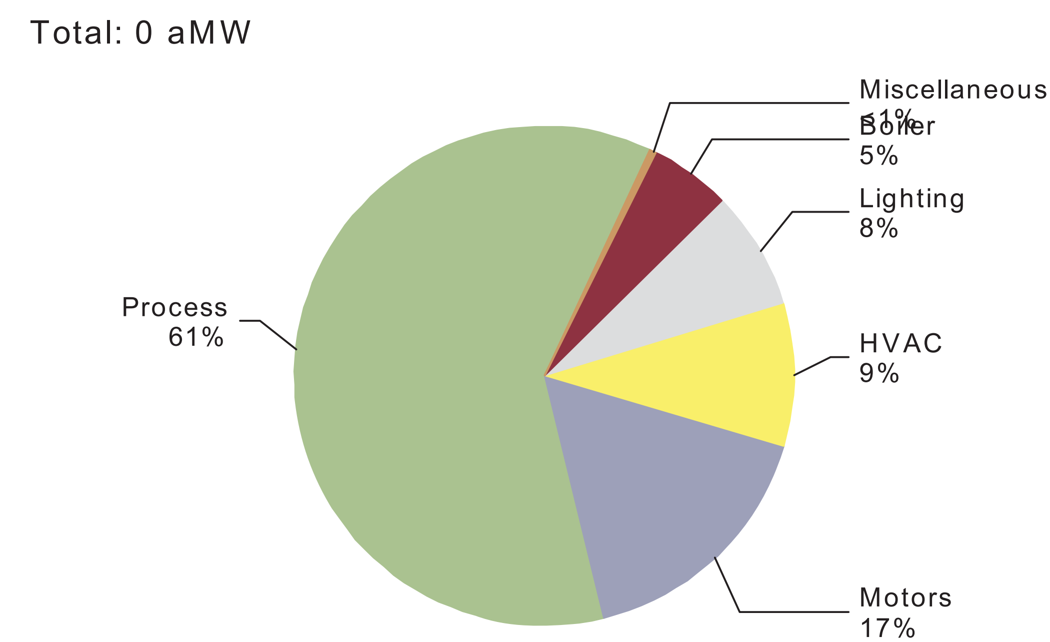


Figure 11: Industrial Technical Potential in 2029 by End Use, Petroleum

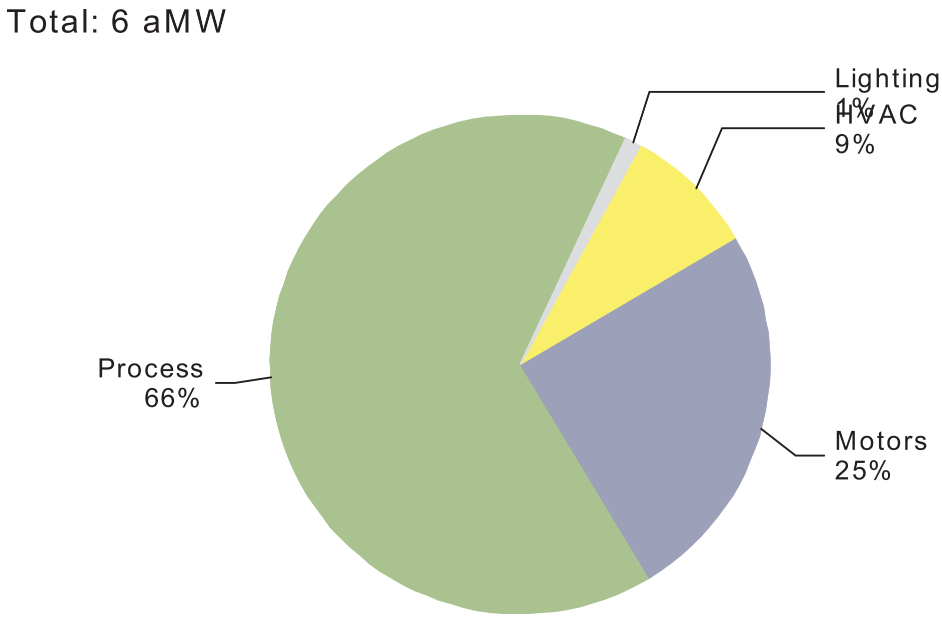


Figure 12: Industrial Technical Potential in 2029 by End Use, PlasticRubber

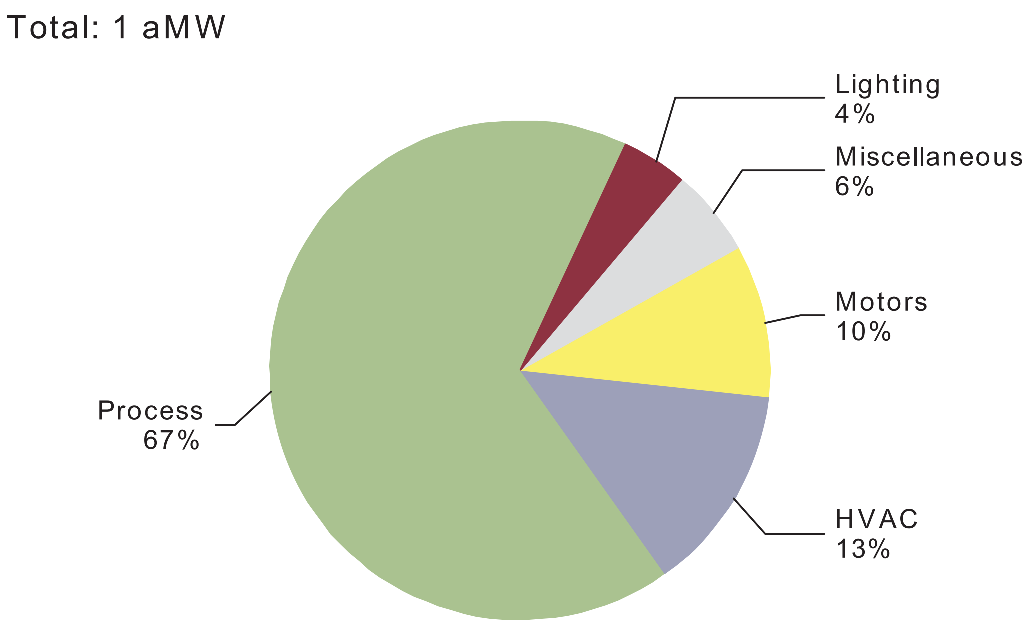


Figure 13: Industrial Technical Potential in 2029 by End Use, Printing

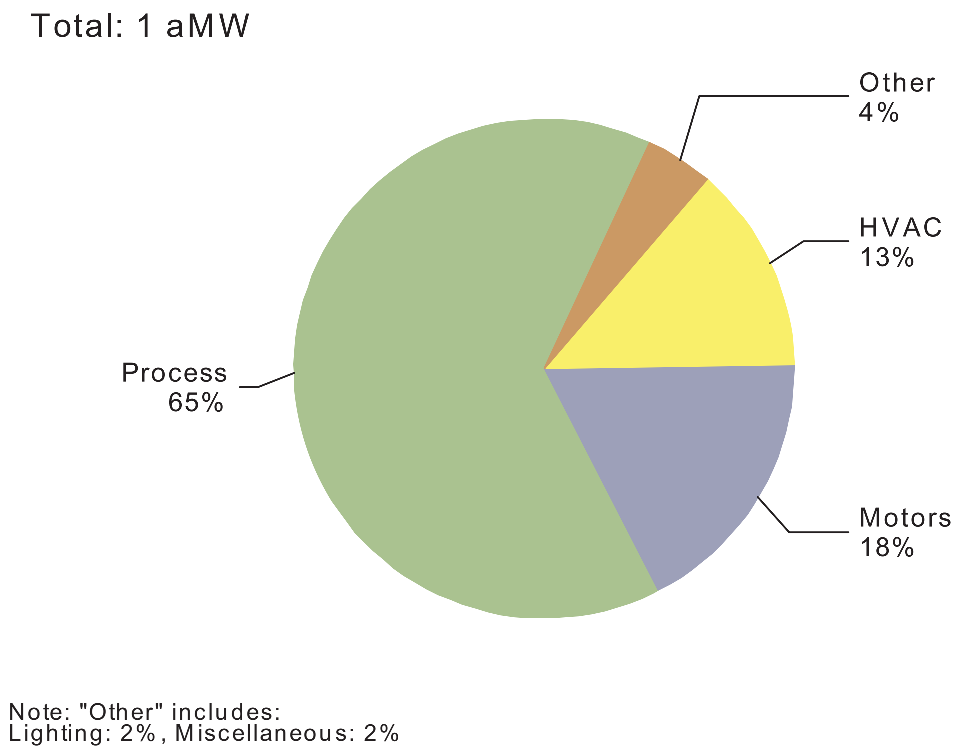


Figure 14: Industrial Technical Potential in 2029 by End Use, Transportation

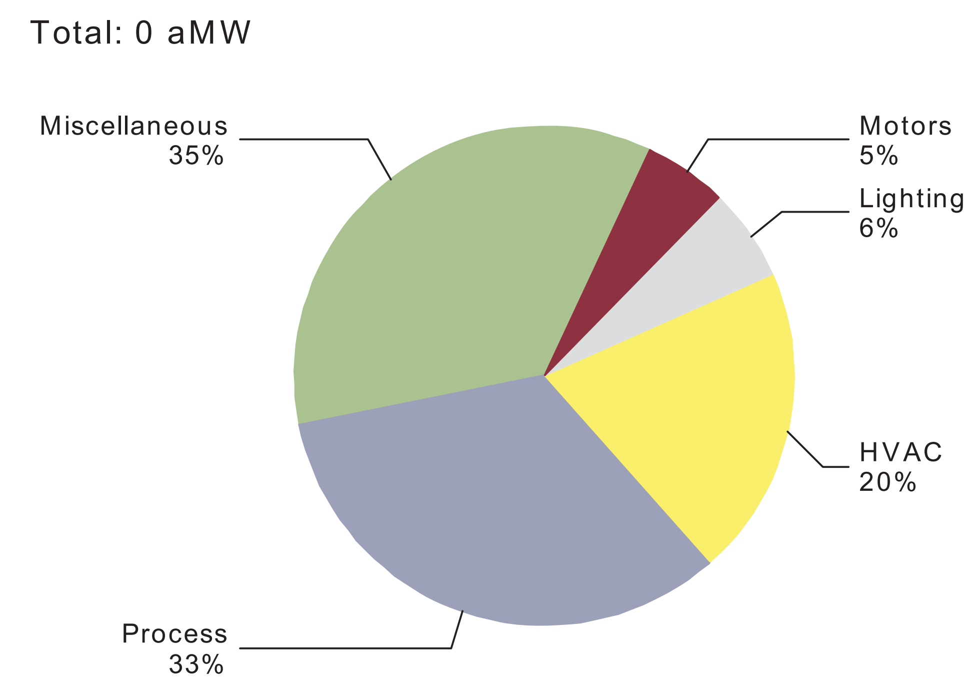
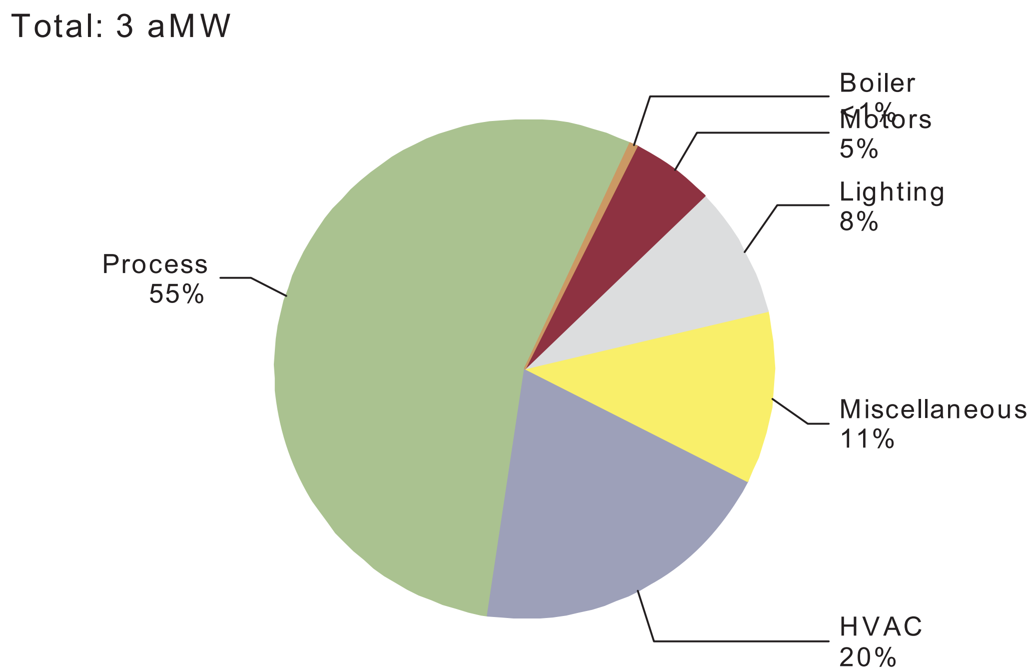
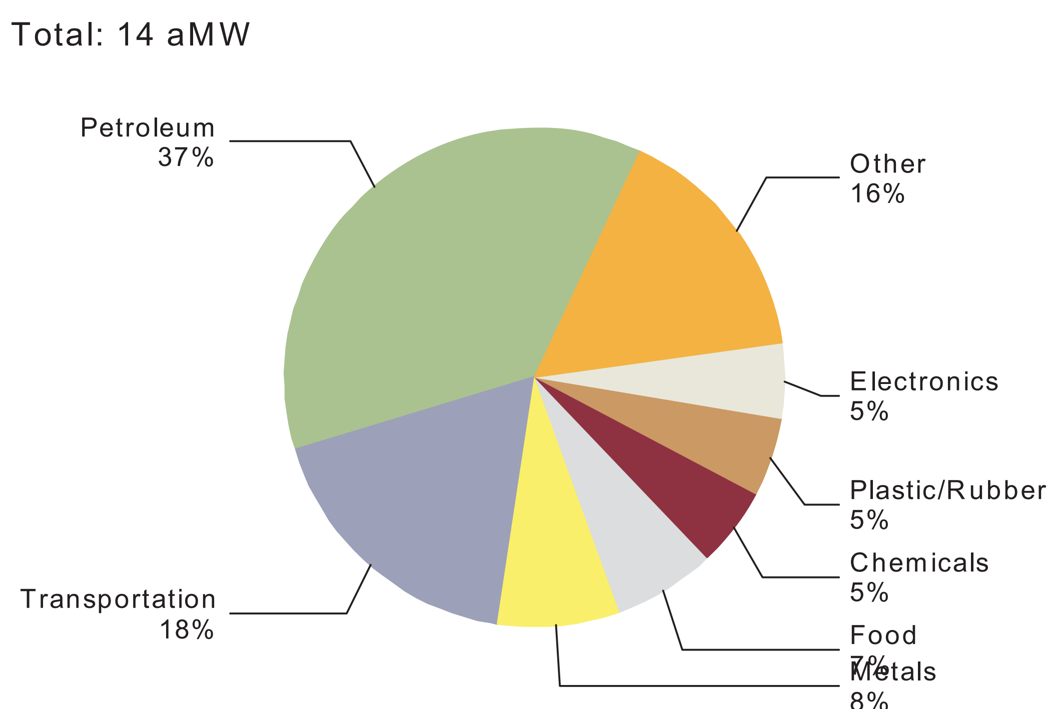


Figure 15: Industrial Technical Potential in 2029 by End Use, Wood



Achievable Technical Potential

Figure 16: Industrial Achievable Technical Potential in 2029 by Segment



Note: "Other" includes:
Wood: 5%, Machinery: 3%, Miscellaneous: 3%, Minerals: 2%, Paper: 2%, Printing: 1%

Figure 17: Industrial Achievable Technical Potential in 2029 by End Use

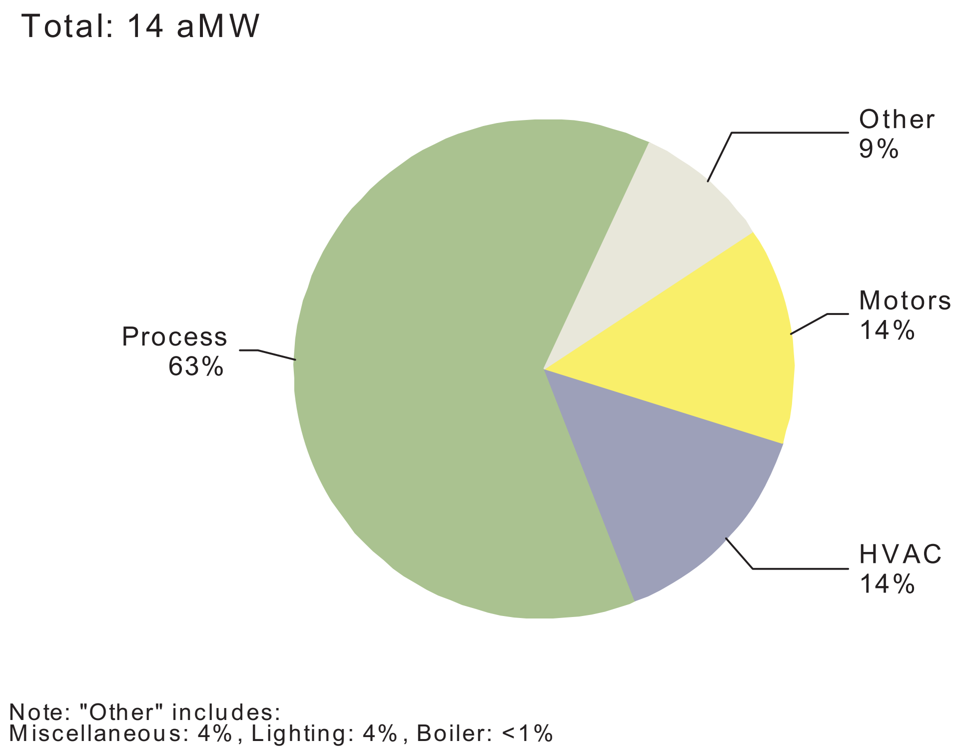


Figure 18: Industrial Achievable Technical Potential in 2029 by End Use, Chemicals

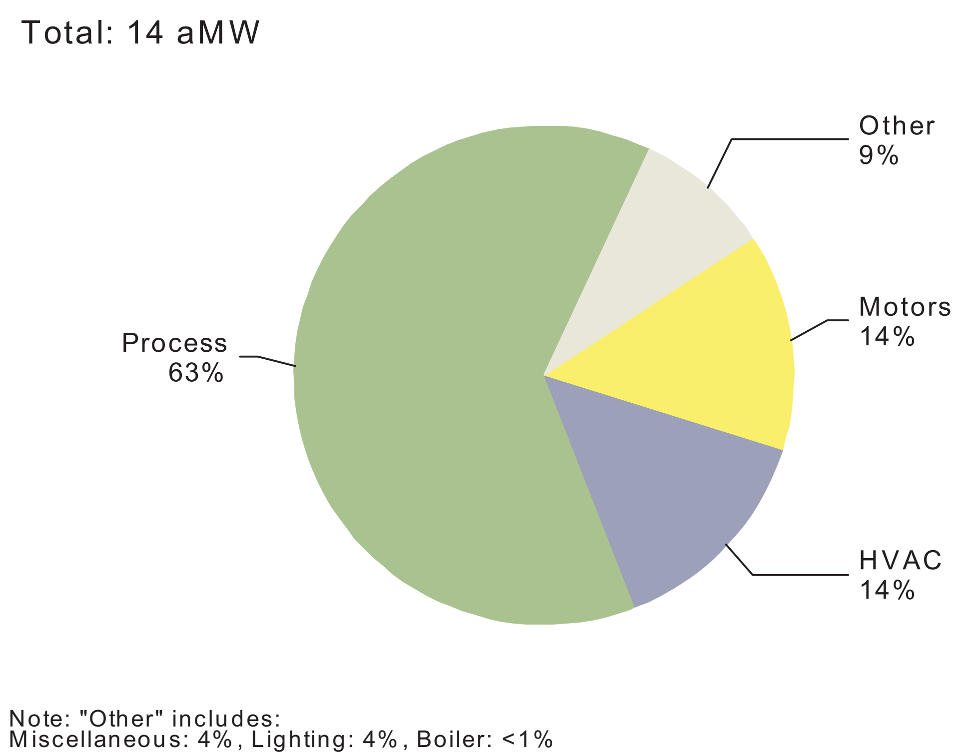


Figure 19: Industrial Achievable Technical Potential in 2029 by End Use, Electronics

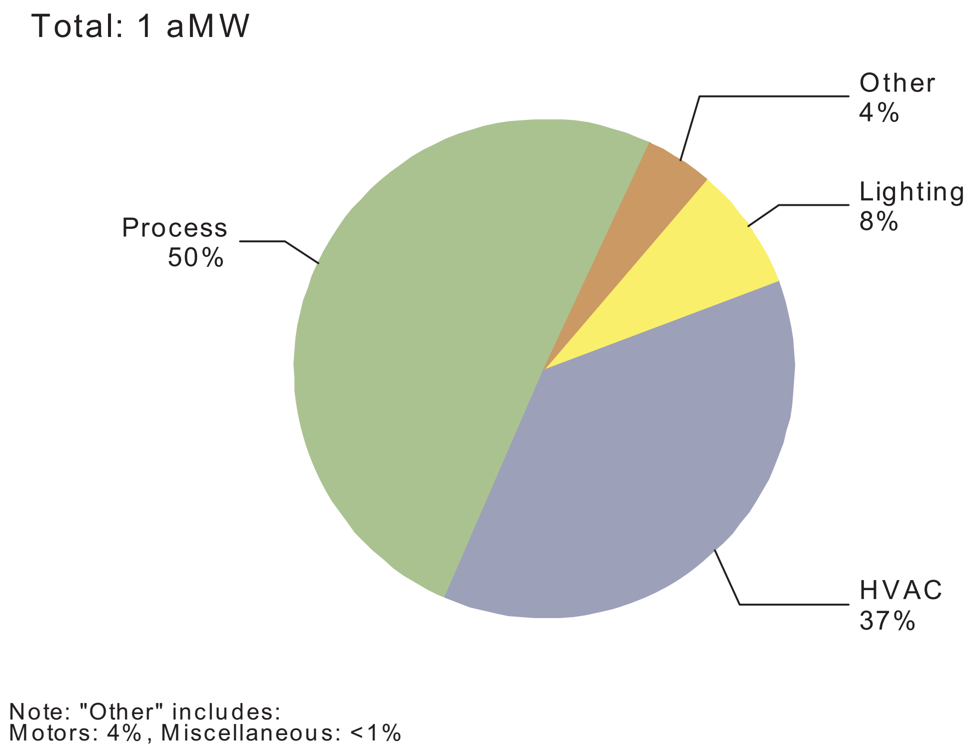


Figure 20: Industrial Achievable Technical Potential in 2029 by End Use, Food

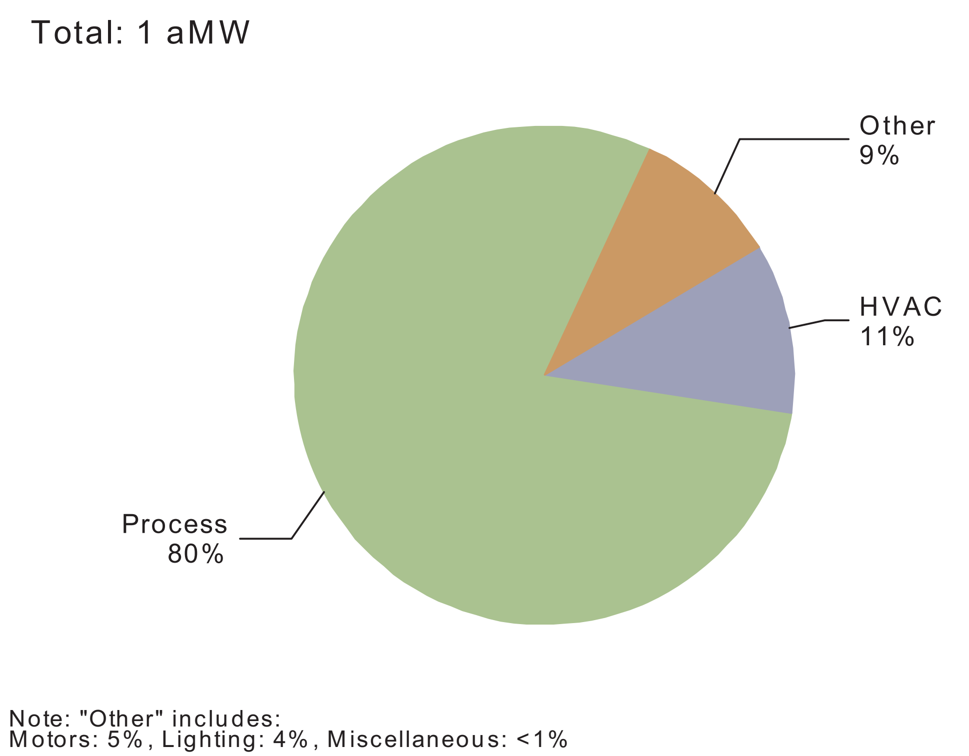


Figure 21: Industrial Achievable Technical Potential in 2029 by End Use, Machinery

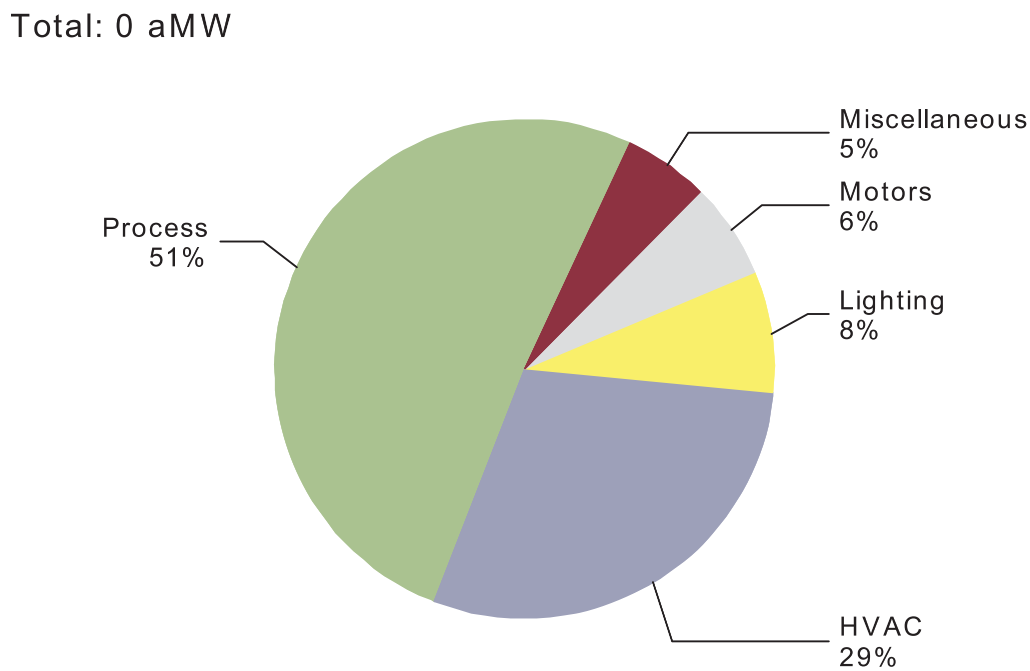


Figure 22: Industrial Achievable Technical Potential in 2029 by End Use, Metals

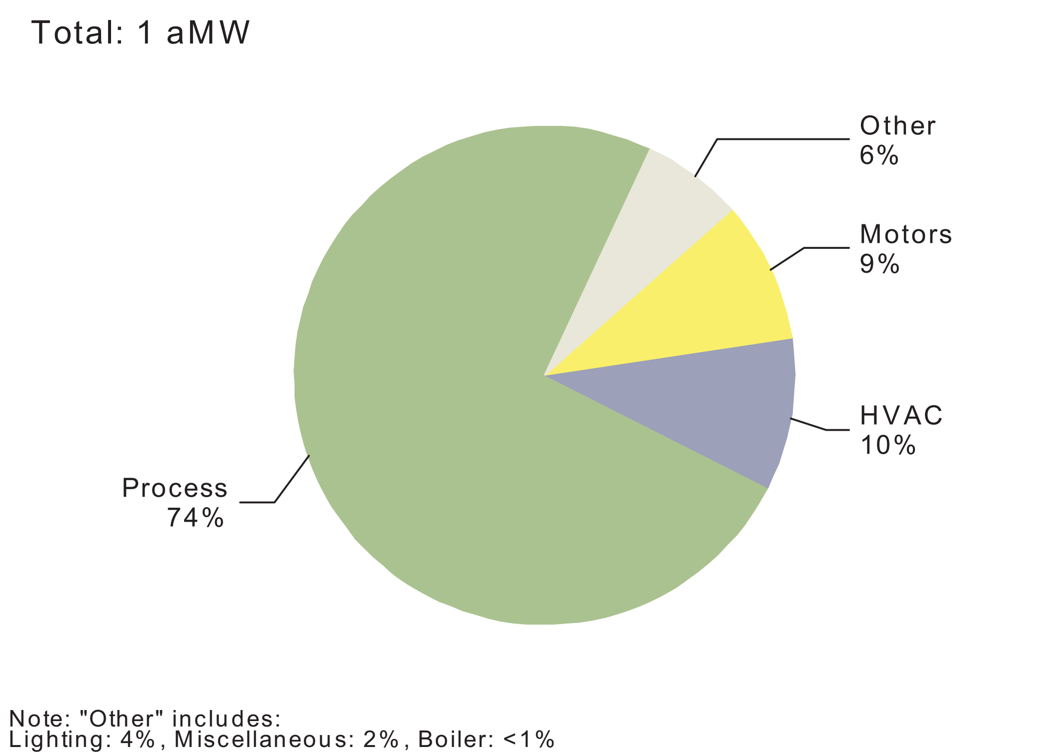


Figure 23: Industrial Achievable Technical Potential in 2029 by End Use, Minerals

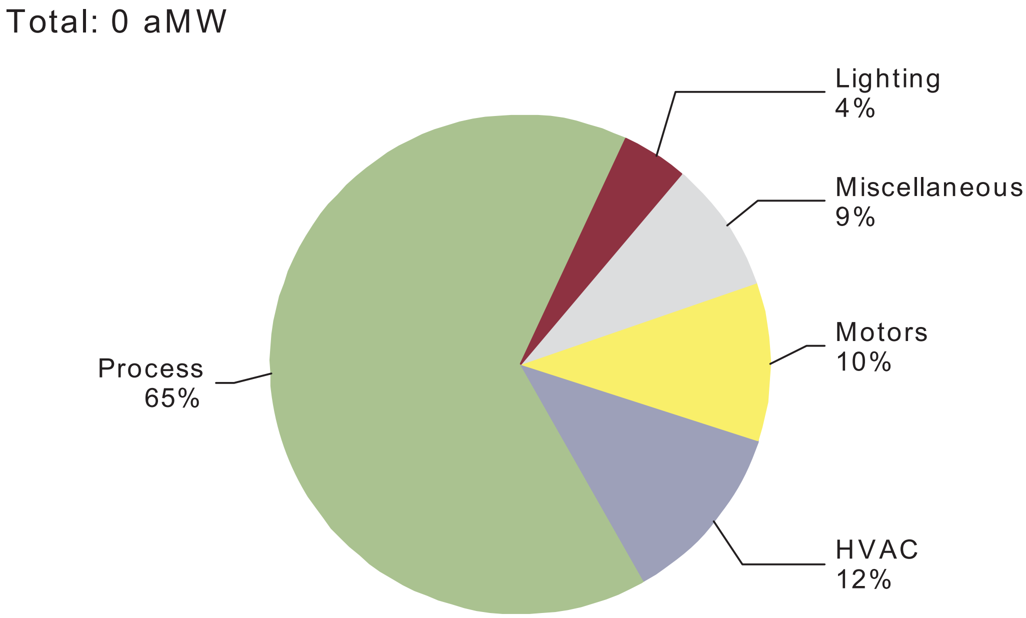
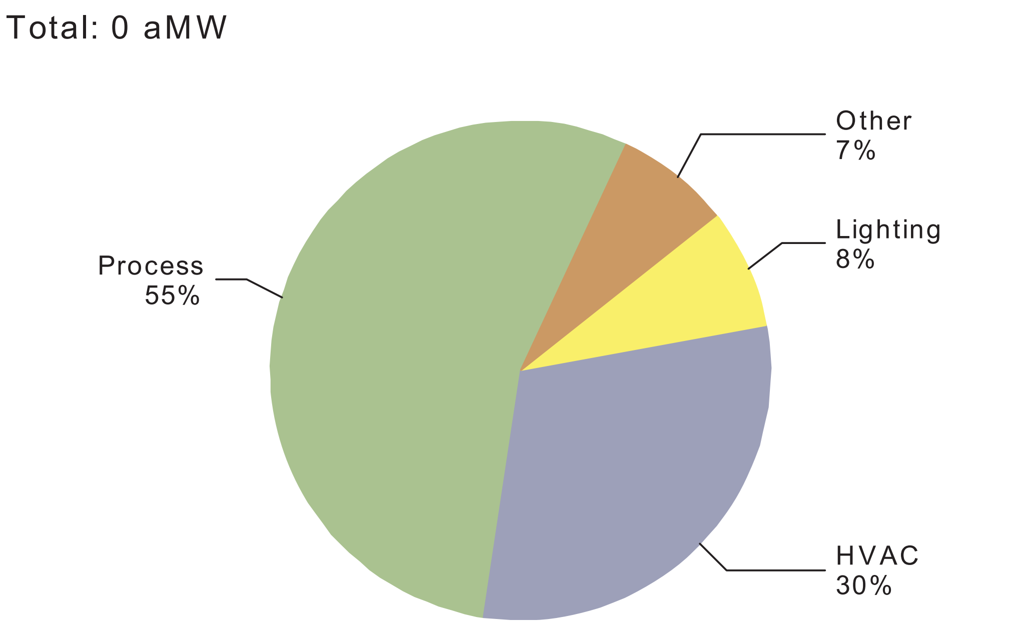


Figure 24: Industrial Achievable Technical Potential in 2029 by End Use, Miscellaneous



Note: "Other" includes:
Motors: 5%, Miscellaneous: 2%

Figure 25: Industrial Achievable Technical Potential in 2029 by End Use, Paper

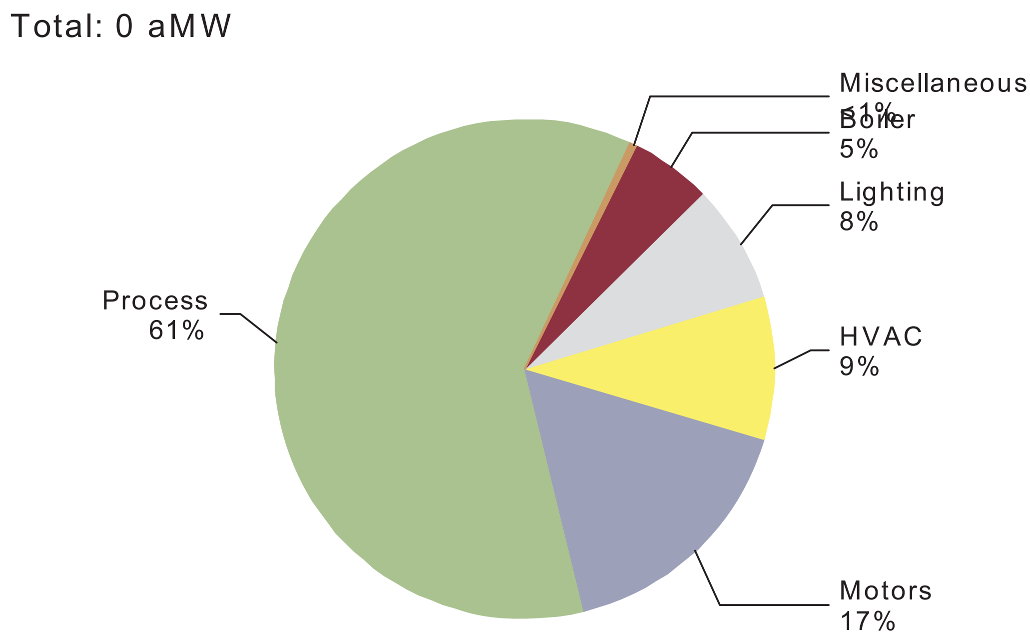


Figure 26: Industrial Achievable Technical Potential in 2029 by End Use, Petroleum

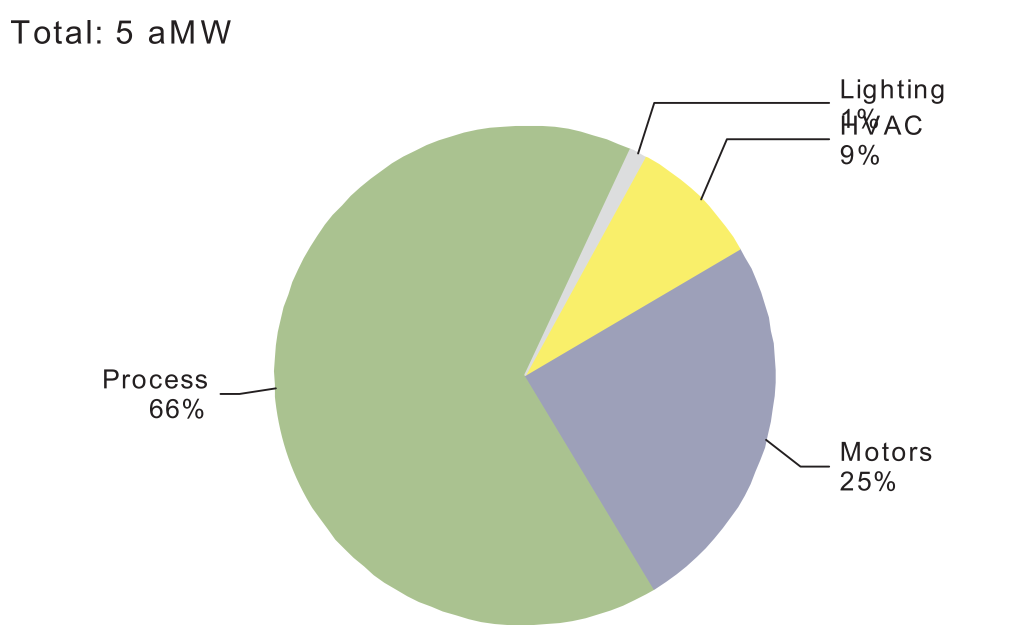


Figure 27: Industrial Achievable Technical Potential in 2029 by End Use, PlasticRubber

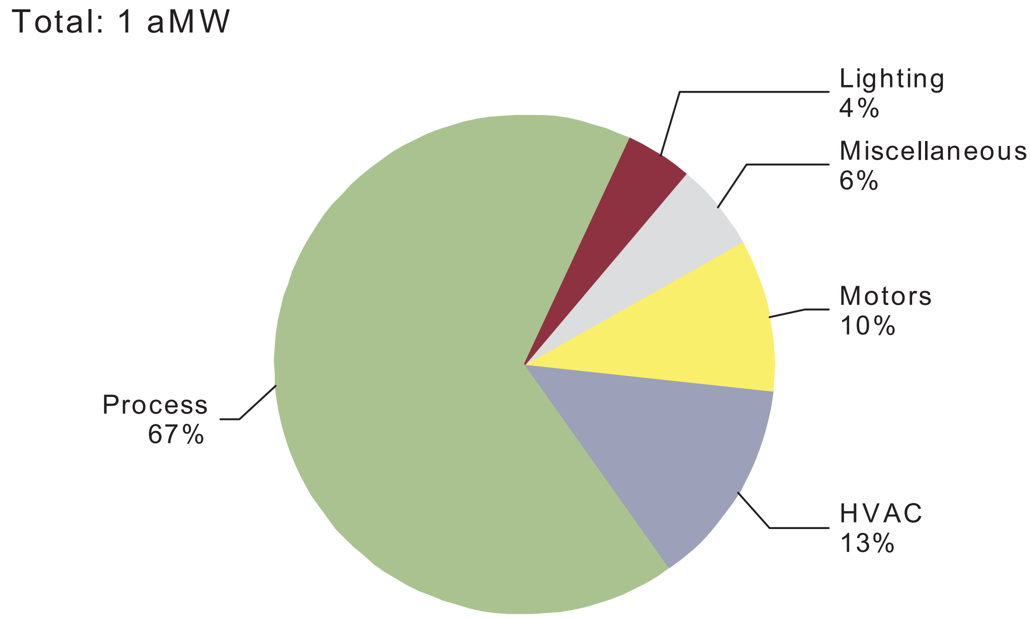
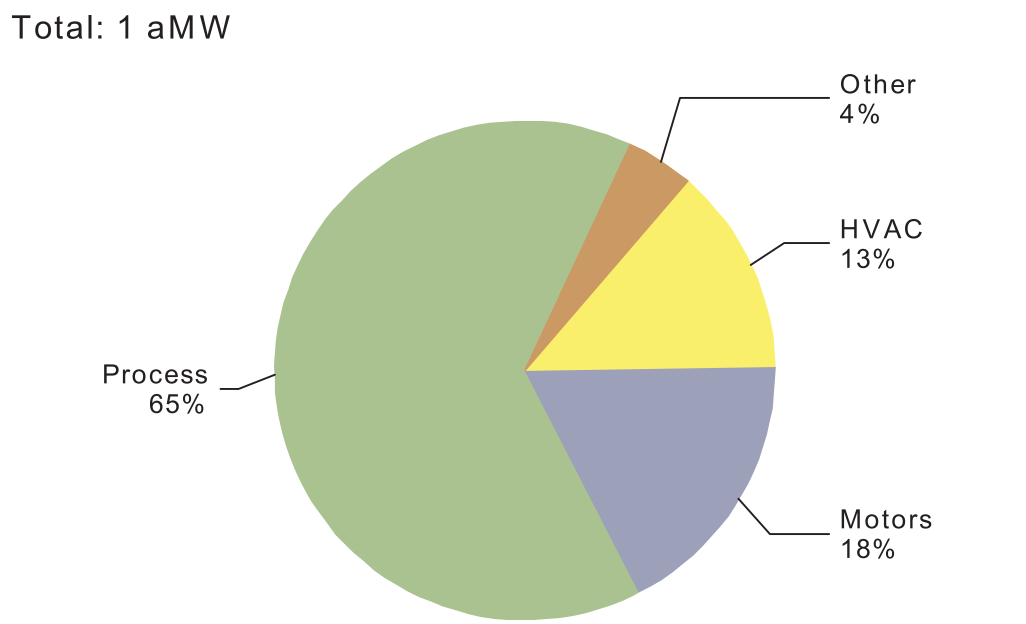


Figure 28: Industrial Achievable Technical Potential in 2029 by End Use, Printing



Note: "Other" includes:
Lighting: 2%, Miscellaneous: 2%

Figure 29: Industrial Achievable Technical Potential in 2029 by End Use, Transportation

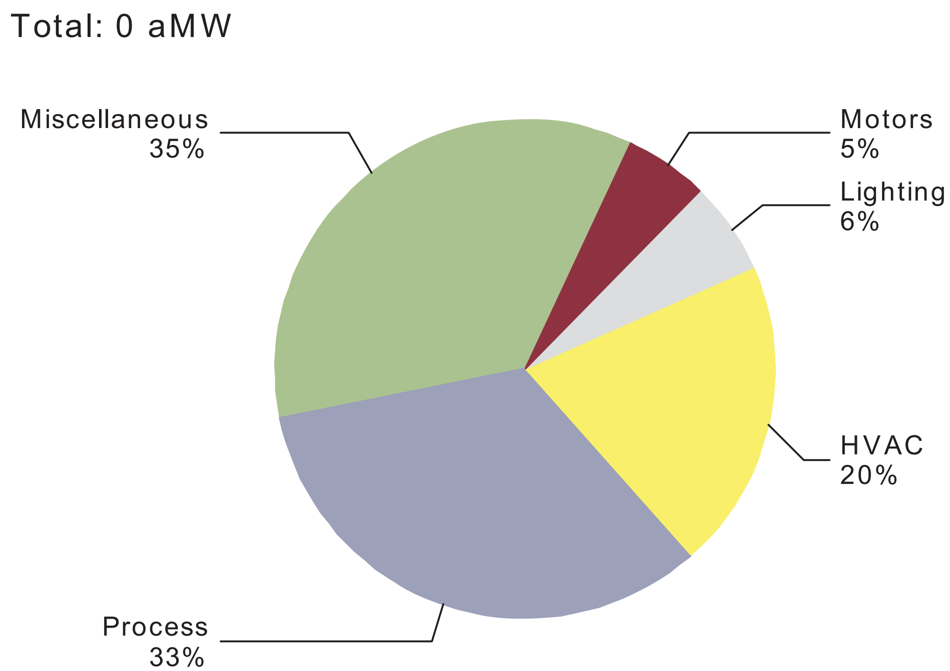
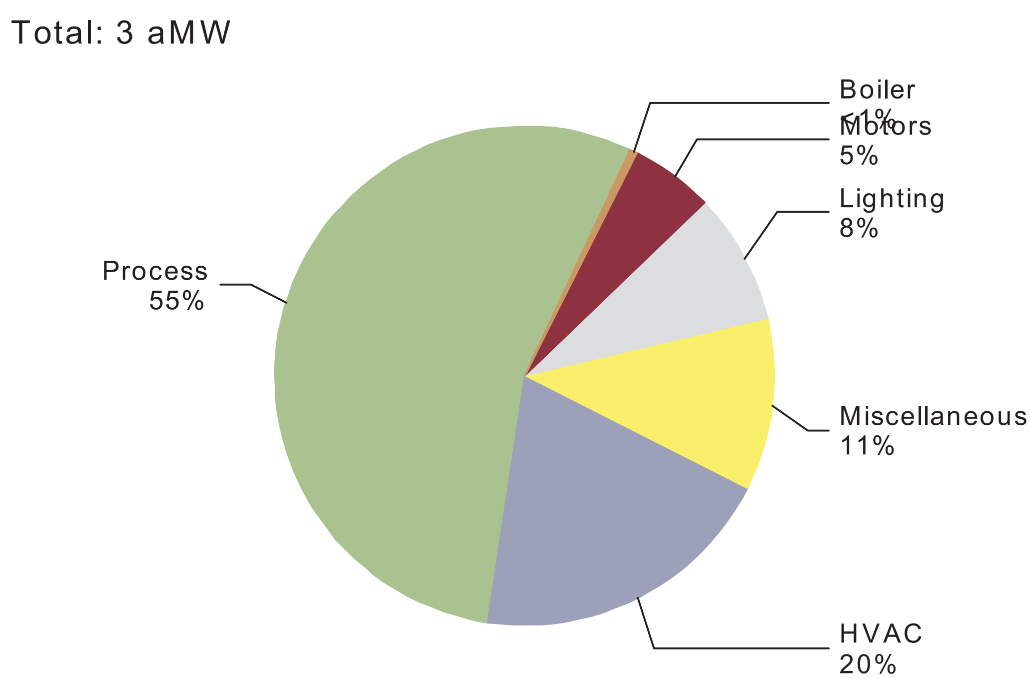


Figure 30: Industrial Achievable Technical Potential in 2029 by End Use, Wood



Industrial Gas

Technical Potential

Figure 1: Industrial Technical Potential in 2029 by Segment

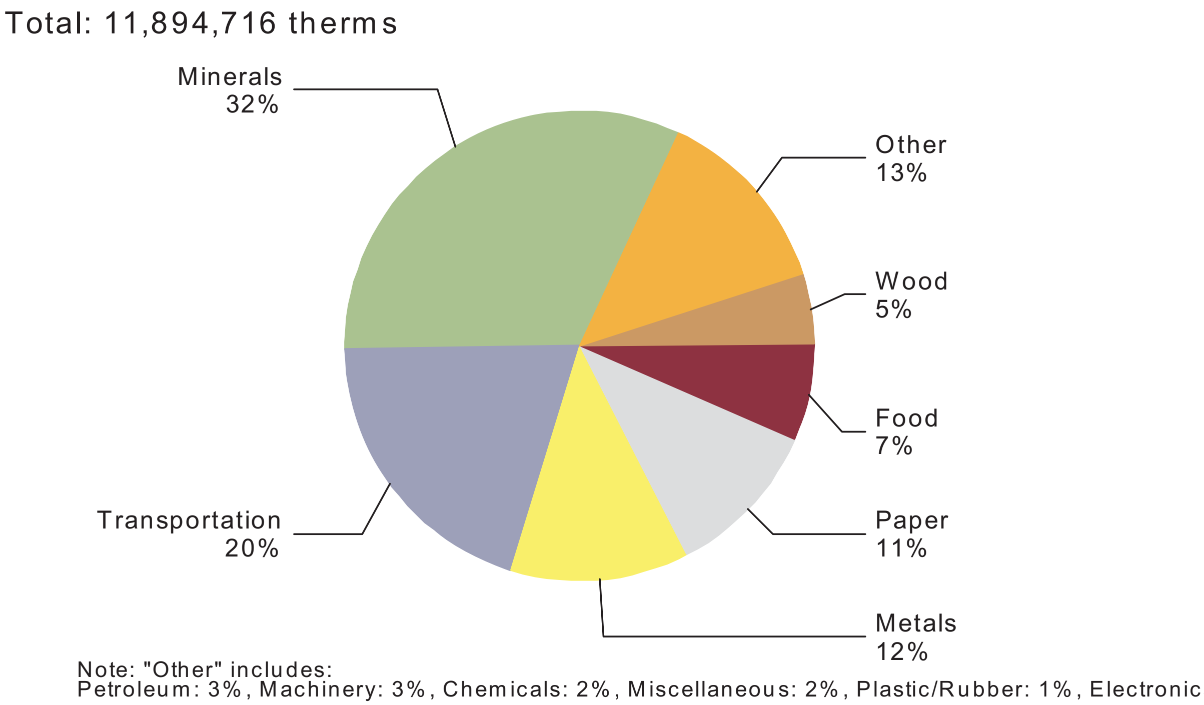


Figure 2: Industrial Technical Potential in 2029 by End Use

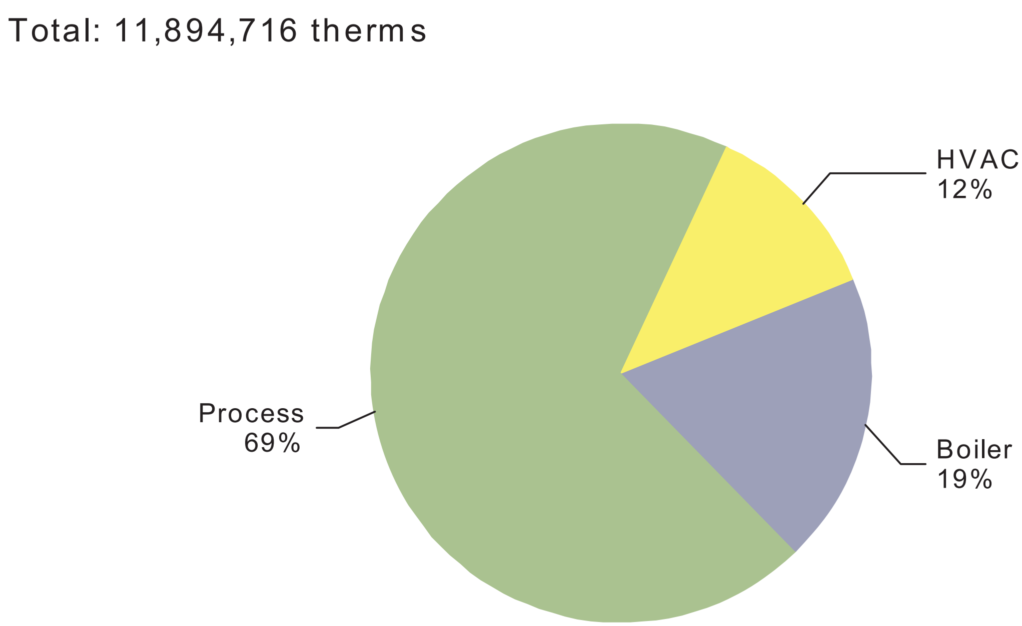


Figure 3: Industrial Technical Potential in 2029 by End Use, Chemicals

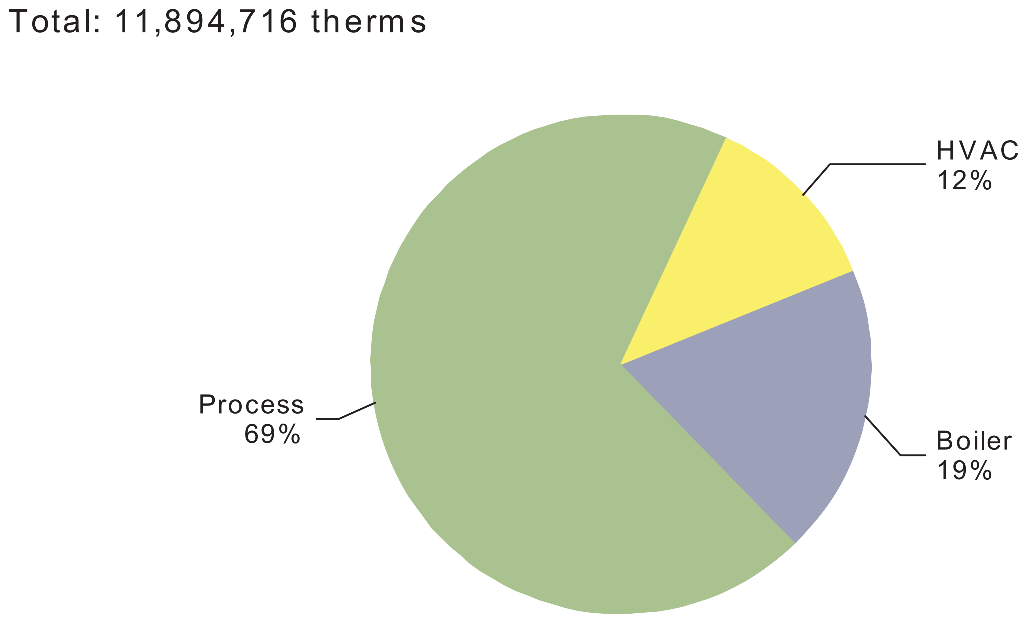


Figure 4: Industrial Technical Potential in 2029 by End Use, Electronics

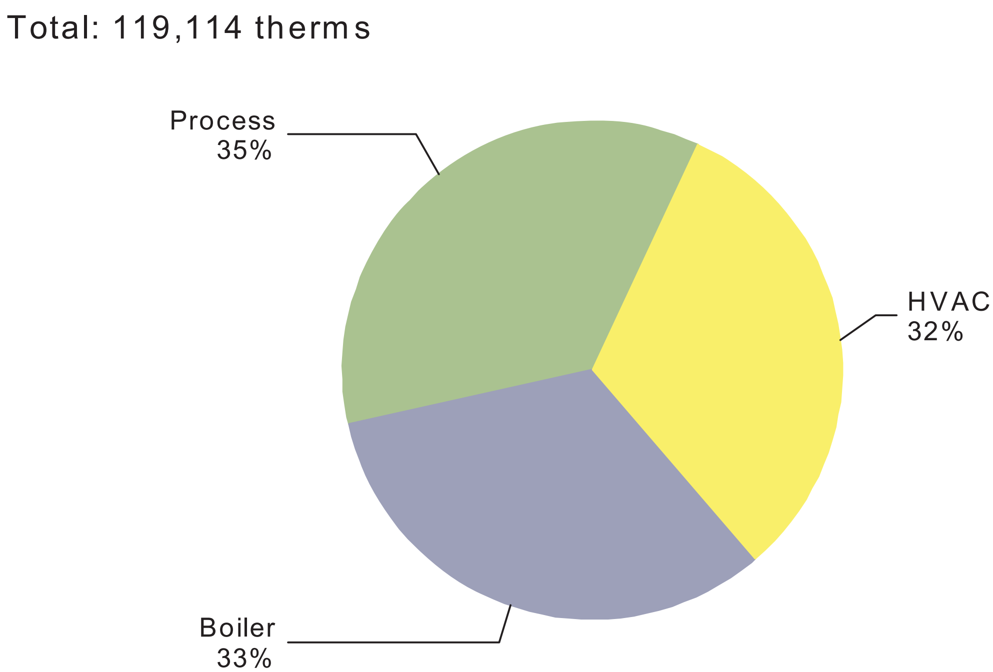


Figure 5: Industrial Technical Potential in 2029 by End Use, Food

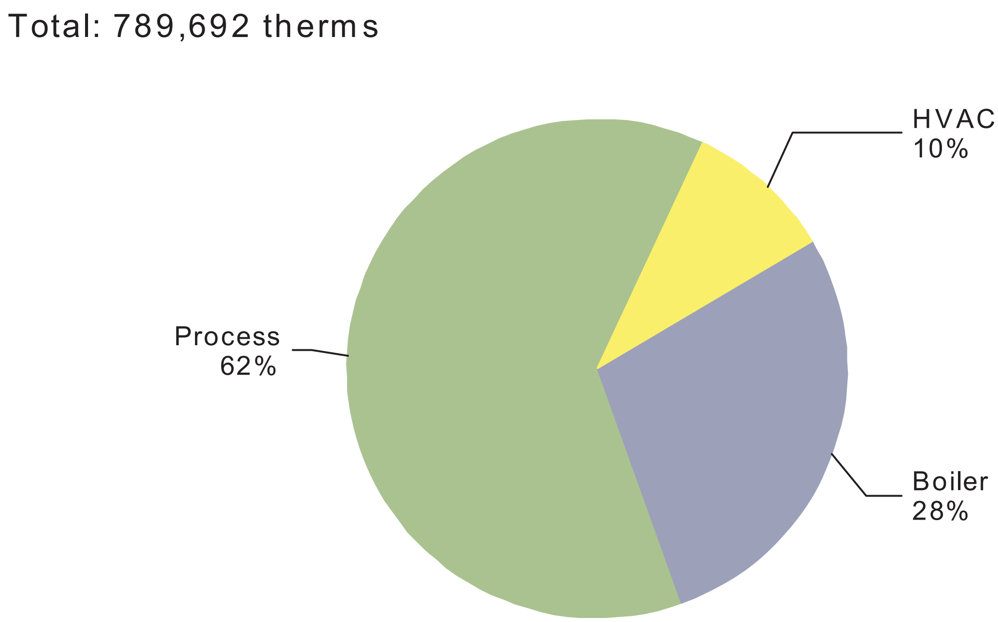


Figure 6: Industrial Technical Potential in 2029 by End Use, Machinery

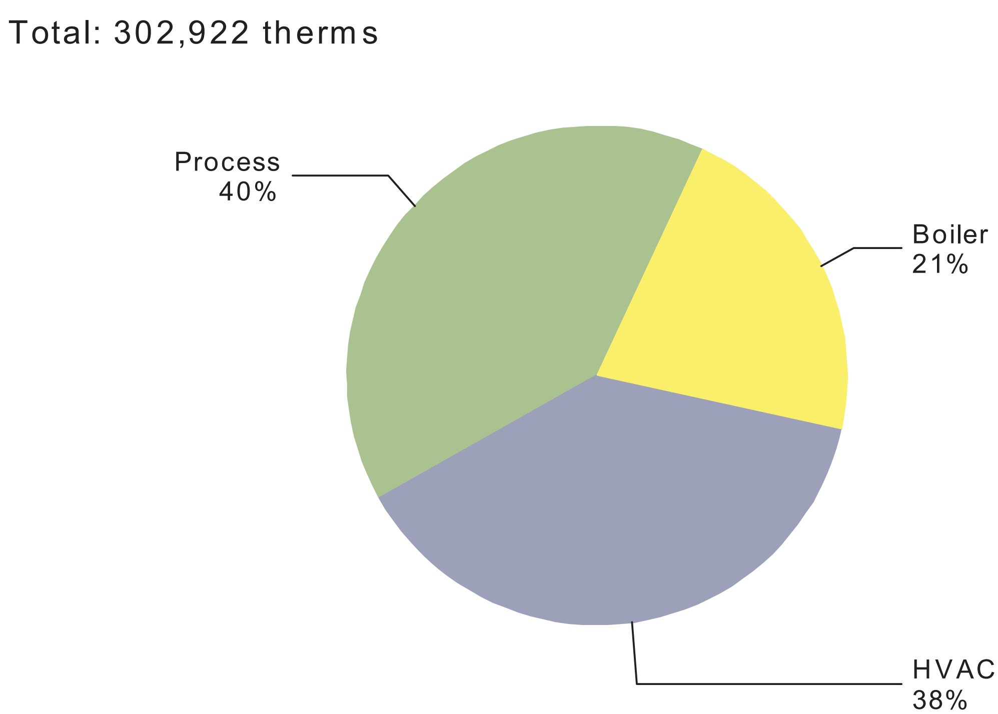


Figure 7: Industrial Technical Potential in 2029 by End Use, Metals

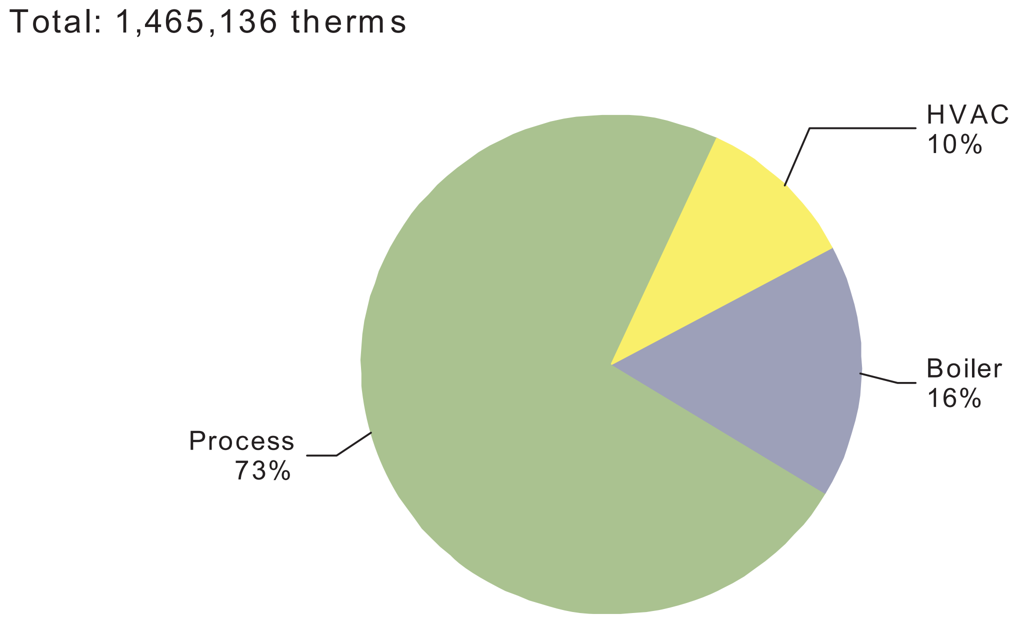


Figure 8: Industrial Technical Potential in 2029 by End Use, Minerals

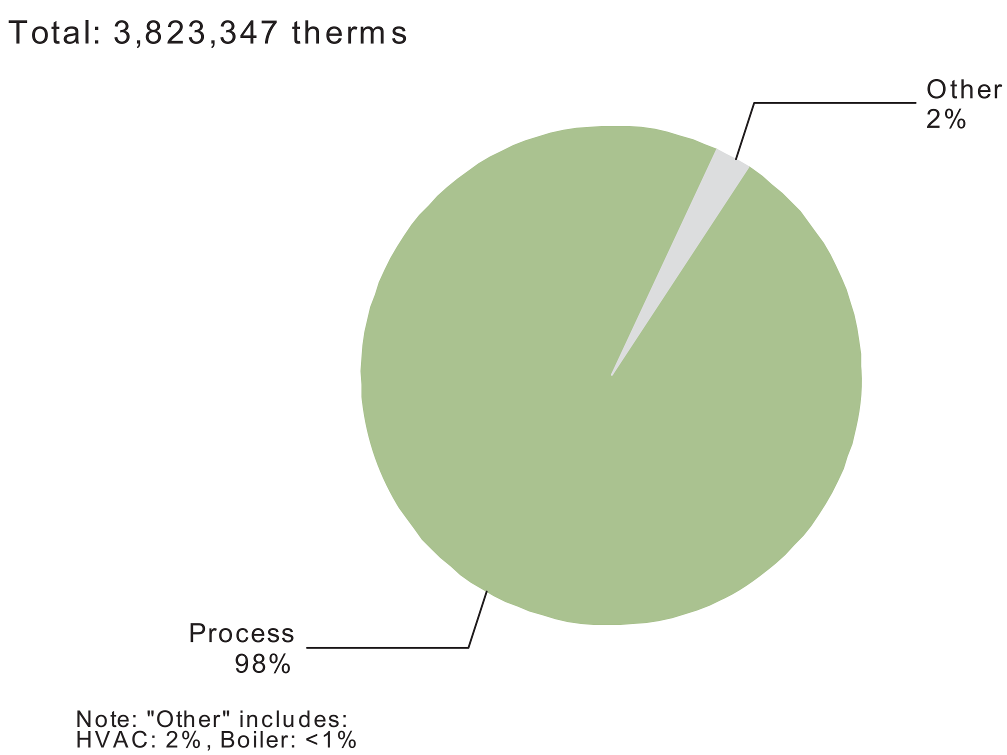


Figure 9: Industrial Technical Potential in 2029 by End Use, Miscellaneous

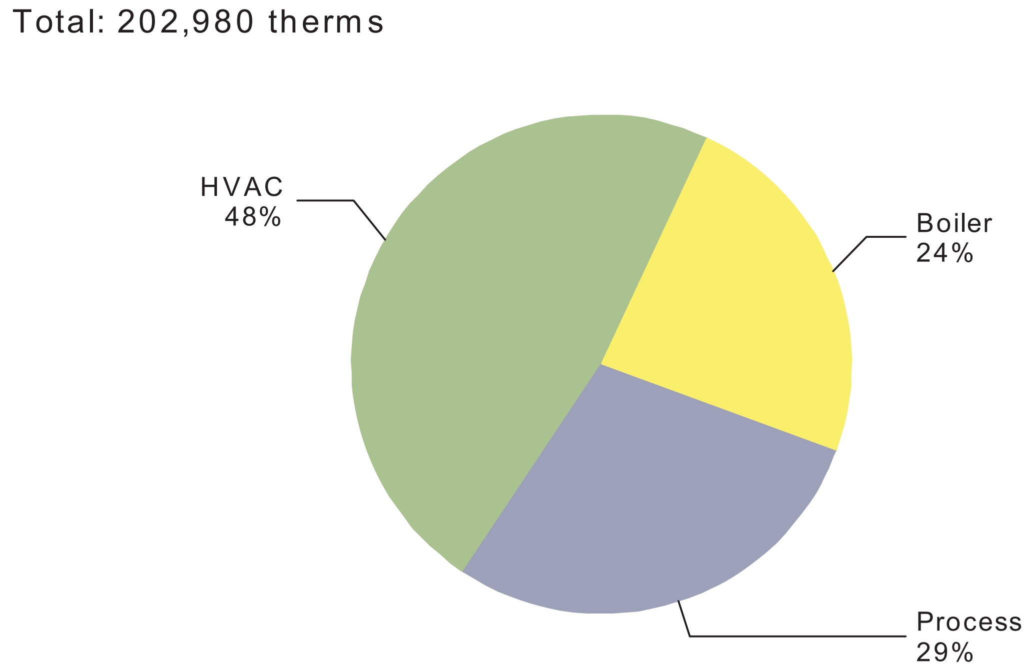


Figure 10: Industrial Technical Potential in 2029 by End Use, Paper

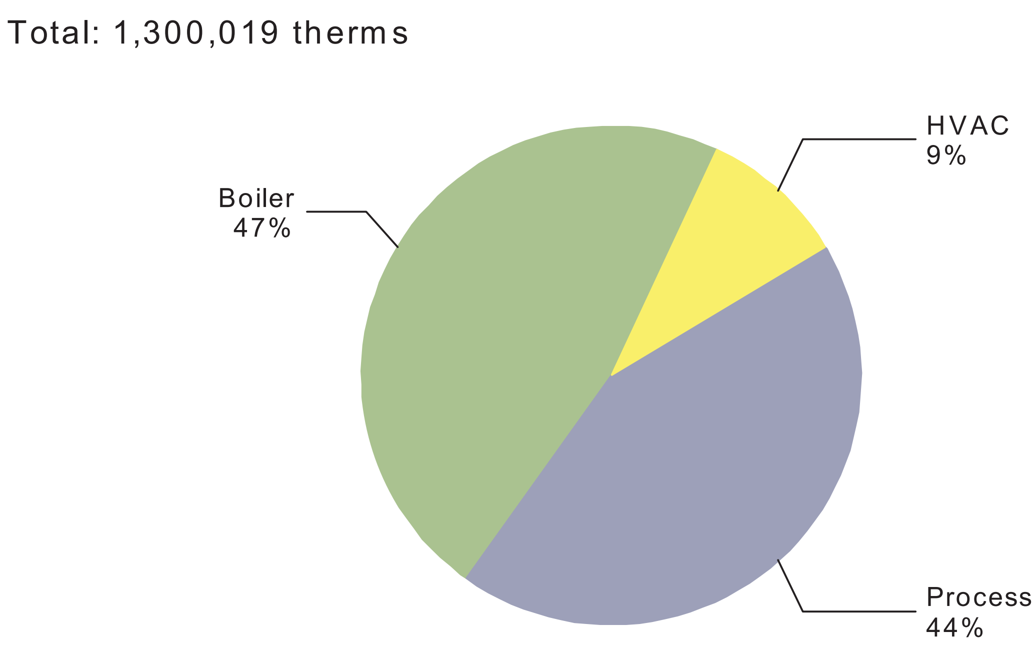


Figure 11: Industrial Technical Potential in 2029 by End Use, Petroleum

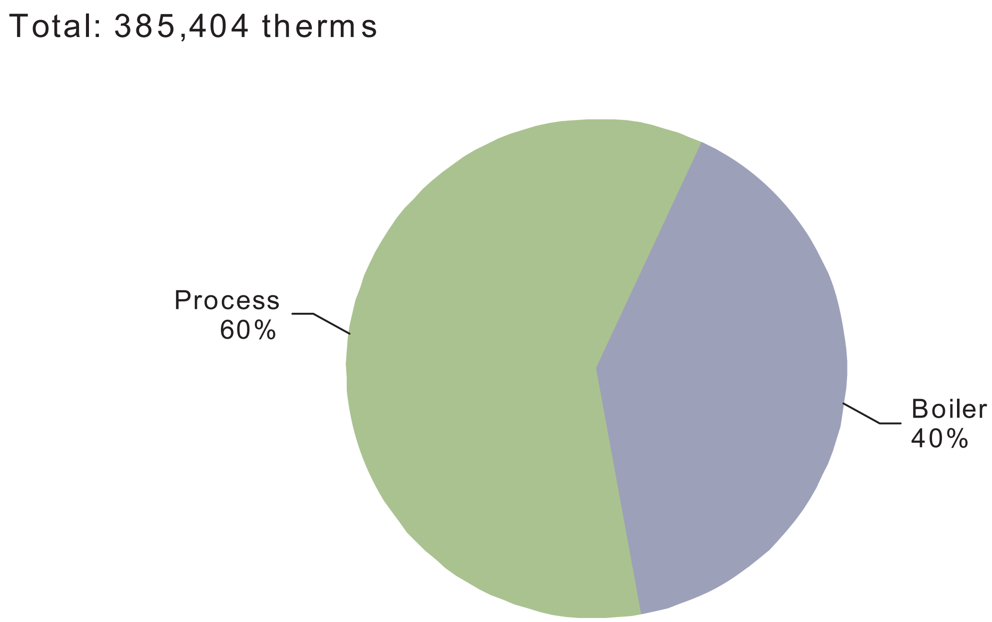


Figure 12: Industrial Technical Potential in 2029 by End Use, PlasticRubber

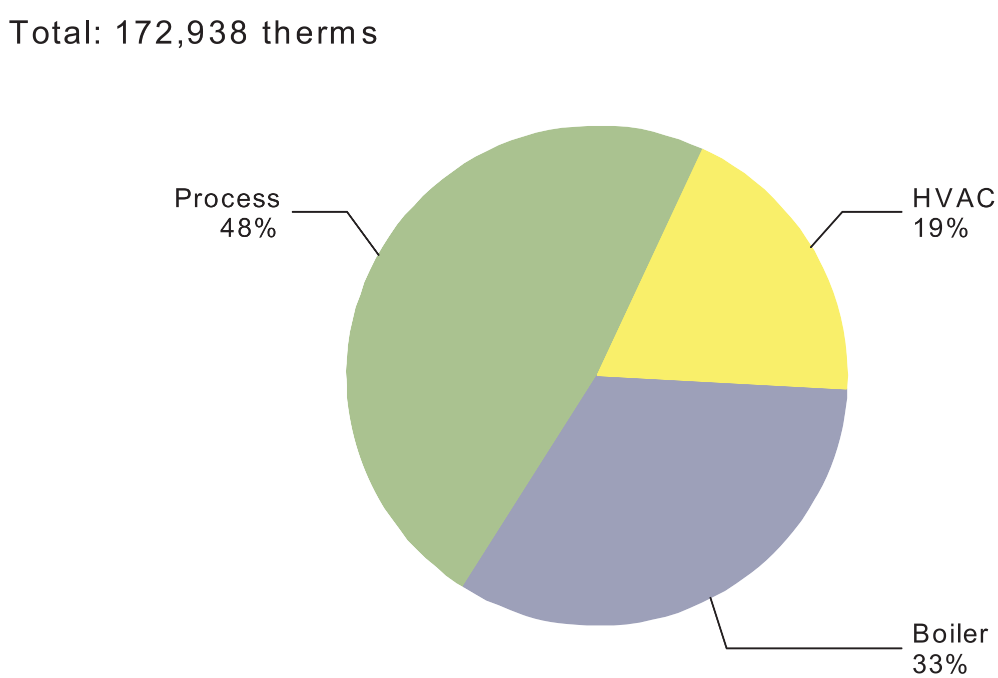


Figure 13: Industrial Technical Potential in 2029 by End Use, Printing

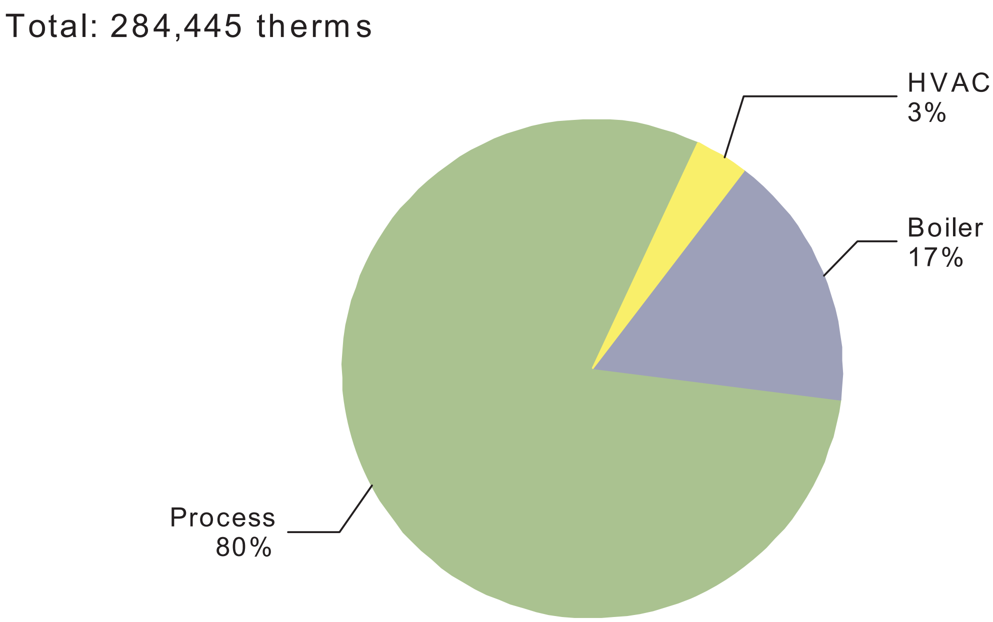


Figure 14: Industrial Technical Potential in 2029 by End Use, Transportation

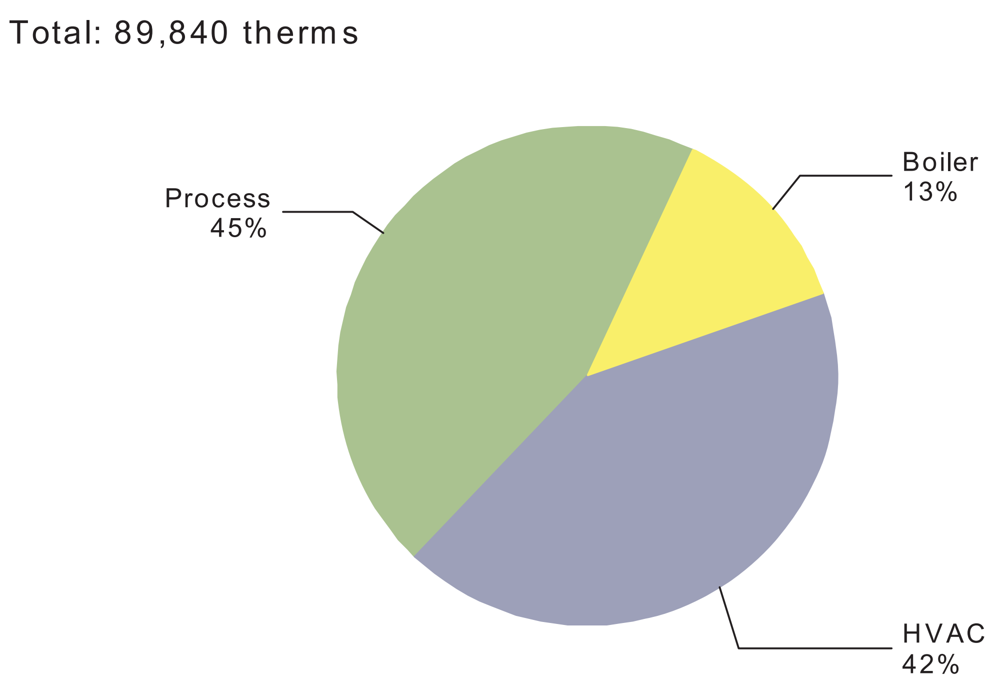
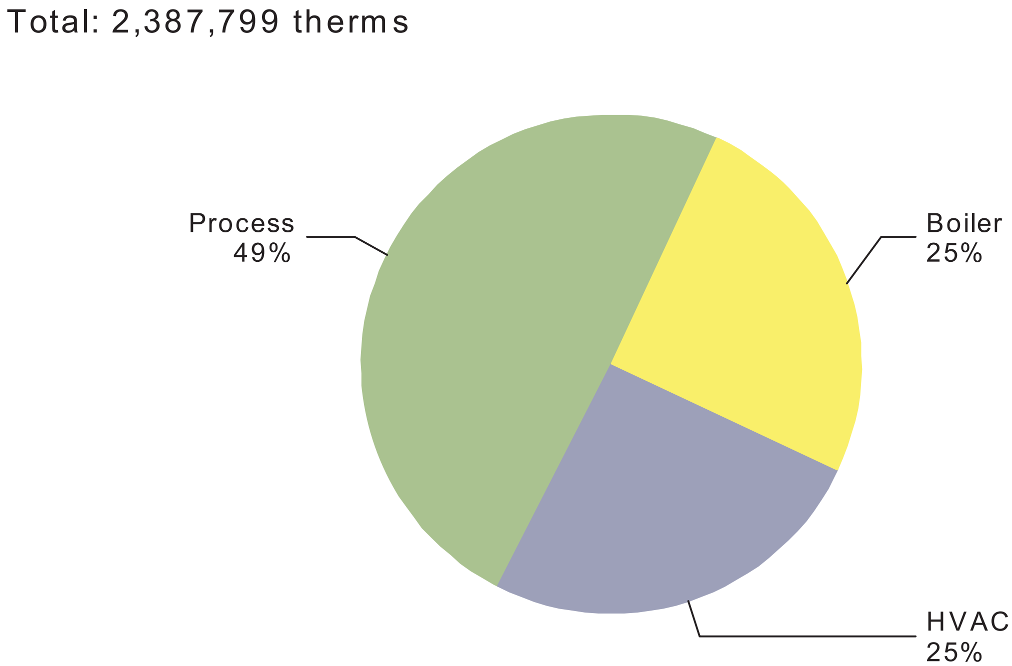


Figure 15: Industrial Technical Potential in 2029 by End Use, Wood



Achievable Technical Potential

Figure 16: Industrial Achievable Technical Potential in 2029 by Segment

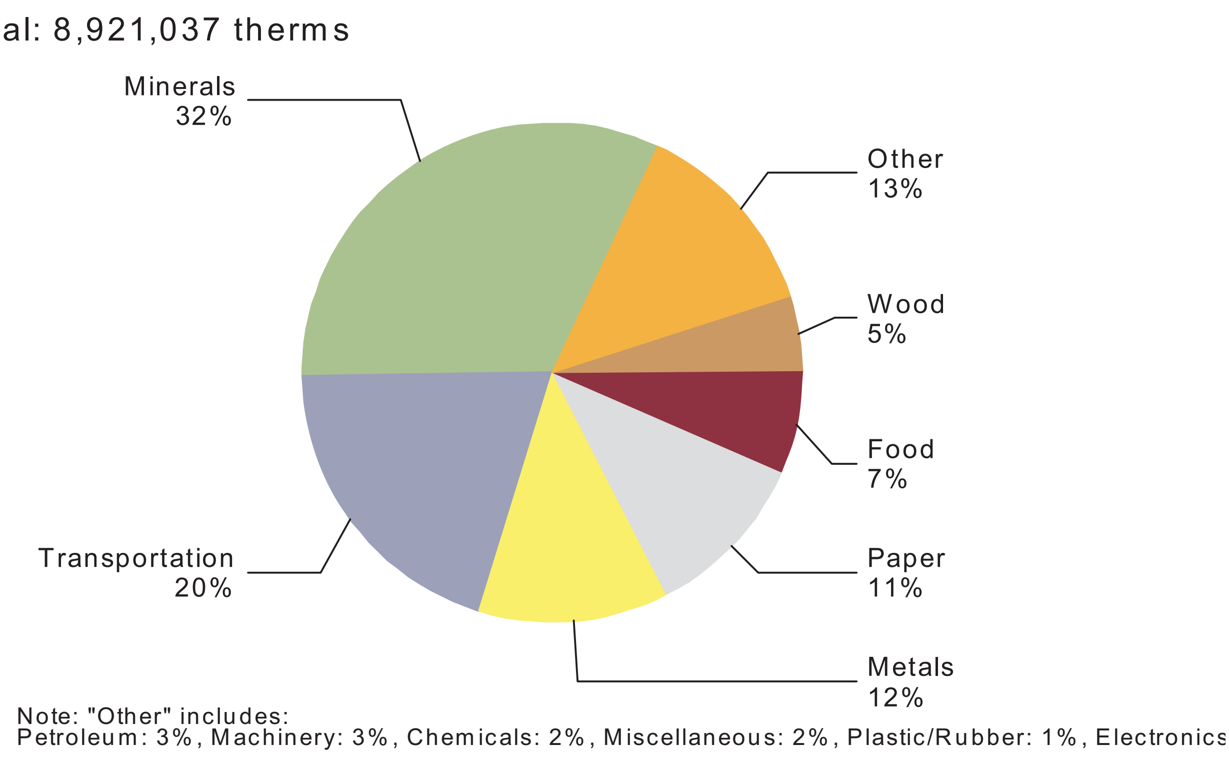


Figure 17: Industrial Achievable Technical Potential in 2029 by End Use

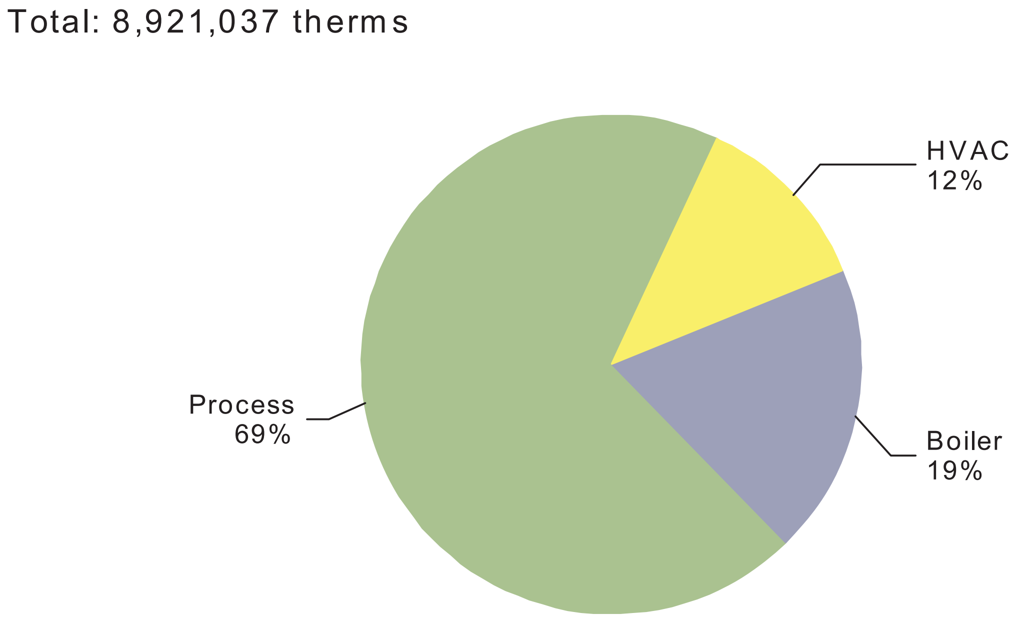


Figure 18: Industrial Achievable Technical Potential in 2029 by End Use, Chemicals

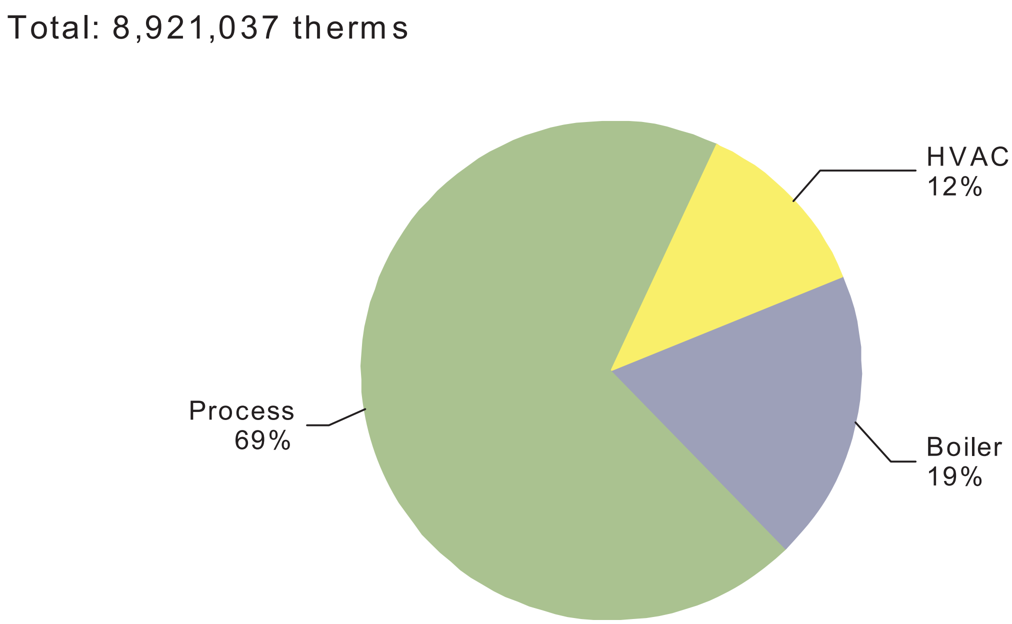


Figure 19: Industrial Achievable Technical Potential in 2029 by End Use, Electronics

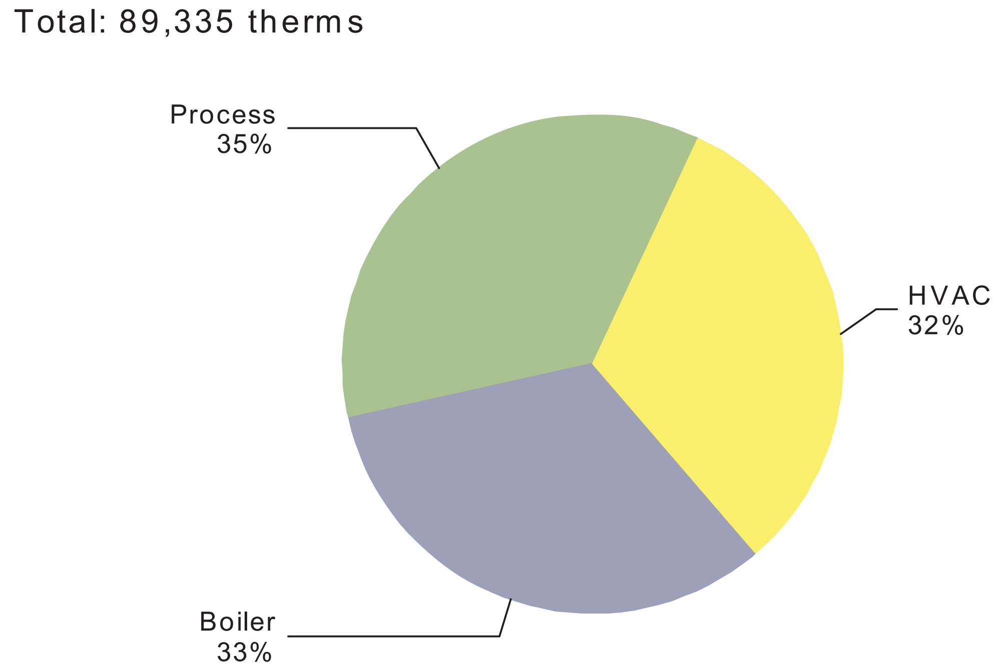


Figure 20: Industrial Achievable Technical Potential in 2029 by End Use, Food

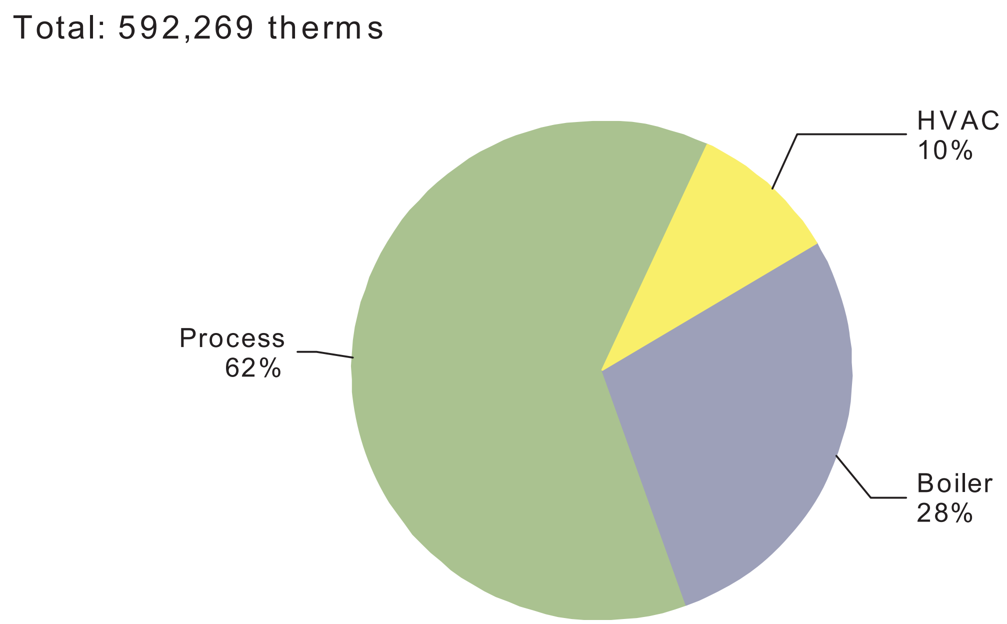


Figure 21: Industrial Achievable Technical Potential in 2029 by End Use, Machinery

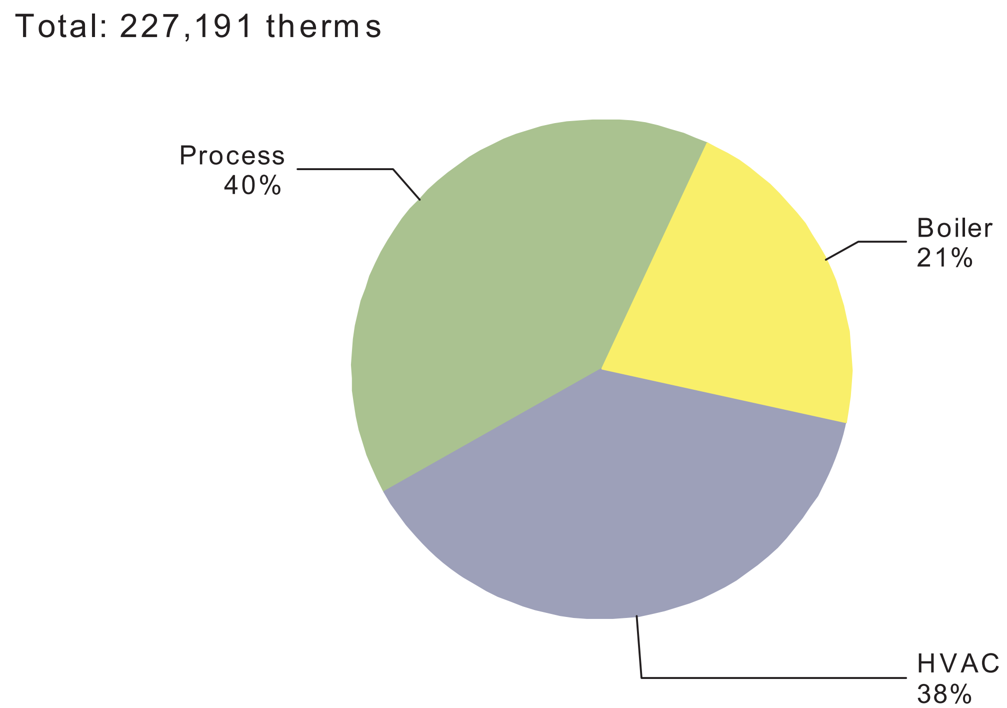


Figure 22: Industrial Achievable Technical Potential in 2029 by End Use, Metals

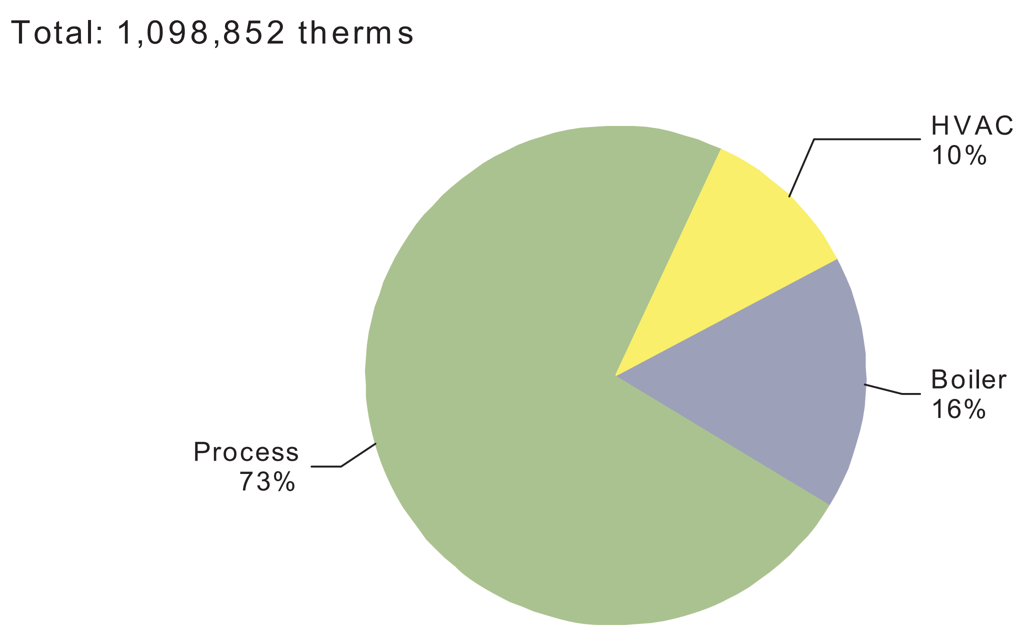


Figure 23: Industrial Achievable Technical Potential in 2029 by End Use, Minerals

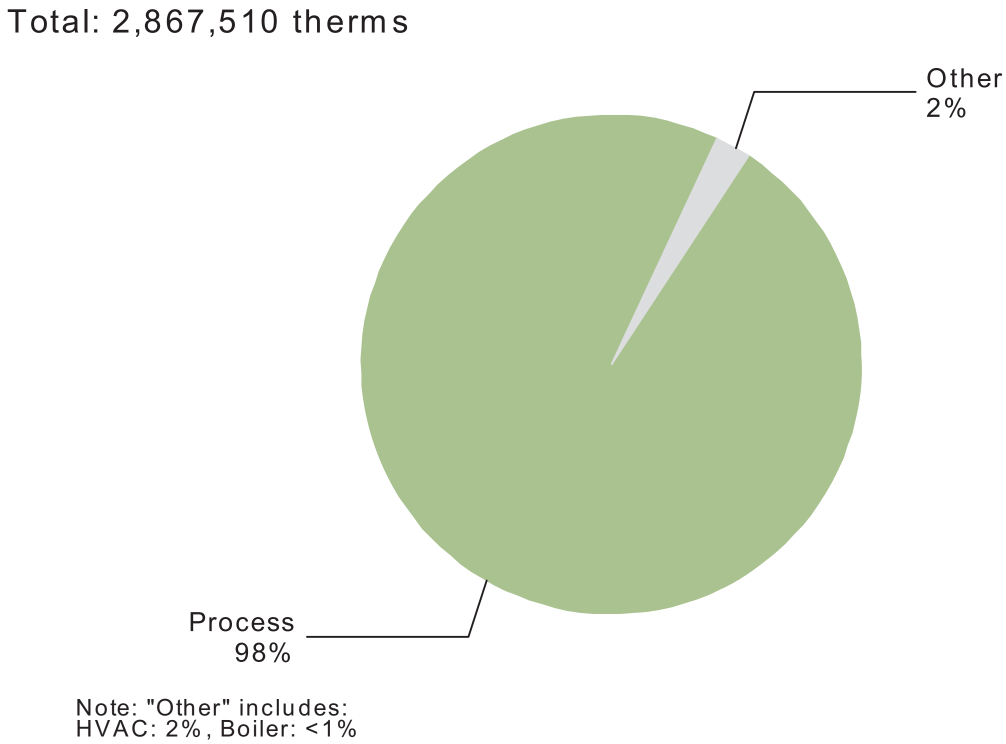


Figure 24: Industrial Achievable Technical Potential in 2029 by End Use, Miscellaneous

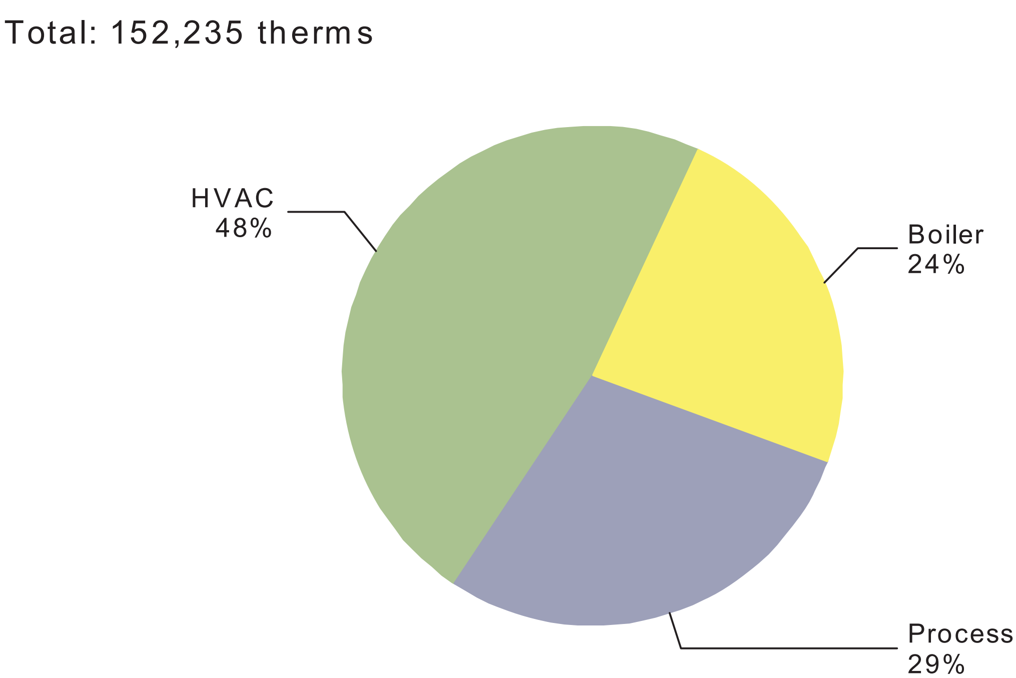


Figure 25: Industrial Achievable Technical Potential in 2029 by End Use, Paper

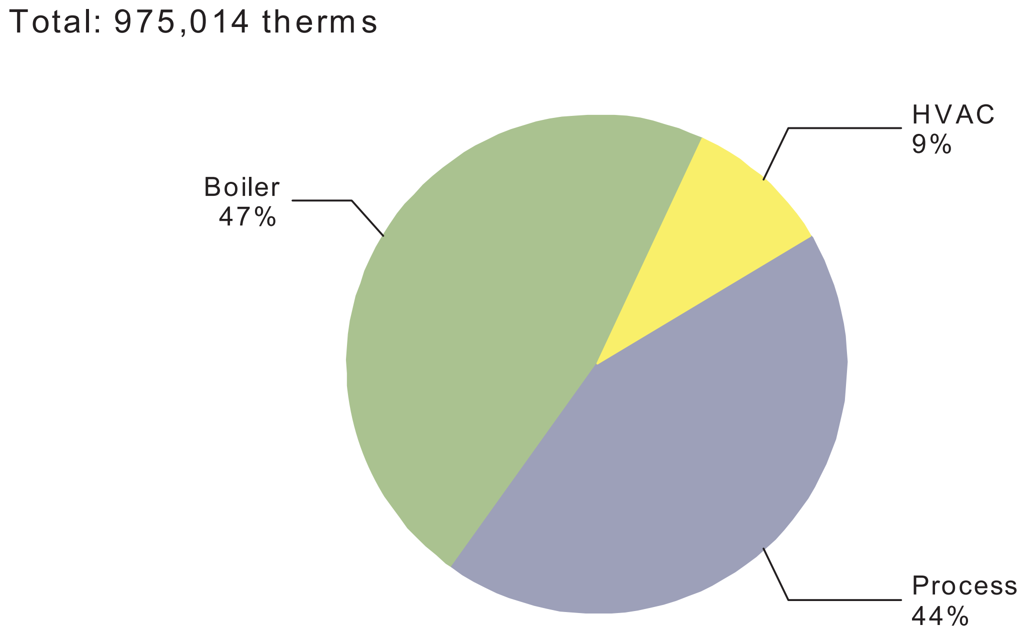


Figure 26: Industrial Achievable Technical Potential in 2029 by End Use, Petroleum

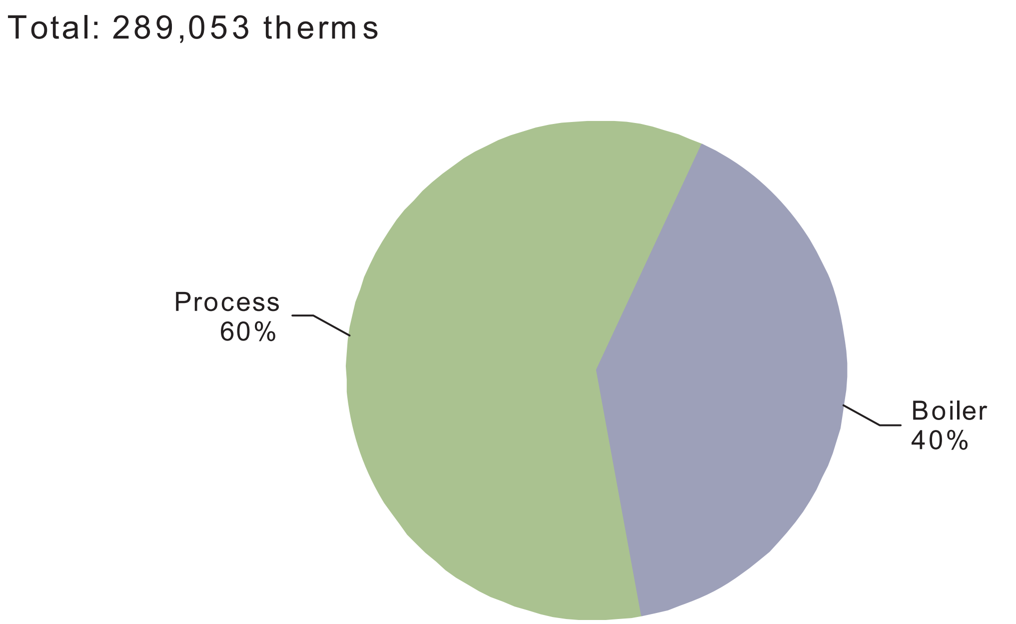


Figure 27: Industrial Achievable Technical Potential in 2029 by End Use, PlasticRubber

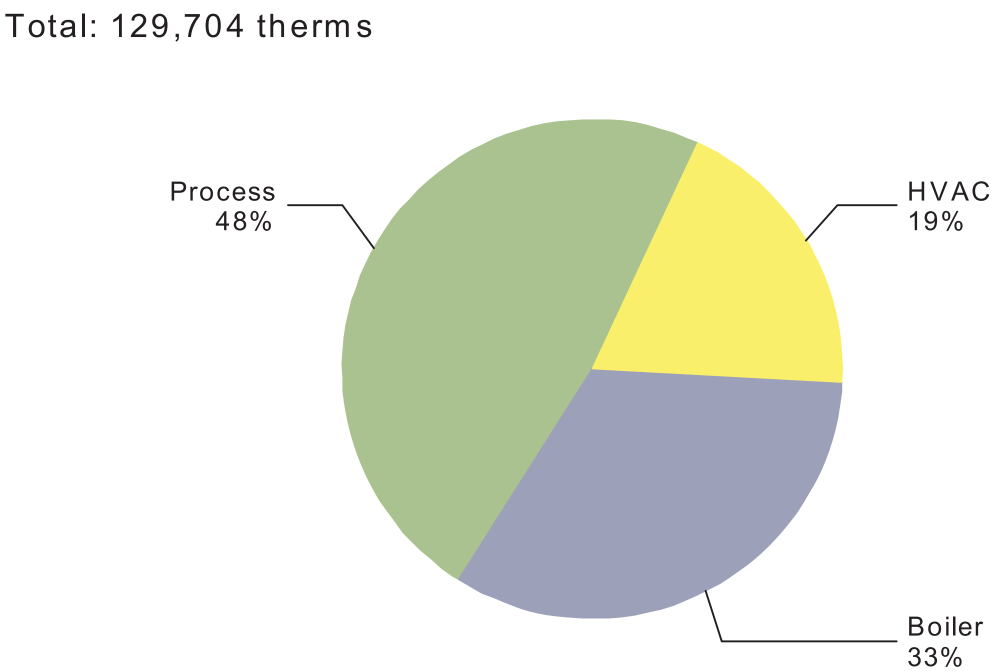


Figure 28: Industrial Achievable Technical Potential in 2029 by End Use, Printing

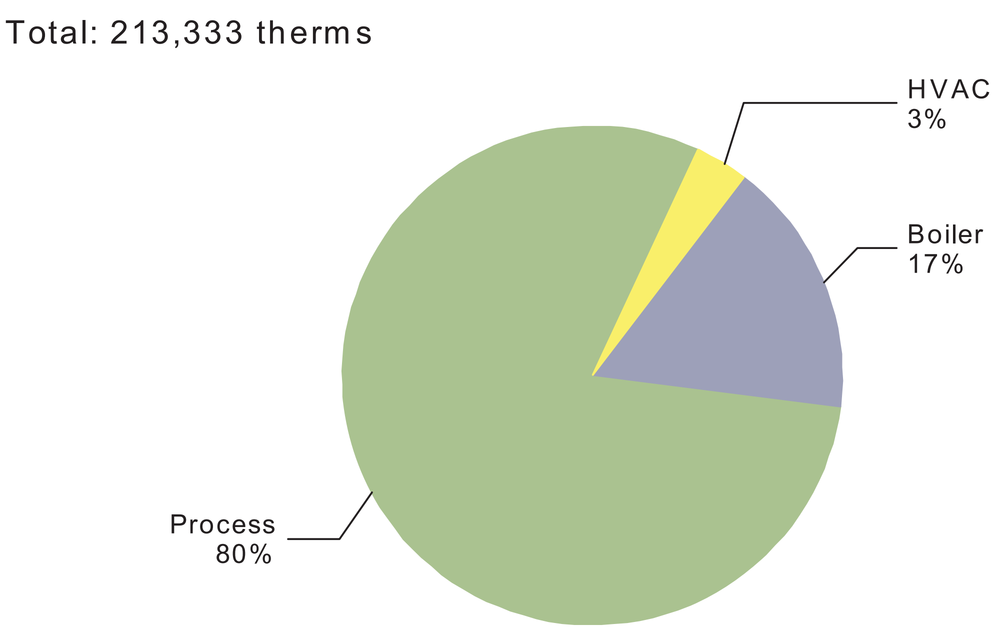


Figure 29: Industrial Achievable Technical Potential in 2029 by End Use, Transportation

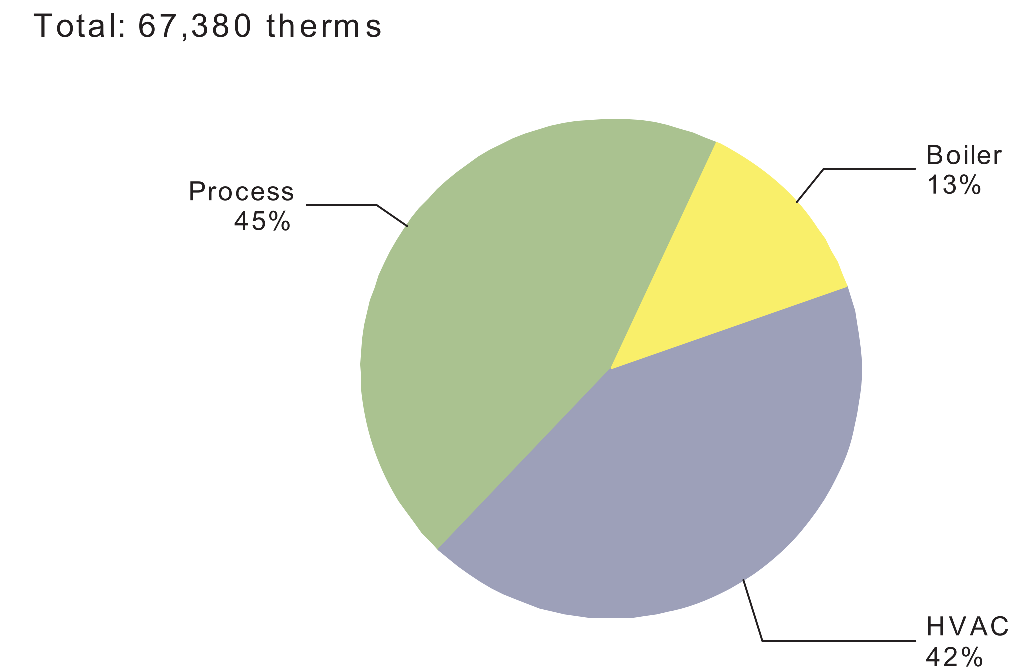
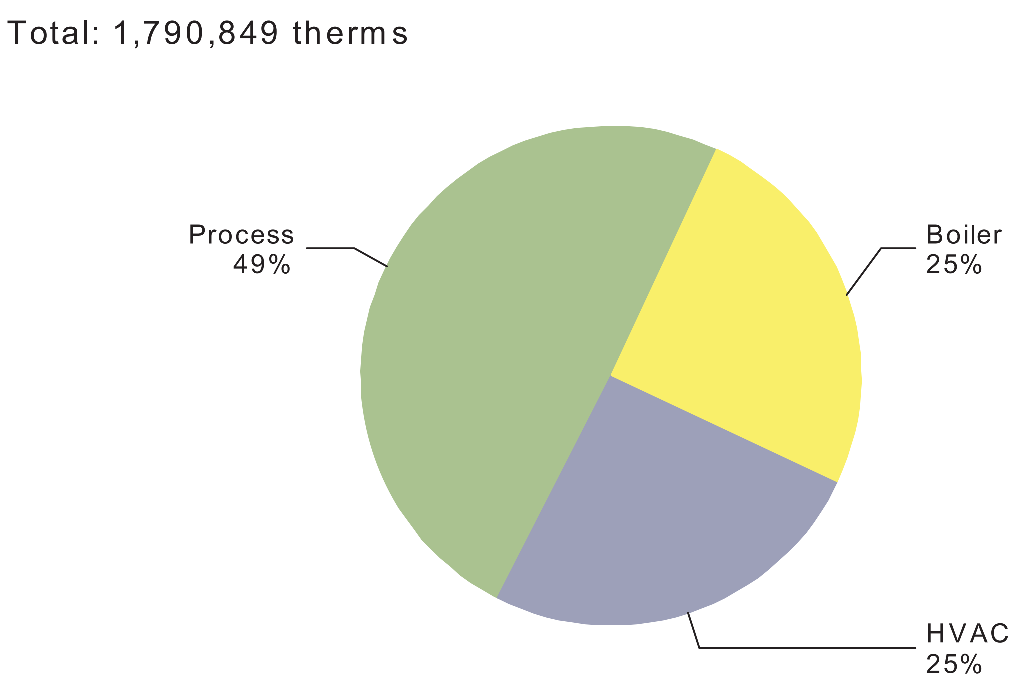


Figure 30: Industrial Achievable Technical Potential in 2029 by End Use, Wood



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Appendix D: Supplemental Material—Fuel Conversion

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Appendix D: Supplemental Material—Fuel Conversion

Economic Assumptions

Discount Rate	8.25%
Inflation Rate	2.50%
Electric T&D Savings	6.70%
Gas T&D Savings	0.80%
Admin Adder	5.00%
Conservation Credit	10.00%
Electric: Carbon Adder	20.00%
Gas: Carbon Adder	10.00%
Main Ext - Short (ft)	50
Main Ext - Medium (ft)	300
Main Ext - Long (ft)	500
Line Cost per foot	$40
In-House Extension	$200
NPV Avoided Generation ($/kW)	$108.25
therms/kWh Conversion Factor	0.0341
Electric Dryer Energy Factor	2.67
Gas Dryer Energy Factor	3.01
Electric Range Energy Factor	0.068
Gas Range Energy Factor	0.112
Electric Retail Rate - Residential	$0.107
Electric Retail Rate - Commercial	$0.090
Gas Retail Rate - Residential	$1.53
Gas Retail Rate - Commercial	$1.39
Utility/Participant Cost Basis	Total
Rate Escalators	Yearly

Source for Electricity Use Data is 2001 Electric End Use Model;
Labor is included for Space/Zone Heating Equipment Cost.
One year potential assumes linear acquisition
UECs for electric dryer/cooking: PSE gas tarrif information
UECs for space/water heating: EndUse Forecaster Model
All calculations done for kWh/therms at GENERATION

End Use	Piping&Labor	Bundling %
Space Heating: Ducted	$700	100%
Space Heating: Baseboard	$500	100%
Clothes Drying	$200	5%
Cooking	$200	5%
Water Heating	$200	70%
Space Heating	$700	100%

Total Customers: Electric and/or Gas Customers/Territory

	New	Existing
Single Familiy	NA	883,839
Commercial	107,443	172,072
MultiFamily	200,715	NA

Distribution by Single Family Home Size

SFam - 1800 sq ft	50%
SFam - 2100 sq ft	10%
SFam - 2400 sq ft	40%

Fuel Conversion Measure Assumptions

Sector	End Use	Measure	Vintage	Baseline	kWh/yr at meter	Elec Equip Cost	Therms/yr at meter	Gas Equip Cost
SFam - 1800 sq ft	Space Heating: Ducted	90% Furnace	Existing	Electric Furnace	7,961	$1,500	507	$2,950
SFam - 1800 sq ft	Space Heating: Baseboard	Wall Heater 84% eff	Existing	Baseboard Heating	6,130	$249	418	$1,549
SFam - 2100 sq ft	Space Heating: Ducted	90% Furnace	Existing	Electric Furnace	9,287	$1,500	591	$2,950
SFam - 2100 sq ft	Space Heating: Baseboard	Wall Heater 84% eff	Existing	Baseboard Heating	7,151	$299	488	$1,549
SFam - 2400 sq ft	Space Heating: Ducted	90% Furnace	Existing	Electric Furnace	10,614	$1,500	676	$2,950
SFam - 2400 sq ft	Space Heating: Baseboard	Wall Heater 84% eff	Existing	Baseboard Heating	8,173	$349	558	$1,549
SFam - 1800 sq ft	Clothes Drying	Moisture Sensor Dryer	Existing	Electric dryer w/ moisture sens, 7.0cuft	755	$410	32	$479
SFam - 1800 sq ft	Cooking	Convection Cooking	Existing	Convection Electric range, 30"	339	$719	15	$649
SFam - 1800 sq ft	Water Heating	Tankless WH	Existing	Electric Water Heater, 50 gal.	3,348	$239	172	$734
SFam - 1800 sq ft	Water Heating	Condensing WH (>80% EF)	Existing	Electric Water Heater, 50 gal.	3,348	$239	190	$812
SFam - 2100 sq ft	Clothes Drying	Moisture Sensor Dryer	Existing	Electric dryer w/ moisture sens, 7.0cuft	755	$410	32	$479
SFam - 2100 sq ft	Cooking	Convection Cooking	Existing	Convection Electric range, 30"	339	$719	15	$649
SFam - 2100 sq ft	Water Heating	Tankless WH	Existing	Electric Water Heater, 50 gal.	3,348	$239	172	$734
SFam - 2100 sq ft	Water Heating	Condensing WH (>80% EF)	Existing	Electric Water Heater, 50 gal.	3,348	$239	190	$812
SFam - 2400 sq ft	Clothes Drying	Moisture Sensor Dryer	Existing	Electric dryer w/ moisture sens, 7.0cuft	755	$410	32	$479
SFam - 2400 sq ft	Cooking	Convection Cooking	Existing	Convection Electric range, 30"	339	$719	15	$649
SFam - 2400 sq ft	Water Heating	Tankless WH	Existing	Electric Water Heater, 50 gal.	3,348	$239	172	$734
SFam - 2400 sq ft	Water Heating	Condensing WH (>80% EF)	Existing	Electric Water Heater, 50 gal.	3,348	$239	190	$812
Commercial	Space Heating: Ducted	90% Furnace	Existing	Electric Furnace	27,124	$6,300	2,175	$6,034
Commercial	Water Heating	Tankless WH	Existing	Electric Water Heater, 50 gal.	8,279	$650	748	$1,874
Commercial	Water Heating	Condensing WH (>80% EF)	Existing	Electric Water Heater, 50 gal.	8,279	$650	748	$2,678
Commercial	Water Heating	Tankless WH	New	Electric Water Heater, 50 gal.	8,605	$650	815	$1,874
Commercial	Water Heating	Condensing WH (>80% EF)	New	Electric Water Heater, 50 gal.	8,605	$650	815	$2,678
Commercial	Space Heating: Ducted	90% Furnace	New	Electric Furnace	18,297	$4,222	1,467	$4,212
MFam Mid Rise: Renter	Space Heating: Ducted	90% Furnace	New	Electric Furnace	3,361	$1,500	299	$2,950
MFam Mid Rise: Renter	Space Heating: Baseboard	90% Furnace	New	Baseboard Heating	2,588	$249	299	$2,950
MFam Mid Rise: Renter	Clothes Drying	Moisture Sensor Dryer	New	Electric dryer w/ moisture sens, 7.0cuft	654	$410	32	$479
MFam Mid Rise: Renter	Cooking	Convection Cooking	New	Convection Electric range, 30"	440	$719	19	$649
MFam Mid Rise: Renter	Water Heating	Tankless WH	New	Electric Water Heater, 50 gal.	1,696	$239	125	$734
MFam Mid Rise: Renter	Water Heating	Condensing WH (>80% EF)	New	Electric Water Heater, 50 gal.	1,696	$239	128	$812
MFam Low Rise: Renter	Space Heating: Ducted	90% Furnace	New	Electric Furnace	3,361	$1,500	299	$2,950
MFam Low Rise: Renter	Space Heating: Baseboard	90% Furnace	New	Baseboard Heating	2,588	$249	299	$2,950
MFam Low Rise: Renter	Clothes Drying	Moisture Sensor Dryer	New	Electric dryer w/ moisture sens, 7.0cuft	654	$410	32	$479
MFam Low Rise: Renter	Cooking	Convection Cooking	New	Convection Electric range, 30"	440	$719	19	$649
MFam Low Rise: Renter	Water Heating	Tankless WH	New	Electric Water Heater, 50 gal.	1,696	$239	125	$734
MFam Low Rise: Renter	Water Heating	Condensing WH (>80% EF)	New	Electric Water Heater, 50 gal.	1,696	$239	128	$812
MFam Mid Rise: Owner	Space Heating: Ducted	90% Furnace	New	Electric Furnace	3,361	$1,500	299	$2,950
MFam Mid Rise: Owner	Space Heating: Baseboard	90% Furnace	New	Baseboard Heating	2,588	$249	299	$2,950
MFam Mid Rise: Owner	Clothes Drying	Moisture Sensor Dryer	New	Electric dryer w/ moisture sens, 7.0cuft	654	$410	32	$479
MFam Mid Rise: Owner	Cooking	Convection Cooking	New	Convection Electric range, 30"	440	$719	19	$649
MFam Mid Rise: Owner	Water Heating	Tankless WH	New	Electric Water Heater, 50 gal.	1,696	$239	125	$734
MFam Mid Rise: Owner	Water Heating	Condensing WH (>80% EF)	New	Electric Water Heater, 50 gal.	1,696	$239	128	$812
MFam Low Rise: Owner	Space Heating: Ducted	90% Furnace	New	Electric Furnace	3,361	$1,500	299	$2,950
MFam Low Rise: Owner	Space Heating: Baseboard	90% Furnace	New	Baseboard Heating	2,588	$249	299	$2,950
MFam Low Rise: Owner	Clothes Drying	Moisture Sensor Dryer	New	Electric dryer w/ moisture sens, 7.0cuft	654	$410	32	$479
MFam Low Rise: Owner	Cooking	Convection Cooking	New	Convection Electric range, 30"	440	$719	19	$649
MFam Low Rise: Owner	Water Heating	Tankless WH	New	Electric Water Heater, 50 gal.	1,696	$239	125	$734
MFam Low Rise: Owner	Water Heating	Condensing WH (>80% EF)	New	Electric Water Heater, 50 gal.	1,696	$239	128	$812

Appendix E: Supplemental Material—Demand Response

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Table of Contents

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Appendix E: Demand Response Resource Materials: Detailed Program Results – Year, Peak Season, and Market Segment

All Demand Response Programs by Year and Peak Season

Table E.1. Achievable Technical Potential, Cost, and Customers by Year and Peak Season

	Winter			Summer		
Year	kW	Cost (2008 $)	Customers	kW	Cost (2008 $)	Customers
2010	4,047	2,619,864	3,690	1,458	524,435	2,275
2011	9,643	1,809,046	8,796	3,472	860,198	5,424
2012	16,875	2,504,836	15,399	6,072	1,258,814	9,497
2013	31,566	4,660,706	28,819	11,351	2,467,974	17,775
2014	54,146	7,333,631	49,455	19,458	3,981,857	30,505
2015	99,963	14,056,267	91,340	35,901	7,752,845	56,347
2016	124,687	11,646,491	113,976	44,754	6,538,222	70,317
2017	142,523	11,403,136	130,330	51,127	6,466,370	80,413
2018	153,042	10,674,691	140,000	54,870	6,108,830	86,386
2019	160,634	10,571,978	146,997	57,562	6,078,360	90,711
2020	163,493	9,880,523	149,665	58,557	5,715,093	92,364
2021	166,351	10,040,346	152,332	59,551	5,810,262	94,017
2022	169,210	10,200,168	154,999	60,546	5,905,432	95,670
2023	172,069	10,359,990	157,667	61,540	6,000,601	97,322
2024	174,928	10,519,813	160,334	62,535	6,095,770	98,975
2025	177,786	10,679,635	163,001	63,529	6,190,940	100,628
2026	180,645	10,839,457	165,669	64,524	6,286,109	102,281
2027	183,504	10,999,279	168,336	65,518	6,381,278	103,934
2028	186,362	11,159,102	171,003	66,513	6,476,447	105,587
2029	189,221	11,318,924	173,670	67,507	6,571,617	107,240

Note: Costs assume no AMR installations for direct load control programs.

Table E.2. Achievable Technical Potential (MW) by Market Segment (2029) and Peak Season

Market Segment	Achievable Potential - Winter	Achievable Potential - Summer
Single Family	117.99	38.10
Multifamily	35.69	6.29
Manufactured	16.26	3.76
Grocery	0.97	1.07
Health	1.44	1.69
Office	6.07	6.27
Retail	1.43	1.52
Lodging	0.25	0.21
Other Comm	1.11	1.16
Restaurant	0.50	0.54
Education	1.93	1.29
Warehouse	0.47	0.52
Food Mfg	0.26	0.36
Primary Metal Mfg	0.03	0.03
Paper Mfg	0.25	0.24
Plastics Rubber Products	0.25	0.38
Chemical Mfg	0.46	0.38
Nonmetallic Mineral Products	0.10	0.11
Industrial Machinery	0.05	0.05
Fabricated Metal Products	0.19	0.17
Printing Related Support	0.00	0.00
Transportation Equipment Mfg	0.79	0.73
Electrical Equipment Mfg	0.00	0.00
Wood Product Mfg	0.17	0.16
Miscellaneous Mfg	0.08	0.12
Petroleum Coal Products	2.36	2.21
Computer Electronic Mfg	0.12	0.13
Waste Water	0.01	0.01
Water	0.00	0.01

Summer DLC - Residential AC and Water Heat

Table E.3. Achievable Technical Potential (kW) by Year: Summer Direct Load Control – Residential Air Conditioning and Water Heat

Year	kW	Customers	Cost (2008 $) No AMR	AMR to AMI	AMI
2010	174	429	90,517	125,659	93,731
2011	414	1,023	149,975	204,067	157,638
2012	725	1,791	220,890	296,792	234,307
2013	1,357	3,352	432,377	582,988	457,489
2014	2,328	5,753	699,352	938,573	742,450
2015	4,301	10,626	1,359,101	1,831,333	1,438,709
2016	5,367	13,261	1,167,170	1,517,926	1,266,514
2017	6,138	15,165	1,164,597	1,488,967	1,278,205
2018	6,594	16,292	1,110,123	1,394,999	1,232,171
2019	6,924	17,107	1,109,330	1,383,042	1,237,488
2020	7,050	17,419	1,049,953	1,292,753	1,180,446
2021	7,176	17,731	1,067,886	1,314,645	1,200,714
2022	7,302	18,042	1,085,818	1,336,536	1,220,981
2023	7,429	18,354	1,103,751	1,358,428	1,241,249
2024	7,555	18,666	1,121,684	1,380,319	1,261,517
2025	7,681	18,977	1,139,617	1,402,211	1,281,785
2026	7,807	19,289	1,157,549	1,424,103	1,302,053
2027	7,933	19,601	1,175,482	1,445,994	1,322,320
2028	8,059	19,912	1,193,415	1,467,886	1,342,588
2029	8,186	20,224	1,211,347	1,489,777	1,362,856

Table E.4. Achievable Technical Potential (MW) by Market Segment (2029): Summer Direct Load Control- Residential Air Conditioning and Water Heat

Market Segment	Achievable Potential
Single Family	7.16
Multifamily	0.18
Manufactured	0.84

Summer Critical Peak Pricing - Residential

Table E.5. Achievable Technical Potential (kW) by Year: Summer Critical Peak Pricing - Residential

Year	kW	Customers	Cost (2008 $)
2010	848	1,843	404,212
2011	2,021	4,394	646,643
2012	3,539	7,693	931,362
2013	6,623	14,398	1,834,455
2014	11,367	24,711	2,942,654
2015	20,996	45,643	5,759,654
2016	26,202	56,960	4,640,271
2017	29,964	65,138	4,486,987
2018	32,190	69,977	4,141,258
2019	33,801	73,480	4,077,086
2020	34,417	74,819	3,768,035
2021	35,033	76,158	3,831,341
2022	35,649	77,497	3,894,646
2023	36,265	78,835	3,957,952
2024	36,881	80,174	4,021,258
2025	37,497	81,513	4,084,563
2026	38,113	82,852	4,147,869
2027	38,729	84,191	4,211,174
2028	39,344	85,530	4,274,480
2029	39,960	86,869	4,337,786

Table E.6. Achievable Technical Potential (MW) by Market Segment (2029): Summer Critical Peak Pricing - Residential

Market Segment	Achievable Potential
Single Family	30.94
Multifamily	6.10
Manufactured	2.92

Summer Direct Load Control - Commercial

Table E.7. Achievable Technical Potential (kW) by Year: Summer Direct Load Control - Commercial

Year	kW	Customers	Cost (2008 $)
2010	60	1	11,441
2011	145	3	21,346
2012	255	6	33,728
2013	481	12	65,364
2014	832	20	108,854
2015	1,546	37	208,817
2016	1,942	46	211,009
2017	2,234	53	226,127
2018	2,413	58	230,447
2019	2,548	61	237,695
2020	2,608	62	235,354
2021	2,668	64	240,628
2022	2,728	65	245,902
2023	2,788	67	251,175
2024	2,848	68	256,449
2025	2,908	70	261,722
2026	2,968	71	266,996
2027	3,028	72	272,270
2028	3,088	74	277,543
2029	3,148	75	282,817

Table E.8. Achievable Technical Potential (MW) by Market Segment (2029): Summer Direct Load Control – Commercial

Market Segment	Achievable Potential
Grocery	0.21
Health	0.30
Office	1.70
Retail	0.20
Lodging	0.02
Other Comm	0.14
Restaurant	0.09
Education	0.32
Warehouse	0.16

Summer Interruptible Loads - Commercial and Industrial

Table E.9. Achievable Technical Potential (kW) by Year: Summer Interruptible Loads - Commercial and Industrial

Year	kW	Customers	Cost (2008 $)
2010	341	1	17,600
2011	807	3	40,949
2012	1,404	5	70,774
2013	2,612	9	131,850
2014	4,455	15	224,464
2015	8,182	28	412,941
2016	10,153	35	506,741
2017	11,548	40	574,538
2018	12,341	43	612,482
2019	12,893	45	639,283
2020	13,063	45	646,891
2021	13,234	46	655,318
2022	13,404	46	663,746
2023	13,574	47	672,174
2024	13,744	47	680,602
2025	13,915	48	689,030
2026	14,085	49	697,457
2027	14,255	49	705,885
2028	14,426	50	714,313
2029	14,596	50	722,741

Table E.10. Achievable Technical Potential (MW) by Market Segment (2029): Summer Interruptible Loads - Commercial and Industrial

Market Segment	Achievable Potential
Grocery	0.68
Health	1.27
Office	4.16
Retail	1.14
Lodging	0.15
Other Comm	0.92
Restaurant	0.41
Education	0.85
Warehouse	0.29
Food Mfg	0.33
Primary Metal Mfg	0.03
Paper Mfg	0.22
Plastics Rubber Products	0.35
Chemical Mfg	0.35
Nonmetallic Mineral Products	0.10
Industrial Machinary	0.04
Fabricated Metal Products	0.16
Printing Related Support	0.00
Transportation Equipment Mfg	0.68
Electrical Equipment Mfg	0.00
Wood Product Mfg	0.15
Miscellaneous Mfg	0.11
Petroleum Coal Products	2.06
Computer Electronic Mfg	0.12
Waste Water	0.01
Water	0.00

Summer Demand Bidding – Commercial and Industrial

Table E.11. Achievable Technical Potential (kW) by Year: Summer Demand Bidding - Commercial and Industrial

Year	kW	Customers	Cost (2008 $)
2010	36	0	665
2011	85	1	1,286
2012	149	2	2,060
2013	278	4	3,928
2014	475	6	6,534
2015	876	11	12,332
2016	1,090	14	13,031
2017	1,243	16	14,122
2018	1,332	17	14,520
2019	1,396	18	14,966
2020	1,418	19	14,860
2021	1,440	19	15,089
2022	1,462	19	15,319
2023	1,484	19	15,549
2024	1,507	20	15,778
2025	1,529	20	16,008
2026	1,551	20	16,237
2027	1,573	21	16,467
2028	1,595	21	16,697
2029	1,618	21	16,926

Table E.12. Achievable Technical Potential (MW) by Market Segment (2029): Summer Demand Bidding - Commercial and Industrial

Market Segment	Achievable Potential
Grocery	0.18
Health	0.12
Office	0.40
Retail	0.18
Lodging	0.03
Other Comm	0.10
Restaurant	0.03
Education	0.12
Warehouse	0.06
Food Mfg	0.03
Primary Metal Mfg	0.00
Paper Mfg	0.02
Plastics Rubber Products	0.03
Chemical Mfg	0.03
Nonmetallic Mineral Products	0.01
Industrial Machinary	0.00
Fabricated Metal Products	0.01
Printing Related Support	0.00
Transportation Equipment Mfg	0.06
Electrical Equipment Mfg	0.00
Wood Product Mfg	0.01
Miscellaneous Mfg	0.01
Petroleum Coal Products	0.15
Computer Electronic Mfg	0.01
Waste Water	0.00
Water	0.00

Winter DLC – Residential Space Heat-Water Heat and Room Heat-Water Heat Programs

Table E.13. Achievable Technical Potential (kW) by Year: Winter Direct Load Control – Residential

	Space Heat-Water Heat Program					Room Heat-Water Heat Program				
			Cost (2008 $)					Cost (2008 $)		
Year	kW	Customers	No AMR	AMR to AMI	AMI	kW	Customers	No AMR	AMR to AMI	AMI
2010	1,006	992	669,340	750,909	676,801	1,150	852	313,974	404,212	267,483
2011	2,398	2,364	406,783	532,297	424,567	2,742	2,030	498,808	646,643	90,647
2012	4,197	4,138	570,660	746,732	601,790	4,800	3,554	715,116	931,362	120,225
2013	7,853	7,743	1,059,394	1,408,709	1,117,646	8,982	6,651	1,410,016	1,834,455	180,808
2014	13,476	13,287	1,676,190	2,230,903	1,776,146	15,412	11,412	2,257,649	2,942,654	272,635
2015	24,887	24,537	3,200,301	4,295,166	3,384,898	28,463	21,076	4,424,456	5,759,654	459,528
2016	31,051	30,616	2,756,486	3,569,399	2,986,811	35,513	26,297	3,517,113	4,640,271	552,282
2017	35,504	35,006	2,750,177	3,501,732	3,013,527	40,606	30,068	3,377,070	4,486,987	619,327
2018	38,135	37,600	2,624,023	3,283,885	2,906,891	43,615	32,296	3,093,554	4,141,258	656,780
2019	40,038	39,476	2,621,857	3,255,735	2,918,840	45,791	33,908	3,034,570	4,077,086	683,211
2020	40,762	40,190	2,484,449	3,046,607	2,786,799	46,619	34,520	2,788,178	3,768,035	690,621
2021	41,485	40,903	2,525,537	3,096,793	2,833,253	47,446	35,133	2,834,478	3,831,341	698,869
2022	42,208	41,616	2,566,625	3,146,979	2,879,708	48,274	35,746	2,880,779	3,894,646	707,117
2023	42,932	42,330	2,607,713	3,197,164	2,926,162	49,101	36,358	2,927,079	3,957,952	715,366
2024	43,655	43,043	2,648,801	3,247,350	2,972,616	49,928	36,971	2,973,380	4,021,258	723,614
2025	44,379	43,756	2,689,889	3,297,536	3,019,071	50,756	37,584	3,019,680	4,084,563	731,862
2026	45,102	44,470	2,730,977	3,347,722	3,065,525	51,583	38,197	3,065,981	4,147,869	740,110
2027	45,826	45,183	2,772,065	3,397,908	3,111,980	52,411	38,809	3,112,281	4,211,174	748,359
2028	46,549	45,896	2,813,153	3,448,093	3,158,434	53,238	39,422	3,158,582	4,274,480	756,607
2029	47,273	46,610	2,854,241	3,498,279	3,204,888	54,066	40,035	3,204,882	4,337,786	764,855

Table E.14. Achievable Technical Potential (MW) by Market Segment (2029): Winter Direct Load Control - Residential Space Heat-Water Heat and Room Heat-Water Heat Programs

Market Segment	Space Heat and Water Heat	Room Heat and Water Heat
Single Family	35.24	32.63
Multifamily	2.74	19.59
Manufactured	9.29	1.85

Winter Critical Peak Pricing - Residential

Table E.15. Achievable Technical Potential (kW) by Year: Winter Critical Peak Pricing - Residential

Year	kW	Customers	Cost (2008 $)
2010	1,455	1,843	864,211
2011	3,470	4,394	706,643
2012	6,076	7,693	991,362
2013	11,371	14,398	1,894,455
2014	19,516	24,711	3,002,654
2015	36,048	45,643	5,819,654
2016	44,986	56,960	4,700,271
2017	51,445	65,138	4,546,987
2018	55,266	69,977	4,201,258
2019	58,033	73,480	4,137,086
2020	59,090	74,819	3,828,035
2021	60,148	76,158	3,891,341
2022	61,205	77,497	3,954,646
2023	62,263	78,835	4,017,952
2024	63,320	80,174	4,081,258
2025	64,377	81,513	4,144,563
2026	65,435	82,852	4,207,869
2027	66,492	84,191	4,271,174
2028	67,550	85,530	4,334,480
2029	68,607	86,869	4,397,786

Table E.16. Achievable Technical Potential by Market Segment (2029): Winter Critical Peak Pricing - Residential

Market Segment	Achievable Potential
Single Family	50.12
Multifamily	13.36
Manufactured	5.12

Winter Direct Load Control - Commercial

Table E.17. Achievable Technical Potential (kW) by Year: Winter Direct Load Control - Commercial

Year	kW	Customers	Cost (2008 $)
2010	62	1	260,310
2011	150	3	69,730
2012	264	5	81,581
2013	498	10	110,998
2014	861	18	152,042
2015	1,600	33	244,998
2016	2,009	42	252,829
2017	2,311	48	269,693
2018	2,497	52	275,979
2019	2,636	55	283,982
2020	2,698	56	282,976
2021	2,760	57	288,220
2022	2,822	59	293,464
2023	2,885	60	298,708
2024	2,947	61	303,952
2025	3,009	63	309,196
2026	3,071	64	314,440
2027	3,133	65	319,684
2028	3,195	66	324,929
2029	3,257	68	330,173

Table E.18. Achievable Technical Potential by Market Segment (2029): Winter Direct Load Control – Commercial

Market Segment	Achievable Potential
Grocery	0.18
Health	0.25
Office	1.70
Retail	0.19
Lodging	0.03
Other Comm	0.15
Restaurant	0.08
Education	0.54
Warehouse	0.14

Winter Interruptible Loads – Commercial and Industrial

Table E.19. Achievable Technical Potential (kW) by Year: Winter Interruptible Loads - Commercial and Industrial

Year	kW	Customers	Cost (2008 $)
2010	338	1	267,483
2011	800	3	90,647
2012	1,391	5	120,225
2013	2,587	9	180,808
2014	4,412	15	272,635
2015	8,101	28	459,528
2016	10,051	35	552,282
2017	11,430	40	619,327
2018	12,213	43	656,780
2019	12,757	44	683,211
2020	12,923	45	690,621
2021	13,090	46	698,869
2022	13,256	46	707,117
2023	13,423	47	715,366
2024	13,589	47	723,614
2025	13,756	48	731,862
2026	13,922	49	740,110
2027	14,089	49	748,359
2028	14,255	50	756,607
2029	14,422	50	764,855

Table E.20. Achievable Technical Potential by Market Segment (2029): Winter Interruptible Loads - Commercial and Industrial

Market Segment	Achievable Potential
Grocery	0.62
Health	1.09
Office	3.98
Retail	1.07
Lodging	0.18
Other Comm	0.87
Restaurant	0.39
Education	1.22
Warehouse	0.27
Food Mfg	0.24
Primary Metal Mfg	0.03
Paper Mfg	0.23
Plastics Rubber Products	0.23
Chemical Mfg	0.43
Nonmetallic Mineral Products	0.10
Industrial Machinary	0.05
Fabricated Metal Products	0.17
Printing Related Support	0.00
Transportation Equipment Mfg	0.73
Electrical Equipment Mfg	0.00
Wood Product Mfg	0.16
Miscellaneous Mfg	0.07
Petroleum Coal Products	2.20
Computer Electronic Mfg	0.11
Waste Water	0.00
Water	0.00

Winter Demand Bidding – Commercial and Industrial

Table E.21. Achievable Technical Potential (kW) by Year: Winter Commercial and Industrial Demand Bidding

Year	kW	Customers	Cost (2008 $)
2010	35	1	250,939
2011	84	2	51,671
2012	147	4	52,563
2013	274	7	54,943
2014	470	12	58,099
2015	865	21	65,484
2016	1,077	27	64,841
2017	1,228	30	65,508
2018	1,316	33	65,445
2019	1,379	34	65,713
2020	1,400	35	65,303
2021	1,422	35	65,537
2022	1,444	36	65,770
2023	1,466	36	66,003
2024	1,488	37	66,237
2025	1,510	37	66,470
2026	1,531	38	66,703
2027	1,553	39	66,937
2028	1,575	39	67,170
2029	1,597	40	67,404

Table E.22. Achievable Technical Potential by Market Segment (2029): Winter Demand Bidding - Commercial and Industrial

Market Segment	Achievable Potential
Grocery	0.17
Health	0.10
Office	0.39
Retail	0.17
Lodging	0.04
Other Comm	0.10
Restaurant	0.03
Education	0.17
Warehouse	0.06
Food Mfg	0.02
Primary Metal Mfg	0.00
Paper Mfg	0.02
Plastics Rubber Products	0.02
Chemical Mfg	0.03
Nonmetallic Mineral Products	0.01
Industrial Machinary	0.00
Fabricated Metal Products	0.01
Printing Related Support	0.00
Transportation Equipment Mfg	0.06
Electrical Equipment Mfg	0.00
Wood Product Mfg	0.01
Miscellaneous Mfg	0.01
Petroleum Coal Products	0.16
Computer Electronic Mfg	0.01
Waste Water	0.00
Water	0.00

Appendix F: Supplemental Material—Distributed Generation

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CHP Background Data

The primary data source for installed cost of CHP technologies is the California's Self-Generation Incentive Program (SGIP).[1] This program, funded by the major investor-owned utilities of California, provides varying levels of incentives for individual customers to install various distributed generation technologies, including CHP, with a maximum capacity of 5 MW. This program has been in effect since 2001, although as of Jan 1, 2008, the program only offers incentives for wind and fuel cells. As such, only data through 2007 is considered in this analysis. The program has a publicly-available database of all installations, including generation technology, capacity, fuel, and total cost.

For the CHP assessment, nameplate capacity is based on the weighted average of the units installed through California's SGIP for both non-renewable generation and anaerobic digesters. Typical nameplate capacities for industrial biomass vary widely; a 4,800 kW unit is used as a proxy based on a study for the Energy Trust of Oregon.[2] It should be realized that these are just proxy values, and larger or smaller units can be installed. These values are summarized in Table 1. Also shown in the table is the net fuel heat rate, measure life and capacity factors for the different generators. Heat rates are from literature values,[3] based on a weighted average of CHP units from the SGIP data. The measure life and capacity factors were also obtained from the literature.[3] Note that these values are assumed equivalent across PSE territory.

Table 1. CHP Prototypical Generating Units

Technology	Nameplate Capacity (kW)	Fuel Heat Rate (MMBTU/MWh)	Measure Life (years)	Capacity Factor
CHP: Non-Renewable				
Reciprocating Engine	644	5.0	20	0.9
Microturbine	140	7.4	15	0.9
Fuel Cell	531	5.8	10	0.95
Gas Turbine	3,174	6.6	20	0.9
CHP: Renewable				
Small Anaerobic Digesters	525	N/A	15	0.8
Large Anaerobic Digesters	1,929	N/A	15	0.8
Industrial Biomass	4,800	N/A	20	0.9

Note: no heat rate is given for the renewable generation technologies; since the fuel is produced on-site the heat rate is not relevant.

With these prototypical generating units, the associated costs are determined from the SGIP database or, for industrial biomass, literature values.[3] The installed costs include: planning and feasibility, engineering and design, permitting, generator equipment costs, waste heat recovery costs, construction and installation, interconnection, service contracts. The SGIP database costs

1 http://www.cpuc.ca.gov/static/energy/electric/051005_sgip.htm

2 "Sizing and Characterizing the Market for Oregon Biopower Projects," prepared for Energy Trust of Oregon, by CH2MHill, 2005.

3 "Gas-Fired Distributed Energy Resource Technology Characterization," National Renewable Energy Laboratory, NREL-TP-620-34783, 2003.

were reduced by 17% to remove the included sales tax (7%) as well a 10% reduction based on higher costs typical of the California market.[4]

It should be noted that, for generators used with anaerobic digesters, any of the three CHP technologies could be used; thus, the costs can vary widely. In this analysis, two size ranges are used and a weighted average cost of the technologies, based on adoption proportions in California, is assumed. The small digesters are coupled with a microturbine, fuel cell, or reciprocating engine, while the large digesters could be coupled with a reciprocating engine or gas turbine. These costs are reported in Table 2. It is assumed the installed cost will negate the effects of inflation (annual increase of 2.5%). Administration costs of 10% of the capital expense are included in total cost and increase with inflation. Fuel costs are calculated from the heat rates using 2010 expected natural gas prices, based on the 2007 projected gas retail rates. Together, these data allow a full life-cycle cost analysis of the resource.

Table 2. Costs for Assessed Technologies (2007$)

Technology	Installed Cost ($/kW)	Annual O&M Costs ($/kW)	Annual Fuel Cost ($/kW)
Reciprocating Engine (RE)	2,314	80	316
Microturbine (MT)	2,623	73	468
Fuel Cell (FC)	5,866	15	385
Gas Turbine (GT)	1,644	49	438
Small Anaerobic Digesters	4,239	58	0
Large Anaerobic Digesters	2,281	64	0
Industrial Biomass	1,800	39	0

For cooling applications, the cost of an absorption chiller is added to the cost of the generator. In addition, the net heat rate is adjusted to account for savings offsetting cooling rather than heating requirements. Cost and technical specifications for the prototypical cooling units are given in Table 3.

Table 3. Cooling CHP Specifications

Size (tons)	Generator	Cost ($/ton)	Net Heat Rate
10	Microturbine	$2,632	11.4
100	Fuel Cell	$1,650	2.9
500	Reciprocating Engine	$580	4.1
800	Gas Turbine	$900	7.0

4 RS Means, 2007

Table 4. Total Number of Dairy and Swine Farms by Zip Code

				Cows		Swine					
		Milk cow inventory, total farms	Hogs and pigs inventory, total farms	500-999	1000+	2000-4999	5000+		cows	500-999 head	15.5%
TOTAL IN PSE TERRITORY		634	282	98	279	120	415			1000+	44%
County	Zip										
KING	98001			0	0	0	0				
KING	98002			0	0	0	0				
KING	98003			0	0	0	0		swine	2000-4999	19%
KING	98004			0	0	0	0			5000+	65.5%
KING	98005			0	0	0	0				
KING	98006			0	0	0	0				
KING	98007			0	0	0	0				
KING	98008			0	0	0	0				
KING	98010		*	0	0	0	0				
KING	98011	*		0	0	0	0				
KING	98013			0	0	0	0				
KING	98014	*	*	0	0	0	0				
KING	98019	10	7	2	4	2	7				
KING	98022	43	20	7	19	8	28				
PIERCE	98022	43	20	7	19	8	28				
KING	98023			0	0	0	0				
KING	98024	*	*	0	0	0	0				
KING	98025			0	0	0	0				
KING	98027			0	0	0	0				
KING	98028			0	0	0	0				
KING	98029			0	0	0	0				
KING	98030			0	0	0	0				
KING	98031			0	0	0	0				
KING	98032		*	0	0	0	0				
KING	98033			0	0	0	0				
KING	98034			0	0	0	0				
KING	98038			0	0	0	0				
KING	98039			0	0	0	0				
KING	98040			0	0	0	0				
KING	98042		*	0	0	0	0				
KING	98045	*		0	0	0	0				
KING	98047		*	0	0	0	0				

PIERCE	98047		*	0	0	0	0				
KING	98050			0	0	0	0				
KING	98051		*	0	0	0	0				
KING	98052			0	0	0	0				
KING	98053		*	0	0	0	0				
KING	98055			0	0	0	0				
KING	98056			0	0	0	0				
KING	98057			0	0	0	0				
KING	98058			0	0	0	0				
KING	98059			0	0	0	0				
KING	98065			0	0	0	0				
KING	98068			0	0	0	0				
KITTITAS	98068			0	0	0	0				
KING	98070		*	0	0	0	0				
KING	98072			0	0	0	0				
SNOHOMISH	98072			0	0	0	0				
KING	98077			0	0	0	0				
SNOHOMISH	98077			0	0	0	0				
KING	98092	5	7	1	2	1	3				
KITSAP	98110			0	0	0	0				
KING	98133			0	0	0	0				
KING	98148			0	0	0	0				
KING	98155			0	0	0	0				
KING	98166			0	0	0	0				
KING	98168			0	0	0	0				
KING	98188			0	0	0	0				
KING	98198			0	0	0	0				
WHATCOM	98220	*	*	0	0	0	0				
SKAGIT	98221		*	0	0	0	0				
KING	98224	26	15	4	11	5	17				
WHATCOM	98225			0	0	0	0				
SKAGIT	98226	15	7	2	7	3	10				
WHATCOM	98226	15	7	2	7	3	10				
WHATCOM	98229	*		0	0	0	0				
WHATCOM	98230	*	*	0	0	0	0				
SKAGIT	98232	9	*	1	4	2	6				
SKAGIT	98233	6	*	1	3	1	4				
SKAGIT	98235			0	0	0	0				
ISLAND	98236	*		0	0	0	0				
SKAGIT	98237		*	0	0	0	0				

SKAGIT	98238			0	0	0	0				
ISLAND	98239	*	*	0	0	0	0				
WHATCOM	98240	14		2	6	3	9				
WHATCOM	98244	11		2	5	2	7				
WHATCOM	98247	58	5	9	26	11	38				
WHATCOM	98248	21	10	3	9	4	14				
ISLAND	98249		*	0	0	0	0				
ISLAND	98253		*	0	0	0	0				
SKAGIT	98255			0	0	0	0				
SKAGIT	98257			0	0	0	0				
ISLAND	98260			0	0	0	0				
WHATCOM	98262			0	0	0	0				
SKAGIT	98263			0	0	0	0				
WHATCOM	98264	99	*	15	44	19	65				
WHATCOM	98266			0	0	0	0				
SKAGIT	98267			0	0	0	0				
SNOHOMISH	98272	8	*	1	4	2	5				
SKAGIT	98273	27	*	4	12	5	18				
SKAGIT	98274	6		1	3	1	4				
WHATCOM	98276			0	0	0	0				
ISLAND	98277	11	*	2	5	2	7				
WHATCOM	98281			0	0	0	0				
SKAGIT	98283	*	*	0	0	0	0				
SKAGIT	98284	26	5	4	11	5	17				
WHATCOM	98284	26	5	4	11	5	17				
KING	98288			0	0	0	0				
SKAGIT	98292	28	25	4	12	5	18				
WHATCOM	98295	25	*	4	11	5	16				
KITSAP	98310			0	0	0	0				
KITSAP	98311			0	0	0	0				
KITSAP	98312		*	0	0	0	0				
PIERCE	98321	7	8	1	3	1	5				
PIERCE	98323			0	0	0	0				
JEFFERSON	98325	12		2	5	2	8				
PIERCE	98327			0	0	0	0				
PIERCE	98328	*	9	0	0	0	0				
PIERCE	98329		*	0	0	0	0				
PIERCE	98332			0	0	0	0				
JEFFERSON	98334			0	0	0	0				
KITSAP	98337	*	*	0	0	0	0				

PIERCE	98338	*	6	0	0	0	0				
JEFFERSON	98339	*	6	0	0	0	0				
KITSAP	98340	*		0	0	0	0				
KITSAP	98342			0	0	0	0				
PIERCE	98344			0	0	0	0				
KITSAP	98345			0	0	0	0				
KITSAP	98346	*	*	0	0	0	0				
KITSAP	98353			0	0	0	0				
PIERCE	98354			0	0	0	0				
JEFFERSON	98358			0	0	0	0				
KITSAP	98359	*		0	0	0	0				
PIERCE	98360	*	*	0	0	0	0				
KITSAP	98364			0	0	0	0				
JEFFERSON	98365			0	0	0	0				
KITSAP	98366	*	8	0	0	0	0				
KITSAP	98367	8	9	1	4	2	5				
JEFFERSON	98368			0	0	0	0				
KITSAP	98370	10	8	2	4	2	7				
PIERCE	98371	*	*	0	0	0	0				
PIERCE	98372			0	0	0	0				
PIERCE	98373			0	0	0	0				
PIERCE	98374			0	0	0	0				
PIERCE	98375	*		0	0	0	0				
JEFFERSON	98376			0	0	0	0				
KITSAP	98380		*	0	0	0	0				
JEFFERSON	98382	14	*	2	6	3	9				
KITSAP	98383		*	0	0	0	0				
PIERCE	98385	*		0	0	0	0				
KITSAP	98386	*		0	0	0	0				
PIERCE	98387		9	0	0	0	0				
PIERCE	98388			0	0	0	0				
PIERCE	98390	*	*	0	0	0	0				
PIERCE	98391	*	*	0	0	0	0				
KITSAP	98392			0	0	0	0				
KITSAP	98393			0	0	0	0				
PIERCE	98396			0	0	0	0				
PIERCE	98422			0	0	0	0				
PIERCE	98424			0	0	0	0				
PIERCE	98439			0	0	0	0				
PIERCE	98445		*	0	0	0	0				

PIERCE	98446	*	5	0	0	0	0				
PIERCE	98498			0	0	0	0				
PIERCE	98499			0	0	0	0				
THURSTON	98501	*	*	0	0	0	0				
THURSTON	98502			0	0	0	0				
THURSTON	98503			0	0	0	0				
THURSTON	98506	*	8	0	0	0	0				
THURSTON	98512	*	*	0	0	0	0				
PIERCE	98513	*	*	0	0	0	0				
THURSTON	98513	*	*	0	0	0	0				
THURSTON	98516			0	0	0	0				
THURSTON	98530			0	0	0	0				
THURSTON	98531	5	12	1	2	1	3				
PIERCE	98558			0	0	0	0				
THURSTON	98568	8	*	1	4	2	5				
THURSTON	98576	*	7	0	0	0	0				
THURSTON	98579	13	12	2	6	2	9				
PIERCE	98580	5	12	1	2	1	3				
THURSTON	98589	*	*	0	0	0	0				
THURSTON	98597	9	9	1	4	2	6				
KITTITAS	98922	*	*	0	0	0	0				
KITTITAS	98925			0	0	0	0				
KITTITAS	98926	11	21	2	5	2	7				
KITTITAS	98934			0	0	0	0				
KITTITAS	98940			0	0	0	0				
KITTITAS	98941			0	0	0	0				
KITTITAS	98943			0	0	0	0				
KITTITAS	98946			0	0	0	0				
* - Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the 'State Total' category.											
Source:	USDA Farms, Land in Farms & Livestock, 2/07										
	http://www.nass.usda.gov/Census_of_Agriculture/index.asp										

Table 5. Existing Landfills in PSE Territory

Project ID #	Landfill ID #	Expansion ID #	LMOP Territory	Landfill Name	Landfill City	Landfill County	State	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW Capacity	LFG Flow to Project (mmscfd)	Emission Reductions (MMTCO2E/yr)
1695	1616	0	3	Hidden Valley LF	Puyallup	Pierce	WA	17,425,280	1959	1999	Land Recovery, Inc.	Operational	1/1/1999			Electricity	Reciprocating Engine	1.9		0.082
1701	1622	0	3	Olympic View LF	Port Orchard	Kitsap	WA	7,004,248	1960	2012	Kitsap County	Operational	1/1/1998		Shaw Environmental, Inc.	Direct	Leachate Evaporation			
1685	1606	0	3	Cedar Hills LF	Maple Valley	King	WA	24,135,629	1962	2012	King County, WA	Construction	6/1/2008		Energy Developments	Electricity	Gas Turbine	17.0		0.729
1692	1613	0	3	Fort Lewis LF #5	Fort Lewis	Pierce	WA	1,198,910	1969	2004	Fort Lewis-PW / ENRD	Candidate								
1736	1656	0	3	Kent Highlands LF	Kent	King	WA	8,000,000	1968	1986	City of Seattle, WA	Candidate								
1694	1615	0	3	Thurston County Waste and Recovery Center	Olympia	Thurston	WA	750,000	1970	2001	Thurston County	Candidate								
1722	1643	0	3	Carnation LF		King	WA			1989		Potential								
1713	1634	0	3	Cedarville LF		Whatcom	WA	250,000	1981	1990		Potential								
1715	1636	0	3	Enumclaw LF		King	WA		1958	1993	Landfill Owner	Potential								
1723	1644	0	3	Gibralter LF		Skagit	WA			1989		Potential								
1716	1637	0	3	Hansville LF		Kitsap	WA	599,880	1962	1989		Potential								
1717	1638	0	3	Hobart LF		King	WA	413,697	1958	1994	Landfill Owner	Potential								
1718	1639	0	3	Inman LF		Skagit	WA				Landfill Owner	Potential								
1727	1648	0	3	Olalla LF		Kitsap	WA			1989		Potential								
1729	1650	0	3	Point Roberts LF		Whatcom	WA			1991		Potential								
1709	1630	0	3	Vashon LF	Vashon Island	King	WA	281,554	1963		Landfill Owner	Potential								

Source: http://www.epa.gov/lmop/proj/index.htm#1

Table 6. Wastewater Treatment Facilities in PSE Territory

County Name +	Authority Name	Facility Name	Watershed Name	Congressional District	Existing Municipal Flow (Mgd)	Present Municipal Flow (Mgd)	Future Municipal Flow (Mgd)	Total Existing Flow (Mgd)	Present Design Flow (Mgd)	Future Design Flow (Mgd)
ISLAND	COUPEVILLE, TOWN OF	COUPEVILLE STP	Puget Sound.	2	0.18	0.21	0.3	0.18	0.21	0.3
ISLAND	LANGLEY WATER AND SEWER D	LANGLEY S/T FACILITY	Puget Sound.	2	0.09	0.128	0.128	0.09	0.128	0.128
ISLAND	OAK HARBOR, CITY OF	OAK HARBOR STP	Puget Sound.	2	0.57	0.595	0.595	0.57	0.595	0.595
ISLAND	PENN COVE SEWER DIST	PENN COVE S.D. STP	Puget Sound.	2	0.04	0.051	0.051	0.04	0.051	0.051
JEFFERSON	PORT TOWNSEND, CITY OF	PORT TOWNSEND STP	Puget Sound., Dungeness-Elwha.	6	0.81	0.81	0.81	0.81	0.81	0.81
KING	DES MOINES SEWER DISTRICT	DES MOINES STP	Puget Sound.	7	4.5	7.65	7.65	4.5	7.65	7.65
KING	DUVALL ,TOWNOF	DUVALL WW TREAT FAC	Snoqualmie.	8	0.636	0.9	0.9	0.636	0.9	0.9
KING	ENUMCLAW, CITY OF, WATER	ENUMCLAW STP	Puyallup.	8	1.8	2.4	3.7	1.83	2.43	3.73
KING	FEDERAL WAY SEWER DIST.	LAKOTA STP	Puget Sound.	9	4	10	10	4	10	10
KING	FEDERAL WAY WATER & SEWER	REDONDO STP	Puget Sound.	9	2.4	4.32	4.32	2.4	4.32	4.32
KING	KING CO. SEWER DISTRICT	SPRING BEACH	Puget Sound.	7			0.005			0.005
KING	MUN OF METRO SEATTLE	RENTON WWTP	Duwamish., Puget Sound.	9	70	122	122	70	122	122
KING	MUN OF METRO SEATTLE	WEST POINT WWTP	Puget Sound.	7	100	133	133	100	133	133
KING	NORTH BEND, CITY OF	NORTH BEND TREATMENT PLAN	Snoqualmie., Hood Canal.	8	0.636	1.06	2.503	0.636	1.06	2.503
KING	SNOQUALMIE ,TOWNOF	SNOQUALMIE LAGOONS	Snoqualmie.	8	0.34	0.72	0.72	0.34	0.72	0.72
KING	SOUTHWEST	MILLER	Puget Sound.	7	3.3	5.2	7	3.3	5.2	

	SUBURBAN SEWER	CREEK STP								
KING	SW SUBURBAN SEWER DISTRIC	SALMON CREEK STP #1	Puget Sound.	7	2.4	6.88	6.88	2.4	6.88	6.88
KING	VASHON SEWER DISTRICT	VASHON STP	Puget Sound.	7	0.175	0.264	0.264	0.175	0.264	0.264
KITSAP	BAINBRIDGE ISLAND CITY OF	WINSLOW S/T FACILITY	Puget Sound.	1	0.39	0.5	0.5	0.39	0.5	0.5
KITSAP	BREMERTON ,CITYOF	BREMERTON STP	Puget Sound.	6	7	10	20	7	10	20
KITSAP	KITSAP CO. COMMISSION ERS	CENT. KITSAP REG. STP	Puget Sound.	1	3.3	5.1	8.79	3.3	5.1	8.79
KITSAP	KITSAP CO. PUBLIC WORKS	KINGSTON STP	Puget Sound.	6	0.14	0.15	0.29	0.14	0.15	0.29
KITSAP	KITSAP CO. S.D. #3	MANCHESTER STP	Puget Sound.	6	0.17	0.23	0.23	0.17	0.23	0.23
KITSAP	KITSAP COUNTY SD #7	FORT WARD	Puget Sound.	6	0.1	0.142	0.142	0.1	0.142	0.142
KITSAP	KITSAP, COUNTY OF	SUQUAMISH STP	Puget Sound.	6	0.1	0.2	0.2	0.1	0.2	0.2
KITSAP	PORT ORCHARD PUBLIC WORKS	RETSIL TREATMENT PLANT	Puget Sound.	6	1.8	2.38	4.8	1.8	2.38	4.8
KITTITAS	CLE ELUM, CITY OF	CLE ELUM S/T FACILITY	Upper Yakima.	4	0.605	0.643	1.45	0.605	0.643	1.45
KITTITAS	ELLENSBURG ,CITYOF	ELLENSBURG STP	Upper Yakima.	4	3.11	8	8	3.11	8	8
KITTITAS	KITTITAS CO. W.D. #6	KITTITAS CO #6 STP	Upper Columbia-Entiat.	4	0.01	0.015	0.09	0.01	0.015	0.09
KITTITAS	KITTITAS, CITY OF	KITTITAS STP	Upper Yakima.	4	0.16	0.28	0.29	0.16	0.28	0.29
KITTITAS	ROSLYN, CITY OF	ROSLYN S/T FACILITY	Upper Yakima.	4	0.136	0.22	0.22	0.136	0.22	0.22
KITTITAS	SNOQUALMIE PASS S.D.	SNOQUALMIE PASS S/T FAC.	Upper Yakima.	4	0.1	0.368	0.368	0.1	0.368	0.368
PIERCE	BUCKLEY, CITY OF	BUCKLEY STP	Puyallup.	8	0.29	0.44	0.44	0.29	0.44	0.44

PIERCE	CARBONADO, CITY OF	CARBONADO S/T FAC.	Puyallup.	8	0.03	0.1	0.1	0.03	0.1	0.1
PIERCE	EATONVILLE ,TOWNOF	EATONVILLE STP	Nisqually.	8	0.08	0.13	0.13	0.08	0.13	0.13
PIERCE	EATONVILLE STP	EATONVILLE WWTP	Nisqually.	8	0.453	0.453	0.534	0.453	0.453	0.534
PIERCE	ELBE, TOWN OF	ELBE COMM. SEPTIC	Nisqually.	8	0.08	0.01	0.01	0.08	0.01	0.01
PIERCE	ORTING ,TOWNOF	ORTING S/T FACILITY	Puyallup.	8	1.2	1.2	1.2	1.2	1.2	1.2
PIERCE	PIERCE COUNTY	CHAMBERS CREEK	Puget Sound.	6	14.3	18	18	14.3	18	18
PIERCE	PIERCE COUNTY	GIG HARBOR STP	Puget Sound.	6	0.886	1.36	3.5	0.886	1.36	3.5
PIERCE	PUYALLUP, CITY OF	PUYALLUP STP	Puyallup.	9	4.78	4.78	4.78	4.78	4.78	4.78
PIERCE	SOUTH PRAIRIE, TOWN OF	SOUTH PRAIRIE AREA	Puyallup.	8	0.038	0.038	0.048	0.038	0.038	0.048
PIERCE	SUMNER, CITY OF	SUMNER STP	Puyallup.	8	1.5	2.62	3.42	1.5	2.62	3.42
PIERCE	TACOMA, CITY OF	TACOMA CENTRAL STP #1	Puyallup., Puget Sound.	6	22.8	38	50	22.8	38	50
PIERCE	TACOMA, CITY OF	TACOMA #3 STP NORTH	Puget Sound.	6	4.4	7	7	4.5	7.1	7.1
PIERCE	WILKESON, TOWN OF	WILKESON STP	Puyallup.	8	0.03	0.03	0.03	0.03	0.03	0.03
SKAGIT	ANACORTES, CITY OF,DEPT PW	ANACORTES STP	Strait Of Georgia.	2	1.59	3.2	3.2	1.59	3.2	3.2
SKAGIT	BURLINGTON ,CITYOF	BURLINGTON S/T FAC.	Lower Skagit.	2	0.8	1.2	1.2	0.8	1.2	1.2
SKAGIT	CONCRETE ,TOWNOF	CONCRETE S/T FACILITY	Upper Skagit., Lower Skagit.	2	0.038	0.038	0.038	0.038	0.038	0.038
SKAGIT	LA CONNER, TOWN OF	LA CONNER S/T FACILITY	Puget Sound.	2	0.15	0.23	0.23	0.15	0.23	0.23
SKAGIT	MOUNT VERNON ,CITYOF	MOUNT VERNON S/T FAC.	Lower Skagit.	2	3	4	4	3.3	4.36	4.36
SKAGIT	SEDRO WOOLLEY ,CITYOF	SEDRO WOOLLEY STP	Lower Skagit.	2	0.65	1.759	1.759	0.65	1.759	1.759
SKAGIT	SKAGIT COUNTY SD # 1	SNEE OOSH BEACH STP	Puget Sound.	2	0.01	0.04	0.04	0.01	0.04	0.04

SKAGIT	SKAGIT COUNTY SD #2	SKAGIT CO. SD # 2 STP	Lower Skagit.	2	0.09	0.17	0.4	0.09	0.17	0.4
THURSTON	CARLYON BEACH WWTP	CARLYON BEACH WWTP	Puget Sound.	3	0.02	0.038	0.038	0.02	0.038	0.038
THURSTON	OLYMPIA, CITY OF	OLYMPIA STP	Puget Sound.	3	17	17	17	17.9	20.6	20.6
THURSTON	THURSTON COUNTY	BOSTON HARBOR WWTF	Puget Sound.	3	0.045	0.045	0.045	0.045	0.045	0.045
THURSTON	THURSTON COUNTY PWD	TAMOSHAN DEVELOPMEN T	Puget Sound.	3	0.01	0.05	0.05	0.01	0.05	0.05
THURSTON	YELM, CITY OF	YELM S/T FACILITY	Nisqually.	3	1	1	1	1	1	1
WHATCOM	BELLINGHAM SEWER DEPT	BELLINGHAM POST POINT TP	Strait Of Georgia., Nooksack.	2	20	30	30	20	30	30
WHATCOM	BIRCH BAY WATER DISTRICT #8	BIRCH BAY STP	Strait Of Georgia.	2	0.6	0.85	0.85	0.6	0.85	0.85
WHATCOM	BLAINE, CITY OF, WAT & SE	BLAINE STP	Strait Of Georgia.	2	0.483	0.68	0.68	0.483	0.68	0.68
WHATCOM	EVERSON, TOWN OF	EVERSON S/T FACILITY	Nooksack.	2	0.12	0.18	0.18	0.12	0.18	0.18
WHATCOM	FERNDALE ,TOWNOF	FERNDALE STP	Nooksack.	2	1.1	2.7	2.7	1.1	2.7	2.7
WHATCOM	LYNDEN ,CITYOF	LYNDEN SEWAGE TREATMENT P	Nooksack.	2	0.31	0.41	0.41	0.31	0.41	0.41

Source: http://www.epa.gov/lmop/proj/index.htm

Table 7. Installed CHP facilities in PSE Territory

State	City	Organization Name	Facility Name	Application	SIC4	NAICS	Op Year	Prime Mover	Capacity (kw)	Fuel Type
WA	Bremerton	Bremerton Wastewater	Bremerton Wastewater	Wastewater Treatment	4952	22132	.	ERENG	152	BIOMASS
WA	Lynden	Vander Haak Dairy	Vander Haak Dairy	Agriculture	241	11212	2004	ERENG	450	BIOMASS
WA	Ferndale	Whatcom Co. MSW	Whatcom Co. MSW	Solid Waste Facilities	4953	562212	1986	B/ST	2000	WAST
WA	Darrington	Hampton Timber Mill	Hampton Timber Mill	Wood Products	2421	321113	2006	B/ST	7200	WOOD
WA	Renton	King County Wastewater Treatment Div.	South Treatment Plant	Wastewater Treatment	4952	562111	2004	CT	9500	BIOMASS
WA	Port Townsend	Port Townsend Paper Company	Port Townsend Paper Company	Pulp and Paper	2621	322121	1990	B/ST	14500	WAST
WA	Burlington	Sierra Pacific - Skagit County	Sierra Pacific	Wood Products	2421	321113	2007	B/ST	26000	WOOD

Prime Mover Code	Description	Sites	Capacity (kW)	Fuel Code	Description
Total		7	59,802	BIOMASS	Biomass, landfill gas, digester gas, bagasse
B/ST	Boiler/Steam Turbine	4	-	WAST	Waste, MSW, black liquor, blast furnace gas, petroleum coke, process gas
CC	Combined Cycle	0	49,700	WOOD	Wood, wood waste
CT	Combustion Turbine	1	9,500		
FCEL	Fuel Cell	0	-		
MT	Microturbine	0	-		
OTR	Other	0	-		
ERENG	Reciprocating Engine	2	602		

Source: http://www.eea-inc.com/chpdata/States/WA.html

Table 8. Number of Facilities by Segment and Average Annual Usage

			Average annual usage bins						
State	Sector	Segment	< 30 kW	30-99 kW	100-199 kW	200-499 kW	500-999 kW	1 - 4.9 MW	5 MW+
WA	IND	Chemical_Mfg	152	10	3	4	1	3	3
WA	IND	Computer_Electronic_Mfg	390	37	16	10	5	2	0
WA	COM	Dry Goods Retail	10086	686	106	94	29	3	0
WA	IND	Electrical_Equipment_Mfg	114	11	1	2	0	0	0
WA	IND	Fabricated_Metal_Products	463	31	7	6	2	4	0
WA	IND	Food_Mfg	473	39	9	15	12	5	0
WA	COM	Grocery	1387	134	72	87	4	3	0
WA	COM	Hospital	5779	278	79	33	11	10	0
WA	COM	Hotel Motel	1488	163	31	24	5	0	0
WA	IND	Industrial_Machinery	640	55	11	5	3	1	0
WA	IND	Miscellaneous_Mfg	1270	75	29	15	1	3	0
WA	IND	Nonmetallic_Mineral_Products	261	26	8	4	2	2	0
WA	COM	Office	38634	1009	282	152	47	31	7
WA	COM	Other_Comm	35669	666	137	76	19	11	1
WA	IND	Paper_Mfg	50	15	4	4	8	1	1
WA	IND	Petroleum_Coal_Products	27	7	2	0	0	0	2
WA	IND	Plastics_Rubber_Products	182	18	9	4	5	2	1
WA	IND	Primary_Metal_Mfg	75	2	2	0	0	1	0
WA	IND	Printing_Related_Support	433	20	7	1	0	0	0
WA	COM	Restaurant	4080	508	15	4	3	3	0
WA	COM	School	1312	516	137	53	1	0	0
WA	IND	Transportation_Equipment_Mfg	422	55	25	12	4	3	3
WA	COM	University	634	38	10	7	8	5	0
WA	COM	Warehouse	4475	279	46	46	10	0	0
WA	IND	Wood_Product_Mfg	356	24	9	6	3	5	0
WA	COM	Swine Farms	0	54	185	0	0	0	0
WA	COM	Dairy Farms	0	0	98	279	0	0	0
WA	COM	Landfills (kW)	0	0	1205	4520	2	28.7	0
WA	COM	Wastewater (kW)	0	0	598	618	0.6	0	0

Clean Energy Background Data

The installed costs and operation and maintenance costs (O&M) for the three clean energy technologies are shown in Table 9. Also included are expected measure life and capacity factors. Capacity factors are an indication of the percentage of the year energy will be produced. Further details for each technology are given below.

Table 9. Costs, Measure Life, and Capacity Factor for Clean Energy Resources

Technology	Average Installed Cost ($/kW)	O&M Cost ($/kW/yr)	Measure Life	Capacity Factor
Building PV[5]	$8,642	$100	25	0.12
Small Hydro[6]	$5,688	$535	40	0.80
Small Wind [7]	$8,197	$20	25	0.06

Building PV

On-site PVs consist of solar electricity-generation from building-mounted photovoltaic panels. PV systems are weather-dependent and rely on the sun to generate electricity. This study focuses on renewable-electricity generation potential from rooftop residential and commercial buildings. PV systems include an array of solar electric modules, an inverter (DC to AC), and a balance of systems. These systems do not have battery back-up equipment and are completely connected to the utility (grid-tied). PV generation is a whole-building electricity generation resource and typically only offsets a portion of baseline loads. In most cases, PV is considered a secondary source of a building's energy needs. When excess PV electricity is generated (more than the building's loads), it is fed back into the grid. This depends heavily on the PV system size and current weather and, for residential and commercial customers, generally occurs when the building is not occupied.

Three primary PV technologies considered are: (1) mono-crystalline (single crystalline cell); (2) poly-crystalline (multi-crystalline cell); and (3) amorphous thin-film. These three technologies currently dominate the solar market.[8] Efficiencies of these technologies are improving annually and are accounted for in this study. This study does not include large PV generation facilities that operate to sell the majority (or all) of their power to the grid and emerging PV technologies.

The PV Watts performance calculator, developed by the National Renewable Energy Laboratory, is used to determine the capacity factor.[9] The amount of solar insolation (i.e., the measure of solar energy received on a given surface area in a given time), based on weather stations, determines the performance potential for the region. To maximize roof area coverage for calculation of technical potential, commercial and multifamily buildings are fixed with 0.0° array tilt (flat roof), while single-family and manufactured homes are fixed at 18.5° tilt (4/12 pitch).

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5 First year cost.
6 Average cost.
7 Average cost and capacity factor.
8 EIA, based on photovoltaic cell and module shipments by type, 2006.
9 http://rredc.nrel.gov/solar/codes_algs/PVWATTS/

However, for actual installations (used in achievable technical potential), the PV arrays are generally fixed at an angle to maximize solar exposure with coverage. This translates to an optimal array tilt of 33.5° for commercial buildings and 22.5° for residential buildings. With this variance in array tilt, there is a slight difference in the capacity factor; however, for PSE territory, the difference is minimal and the capacity factor for both sectors is 0.12.

PV Energy Costs. The primary and secondary resources for PV installed costs are from the California Energy Commission (CEC), the Energy Trust of Oregon (ETO), the U.S. Department of Energy (DOE), and other on-line sources. Cost analysis for PV installation of other programs results in an average installation cost in 2006 of $9/W[10]; a cost of $8.64/W in 2010 is assumed for this analysis. Given expected technological improvements, the installed cost of PV is assumed to nearly halve by 2029 to $4.73/W.[11, 12, 13, 14, 15] Other technical data have been acquired from multiple primary and secondary resources to determine measure life (25 years[16]), and O&M costs. O&M costs of $100/kW/yr include inverter replacement every ten years and seasonal module washing.[17]

10 "Solar Trends: California Energy Commission" by SunPower Consulting LLC provided cost analysis, August 2006, ETO, and DOE.

11 NREL, "Solar Electric Power: The US Photovoltaic Industry Roadmap", 2001

12 EERE, "Solar Energy Technologies Multi-Year Technical Plan 2003-2007", 2004

13 DOE/EIA, "Annual Energy Outlook 2008", 2008

14 Prometheus Institute, "PV Technology, Performance, and Cost", 2007

15 PSE PV cost projections and PV costs include installed labor, contractor profit and overhead

16 Data was averaged from the following sources: NREL, NW Power, and Conservation Council, and typical warranty periods.

17 NREL, "A Review of PV Inverter Technology Cost and Performance Projections", 2006.

Table 10. Summary Market Potential

Market Scenario	Market Potential 2029 (MW)	Market Potential 2029 (aMW)	Market Potential (Percent of Technical) in 2029	Levelized Cost w/out Subsidy	Levelized Cost w/ Subsidy	Cost per kW in 2010	Cost per kW in 2029	Annual O&M Cost per kW
PV Market	172	21	0.79%	$0.69	$0.61	$8,642	$4,733	$100

172 MW

PV Growth			2009	2010	2011	2012	2013	2014
Commercial	Tech MW		7,429	7,766	8,118	8,487	8,872	9,275
	Tech aMW		732	765	792	820	850	881
Residential	Tech MW		1,759	1,831	1,906	1,983	2,062	2,145
	Tech aMW		188	195	201	208	214	221
Ccombined	Tech MW		9,188	9,597	10,024	10,470	10,935	11,420
	Tech aMW		919	960	993	1,028	1,064	1,101
Market Potential (Percent of Technical)		0.039%	0.79%	0.79%	0.79%	0.79%	0.79%	0.79%
Market Curve Cumulative Commercial		DSM	3%	1%	3%	5%	7%	11%
Market Curve Cumulative Residential		DSM	3%	6%	13%	19%	28%	42%
Commercial	Market MW		(1.75)	0.76	1.99	3.13	4.90	7.69
	Market aMW		(0.21)	0.09	0.24	0.38	0.60	0.94
Residential	Market MW		(0.41)	0.79	1.87	2.92	4.56	7.11
	Market aMW		(0.19)	0.10	0.23	0.35	0.55	0.86
Combined	Market MW		(2.17)	1.55	3.87	6.05	9.46	14.80
	Market aMW		(0.41)	0.19	0.47	0.73	1.15	1.80
			(Existing Capicity)					

Assumptions	
Admin Cost %	10%
O&M Fixed $/kW	$100
PV Life yrs	25
Inflation %	2.0%
Discount Rate %	8.4%

Without State and Federal Incentives

Commercial			
			Cost per kW ($)
At Customer			MW
			aMW
At Generation			MW_w/adders
Line Loss:	6.7%		aMW+adders
Lev Cost:	$0.68	$/kWh	Inst costs ($)
Lev Cost w/adders:	$0.63	$/kWh	O&M ($)
NPV:	$434,848	($000)	Lump sum ($)
Residential			
			Cost per kW ($)
At Customer			MW
			aMW
At Generation			MW_w/adders
Line Loss:	6.7%		aMW+adders
Lev Cost:	$0.75	$/kWh	Inst costs ($)
Lev Cost w/adders:	$0.71	$/kWh	O&M ($)
NPV:	$123,764	($000)	Lump sum ($)
Combined Commercial and Residential PV			
At Customer			MW
			aMW
At Generation			MW_w/adders
Line Loss:	6.7%		aMW+adders
Lev Cost:	$0.69	$/kWh	Inst costs ($)
Lev Cost w/adders:	$0.65	$/kWh	O&M ($)
NPV:	$558,612	($000)	Lump sum ($)

With State and Federal Incentives

No Subsiby			
Lev Cost:	Com	$/kWh	$0.68
Lev Cost:	Res	$/kWh	$0.75
Lev Cost w/add	Com	$/kWh	$0.63
Lev Cost w/add	Res	$/kWh	$0.71
Federal Tax Credit (ITC)			
Lev Cost:	Com	$/kWh	$0.59
Lev Cost:	Res	$/kWh	$0.64
Lev Cost w/add	Com	$/kWh	$0.55
Lev Cost w/add	Res	$/kWh	$0.60
State Tax Credit (BETC)			
Lev Cost:	Com	$/kWh	$0.68
Lev Cost:	Res	$/kWh	$0.75
Lev Cost w/add	Com	$/kWh	$0.63
Lev Cost w/add	Res	$/kWh	$0.71
Production Subsidy			
Lev Cost:	Com	$/kWh	$0.67
Lev Cost:	Res	$/kWh	$0.74
Lev Cost w/add	Com	$/kWh	$0.63
Lev Cost w/add	Res	$/kWh	$0.69
Federal Tax Credit (ITC) and State Tax Credit (BETC)			
Lev Cost:	Com	$/kWh	$0.59
Lev Cost:	Res	$/kWh	$0.64
Lev Cost w/add	Com	$/kWh	$0.55
Lev Cost w/add	Res	$/kWh	$0.60
Federal Tax Credit (ITC), State Tax Credit (BETC) and Production Subsidy			
Lev Cost:	Com	$/kWh	$0.59
Lev Cost:	Res	$/kWh	$0.63
Lev Cost w/add	Com	$/kWh	$0.55
Lev Cost w/add	Res	$/kWh	$0.59

Assumptions

Optimal Capacit	Com	CF	0.12
Optimal Capacit	Res	CF	0.12
Output (kWh/kW	Com	kWh/kW/year	1071
Output (kWh/kW	Res	kWh/kW/year	1055

Subsidy

Federal Tax Cre	Com	%	30%
Federal Tax Cre	Res	%	30%
State Tax Credi	Com	%	0%
State Tax Credi	Res	%	0%
Production Sub:	Com	$/kWh	$0.15
Production Sub:	Res	$/kWh	$0.15
Production Sub:	Com	Term END	2015
Production Sub:	Res	Term END	2015

Table 11. PSE DG: PV Technicial Potential

Sector	Building Type	Capacity Factor	2010 kW	2029 kW	2010 kWh*	2029 kWh*	2010 aMW*	2029 aMW*
Commercial Sector	Dry_Goods_Retail	0.10	527,704	1,225,104	5,358,119	10,876,686	52	106
	Grocery	0.10	108,686	252,322	1,103,557	2,240,159	11	22
	Hospital	0.10	341,608	793,068	3,468,566	7,040,998	34	68
	Hotel_Motel	0.10	40,762	94,631	413,880	840,154	4	8
	Office	0.10	2,855,720	6,629,761	28,995,952	58,860,181	281	571
	Other	0.10	2,922,078	6,783,817	29,669,729	60,227,912	288	584
	Restaurant	0.10	161,742	375,496	1,642,272	3,333,721	16	32
	School	0.10	167,520	388,909	1,700,936	3,452,806	16	33
	University	0.10	84,933	197,178	862,379	1,750,582	8	17
	Warehouse	0.10	556,875	1,292,826	5,654,309	11,477,935	55	111
	Total Commercial (MW/MWh)	0.10	7,768	18,033	78,870	160,101	765	1,553
Residential Sector	Multi_Family	0.10	490,913	1,028,038	4,984,552	9,059,404	48	88
	Manufactured	0.11	196,790	412,105	1,768,841	3,214,862	22	40
	Single_Family	0.11	1,143,905	2,395,492	10,281,958	18,687,418	127	231
	Total Residential (MW/MWh)	0.11	1,832	3,836	17,035	30,962	198	359
	Total Technical Potential (MW/MWh)	0.10	9,599	21,869	95,905	191,063	963	1,912

Table 12. Module, Inverter and Total System Costs, System Prices

Assumptions
2008 $
Inflation rate 2.00%

MARKET CASE 2008 $

	Sector	Distributor Module Cost per Watt	Distributor Inverter Cost per Watt	Labor Installed Costs per Watt	Install Costs per Watt	Bulk Quantity Discount	Customers % Receiving Bulk Discount	TOTAL Install Cost per Watt	Source
2008 Costs	Commercial	$ 4.82	$ 0.72	$ 3.61	$ 9.15	5%	40%	$ 8.96	SolarBuzz.co
	Com %	53%	8%	39%	100%				
	Residential	$ 4.82	$ 0.72	$ 3.61	$ 9.15	0%	0%	$ 9.15	SolarBuzz.co
	Res %	53%	8%	39%	100%				
2010 Costs	Commercial	$ 4.40	$ 0.66	$ 3.29	$ 8.35	8%	40%	$ 8.10	Prometheus
	Com %	53%	8%	39%	100%				
	Residential	$ 4.49	$ 0.67	$ 3.36	$ 8.52	0%	0%	$ 8.52	Prometheus
	Res %	53%	8%	39%	100%				
2015 Costs	Commercial	$ 3.97	$ 0.59	$ 2.97	$ 7.54	10%	40%	$ 7.24	Prometheus
	Com %	53%	8%	39%	100%				
	Residential	$ 4.05	$ 0.61	$ 3.03	$ 7.69	0%	0%	$ 7.69	Prometheus
	Res %	53%	8%	39%	100%				
2020 Costs	Commercial	$ 3.43	$ 0.51	$ 2.57	$ 6.52	10%	40%	$ 6.26	DOE/NREL
	Com %	53%	8%	39%	100%				
	Residential	$ 3.50	$ 0.52	$ 2.62	$ 6.65	0%	0%	$ 6.65	DOE/NREL
	Res %	53%	8%	39%	100%				
2025 Costs - 2030 Costs	Commercial	$ 1.84	$ 0.54	$ 2.31	$ 4.68	10%	40%	$ 4.50	DOE/NREL
	Com %	39%	11%	49%	100%				
	Residential	$ 1.88	$ 0.55	$ 2.35	$ 4.78	0%	0%	$ 4.78	DOE/NREL
	Res %	39%	11%	49%	100%				

Sector	PV Cost	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Commercial	Market Case	$ 8.96	$ 8.76	$ 8.55	$ 8.35	$ 8.15	$ 7.94	$ 7.74	$ 7.54	$ 7.33	$ 7.13	$ 6.93	$ 6.72	$ 6.52
Residential	Market Case	$ 9.15	$ 8.94	$ 8.73	$ 8.52	$ 8.31	$ 8.11	$ 7.90	$ 7.69	$ 7.48	$ 7.27	$ 7.07	$ 6.86	$ 6.65
Commercial	Base Case	$ 8.96	$ 8.53	$ 8.10	$ 7.93	$ 7.75	$ 7.58	$ 7.41	$ 7.24	$ 7.04	$ 6.84	$ 6.65	$ 6.45	$ 6.26
Residential	Base Case	$ 9.15	$ 8.83	$ 8.52	$ 8.36	$ 8.19	$ 8.02	$ 7.86	$ 7.69	$ 7.48	$ 7.27	$ 7.07	$ 6.86	$ 6.65
Commercial	High Case	$ 5.87	$ 5.42	$ 5.40	$ 5.18	$ 4.95	$ 4.26	$ 4.51	$ 3.67	$ 4.10	$ 3.93	$ 3.78	$ 3.63	$ 3.61
Residential	High Case	$ 6.16	$ 5.69	$ 5.67	$ 5.43	$ 5.20	$ 4.47	$ 4.73	$ 3.85	$ 4.30	$ 4.13	$ 3.97	$ 3.81	$ 3.79

Market Case = Assume PV costs decrease based on market data by 50% in 2029 based on DOE/NREL while install costs remain high
Base Case = Assume PV costs decrease based on market data by 66% in 2029 based on DOE/NREL
High Case = Assume PV costs decrease based on aggressive market data - assume cost data from sources (average)

Sources

1 **SOLARBUZZ**

Lowest Prices ($/Wp)

The tracking of the lowest price band in the survey is measured against the number of prices below $4.75 per watt (previously analyzed to below $4.50 per watt).
As of July 2008, there are currently 188 solar module prices below $4.75 per watt (€2.99 per watt) or 13.0% of the total sample.
This compares with 201 prices below $4.75 per watt in June.
The lowest retail price for a multicrystalline solar module is $4.17 per watt (€2.63 per watt) from a US retailer.
The lowest retail price for a monocrystalline module is $4.35 per watt (€2.74 per watt), also from a US retailer.
The module cost represents around 50 - 60% of the total installed cost of a Solar Energy System.

Year	Distributor Modu	Distributor Invert	Module % of To	Total Installed Cost $/Watt
2005	$ 4.57		53%	$ 8.67
2006	$ 4.82	$ 0.71	53%	$ 9.14
2007	$ 4.85	$ 0.71	53%	$ 9.21
2008	$ 4.82	$ 0.72	53%	$ 9.15
Averaged:	$ 4.76	$ 0.71	$ 0.53	$ 9.04

2 **NREL**

Accounding to NREL's U.S. Photovoltaics Industry Roadmap, in 2027 the estimated installed cost for PV will be:
estimated: $ 3.25 $/Watt

3 **California Energy Commission (CEC)**

http://www.renewableenergyaccess.com/rea/news/infocus/story?id=46191
http://www.renewableenergyaccess.com/assets/images/story/2006/10/11/table1.gif
Average Installed costs in CA for less than 30kW over the last 5 years

2002	$ 9.97
2003	$ 9.00
2004	$ 8.63
2005	$ 8.71
2006	$ 9.14
Averaged:	$ 9.09

Table 13. Module Power Density Assumptions

* Power Density

Technology	% shares in x-S	Module power density (Wp/sq. ft). 2010
Mono crystalline	25%	15.9
Poly-crystalline/Ribbon	44%	14.7
Amorphous silicon (thin film)	30%	7.1
Weighted average		12.7

System power density (Wp/sq. ft.)

2010	2015	2029
10.18	11.28	15.07

Module power density (w/sq.ft.)
System power density (w/sq.ft) = 1.25 / Module power density (this accounts for the additional space required for installation such as space bewteen modules, racking, wiring, etc)

U.S. National Photovoltaics Program Goals - 2000-2005

	1995	2000	2005	2020-2030	
Module Efficiency (percent)	7-17	8-18	10-20	15-25	*assume average
average eff percent	12	13	15	20	
Increase per yr	-	0.20	0.40	0.25	
Change in %		1.6%	3.0%	1.6%	
		average	2.09%		

Source: U.S. Department of Energy, *Photovoltaics - Energy for the New Millennium: The National Photovoltaics Program Plan 2000-2004*, DOE/GO-10099-940 (Washington, DC, January 2000), p. 9.

Note: Table shows range of module efficiencies for commercial flat-plate and concentrator modules

Sources:
Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey." Link: http://www.eia.doe.gov/cneaf/solar.renewables/page/solarreport/solar.html
IEA 2002: http://iea-pvps.org/pv/materials.htm
NREL: 2007 R&D Future - PROJECTIONS OF FUTURE PERFORMANCE Graph
NREL: 2005 http://www.nrel.gov/docs/fy05osti/37353.pdf

Comparible Sources:

Energy Foundation 2004

Technology	% share in x-Si Production	Module power density (Wp/sq. ft).	System power density (Wp/sq. ft.) 2003	2010	2025
Mono crystalline	41%	12.2	8.70	10.20	12.30
Poly-crystalline	59%	9.9			
Weighted average		10.80			
Based on 2.4% increase per yr					

Energy Foundation PV: http://www.ef.org/documents/EF-Final-Final2.pdf

Table 14. PSE Building Assumptions

RESIDENTIAL

Residential Assumptions	Roof Pitch			Usable roof orientation by % (max 25%)				Usable Sq.Ft. Factors				Total
Building Type	Roof Pitch	Pitch in Degrees	% increase in r	N	E	S	W	% sq.ft. roof d	% usable sqft	% sq.ft. availa	Tree or buildi	Total Usable Sq.Ft.
Multi_Family*	0/12 pitch	0	1	25%	25%	25%	25%	100%	100%	70%	50%	35.0%
Manufactured	4/12 pitch	18.43	1.05	0%	25%	25%	25%	50%	38%	85%	50%	16.8%
Single_Family	4/12 pitch	18.43	1.05	0%	25%	25%	25%	50%	38%	85%	50%	16.8%

Manufactured Homes and Single-Family assumes 15% loss due to obstructions
Multi-Family assume 30% loss due to obstructions
All residential building types assume 50% loss due to shading (by trees and other buildings) and technical feasiblity
* All mulit-family units are considered flat roof and use the same commercial times 50% of useable area factor
Assumptions based inpart on Cadmus Solar experience and with reasonable limits based on Energy Foundation PV report: http://www.ef.org/documents/EF-Final-Final2.pdf

COMMERCIAL

Comparison of sources determine of available roof sq.ft.

Source	% sq.st. area un-available	Factor (placement an	Total Sq.ft. un-	Total Usable	Source Links
Energy Foundation**	5%	7	35%	**65%**	Energy Foundation PV: http://www.ef.org/documents/EF-Final-Final2.pdf
San Diego Gas & Electric	20%	1	20%	**80%**	TECHNICAL POTENTIAL FOR ROOFTOP PHOTOVOLTAICS IN THE SAN DIEGO REGION: http://www.sandiego.edu/epic

**An estimated 5% of commercial building roofing space is occupied by HVAC and other structures. Small obstructions create problems with mechanical array placement while large obstructions share areas up to 7x that of the footprint. Hence, around 35% of roof area is considered to be unavailable due to shading. In some commercial buildings such as shopping center, rooftops tend to be geometrically more complex than in other buildings and the percentage of unavailable space may be slightly higher.

Commercial Assumptions

All commercial building types are assumed flat: roof pitch 0

Building Type	Obstructions and Equipmer	Parapet access (2)	Equipment Sha	Building Shad	Total % loss	Total Usable sq.ft.
Dry_Goods_Retail	10%	5%	5%	15%	35%	65%
Grocery	10%	5%	5%	15%	35%	65%
Hospital	10%	5%	5%	15%	35%	65%
Hotel_Motel	10%	5%	5%	15%	35%	65%
Office	10%	5%	5%	15%	35%	65%
Other	10%	5%	5%	15%	35%	65%
Restaurant	10%	5%	5%	15%	35%	65%
School	10%	5%	5%	15%	35%	65%
University	10%	5%	5%	15%	35%	65%
Warehouse	10%	5%	5%	15%	35%	65%

1) The obstructions and equipment are assumed to 10% of the building roof and is assumed there is additional shading of 50% by that equipment
2) Parapet access is required by code / OSHA, assume 5% loss in sq.ft.
3) Building shading accounts for the surrounding building and other technical restrictions, it is assumed that more shading occurs in an urban setting due to the surrounding buildings

General Building Assumptions

Bldg ID	Building Type	Building Sq.Ft.	Estimated Floors
RT0	Dry_Goods_Retail	6,421	1
GR0	Grocery	8,637	1
HEH	Hospital	14,803	2
LG0	Hotel_Motel	12,772	4
OF0	Office	9,525	1
OCM	Other	10,699	1
RS0	Restaurant	4,699	1
EDS	School	22,241	2
EDU	University	32,392	2
WA0	Warehouse	15,284	1
TCOM	**Total Commercial**	137,473	2
MF0	Multi_Family	1,300	2
MN0	Manufactured	1,570	1
SF0	Single_Family	1,921	2
TRES	**Total Residential**	4,791	2

Table 15. PV WATTS Assumptions

Overall DC to AC Derate Factor Component Derate Factors	Component Derate Values	Range of Acceptable Values
PV module nameplate DC rating	0.95	0.80 - 1.05
Inverter and Transformer	0.92	0.88 - 0.96
Mismatch	0.98	0.97 - 0.995
Diodes and connections	0.995	0.99 - 0.997
DC wiring	0.98	0.97 - 0.99
AC wiring	0.99	0.98 - 0.993
Soiling	0.95	0.30 - 0.995
System availability	0.98	0.00 - 0.995
Shading	1	0.00 - 1.00
Sun-tracking	1	0.95 - 1.00
Age	1	0.70 - 1.00
Overall DC to AC derate factor	77%	PVWATTS Default

Source:
PVWATTS: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/
See link for more information: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/derate.cgi

Residential Assumptions

PVWATTS: Hourly PV Performance Data	
City:	SEATTLE
State:	WA
Lat (deg N):	47.45
Long (deg W):	122.3
Elev (m):	122
Array Type:	"Fixed Tilt"
Array Tilt (deg):	18.5
Array Azimuth (deg):	180
DC Rating (kW):	1000
DC to AC Derate Factor:	0.77
AC Rating (kW):	770

Commercial Assumptions

PVWATTS: Hourly PV Performa
City:
State:
Lat (deg N):
Long (deg W):
Elev (m):
Array Type:
Array Tilt (deg):
Array Azimuth (deg):
DC Rating (kW):
DC to AC Derate Factor:
AC Rating (kW):

Small Hydro

Hydraulic power can be captured wherever a flow of water falls from a higher level to a lower level, which usually occurs where a stream runs down a hillside, a river passes over a waterfall or man-made weir, or where a reservoir discharges water back into the main river. The vertical fall of the water is known as the "head," and this, along with the flow rate, determines the power output. The primary resource used in this study to evaluate potential sites for hydro development was the Virtual Hydropower Prospector (VHP), which is available through the Idaho National Laboratory.[18] The VHP is a GIS-based tool that allows users to identify existing and potential small hydro sites (≥10 kWa).

The most small or micro hydro systems are run-of-river structures and do not require dams. The water flowing in the stream is channeled into pipes (or a penstock) and then into a turbine, which generates electricity. The water is then returned to the stream downstream from the turbine. The environmental footprints of run-of-river facilities are much smaller than those of larger hydro plants, which require large storage reservoirs. No land is flooded to create a reservoir for the plant, but a small weir may be installed to help regulate flow.

The benefits of small hydro are many and include:

- High efficiency (70% – 90%).
- A high capacity factor.
- A high level of predictability, varying with annual rainfall patterns.
- Slow rate of change for output power, which varies only gradually from day to day (not from minute to minute).
- A long-lasting and robust technology; systems can be engineered to last for 40 years or more.
- Low environmental impact; fish and other wildlife are generally not affected by the installation.

Hydro Energy Costs

Costs vary considerably according to the size of the system installed, with the cost per kW going down as the system size increases. For this study, costs were taken from a study prepared for BC Hydro[19] and include the following installation related costs: penstock, intake, powerhouse, generating equipment, access road, switchyard, and transmission line. A percentage of the equipment costs are added to the total cost to account for engineering costs (20%) and contingency costs (30%).

Cadmus used cost data from sites with less than one mile of transmission required for installation; these sites ranged from 100 to 3700 kW. Estimated installed costs were $5,688/kW, with additional O&M costs of $535/kW per year (calculated as 9.4% of installed cost).

18 http://hydropower.inl.gov/prospector

19 *Green Energy Study for British Columbia Phase 2: Mainland*; Small Hydro, October 2002, Prepared for BC Hydro by Sigma Engineering Ltd.

Table 16. Cost Estimation

Stream	Name	F3	Lat_Long	Region	Flow (m/s)	Head (m)	Penstock Length (m)	Penstock Diameter (m)	Power (kW)	Cost ($1000)	Transmission Dist (km)	Capacity Factor
11	DAVIS	CR	5008/11657	1	0.8	122	500	0.52	800	1578	0.5	0.47
16	FALL	CR	5036/11853	1	0.45	500	1000	0.41	1800	2347	1.5	0.45
18	FERRY	CR	5015/11839	1	1.1	150	3100	0.78	1300	4060	1	0.51
23	HOLSTEIN	CR	5018/11835	1	0.29	150	1200	0.41	300	1605	1	0.45
30	LEGERWOOD	CR	5058/11846	1	0.53	250	1300	0.47	1000	2594	1.5	0.45
33	LOFTUS	CR	5056/11849	1	0.75	250	1000	0.51	1500	2378	0.5	0.45
34	LOST	LEDGE	5006/11656	1	0.28	430	1700	0.36	900	1639	0.5	0.47
46	SCHROEDER	CR	5002/11653	1	0.64	300	2300	0.53	1500	3502	0.5	0.47
63	UNNAMED	CR	5055/11807	1	0.85	250	1150	0.54	1700	2755	1	0.45
69	BLURTON	CR	5041/11902	2	0.48	400	1600	0.44	1500	2383	1	0.45
72	CADWALLADER	CR	5046/12248	2	4.8	50	600	1.2	1900	4284	0.5	0.52
73	CHASE	CR	5049/11941	2	0.99	100	500	0.58	800	1591	0	0.45
75	CORNING	CR	5054/11932	2	0.52	100	700	0.49	400	1251	0	0.45
76	CYPRESS	CR	4920/12314	2	1.3	105	825	0.7	1100	1782	0	0.55
82	HUMMING	BIRD	5046/11900	2	0.3	250	750	0.36	600	1103	1	0.45
87	MARA	CR	5046/11900	2	0.46	250	1000	0.44	900	1389	1	0.45
90	PAUL	CR	4915/12001	2	0.67	120	400	0.47	600	2190	1	0.4
91	PAVILION	CR	5054/12146	2	0.15	350	2350	0.36	400	1686	0	0.5
94	POTLATCH	CR	4935/12319	2	0.43	150	1300	0.47	500	2061	1	0.55
101	TRETHEWAY	CR	4942/12205	2	7.5	30	150	1.3	1800	4228	0	0.55
104	UNNAMED	CR	4918/12004	2	0.08	600	1300	0.2	400	1380	1	0.4
105	UNNAMED	CR	4941/12335	2	0.18	793	1800	0.31	1100	2585	0	0.57
106	UNNAMED	CR	4940/12335	2	0.15	1037	2400	0.25	1200	3276	0	0.6
113	WHITE	CR	5051/11919	2	0.6	50	300	0.5	200	1005	0	0.6
114	WHITECAP	CR	5043/12218	2	0.73	200	950	0.52	1100	2415	1	0.52
118	ADRIAN	CR	4948/12527	3	1.8	50	625	0.87	700	2352	0	0.65
119	AHAMINGUS	CR	4941/12607	3	0.99	40	100	0.52	300	1155	0.5	0.65
126	BIG	TREE	5015/12545	3	1.7	100	1900	0.92	1300	3889	1.5	0.67
130	CANTON	CR	4949/12628	3	3.1	30	800	1.2	700	3447	1.5	0.65
144	HEADQUARTERS	CR	4942/12507	3	1.5	50	250	0.68	600	1668	1.4	0.65
174	OKTWANCH	R	4947/12615	3	1.6	30	400	0.83	400	2072	0.9	0.65
185	SOMBRIO	R	4831/12417	3	0.87	50	380	0.6	300	1365	0.5	0.51
192	TLOOLS	CR	4952/12545	3	3	50	625	1.1	1200	2971	1	0.65
205	UNNAMED	CR	4948/12625	3	1.2	30	200	0.65	300	1310	0.5	0.65
211	UNNAMED	CR	4948/12617	3	2	30	400	0.9	500	2061	1.5	0.65
216	UNNAMED	CR	5030/12654	3	1.4	60	500	0.73	700	2032	1.6	0.68
220	UNNAMED	CR	5005/12625	3	2	60	1250	0.99	900	3051	0.8	0.64
224	UNNAMED	CR	5005/12628	3	1.5	90	1320	0.83	1100	3038	1.2	0.64
232	UPANA	CR	4948/12605	3	5.8	30	800	1.5	1400	4587	0.1	0.65
236	WARD	CR	4947/12604	3	0.86	30	200	0.58	200	1122	0.4	0.65
255	SWIFT	CR	5251/11916	4	3.7	61	1425	1.3	1800	5154	0.9	0.5
265	MCLEESE	CR	5220/12217	5	0.3	150	1300	0.45	400	1424	0	0.45
268	UNNAMED	CR	5155/12444	5	0.5	61	750	0.53	200	1487	1	0.4
269	UNNAMED	CR	5144/12427	5	0.4	425	3700	0.47	1300	4129	1	0.45
274	NOOMST	CR	5226/12613	6	3.4	61	550	1	1600	3712	1	0.65
275	NOOSGULCH	CR	5226/12623	6	8.4	30	700	1.7	2000	5904	1	0.65
276	TASTSQUAN	CR	5222/12645	6	1.9	91	250	0.67	1400	2240	0.5	0.65
288	ALICE	CR	5440/12847	8	1.9	92	1200	0.89	1400	3388	1	0.6
299	HANKIN	CR	5435/12826	8	1	91	950	0.67	700	3406	1	0.6
310	TROUT	CR	5451/12719	8	1.6	50	500	0.79	600	1753	0	0.6
325	UNNAMED	CR	5410/12956	9	0.1	650	2000	0.23	500	2342	0.5	0.7
353	TELEGRAPH	CR	5754/13110	13	0.56	152	1200	0.51	700	2048	0	0.45

Source: BC Hydro, Microhydro/small hydro potential, INVENTORY OF UNDEVELOPED OPPORTUNITIES AT POTENTIAL MICROHYDRO SITES IN BRITISH COLUMBIA, March 2000

Size (kW)	Cost/KW (power curve)	Cost/KW (linear model)
20	$ 15,386	$ 4,685
30	$ 12,799	$ 4,668
40	$ 11,232	$ 4,652
60	$ 9,344	$ 4,618
80	$ 8,200	$ 4,585
100	$ 7,410	$ 4,551
300	$ 4,500	$ 4,215
500	$ 3,568	$ 3,880
1000	$ 2,605	$ 3,041

Table 17. Summed Average Stream Flow for all Available Stream Data in the Specified County (Average Taken over a Five Year Period)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	# streams (n)
Whatcom	26,812	17,526	18,798	18,047	19,782	21,939	16,907	10,357	9,792	17,213	29,304	21,953	20
Skagit	68,642	50,266	49,824	46,188	52,094	64,099	48,141	29,870	28,863	46,460	80,168	57,785	8
Jefferson	15,641	7,578	11,045	6,692	4,872	4,361	3,427	1,937	2,064	7,550	14,328	12,563	4
King	36,237	24,457	26,522	23,221	24,109	20,538	10,089	6,996	8,385	13,950	34,339	27,140	44
Pierce	14,874	9,962	10,456	10,838	11,903	12,113	8,674	6,562	5,608	6,961	11,622	12,738	20
Thurston	13,708	8,422	8,669	5,880	3,509	2,594	1,784	1,547	1,692	2,658	9,380	11,019	8
Kitsap	165	71	86	49	29	18	15	13	13	38	81	131	3
Kittitas	1,557	1,733	2,313	2,431	2,662	2,922	3,752	3,681	1,537	1,019	1,332	1,142	1
Island	-	-	-	-	-	-	-	-	-	-	-	-	
Total	177,636	120,015	127,713	113,347	118,962	128,584	92,788	60,962	57,954	95,849	180,555	144,471	
% of max	98%	66%	71%	63%	66%	71%	51%	34%	32%	53%	100%	80%	

Small Wind

Wind energy is converted to mechanical or electrical energy through the use of a wind turbine. Wind energy is an intermittent resource, meaning that the energy output varies and is unpredictable. Despite the intermittency of the wind, the wind energy industry is growing; small wind saw an average growth of 14 percent. The total installed capacity of small wind (<100 kW) in the U.S. is estimated to be between 55-60 MW as of 2007.[20]

Small wind turbines are generally defined as having an installed capacity of up to 100 kW. For this analysis, the focus was on residential systems of 1.9 kW and 10 kW. Residential systems tend to be smaller, due to both cost constraints and the amount of energy needed.

The AWEA Small Wind Turbine Global Market Study 2008 conducted a survey with many players in the small wind industry, including researchers, component vendors, manufacturers, engineers, consultants, utilities, local government offices, and dealers/distributors/installers[21]. The survey found that the top market barrier to installing small wind turbines was cost to the customer. Additional key barriers included restrictive zoning and permitting rules, and lack of financial incentives.

Small Wind Energy Costs

The cost for a wind turbine varies by the size of the system installed. In general, as the installed capacity of wind turbines increases, the installed cost per kW decreases. Costs are assumed to be nominally constant. However, it should be recognized that costs may increase due to tighter steel supplies. Costs were taken primarily from turbine manufacturer and distributor websites or discussions with manufacturers.

Table 18. Basic Information and Assumptions

Residential Retail Rate	0.098
Discount Rate	8.25%
Wind Turbine Measure Life	25
O&M costs per KW	$20.00
Washington State Tax Incentive	$0.12
Inflation	3%

Table 19. Turbine Installed and O&M Costs

	Installed Cost	O&M cost, yearly
Abundant Renewable Energy Model: ARE 442 10KW	$90,000	$200.00
Southwest Windpower Model: Skystream 3.7 1.9KW	$11,000	$38.00

20 Compiled from American Wind Energy Association. Home and Farm Wind Energy Systems: Reaching the Next Level. AWEA. June 2005. and American Wind Energy Association. AWEA Small Wind Turbine Global Market Study 2008. AWEA. June 2008.

21 American Wind Energy Association. AWEA Small Wind Turbine Global Market Study 2008. AWEA. June 2008.

Table 20. Costs, Measure Life and Capacity Factor for Clean Energy Resources

	Cost
Average Installed Cost	$8,197
Average O&M Cost	$20

Table 21. Annual kWh Production by location, per turbine

	Abundant Renewable Energy Model: ARE 442 10KW	Southwest Windpower Model: Skystream 3.7 1.9KW
Seattle	5,972	1,435
Olympia	3,997	965
Yakima	4,762	1,113

Table 22. Estimated Pay-back Period, in years, with tax incentives

	Abundant Renewable Energy Model: ARE 442 10KW	Southwest Windpower Model: Skystream 3.7 1.9KW
Seattle	69	35
Olympia	103	52
Yakima	87	45

Table 23. NPV of Total Cost and Levelized Cost by Turbine and Wind Region

	Abundant Renewable Energy Model: ARE 442 10KW	Southwest Windpower Model: Skystream 3.7 1.9KW
NPV of total cost	$92,090	$11,397
Seattle Levelized Cost per kWh	$1.49	$0.76
Olympia Levelized Cost per kWh	$2.20	$1.13
Yakima Levelized Cost per kWh	$1.85	$0.98

Table 24. Power Supply Curves

Company Name:	Abundant Renewable Energy	Southwest Windpower
Model:	ARE 442	Skystream 3.7
Rating (kW):	10	1.9
Installed Cost ($):	$90,000	$11,000
O&M Cost ($/year)	$200	$38
Windspeed (m/s)	Power (kW)	Power (kW)
0	0	0
2	0	0
4	0.8	0.2
6	2	0.5
8	6	1.3
10	9.2	2
12	10.5	2.5
14	10.3	2.6
16	10	2.3
18	10	2.1
20	10	2
22	10	2
24	10	2

Table 25. Technical Potential in 2029 (aMW)

Sector	aMW
Residential	53.01
Commercial	12.94
Industrial	0.44
TOTAL	**66.39**

Table 26. Nameplate Potential

Sector	MW
Residential	800
Commercial	445
Industrial	17
TOTAL	**1,261**

Table 27. Peak Hour MW Produced

Sector	MW
Residential	53
Commercial	7,608
Industrial	206
TOTAL	**7,867**

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