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2013 PCORC
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-13____**

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

APRIL 25, 2013

2011 INTEGRATED RESOURCE PLAN

May 30, 2011

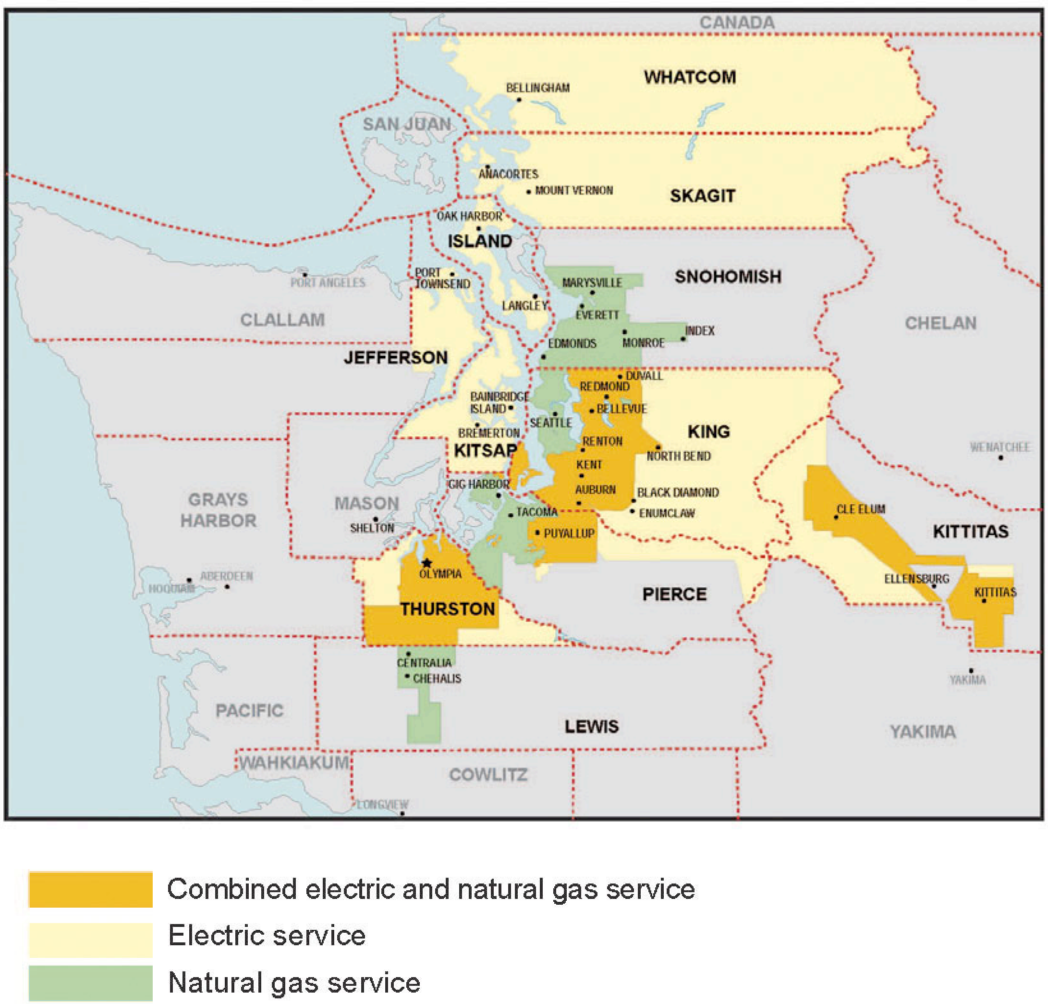
CHAPTERS 1-7

PSE.com

PSE PUGET SOUND ENERGY

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.



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Executive Summary

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Since 2008, the energy marketplace has evolved considerably. The historical growth that pressured the region to increase generating capacity has subsided and given way to a "new normal" in the aftermath of the recession of 2008 and secular industry decline. Energy efficiency, diminished demand due to the recession, and the rapid growth of zero variable cost renewable energy result in the Pacific Northwest being surplus on generation resources. This has led to so called "surplus energy" events which occur when the supply of electricity is greater than the demand and tend to drive market prices to low or even negative levels. Events like these are common in a hydro-electric based system, like the Pacific Northwest, but the situation has been exacerbated by the recent development of renewable resources intended to meet state renewable energy targets. Significant operational challenges and portfolio value implications exist for both the company and the regional transmission provider, as the region seeks ways to better integrate renewable resources in a manner that balances compliance with environmental mandates yet does not create winners or losers in the regions energy and renewable market place. These surpluses are expected to last for the foreseeable future and will undoubtedly create downward pressure on short-term market prices. The outlook for natural gas supply and price has also changed significantly now that new technology has allowed economic access to large shale bed deposits in British Columbia, and across North America.

The potential benefits of these market developments are captured in this plan for our electric customers. As in the past, our plan relies on continued acquisition of demand-side resources and those renewable resources needed to meet legal requirements. Also as in the recent past, the company must manage the expiration of supply agreements that create the prospect of a significant capacity shortfall. This plan, however, unlike its predecessor, suggests that capacity shortfalls may be most economically met by adding peaking resources and transmission capacity to the extent that expiring resources cannot be economically renewed or are otherwise unavailable or undesirable. Such a strategy would enable PSE to capture for customers the value presented by lower market prices created by the region's energy surplus. Production technology advances and increased production of natural gas have largely allayed concerns expressed in prior plans about supply diversity and cost.

Integrated resource plans are a means of examining the potential outcomes over time of different resource decisions within a matrix of varying assumptions and risk scenarios. Accordingly, our plan avoids point estimates and a fixed view of the future. Actual resource additions and portfolio costs will surely vary from any single estimate we may make today. Markets are dynamic and we use our RFP process and unanticipated market opportunities to create value propositions for our customers in real time. Furthermore, as rapid and significant changes in the marketplace make clear, change is constant and we must remain flexible. The great value of the bi-annual planning process is that we take the time and make the effort to consider market developments, technology advances, and ever-improving analytical methods to create a fresh and flexible view of the 20-year horizon ahead and the challenges and opportunities that are surely to arise.

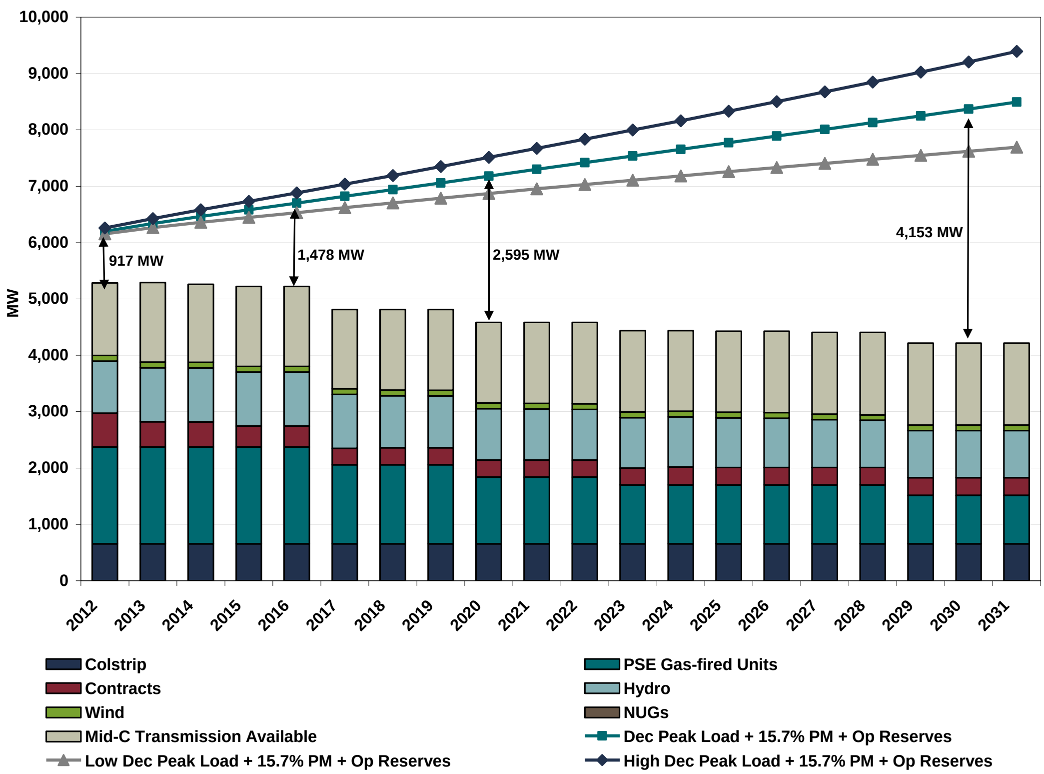
1. Electric Resource Plan

Electric Resource Need

PSE must meet the physical needs of our customers reliably. Those physical needs are simplified and expressed in terms of peak hour capacity and energy for resource planning purposes. Operating reserves are included in physical needs; these are required by contract with the Northwest Power Pool and by the North American Electric Reliability Corporation (NERC), to ensure total system reliability. In addition to meeting customers' physical needs, Washington state law (RCW 19.285) also requires utilities to acquire specified amounts of renewable energy credits. There are details in the law such that complying with RCW 19.285 may not directly correspond to meeting physical needs, so this is expressed as a separate category of resource need.

Electric peak hour capacity need. Notwithstanding the regional surplus of energy the company's electric resource outlook indicates the need for an additional 917 MW of peak hour capacity by 2012, 1,478 MW by 2016, and 2,595 MW by 2020. This includes the resources required to meet peak hour customer demand events, and the planning margin and operating reserves that must be maintained to achieve acceptable reliability.[1] Figure 1-1 illustrates the effective peak hour capacity need, based on existing supply-side resources. Wind is hard to discern because its contribution to capacity need is small.[2]

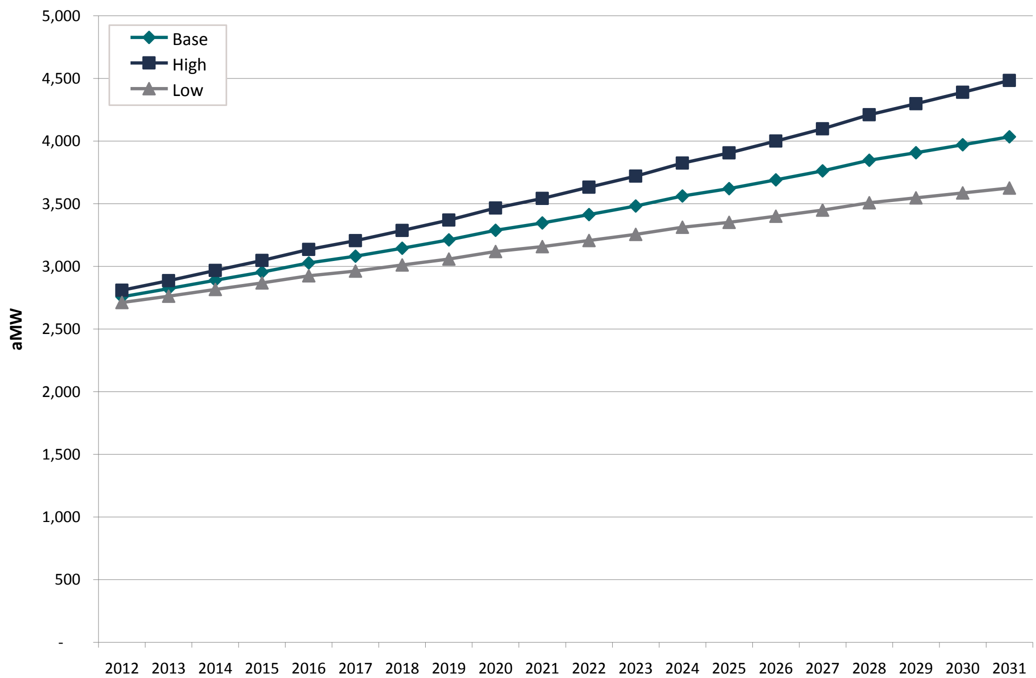
Figure 1-1
Electric Peak Hour Capacity Resource Need
Projected peak hour need and effective capacity of existing resources



[1] *Refer to Chapter 5 for a description of electric planning standards.*
[2] *See Appendix I for a summary of PSE's Effective Load-carrying Capability of Wind analysis.*

Energy need. Peak hour capacity is an important aspect of PSE's ability to adequately meet the physical needs of our customers. However, our customers demand electric service in more than just one hour each year—they expect reliable electric service during all hours. Figure 1-2 illustrates the company's annual energy forecast. This "energy need" is translated to an hourly basis for analytical purposes. Load forecasts in this chart are aggregated to an annual basis.

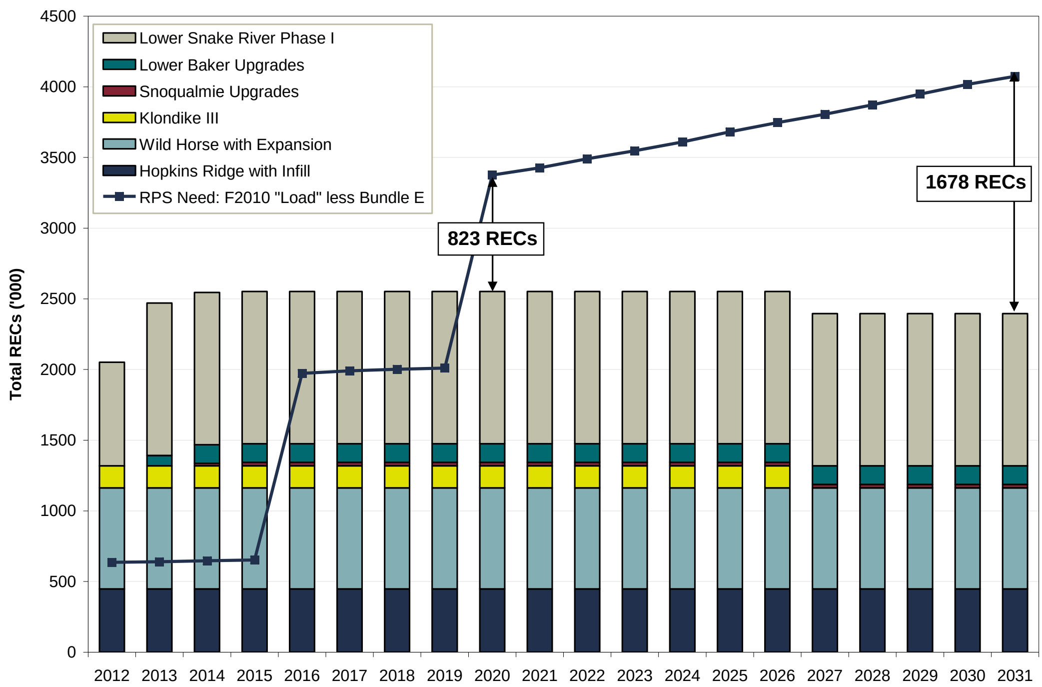
Figure 1-2
Energy Need--Annual MWh sales forecasts



Renewable resources. In addition to reliably meeting the physical needs of our customers, Washington state's renewable portfolio standard (RPS) requires that PSE meet specific targets for qualifying renewable energy. The company must have sufficient "qualifying renewable energy" to equal at least 3% of sales by 2012, 9% by 2016, and 15% by 2020. Figure 1-3 compares existing qualifying renewable resources with these requirements. Qualifying renewable energy is expressed in annual qualifying renewable energy credits (RECs) rather than Megawatt hours, because the state law incorporates multipliers that apply in some cases. For example, PSE's Lower Snake River project receives a 1.2x REC multiplier, because qualifying apprentice labor was used in construction. Thus, the project is expected to generate approximately 900,000 MWh per year of electricity, but would contribute about 1,080,000 RECs toward meeting need. Note that this is a long-term view. PSE has sold surplus RECs to various counterparties, which is not reflected on this chart.

Figure 1-3

Renewable Resource/REC Need



Operational Needs as Balancing Authority. PSE's IRP is focused on the Company's resource needs as a merchant, load-serving utility. PSE did not go far down the path of reflecting additional kinds of resource needs—such as renewable resource integration service—that are required of a balancing authority. As a balancing authority, PSE may be called upon to integrate our own intermittent renewable resources, as well as those of third parties that may request to interconnect to our transmission system. This may become increasingly important in the future and could influence resource needs and alternatives. Additional dialogue and investigation in this area will be helpful in future resource plans.

Electric Plan Portfolio

Figure 1-4 summarizes the electric resource plan, in terms of peak hour capacity. This plan is the "integrated resource planning solution." It reflects the lowest reasonable cost portfolio of resources that meets the projected capacity, energy, and renewable resource needs described above. Except for demand-side resources, which significantly reduce risk, most of the other resources show the same risk profile.

Figure 1-4
Cumulative Capacity of Resource Additions (MW)

	2016	2020	2025	2031
Demand-side Resources	423	815	1106	1319
Wind	0	300	300	400
Biomass	0	25	25	50
Transmission + Market	0	500	500	500
Peakers	1065	1278	1704	2443

Electric Plan Highlights

- Demand-side resources (DSR). This plan—like prior plans—includes so much conservation that significant changes in avoided cost had little impact on how much could be acquired cost effectively. PSE's analysis indicates that acquiring demand-side resources on a more aggressive pace than assumed in the Northwest Power Planning Council's 6th Power Plan would be cost effective, and this is reflected in the resource plan.
- Renewable resources. Temporary federal investment incentives can affect timing of when it is most cost effective to bring additional renewable resources into the portfolio. As such incentives have not been extended, the plan includes additional renewable resources essentially just in time to meet RPS requirements.
- Additional transmission capacity. Expanded transmission to access the surplus of generating resources in the region was found cost effective across all scenarios. Transmission also provides additional strategic benefits, as described in Chapter 2.
- Peakers are more cost effective than CCCT plants: Peakers for peak hour capacity with market purchases for remaining energy needs (after demand-side and renewable resources) is more cost effective than a combination of new CCCT plants, natural gas, and market energy.

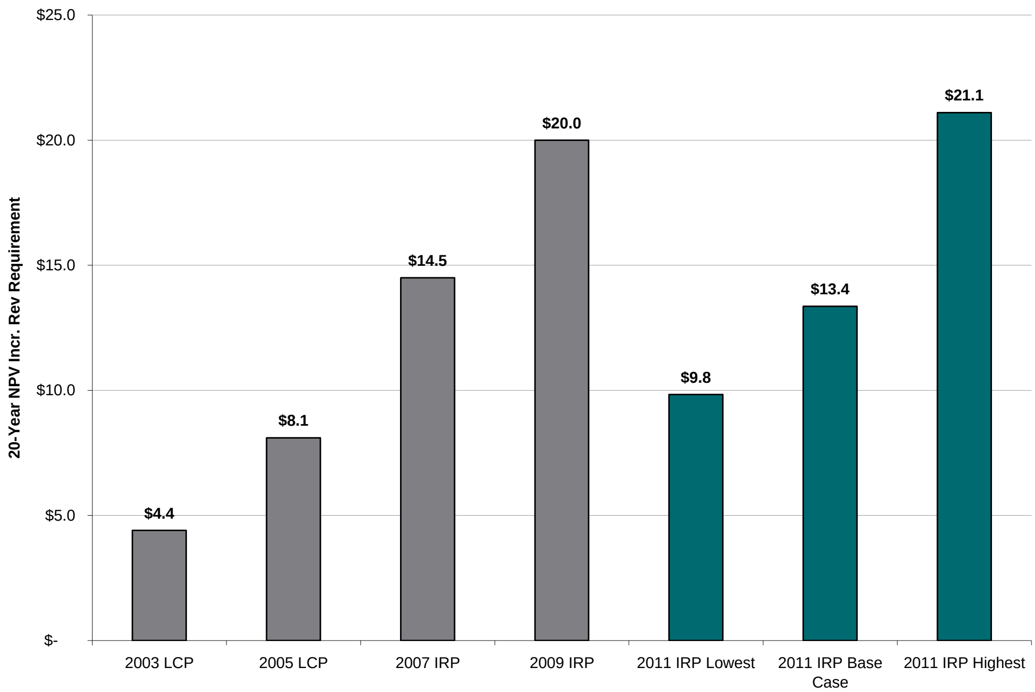
Electric Planning Key Findings

- Durability across future scenarios. The lowest cost plans are very similar across a wide range of future market conditions.[3] That is, external market conditions have little impact on the lowest cost mix of resources.
- Importance of actual acquisitions. How resource need gets filled in the acquisition process can have significant impacts. Long-term contracts from existing resources or extending the life of older peaking units could significantly change the need for generation fuel/pipeline capacity, have different implications for long-term transmission and distribution planning, and create different needs for financial planning.
- Reliance on regional surplus. The Plan allows PSE's customers to take advantage of the growing surplus of generating resources in the region. This approach, however, requires PSE to be vigilant about regional resource adequacy, in order to adjust resource plans when (or if) the region begins to become deficit during critical winter periods.
- Shutting down regional coal plants could have significant implications: Carbon regulation via price was shown to have large impacts on costs, but little impact on resource plans. We did consider a case where Boardman, Centralia, and Colstrip are all shuttered by 2020. In this case, several thousand MW of CCCT capacity would be needed in the region, including replacement of PSE's share of Colstrip units with CCCT generation, either owned or contracted. This would increase PSE's portfolio costs by over $200 million per year, but would result in lower CO_2 emissions.[4] PSE was not, however, able to analyze impacts on the reliability of the regional transmission grid, which could be significant.

[3] *Please refer to Chapter 4, Key Assumptions, for additional information on the variety of scenarios and sensitivities explored in this IRP.*
[4] *Please refer to Chapter 5 for details on projected CO_2 emissions.*

Electric portfolio costs. The long-term outlook for incremental portfolio costs had been increasing with each resource plan since 2003. Figure 1-5, below, shows a more moderate outlook, but with considerable uncertainty. The primary reason the 2011 IRP Base Case is considerably lower than the 2009 IRP is that taxes on CO_2 or cap-and-trade regulation on CO_2 no longer looks imminent, as it did in prior IRPs. Note, the 2011 IRP Highest cost shown below uses the same carbon cost as that shown from the 2009 IRP. While the outlook for costs is lower than in the 2009 IRP, uncertainty is still key. The highest cost scenario is more than twice as high as the lowest.

Figure 1-5
Incremental Portfolio Costs over Time

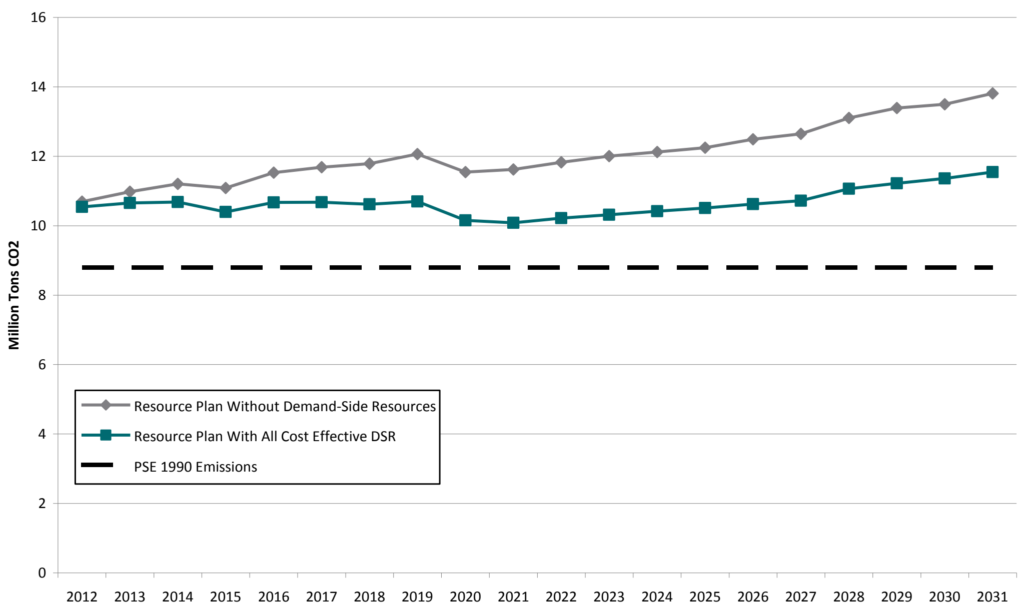


Carbon emissions associated with electric service.

Reducing carbon emissions in Washington state is a legal goal under RCW 70.235. There are no requirements for electric utilities to take any specific actions or limit emissions, so PSE's Base Case scenario includes no such specific constraints. Demand-side resources, however, play an important role in reducing carbon emissions. Figure 1-6 demonstrates that demand-side resources would reduce PSE's carbon emissions by about 1.4 million tons of CO_2 per year by 2020, which is approximately a 12% reduction in forecast emissions. Note, Figure 1-6 illustrates a forecast of direct and indirect CO_2 emissions from market purchases and sales.

Figure 1-6

Projected CO_2 Emissions and Savings from Cost-effective Demand-side Resources



2. *Gas Sales Resource Plan*

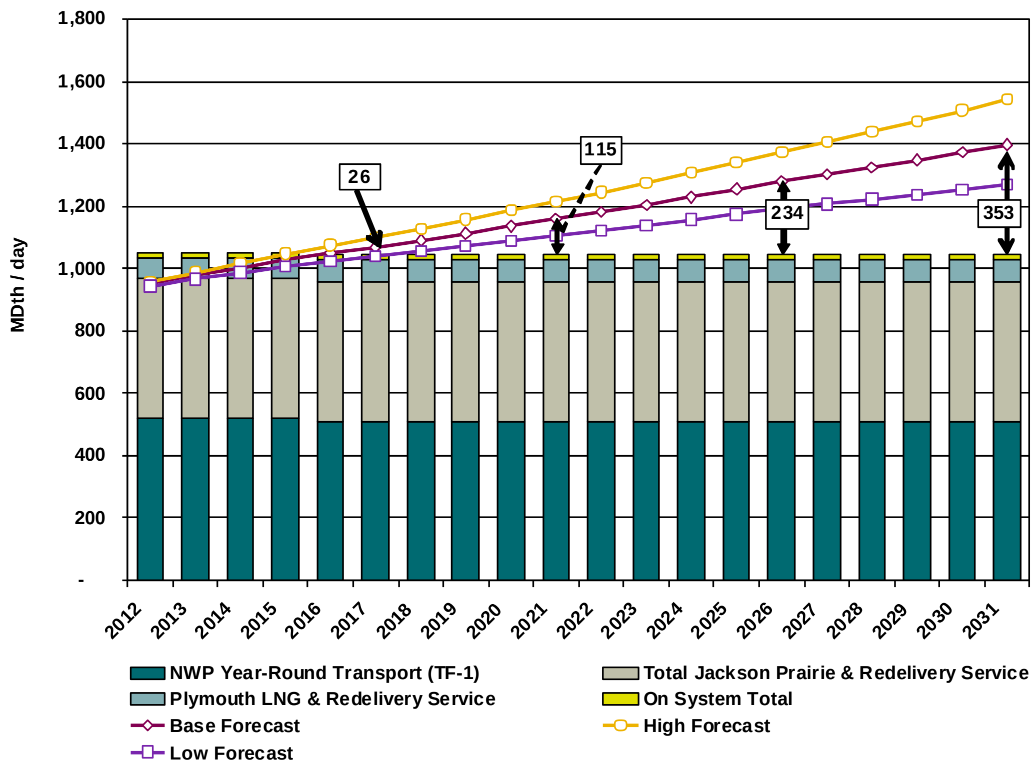
PSE develops a separate integrated resource plan to address the needs of more than 750,000 retail gas sales customers. The needs of gas sales customers are more straightforward and easier to predict than those of the electric utility. This plan is developed in accordance with WAC 480-90-238, the IRP rule for gas utilities. In the 2009 IRP, PSE presented a combined sales and generation-fuel resource plan, in addition to a stand-alone gas sales resource plan. In this IRP, PSE is not highlighting the generation fuel aspect. Generation fuel requirements are very specific to generation that is actually acquired, rather than what is projected in the electric resource plan. That is, if all the electric resource need is met with contracts from existing resources, PSE's electric needs may not require any additional gas infrastructure in the region.[5]

[5] *PSE did perform generation fuel analysis, which is presented in Chapter 6. Results in the Executive Summary focus only on the resource plan for the gas sales portfolio.*

Gas Sales Resource Need

Resource need for the gas sales portfolio is based on peak-day capacity. We plan supply to meet firm loads on a 13 degree design peak day, which corresponds to a 52 Heating Degree Day. Given that PSE's portfolio includes a significant amount of storage and the region's climate is relatively moderate, this planning standard is adequate to reliably meet the needs of our gas customers. Figure 1-7 illustrates that PSE's load and resources are in balance until about 2017.

Figure 1-7
Gas Sales Resource Need



Gas Plan Portfolio

Figure 1-8 summarizes the gas resource plan in terms of peak-day capacity in MDth per day. As with the electric resource plan, this is the "integrated resource planning solution." It combines the amount of demand-side resources that are cost effective with supply-side resources in order to minimize the cost of meeting projected need.

Figure 1-8
Gas Resource Plan, Cumulative Additions

	2016/17	2020/21	2024/5	2030/31
Demand-side Resources	31	56	65	78
NWP + Westcoast Exp	34	112	145	182
Cross-Cascades	0	0	0	31
Local LNG Storage	0	0	51	51

Gas Resource Plan Highlights

- Demand-side resources. Cost-effective DSR on the gas side is much more sensitive to avoided costs than on the electric side. In this IRP, Base Case avoided costs are lower, which reduces 20-year conservation relative to the 2009 IRP. However, testing more aggressive ramp rates found that accelerating acquisition of demand-side resources led to lower total costs for customers in the long run. While the total 20-year conservation is lower, more is assumed to be acquired in the near-term. This means the annual amount of demand-side resources for the first few years of this plan is close to that shown in the 2009 IRP.
- Increasing reliance on Northern B.C., at least early. In the first half of the planning period, additional capacity to northern British Columbia appears more cost effective than capacity east to the Rockies or Alberta. Later in the planning horizon, a Cross-Cascades pipeline expansion appears to be part of the lowest reasonable cost solution. This would allow PSE to access more Alberta and/or Rocky Mountain supplies.
- Storage resources. The lowest reasonable cost plan includes liquefied natural gas (LNG) storage in the outer years of the plan.

Gas Resource Planning Key Findings

- Sensitivity to assumptions. Unlike the electric side, the cost effectiveness of demand-side resources is significantly impacted by market conditions on the gas side. The range of impacts is broad. Under the Base Case scenario, approx. 23 percent of peak capacity needs by 2031 are met with demand-side resources. On the extreme high end, in the Green World Scenario demand-side resources could meet approximately 80 percent of capacity needs. On the extreme low end, approximately 8 percent of capacity needs would be met with demand-side resources in the Very Low Gas Price sensitivity.
- Diversity of supply. Increasing reliance on Northern B.C., appears cost effective. Concern about maintaining diversity remains, but it does not appear cost effective to pursue until later in the planning horizon under IRP assumptions.
- Actual results may vary . . . The resource plan is based on assumptions of what various resources and pipeline expansions might cost. It is also based on current forecasts of market prices, and relative prices across different supply basins. If relative costs of supply alternatives turn out to be different during the acquisition process, actual acquisitions may be different from the plan presented here.
- . . . Especially for generation fuel. Gas infrastructure for generation fuel is extremely difficult to predict. It must be based on actual electric resources acquired. Plant types (peakers vs. CCCT), whether the unit has oil back-up, whether the underlying plant exists or is new (without regard to ownership), contract types (sales or tolls), and physical locations (again without regard to ownership), all can dramatically influence PSE’s need for generation fuel. Dispatchable gas-fired generation can create significant swings as units are economically dispatched one day, and then turned off the next, which leads to the possible need for additional gas storage in the future to manage them.

3. Action Plans

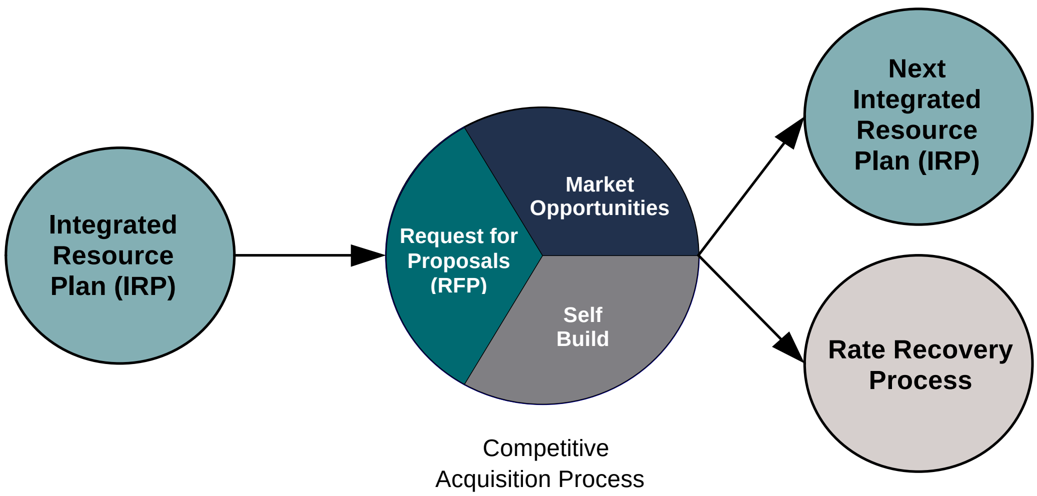
One of PSE's main objectives is to pursue acquisition of both demand- and supply-side resources that will accrue long-term benefits to our customers. The short-term, two-year electric and gas plans presented below outline specific actions for implementing the long-range integrated resource plans discussed in this 2011 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 the implications those 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 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 1-9 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 1-9 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 1-9
Relationship between the IRP and the Acquisition Process



Electric Resource Action Plan

- Resource adequacy. Continue to refine PSE's analysis of resource need, including the impacts of demand-response. Also, remain actively engaged in regional groups and forums focused on regional resource adequacy for energy and capacity.
- Demand-side resources. Work with external stakeholders in the CRAG process to separate demand-side resources in the plan into non-programmatic and programmatic potentials. Consider real-world risks to achieving conservation potentials as we work with the CRAG in establishing goals and targets for compliance and tariff filings, using this IRP as a starting point. Also, begin ramping up efforts to increase demand-response programs based on cost effectiveness. Issue RFPs, as appropriate, to assist with efficient acquisition of demand-side resources.
- Renewable resources. Continue to work toward meeting renewable energy targets via the formal RFP process and by looking for market opportunities to capture cost-effective renewable resource acquisitions for our customers. Continue refining our forecasting capabilities for wind-related ancillary service needs.
- Transmission to market. Develop actionable alternatives for additional transmission to market. Consider those alternatives along-side other supply-side resource alternatives in the acquisition process.
- Thermal resources/additional resources. Use the formal RFP process, seek market opportunities, and consider self-build alternatives for base-load and peaking resources to capture cost-effective thermal resource acquisitions for our customers, and to ensure reliable and stable operation of the electric system. Develop actionable thermal resource plans informed by results of the RFP/acquisition process.
- Resource Needs as Balancing Authority: Engage in discussions with the Commission and other stakeholders on how balancing authority-level operational issues should be addressed in the Company's resource planning process. Work toward investigating whether it is worthwhile to reflect this level of operating detail in the resource planning framework.

Gas Sales Resource Action Plan

- Demand-side resources. Work with external stakeholders in the CRAG process to separate demand-side resources in the plan into non-programmatic and programmatic potentials. Consider real-world risks to achieving conservation potentials as we work with the CRAG in establishing goals, targets, and tariff filings, using this IRP as a starting point. Issue RFPs, as appropriate, to assist with efficient acquisition of demand-side resources.
- Supply-side resource alternatives. Prepare for potential need for additional capacity in the future. Work with other owners of Jackson Prairie to study the feasibility and possible costs of future expansion. Look for opportunities to possibly acquire existing capacity in the next two years which may be more cost effective than waiting until 2013/2014 to begin pipeline expansion/acquisition designed to meet 2016/17 needs.
- Generation fuel supply. Coordinate fuel supply planning with energy supply acquisitions. As additional gas-fired generation requirements are added to the portfolio, additional regional storage resources may be needed to manage the physical swings in gas supply needed for generation fuel.

Developing the Plan

Contents

Quantitative analysis and qualitative judgment both play a part in developing the resource plans presented in the IRP.

Risk analysis is at the core of the IRP planning process. We strive to develop an understanding of how different future conditions would affect and influence the lowest reasonable cost mix of resources. We develop forecasts, estimates, and assumptions about key factors that influence portfolio costs: customer demand, power and natural gas prices, and possible CO_2 costs. Then we combine these inputs into scenarios – different "pictures" of the future that reflect a set of integrated assumptions that could occur together. Finally, we use the scenarios to test how portfolio costs and risks respond to changes in economic conditions, environmental legislation, natural gas prices, and energy policy. In some cases, we then isolate a single variable for further study.

The main elements of the analysis are summarized below.[1]

2011 IRP SCENARIOS

The Base Case. All other scenarios are described by how they differ from it.

Low Growth models weaker long-term economic growth than the Base Case.

High Growth models more robust long-term economic growth.

Very Low Gas Price models the impact of very weak long-term gas prices.

Very High Gas Price models a future in which gas prices are extremely high.

Base + CO_2 tests portfolio decisions in a world with moderate CO_2 costs.

Green World tests portfolio decisions in a world with high CO_2 and high gas prices.

The analysis also studied different demand-side resource ramp rates, examined the implications of shuttering the region's coal plants and the impact of investment incentives on renewable resource additions, and compared peaking plant costs and risks with those of CCCT plants.

Qualitative judgments inform the quantitative analysis at every step. The range of estimates and forecasts for key inputs derives from our observations of the current planning environment. The scenarios we develop reflect judgment about the possible challenges PSE and its customers may face over the next 20 years. And our experience in the marketplace informs the evaluation of analysis results.

[1] *For a detailed discussion of how key inputs, scenarios, and sensitivities were developed for this IRP, see Chapter 4, Key Assumptions.*

1. Electric Resource Plan

The 2011 IRP electric resource plan is summarized below and in Figure 2-1.

- The plan is built around Base Case scenario assumptions.
- A 10-year ramp rate for acquiring demand-side resources (DSR) is reflected.
- Renewable resources are acquired just in time to meet RCW 19.285 requirements.
- Peaking plants and transmission plus market power purchases fill remaining need.

A description of the thinking that produced the plan follows.

Figure 2-1
2011 IRP Electric Resource Plan
Cumulative Nameplate Resource Additions to Existing Electric Resources (MW)

	2016	2020	2025	2031
Demand-side resources	423	815	1106	1319
Wind	0	300	300	400
Biomass	0	25	25	50
New transmission + market	0	500	500	500
Peakers	1065	1278	1704	2443

2. Electric Results across Scenarios

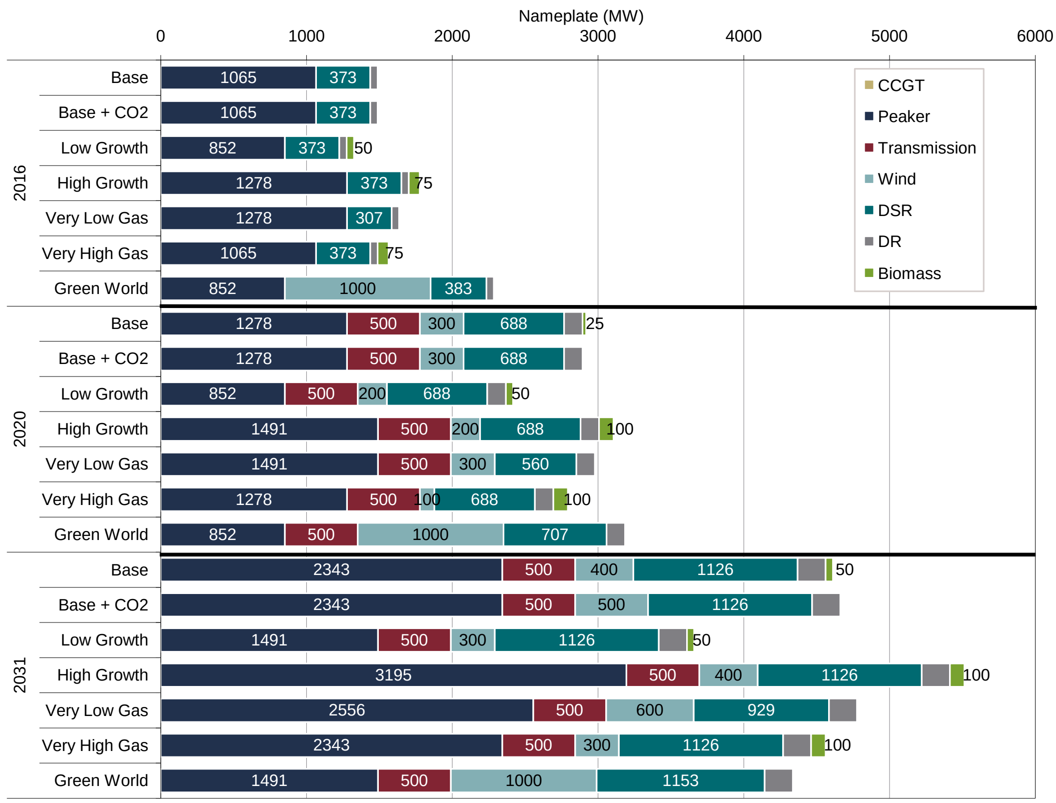
Figure 2-2 shows portfolios identified for the seven scenarios analyzed. All portfolios had to be integrated, meaning they had to consider supply- and demand-side resources on an equal footing. All were required to meet three objectives: physical capacity need (peak demand), energy need (meet customer demands across all hours), and renewable need. Finally, all had to fulfill these requirements at the lowest reasonable cost given the specific scenario.

A high degree of consistency. Least-cost resource plans were very consistent across scenarios. The same amount of conservation is found to be cost effective across nearly all scenarios, renewable resources are added at very similar rates, and additional transmission plus market power purchases and gas-fired, single-cycle peaking generators with oil back-up (peakers) fill remaining resource need.

This is a powerful finding. It means that the wide variety of external market factors modeled in these scenarios will have little impact on the lowest reasonable cost mix of resources. If we find ourselves on the High or Low Growth paths, the number of peaking plants would need to be adjusted up or down; also, a slight rebalancing of wind versus biomass occurs across the different scenarios. But overall, there appears to be little risk in making a resource decision under one market scenario that we would regret if conditions changed. We chose to build the plan around the Base Case scenario.

Figure 2-2

Electric Portfolios by Scenario



Two exceptions appeared among these consistent results: These occurred in the Green World scenario and in the sensitivity that tested shuttering the region's coal plants. Should conditions in the future be as drastically different from the Base Case as those modeled in either of these situations, PSE will have to adjust its portfolio.

Green World

In Green World, CO_2 emission costs rise from $37 per ton in 2012 to $149 per ton in 2031. Gas prices move higher as developers of new generating resources switch from coal to gas to satisfy legal and environmental requirements, thereby increasing demand. And the region's use of gas-fired generation increases as more intermittent, renewable energy generation comes online (wind and solar). We felt it was important to explore the consequences of this scenario even though the high natural gas prices and government-imposed carbon costs modeled appear unrealistic in the current environment. Improving economic conditions and/or increasing pressure due to climate change could shift the picture over the 20-year planning horizon.

Green World has a different planning result than many of the other scenarios. There is a small increase in demand-side resources, but the big change is in wind resources. In Green World, wind energy is cheaper than market, so PSE would minimize costs by replacing market energy with wind to the extent possible to meet energy needs. The output of the analysis is clear: If wind becomes the lowest reasonable cost resource for meeting customers' energy needs, PSE should seek to increase the amount of wind in the portfolio.

Our experience in the marketplace suggests that higher demand for wind generators would probably push the cost up – as we saw between 2005 and 2009. If the region were flooded with utilities and independent power producers building wind farms because they were less expensive than market, development costs would probably exceed those modeled here. Higher wind penetration rates in the region would also probably push integration costs significantly higher than what is assumed in the analysis—including possibly adding resources dedicated to integrating the wind. While long-haul wind was considered in this IRP, it was not modeled as a resource alternative. Based on analysis of the 2009 IRP and 2010 RFP analysis, long-haul would clearly not be cost-competitive with Northwest wind. Perhaps that would be different in a Green World scenario as regional integration costs and supply curves changed. If wind was *still* cheaper than market, PSE would have to adopt an energy related planning standard as a cap, to ensure the company built only what was necessary to meet load. Energy standards for Green World were not investigated in this IRP because the likelihood that such markets will develop is small, and because PSE would have time to develop standards as these conditions developed.

No Northwest Coal

The "No Northwest Coal" sensitivity analyzes how PSE would design a portfolio if policy decisions forced the shutdown of three regional coal plants, Centralia in Washington, Boardman in Oregon, and Colstrip in Montana. Washington State's commitment to reduce emissions to 1990 levels by 2020, and ongoing discussions about the future of Centralia and Boardman led us to judge it prudent to explore the possible consequences of eliminating not just coal resources in this state, but to include the potential for Colstrip to be shut down as well.

Should all three plants be shuttered, PSE would directly lose 677 MW (Megawatts) of base load generation from its share of Colstrip and the region would need to replace several thousands of MW now supplied by Boardman, Centralia, and the rest of Colstrip. In a No Northwest Coal future, it is likely PSE would build or acquire at least enough resources or purchased power agreements to cover the loss of Colstrip. The resources could be CCCTs (combined-cycle combustion turbines), purchased power agreements or some combination of resources that would reduce cost while still meeting customers' needs. All other resource alternatives, including demand-side resources and renewables, would remain unchanged. Should no other parties in the region react to the loss of base load generation, PSE may find it advantageous to develop its own base load resources to meet its needs and possibly even to sell into the market.

That said, a "No Northwest Coal" situation could create several challenges for the region that are not possible to model in the IRP. The location of the additional CCCT plants is difficult to predict for one thing, and location determines transmission impacts. Throughout the region, power flows would change, and transmission and generation operation across the system could turn out to be very different from the way the region operates today. Additionally, market heat rates[2] could be significantly different than what we have seen historically. This will require PSE to perform additional analysis to better

[2] *Market heat rate refers to the spread between the market price of natural gas and the market price of electricity. It is a key factor driving the relative value of peakers and CCCT plants.*

understand how shutting down regional coal plants could affect the behavior of market heat rates.

3. Other Considerations

In addition to scenarios, PSE used sensitivities and other means to isolate certain variables for further study. The following findings influenced thinking on the plan; they are described more fully below.

- Pursuing a more aggressive pace of DSR acquisition than reflected in the 6th Power Plan of the Northwest Power and Conservation Council (NPCC) was found to be cost-effective.
- Financial incentives were found to influence the timing of renewable resource acquisitions, but only as such incentives expired.
- Peakers were found to be more cost effective than CCCT plants given current market conditions.

DSR ramp rates. To investigate ramp rates, PSE had Cadmus develop two detailed alternatives. One was based on a detailed, measure-by-measure analysis of ramp rates used in the NPCC's 6th Power Plan, which generally tended to spread some discretionary measures over 12-16 years. The other was a more aggressive pace of acquisition, acquiring discretionary measures on a 10-year ramp rate. The 10-year ramp rate was found to be more cost effective, as shown in Figure 2-3 below, and therefore is included in the plan.

Figure 2-3
Comparison of PSE vs. NPCC DSR Ramp Rates

Base Scenario	20-yr Expected Incr Rev Req ($Billions)	Bundle	DR
Base (PSE Ramp)	$13.36	E	Yes
Base + 6^{th} Power Plan Ramp	$13.53	E	Yes

Financial incentives for renewable resources. We examined how the extension of federal financial incentives might affect the timing and amount of renewable resource additions by testing several alternatives. In the past, we have observed that expiring deadlines made it cost effective for our customers to accelerate acquisition of these resources ahead of renewable portfolio standard (RPS) timelines. Overall, findings indicated that extension of financial incentives *could* influence timing of renewable resource additions, but it did not increase the amount of additions over RCW 19.285 requirements. Only expiration dates accelerated timing, otherwise additions were made just in time to meet obligations.

Peakers vs. CCCT generating plants. We looked closely at the analysis recommendation of peaking plants over CCCT plants because it differed from prior plans. "Peakers" are gas-fired, single-cycle generating units that operate for short periods of time when demand is greatest. They have low fixed costs and high variable operating costs, so they are not economically dispatched often (meaning it is usually cheaper to buy market power than run the peakers). "CCCTs" are gas-fired, combined-cycle combustion turbines. These cost more to build, but have lower variable costs; because they operate more efficiently, they would be economically dispatched for longer periods of time. Given marketplace conditions in the current planning environment, we found that peakers provided PSE with a way to manage high fixed-cost risks. In contrast, CCCT plants provided a hedge with respect to variable costs, but such a small one that it did not justify the higher cost of construction.

Actual results may vary. Integrated resource plans are a means of examining the potential outcomes over time of different resource decisions within a matrix of varying assumptions and risk scenarios. Markets are dynamic and we use our RFP process and unanticipated market opportunities to create value propositions for our customers. Actual resource additions and portfolio costs will surely vary from those presented in the IRP. With the region surplus on capacity and energy, purchased power agreements backed by existing resources and delivered to PSE's system may cost less than building additional transmission and/or new peakers. Acquiring distressed generating assets—thermal and/or renewable—for significantly lower cost than assumed in this IRP may be possible. Also, older peaking units may be refurbished rather than retired, reducing the amount of additional capacity needed to serve customers. The acquisition process will build on the lessons learned in the IRP, and utilize updated information on market conditions and new opportunities.

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4. Gas Resource Plan

For reference, the 2011 IRP gas sales resource plan is summarized in Figure 2-4, below. Following is a description of the thinking that produced the plan.

Figure 2-4
Gas for Sales Resource Plan

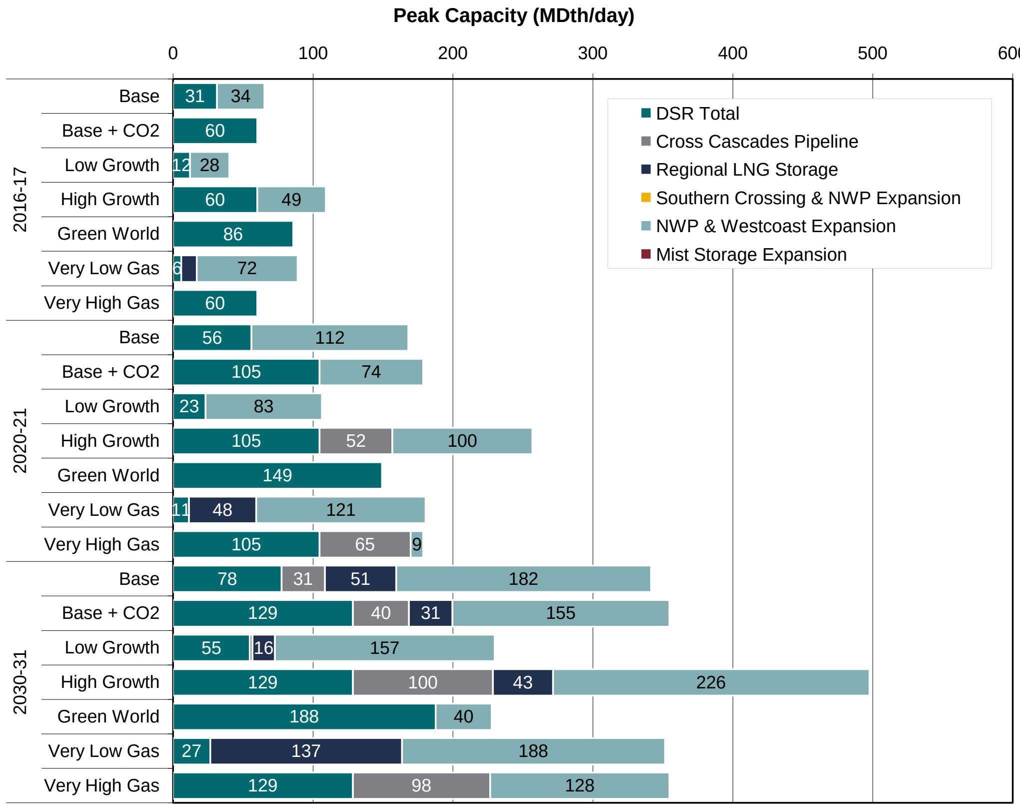
Peak Resource Additions in MDth/day				
	2016-17	2020-21	2024-25	2030-31
Demand-side resources	31	56	65	78
Cross-Cascades pipeline				31
Regional LNG storage			51	51
NWP/Westcoast expansion	34	112	145	182

Overview of Gas Sales Analysis

The gas sales resource plan integrates demand-side resources with supply-side resources to arrive at the lowest reasonable cost portfolio capable of meeting needs over the 20-year planning period. The plan identified above is the optimal portfolio produced by the SENDOUT analysis tool for the Base Case scenario. While SENDOUT results are theoretical portfolios based specified inputs and must be reviewed based on judgment and market conditions, in this case the SENDOUT results appear to be both reasonable and achievable. No changes were made to the model results.

As with the electric analysis, the gas sales analysis examined the lowest reasonable cost mix of resources across the range of eight scenarios described at the beginning of this chapter. Figure 2-5 illustrates the lowest reasonable cost mix of resources across those potential future conditions.

Figure 2-5
Gas Sales Portfolios by Scenario



5. Gas Results across Scenarios

As shown in Figure 2-5 there is a relatively big difference in the amount of DSR among the various scenarios. For gas planning, we found that the amount of DSR is quite sensitive to underlying gas prices. The other primary addition selected in all scenarios is increased capacity on the Westcoast pipeline from northern British Columbia (B.C.) to the Sumas hub at the international border, and then on Northwest Pipeline (NWP) from Sumas to PSE's service territory. Limited amounts of regional liquefied natural gas (LNG) storage and cross- Cascades pipeline are selected in the later years. The combination of additional DSR and pipeline capacity on Westcoast and NWP meets all need thru 2020-21.

Demand-side resource additions. The gas sales resource plan includes about 3,270 MDth of demand-side resource savings by 2017, which translates to peak capacity savings of approximately 31 MDth per day. The annual acquisition rate over the first two years (2012-13) is about 500 MDth per year. This represents a small increase over PSE's current acquisition rate of approximately 450 MDth per year.

Because of the variability in the amount of DSR across the various scenarios we reviewed our acquisition experience over the past few years as well as doing a number of sensitivity tests to confirm that the amounts included in the Base Case scenario are reasonable and lowest cost. Discussions with PSE's Energy Efficiency Services group confirmed that the increase of the acquisition rate from about 450 to 500 MDth per year is achievable. To assess the impact of over- or under-acquiring DSR, we tested the net present value (NPV) impact of acquiring the amount of DSR included the Green World and Very Low Gas Price scenarios in the Base Case. The results are shown in Figure 2-6 below.

Figure 2-6
Impact of DSR Acquisition Level on Base Scenario, NPV Portfolio Costs

DSR Amount	NPV ($ - Billions)
Very Low Gas Price Amount	10.25
Base Amount	10.16
Green World Amount	10.29

Accelerated DSR ramp rates. We also investigated accelerating discretionary DSR measures by ramping them in over the first 10 years rather than over the full 20-year study period. The NPV of portfolio cost was $10.16 billion using the 10-year ramping compared to $10.18 billion for the 20-year ramping. The resource plan reflects the 10-year ramping of the discretionary measures.

SENDOUT's Monte Carlo capability was used to check the robustness of the DSR levels in the Base Case under a wide range of gas prices and loads, and the same amount of DSR was selected in over 95% of the draws.

Based on these results we included the Base Case levels of DSR from the SENDOUT results in the final resource plan.

Westcoast and Northwest pipeline expansion: Northern B.C. gas supply. The gas sales plan calls for a 34 MDth per day expansion of Westcoast/Northwest pipeline capacity by the winter of 2016-17 and further expansions over the planning horizon. The Westcoast/Northwest pipeline expansion alternative was expected since it is the lowest-cost alternative, and provides access to an ample, relatively low cost gas supply in northern B.C. The combination of Westcoast/Northwest pipeline capacity expansion and cost-effective DSR is a robust decision among the various planning scenarios.

The Monte Carlo results indicate that the resource plan amount (112 MDth per day) of this alternative is selected in 77% of the draws.

Regional LNG storage and cross-Cascades capacity.
A relatively small amount of regional LNG storage (51 MDth per day) is included in the resource plan beginning in 2021, and 31 MDth per day of cross-Cascades pipeline capacity is included later in the planning horizon. To achieve "economies of scale," development of either of these projects will require substantial size to be cost effective. For example, a regional LNG storage facility would need deliverability of perhaps 150 MDth per day to be cost effective, and a cross-Cascades pipeline would need a capacity of perhaps 250-300 MDth per day, depending on the specific project. It is unlikely that PSE would proceed with either project without partners. This does not appear to be an immediate concern, since there are other alternatives, and since regional LNG storage and cross-Cascades capacity are not included in the plan for several years.

Alternatives not included. Neither acquisition of capacity at the Mist storage facility nor participation in an expansion of the Southern Crossing pipeline was selected in any of the scenarios. The cost of the Southern Crossing alternative is relatively high; the use of multiple of pipelines would result in high transportation costs that are not expected to be offset by lower gas prices at the AECO supply hub.

While not included in the resource plan, leasing capacity from an expansion at the Mist gas storage facility does have some attractive features. It is located in Northwestern Oregon relatively close to PSE's service territory and is an existing, proven alternative. If the operating characteristics prove to be a good match for PSE's needs and if a cost-effective redelivery service can be developed it may be an attractive alternative in the future. PSE will continue to investigate this alternative.

Planning Environment

Contents

Here we present the factors and conditions that defined the planning context for the 2011 IRP. We also describe briefly how the related risks and challenges were treated in the analysis.

New considerations for this IRP include:

- Slow economic growth and even slower job growth
- A regional energy surplus that is expected to last for years
- Significantly increased estimates for North American natural gas supplies and production
- Over-generation and the attendant transmission and market challenges.

Other planning considerations include:

- Uncertainty about CO_2 costs and regulation
- The influence of RPS requirements on portfolio builds
- Limited resource alternatives
- The effects of increasing reliance on natural gas for power generation
- The limitations and modeling challenges of "real world" demand-side resources (DSR)

1. Economic Environment

Economic activity, demand, and resource timing. The quantity and shape of the energy our customers will demand in the future depends a great deal on economic activity and technological advancement. Factors such as employment and population growth are key determinants of our resource need.

The energy marketplace outlook has changed considerably over the past three years. Following a sharp economic contraction, growth is slow and job growth is even slower. Job growth is the arguably the single most important variable in predicting future loads. A strong labor market is indicative of strong residential and commercial demand. As discussed in Chapter 4, Key Assumptions, and Appendix H, Demand Forecasts, job growth in the Pacific Northwest is forecast to be weak.

But today's weak economic outlook can change, and this creates uncertainty around long-range planning:

- How long will demand remain subdued?
- How might more robust growth impact the company?

The estimated timing and size of resource needs vary greatly depending on these and many other variables. New supply and transmission resources take time to develop, so portfolios must be both flexible and robust to meet changing conditions

Accordingly, the IRP modeled a range of demand forecasts based on different economic outlooks to incorporate this uncertainty.

Regional energy surplus. Today, the Pacific Northwest finds itself highly interconnected by transmission to Canada in the north and California in the south. Our regions are interdependent both physically and in market terms. Accordingly, our planning, our markets, and our system operations must be carefully coordinated. The Pacific Northwest is "long" on generation resources for both energy and capacity – provided sufficient transmission exists to deliver that electricity into and out of the region and to the ultimate load. Constraints to PSE's ability to access this regional surplus is an important aspect of PSE's capacity resource need reflected in resource planning analysis.

The conclusion that the region is long on resources is based on analytical findings of the Pacific Northwest Regional Resource Adequacy Forum (Resource Adequacy Forum). Created in 2005 by the Northwest Power and Conservation Council (NPCC) and BPA, the Resource Adequacy Forum's express purpose is "developing a framework to provide a. . . means of assessing whether the region has sufficient deliverable resources to meet its electricity demands reliably." Their assessment is based on forecasts of loads, existing (not planned) generation, and conservation consistent with the NPCC's 6th Power Plan; it looks five years into the future. Their analysis concludes that the region has sufficient energy and capacity to meet adequacy metrics, provided such resources can be delivered to loads.[1] PSE is an active participant in the Forum's work, and we find their detailed examination of the sufficiency of market resources extremely useful to the resource planning process.

2. *Policy Requirements and Influences*

Renewable portfolio standards (RPS). The state of Washington's RPS continues to require renewable resource additions to PSE's planning portfolios. The RPS requires that PSE meet 3% of load with renewable resources by 2012, 9% by 2016, and 15% by 2020. The company, the region, and the I-5 corridor markets are in the early days of estimating the direct costs and indirect benefits of the addition of large-scale, zero-variable-cost renewables to a slow-growing energy market. Great caution must be exercised when discussing the long-term costs and benefits of renewable energy; RPS standards have the potential to create economic winners and losers in the marketplace and pronouncements about renewable costs and operational impacts must be carefully considered.

The company's RPS need is expressed in units called renewable energy credits (RECs). To model RPS need for the IRP analysis, PSE tested how different load levels affected our need for RECs.

A revenue requirement cost cap is also included in the statute that governs RPS requirements. According to RCW 19.285 all electric utilities in Washington must meet 15% of their electric load with eligible renewable resources by 2020. However, if the incremental cost of those renewable resources compared to an equivalent non-

[1] *See* http://www.nwcouncil.org/energy/resource/Default.asp

renewable is greater than 4% of its revenue requirement, then a utility shall be considered in compliance with the annual target. PSE will examine if incremental renewable resource additions place the company at or above the cost cap. Unfortunately, the statute does not contemplate that market-wide level must run/must take renewable resources lower market heat rates and market prices thus lowering portfolio costs to companies like PSE that are short energy. The actual all-in portfolio cost to customers of renewables is likely overstated. The state will have to find means and methods to estimate such effects and reflect them in the statutory framework in the future

The last section of Appendix I, Electric Analysis, fully discusses how close PSE comes to reaching the incremental cost cap.

Surplus energy events. So-called “surplus energy events” occur when the supply of electricity exceeds demand. Such events have been common to the region for many years and are not new. The rapid growth of wind in the region will make periodic surpluses even more common. Surplus energy events tend to lower market prices, and in some instances they result negative market power prices. BPA, the region’s largest transmission operator and the operator of the federal hydroelectric system, published the Columbia River high-water operations study in September 2010. In it, BPA describes how it managed surplus energy events in June 2010 by taking a combination of measures. These included providing zero-cost energy to generators in hopes of displacing higher-cost generation, thereby bringing the supply – demand balance into equilibrium. While helpful, it is likely that market mechanisms that occasionally provide for negative-cost energy will be needed in the future. Such mechanisms are proving very effective in other regions where regional transmission providers rely on market signals to manage generator activity to balance the system.

It is unclear how the region’s transmission provider will evolve its practices to reflect the realities of federal and state policies toward renewable energy and the inexorable march toward larger regional transmission systems that rely on market mechanisms to balance and operate the system.

No Northwest Coal? The state of Washington has bound itself by law to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020.[2] Currently, the state is discussing the future of the Centralia coal-fired generation plant. The Boardman plant (located in Oregon) faces significant retrofit investments in order to comply with emission regulations, particularly with regard to mercury. Portland General Electric has agreed to shut down Boardman in 2020, though the regulatory process has not been completed. Though neither plant currently supplies power directly to PSE on a long-term contractual basis, if their operations were significantly curtailed or shut down, PSE and its customers would be affected by the resulting impacts on market prices and regional transmission reliability.

To model the possibility that future regulatory policies could force the closure of the region's coal plants, PSE's analysis in this IRP includes a "No Northwest Coal" sensitivity in which the company also loses access to the Colstrip generating plant in Montana. The absence of regional coal-fired generation plants may cause a scenario where the region becomes "short" energy and capacity. How markets and laws and regulations respond to such events will impact PSE's judgments about whether participating in replacement baseload gas CCCT generation would be least cost for our customers.

CO_2 emissions costs. The consequences of potential CO_2 emissions costs and regulations can have significant impacts on PSE's cost structures, but only a small impact on resource decisions. Emissions charges will increase the cost of fossil fuel-burning power plants and change market power prices, but analysis in this IRP demonstrates that politically sustainable carbon cost policies would probably have little impact on the least-cost mix of resources ultimately selected to meet need. While it no longer seems likely that the federal government will take immediate action to limit greenhouse gas emissions through taxation or a cap-and-trade system, state governments remain active in the arena. It is entirely possible that future policy decisions could increase emissions costs within the 20-year planning horizon.

To capture this uncertainty, the IRP analysis models a range of CO_2 costs that vary from $0.32 to $150 per ton. Increasing the use of renewable resources is only part of the solution. Resources like wind and solar must be backed up with other power supplies

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[2] *RCW 70.235.020*

because they generate intermittently, and the back-up generation will most often use fossil fuels.

Fueling electric cars. Seattle is a test market for Nissan's new all-electric vehicle, the Leaf; Chevy introduced the Volt, a plug-in hybrid in 2010; and President Obama has said he wants to pursue policies that will place one million electric cars on the road by 2015. How will electric vehicles affect PSE's resource portfolio? PSE has been working with local governments, companies, and other stakeholders to plan for the infrastructure needs of these vehicles. Meanwhile, this IRP tests how the adoption of these vehicles will affect the company's resource needs, and future IRPs will make adjustments to the vehicle forecast to account for marketplace developments.

3. Resource Considerations

Transmission to market to capture the benefit of regional energy surplus. At this time, the company relies on resources that lie on both the east and west sides of the Cascade Range. Should we become unable to continue to rely on economic supplies from west-based resources, we may have to consider ways to augment transmission access other geographical areas. Such resources could be made available by the regional transmission provider and/or by investment in new transmission lines.

While the company has developed preliminary conceptual estimates of costs to develop or acquire transmission, this is not intended to reflect a specific transmission project. Rather, theoretical incremental transmission is postulated as a means of testing a solution that would make it possible for PSE to access additional market energy on a firm basis. This resource alternative was examined to determine if it should be investigated in more detail during the company's resource acquisition process.

PSE currently uses 1,200 MW of transmission capacity to meet its needs. The company's experience in the market will allow it to assess the potential benefits of access to additional market supplies. These additions could consist of energy purchases from the Mid-C trading hub, purchased power agreements (PPA) secured from an existing resource, acquisition of an existing resource outside of our service territory, or some combination of the above.

Air quality issues on the west side of the Cascades pose significant challenges to the siting of new thermal generation projects, and opportunities are limited and shrinking over time. While the IRP does not explicitly model where a new resource will be developed, it does assume that any new generation can be delivered to its service territory using firm transmission service. If future power plants cannot be built on the west side due to air quality limitations, the incremental transmission hypothesis may become part of the solution for delivering power to PSE's service territory from other parts of the region.

Limited alternatives. Consistent with the 2009 IRP, resource alternatives remain limited. For PSE, market purchases, possibly firmed up for delivery by gas-fired peakers with oil back-up if firm transmission is not available, will be likely to increase. Gas-fired CCCT plants are also potential viable resources, though constructing a new CCCT plant under expected market conditions would be challenging. With respect to renewable resources, PSE has found that wind and biomass are the only practical alternatives for PSE's portfolio at this time. Solar and geothermal resources remain theoretically and morally attractive options, but are not yet cost competitive or capable of attaining utility scale. However, rapid reductions in the cost of solar could alter that assessment in the next decade if they continue. Large-scale expansion of the region's hydroelectric generation portfolio is not likely due to licensing challenges and fish constraints; nuclear generation is not financially feasible and remains vexed by fuel cycle and safety concerns; and coal generation is constrained due to legislative policy and environmental enforcement issues. Limited development of biomass has occurred (and is included in this IRP), but utility-scale renewable options have not yet expanded much beyond wind and solar.

Natural gas. Reliance on natural gas for electric generation will continue to increase for the foreseeable future. Aside from market power plus transmission capacity – and after adding demand-side and wind resources – natural gas-fueled generation (in the form of peaking plants that furnish back-up reliability or CCCT plants that run for energy purposes) appears to be the only viable option for filling resource need.

Gas supplies and pricing. Earlier concerns about supply diversity have been allayed by a dramatic increase in production that has taken place over the past two to three years. The application of horizontal drilling and rock fracturing technologies has made it feasible to recover gas from shale-gas deposits that are widely dispersed across North America. The Marcellus shale in Appalachia, the Fayetteville and Haynesville shale in the Southeast, the Barnett shale in Texas, and shale reserves in the Rockies area all have significant reserves. Canadian supplies have increased due to production from the Montney and Horn River shales in northern B.C. These supplies are being developed at relatively low costs (less than $5 to $6 per MMBtu).

Gas prices have declined significantly as supplies have increased. For example, the forward market prices for calendar year 2012 declined from about $7.10/MMBtu in March 2009 to about $4.75/MMBtu in January 2011. Over the next several years however, prices are expected to increase due to a number of possible developments. Among them:

- possible carbon legislation,
- coal plant retirements caused by more stringent regulation of SO_2 and mercury emissions,
- the switch from oil to gas by energy-intensive industries if gas prices remain lower than crude oil on a heat-content basis, and
- possible LNG exports.

Transportation and storage. While supplies are abundant now, the natural gas transportation system is likely to come under increasing stress as more and more of the region's electric generation requires natural gas for fuel. Significant additions of gas-fired resources – as with the 2,400 MW of peaking plants added over the 20-year planning period in this IRP – could create unprecedented swings in gas loads on the interstate pipeline system and strain the entire supply chain. Increasing reliance on natural gas is likely to increase the need for gas storage in the future.

Wind. Renewable energy tax and grant incentives may affect the timing and cost of adding wind resources to the portfolio. Generally, the lowest cost strategy to meet the RPS requirements is to acquire RECs as they are needed; however, the presence of expiring tax incentives can make it less expensive to develop new wind resources before the tax incentives expire than it will be to do so after they expire. To incorporate this variable in the analysis – and to examine how to best meet RPS targets while minimizing cost to customers – this IRP tested how different policies regarding the extension of tax incentives affect the cost and timing of additional renewable resources.

Wind Integration. As of December 2010, there is over 4,700 MW of installed wind capacity in the Pacific Northwest including Washington, Oregon, Montana, and

Idaho. Another 11,000 MW of wind is under construction or in various stages of the permitting process.[3] Over 3,000 MW of installed wind capacity is interconnected to BPA's balancing authority. The region trails other parts of the country in implementing market mechanisms to assure efficient and reliable system operations. PSE is actively engaged in the regional dialogue to help advance the adoption of flexible, market-based mechanisms to help assure a flexible, fair and reliable regional transmission grid. PSE is also closely examining its own portfolio to optimize the management of its wind on its own system.

Wind is an intermittent and non-dispatchable generation resource with two primary generating characteristics that present integration challenges: first, the variability in output that results from the natural, minute-to-minute volatility of wind and second, the uncertainty associated with accurately forecasting wind output. While the variability can be managed similarly to managing PSE's load, the unpredictable nature of wind creates additional system uncertainty. The combined uncertainties around wind and load are drivers of the company's need to carry balancing reserves.

Currently, balancing reserves are provided primarily by the company's mid-Columbia hydroelectric assets. As these contracts expire, however, the company anticipates using natural gas turbines more frequently to provide reliable reserves that were formerly supplied by mid-Columbia hydropower. We anticipate more gas turbine starts, more off-peak operation, and potential changes to maintenance schedules. Wind integration is further discussed in Appendix G.

Demand-side resources.

The acquisition of demand-side resources is dependent on the decisions of many individual customers to undertake a wide array of actions. These actions can range from installing a compact fluorescent light (CFL) bulb to overhauling a large industrial facility. For example, in 2010 PSE achieved 56,690 MWh of savings from the purchase of 2.3 million CFL bulbs and fixtures by residential customers. In that same time frame, PSE also achieved 76,003 MWh of savings from 872 custom commercial/industrial customer efficiency projects.

Customers may be driven by a variety of motivations: cost savings, comfort, productivity, environmental responsibility, or legal compliance. Barriers to widespread customer adoption of demand-side measures include high first costs, access to information about

[3] *Renewable Northwest Project*, http://rnp.org/node/New-Renewables

benefits and costs, convenience, decision timing, unfamiliar technologies, and capacity of the supply-chain infrastructure. Customer decisions are further affected by more “global” factors, such as employment, income, or general industry conditions.

Projecting energy savings available from a specific market or measure in a particular time period is a less than perfect science due to this complexity. Assumptions are made that are simplifications of the real world, particularly around the level and timing of customer adoption of demand-side measures. Actual customer behavior will likely follow a different path than predicted by a planning model.

In addition to general market complexity, PSE, like any utility, must determine how much of the total available demand-side resource potential is within its control to achieve. Generally speaking, demand-side resource potential may be achieved through utility-funded programs, tax incentives, mandated codes and standards, or independently by customers with no utility or government encouragement. The total “achievable” potential may therefore require further screening to determine what can realistically be acquired by utility programs.

Finally, PSE must balance positive and negative customer impacts, regulatory requirements, and financial performance, including lost revenues from reduced sales, in setting its program mix and targets.

Key Assumptions

Contents

This chapter describes the forecasts, estimates, and assumptions that were developed as key inputs to the quantitative analysis conducted for this IRP. We combine these into scenarios and sensitivities to test resource portfolios in different possible futures and to measure the effects of an isolated variable.

PSE develops ranges of forecasts, estimates and assumptions for the following key areas.

- Demand
- Power prices
- Gas prices
- CO_2 costs

We then combine these in different ways to create scenarios. Scenarios are "pictures" of the future that reflect a set of integrated assumptions that could occur together. This enables us to test how portfolio costs and risks respond to changes in economic conditions, environmental legislation, natural gas prices, and energy policy. In addition, we develop sensitivities that allow us to isolate the effect of a single variable; sensitivities start with the Base Case and change only one input. The scenarios and sensitivities developed for this IRP are listed below.

Scenarios	Sensitivities
Base Case	No Northwest Coal
Low Growth	No Peakers
High Growth	Thermal Mix
Very Low Gas Prices	Fixed (firm) gas transport cost for peakers
Very High Gas Prices	Renewable tax credit extends to 2013
Base + CO2	Renewable tax credit extends to 2016
Green World	Renewable tax credit extends to 2020
	Renewable tax credit extends to 2031
	DSR Ramp Rates
	Plug-in vehicles

1. Key Inputs

Demand Forecasts

Customer load is the single most important input assumption to the IRP analysis. The demand forecast PSE develops for the IRP is an estimate of energy sales, customer counts, and peak demand over a 20-year period. 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. To develop assumptions about national and regional economic trends has been particularly challenging due to continually changing conditions throughout the period. These included a series of abrupt declines throughout the second half of 2008, and an uncertain and slow recovery process during 2009 and early 2010.

Three demand forecasts were used for portfolio analysis in this IRP.

The 2011 IRP Base scenario uses the F2010 Base load forecast. This forecast is based on 2010 macroeconomic conditions such as population growth and unemployment. Details of the load forecast can be found in Appendix H.

The 2011 IRP Low Growth scenario uses the F2010 Low load forecast. This load forecast was developed to be a pessimistic view of the macroeconomic variables identified in the base forecast. The pessimistic view creates a lower demand that PSE needs to meet.

The 2011 IRP High Growth scenario uses the F2010 High Load forecast which is a more optimistic view of the base load forecast.

Why don't they match?

The load forecasts that appear in the IRP often do not match the load forecasts presented in rate cases or during acquisition discussions. Why is this?

The IRP analysis takes 12 to 18 months to complete. Load forecasts are so central to the analysis that they are one of the first inputs we need to develop.

By the time the IRP is completed, the company will have updated the load forecast. The range of possibilities in the IRP forecast is sufficient for long-term planning purposes, but PSE will always present the most current forecast for rate cases or when making acquisition decisions.

The graphs below show the peak load and annual energy load forecasts for Gas Sales and Electric. See Appendix H for a full discussion of how the IRP forecasts were developed.

Figure 4-1
PSE Peak Electric Load Forecast

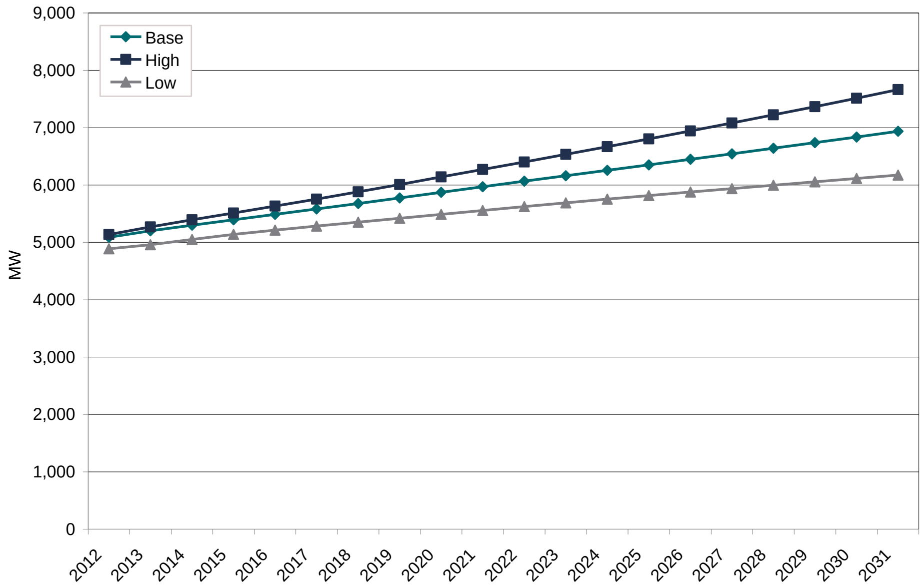


Figure 4-2
PSE Annual Electric Load Forecasts 2010-201

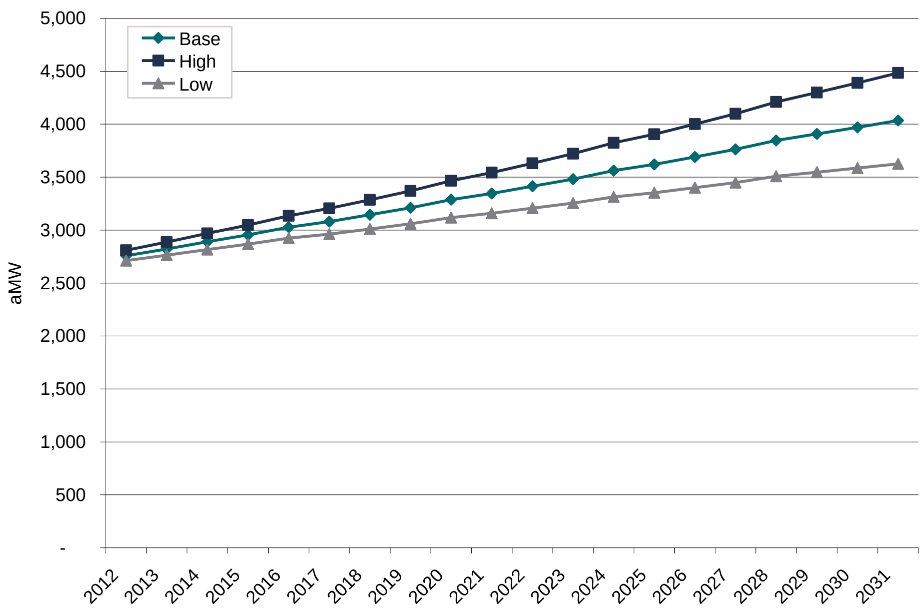


Figure 4-3
PSE Peak Day Gas Sales Forecast

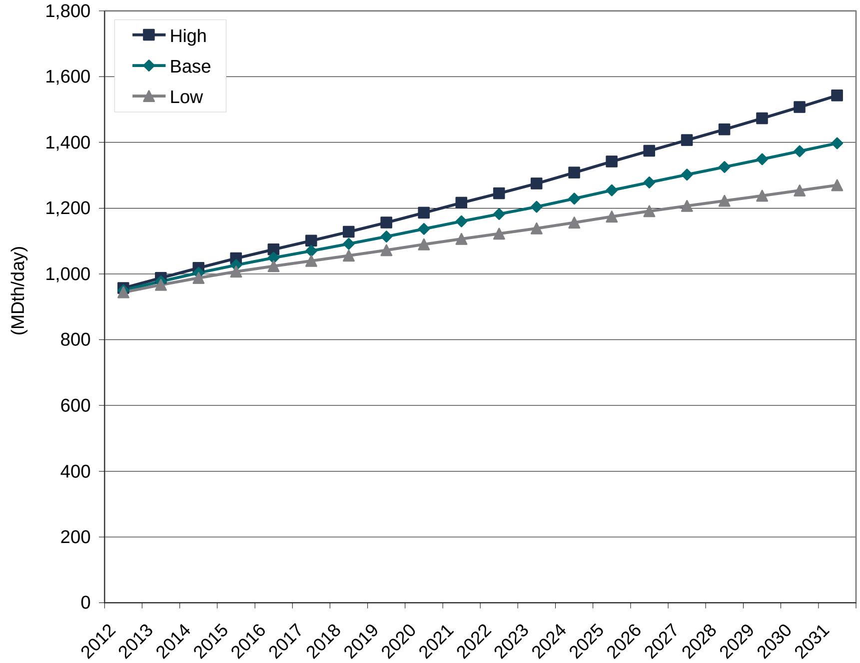
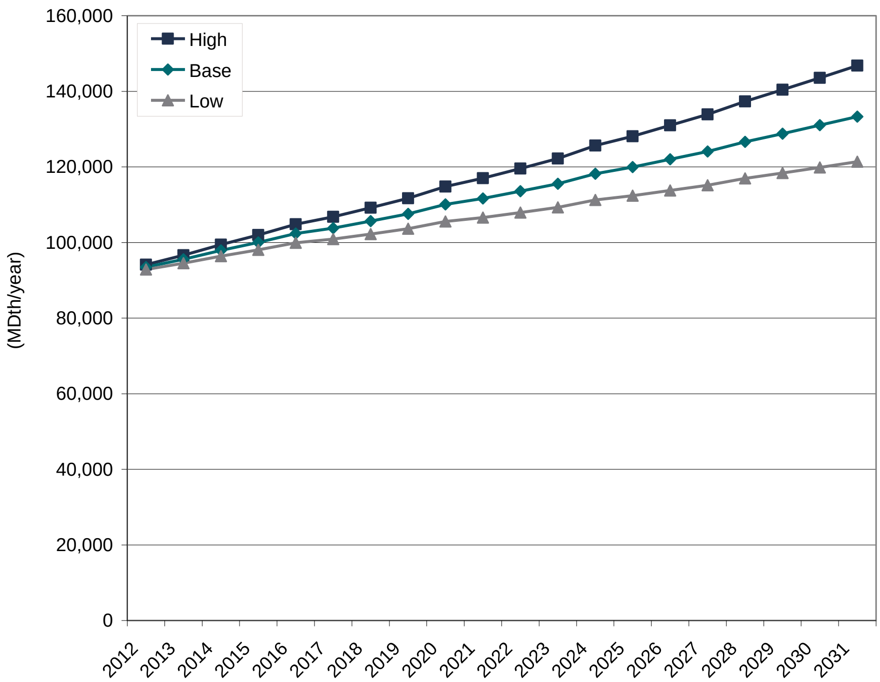


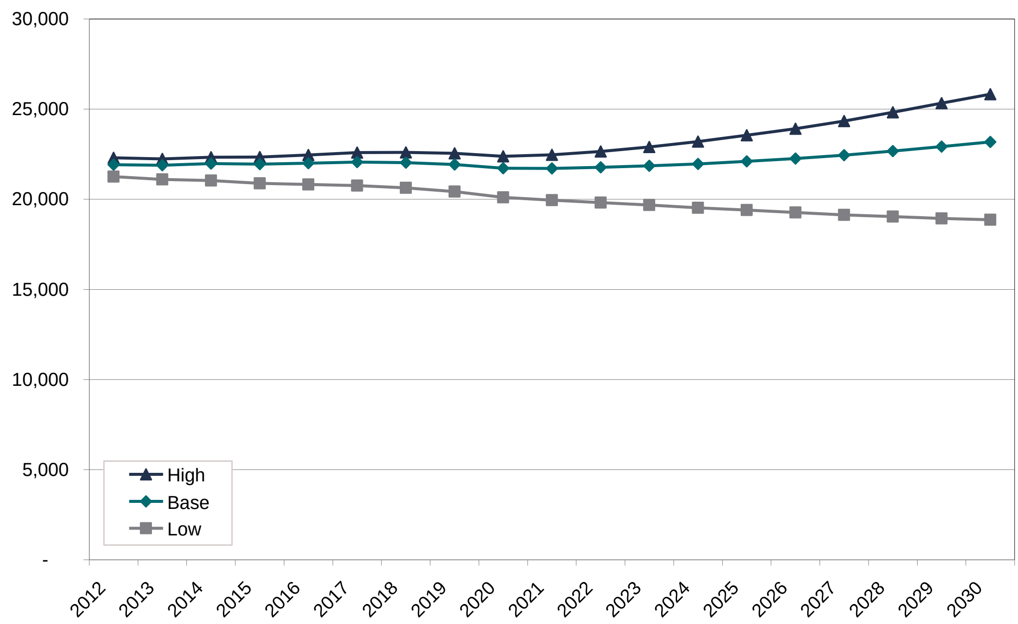
Figure 4-4
PSE Annual Gas Sales Load Forecast



Regional Load

To develop power prices, PSE must use a forecast of regional load. This IRP uses the Northwest Power and Conservation Council's regional forecast from the 6th Power Plan. Figure 4-5 below shows the regional forecast, as well as high and low variations.

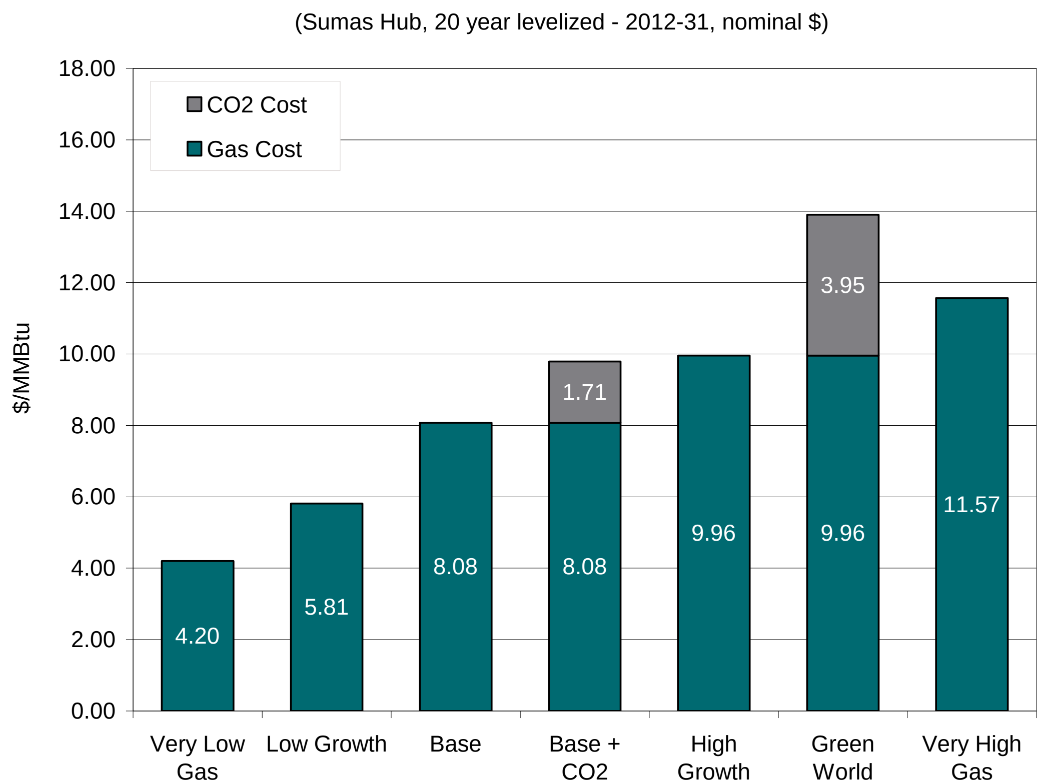
Figure 4-5
NPCC Regional Forecast



Gas Prices

Gas price assumptions for the Base Case are a combination of forward market prices and fundamental forecasts acquired from Wood Mackenzie, a well known macroeconomic and energy forecasting consultancy. Wood Mackenzie's gas market analysis includes regional, North American, and international factors, as well as Canadian markets and LNG imports. They also provide a high and low fundamental forecast from which PSE derived the very high and very low gas price forecasts used in two of the scenarios. The range of 20-year levelized gas prices and associated CO_2 costs used in the analysis is illustrated in Figure 4-6 below.

Figure 4-6
Levelized Gas Prices by Scenario



CO_2 Prices

To capture a range of uncertainty around CO_2 costs, PSE developed the following estimates as inputs.

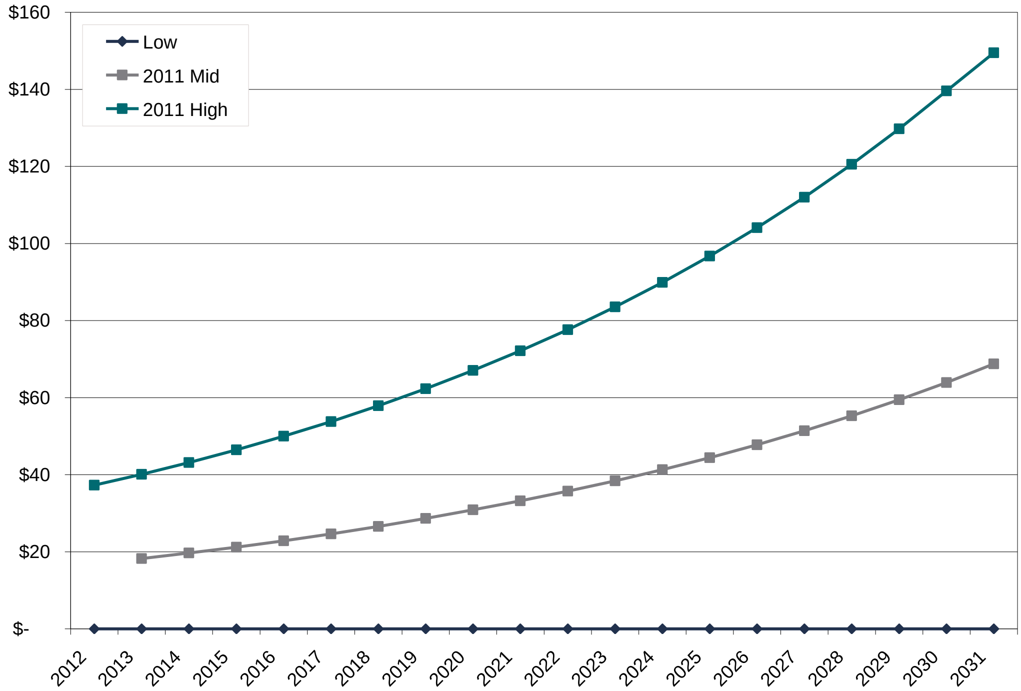
Low CO_2 cost. **$0.32 per ton.** This estimate is based on existing Washington law RCW 80.70, which applies to new fossil fuel-fired thermal generation built within the state. For modeling purposes, a reasonable simplification is that compliance requires payment of $1.60 per ton of CO_2 to cover 20% of emissions, or $0.32 per ton. This $0.32 per ton is applied to CO_2 emissions for the entire WECC. Low CO_2 cost was modeled in all scenarios except Base + CO_2 and Green World.

Moderate CO_2 cost. **$18 per ton in 2013 to $69 per ton in 2031.** This estimate was developed using the CO_2 prices modeled and published by the Environmental Protection Agency (EPA) in their analysis of the Kerry-Lieberman "American Power Act" cap-and-trade scheme. In this environment, CO_2 costs are reflected in gas prices and power prices. Moderate CO_2 cost was included in the Base + CO_2 scenario.

High CO_2 cost. **$37 per ton in 2013 to $149 per ton in 2031.** This estimate was developed using the CO_2 prices modeled and published by the EPA in their analysis of the Waxman-Markey "American Clean Energy and Security Act" cap-and-trade scheme. In this environment, CO_2 costs are reflected in gas prices and power prices. High CO_2 cost was included in the Green World scenario.

The range of CO_2 costs used in the IRP is illustrated below in Figure 4-7.

Figure 4-7
CO_2 Costs Used in the Analysis



2. Scenarios and Sensitivities

The scenarios and sensitivities developed for this IRP enable us to test portfolio costs and risks in a wide variety of possible future conditions and isolate the effects of an individual variable.

The full range of scenarios is described first, followed by a detailed description of the Base Case against which others are defined by reference. Descriptions of the sensitivities follow. Finally, a summary table of scenario and sensitivity assumptions appears at the end of this chapter.

Scenarios

PSE developed eight scenarios for this IRP. (Note that 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).

The Base Case scenario provides a starting set of assumptions; other scenarios are described by how they differ from it. A full description of the Base Case follows these summaries.

Low Growth models weaker long-term economic growth than the Base Case.

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

A low growth rate has been applied for the WECC region, and the F2010 Low Growth demand forecast has been applied for PSE. Wood Mackenzie's long-run low forecast is applied to natural gas prices.

High Growth models more robust long-term economic growth than the reference case.

- Demand for energy is higher in the region and in PSE's service territory.
- Natural gas prices are higher as a result of increased demand.

The High growth rate has been applied in the WECC region, and the F2010 High Growth demand forecast for PSE. Wood Mackenzie's long-run high forecast is applied to gas prices.

Very Low Gas Price models the impact of very weak long-term gas prices.

- Gas prices remain constant in nominal terms throughout the study period.

Prices remain at 2012 levels ($4.20 per MMBTu) throughout the 20-year period, which translates to a levelized price approximately $1.61 per MMBTu lower than the low gas price forecast.

Very High Gas Price models a future in which gas prices are extremely high.

- Gas prices are substantially higher than other forecasts.

Prices were developed to be “symmetrical” with the very low price forecast. Thus, the levelized price is $1.61 per MMBtu higher than the high gas price forecast ($11.57 compared to $9.96 for the high price forecast).

Base + CO_2 This scenario tests portfolio decisions in a world with moderate CO_2 costs.

- Power and gas prices reflect higher CO_2 costs than the Base Case.

Moderate CO_2 prices based on the American Power Act are used.

Green World tests portfolio decisions in a world with high CO_2 costs.

- CO_2 emission costs are much higher.
- Gas prices are much higher.
- Demand for electricity is lower because of price and social preference.

CO2 emission costs rise from $37 per ton in 2012 to $149 per ton in 2031 – per the High CO2 cost estimates developed from on the American Clean Energy and Security Act. Gas prices move higher as developers of new generating resources switch to gas from coal to satisfy legal and environmental requirements, thereby increasing demand. The region’s use of gas-fired generation increases as more intermittent, renewable energy generation comes online (wind and solar). In Green World, the high gas price forecast applies. A low growth rate applies for the WECC region, and the F2010 Low Growth demand forecast applies for PSE.

Base Case Description

Modifications made in the other scenarios and sensitivities are deviations from the reference points established in the base case assumptions described below.

Resource costs. The estimated cost of generic resources is based on offers received in response to PSE's formal 2010 Requests for Proposals (RFPs), along with information obtained during 2010 as part of PSE's ongoing market activity. Offer prices received were not firm and were occasionally revised. The cost of each resource is escalated at varying rates over the 20-year time horizon. A 2.5% annual inflation rate was assumed in this analysis.

In general, cost assumptions represent the "all-in" cost to deliver a resource to customers, which includes plant, siting, 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 the Energy Information Administration (EIA) in the Annual Energy Outlook (AEO) Base Case scenario. New equipment heat rates are expected to improve slightly over time, as they have in the past.

Regional demand growth. PSE based regional demand growth on the forecast published in the 6th Power Plan by the Northwest Power and Conservation Council (NPCC).

PSE demand growth. PSE-specific demand growth incorporates assumptions about regional demand growth, but also includes many factors specific to the service territory. Development of PSE demand forecasts is discussed in detail in Appendix H. For this reference scenario, we assume the F2010 Base demand forecast.

Natural gas prices. Gas price forecasts are a combination of forward marks in the near term and Wood Mackenzie forecasts for the longer term.

- From 2010 through 2015, PSE used the three month average of forward marks for the period ending July 30, 2010. Forward marks reflect the price of gas being purchased at a given point in time for future delivery.
- Beyond 2015, PSE uses long-run, fundamentals-based gas price forecasts acquired from Wood Mackenzie. Wood Mackenzie's modeling assumptions and resulting forecasts are first compared with other forecasts for reasonableness.

CO_2 costs. This scenario assumes a CO_2 costs in current state law, this is effectively a charge of $0.32 per ton starting in 2012 which remains constant over the study period.

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 $22 (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 2012, and that no further PTCs are available for new resource development as of 2013.

Investment tax credits. The Investment Tax Credit (ITC) is another federal subsidy related to production of renewable energy. Currently, the ITC amounts to 30% of the eligible capital cost for renewable resources; it is scheduled to expire at the end of 2012. Through 2012, this scenario assumes ITCs remain at current levels.

Treasury Grant. The Treasury Grant (Grant) is a third federal subsidy available to qualifying renewable energy projects. This subsidy differs from the previous two in that it is a cash payment, versus a tax credit, from the federal government. Currently, the Grant amounts to 30% of the eligible capital cost for renewable resources; it is scheduled to expire at the end of 2012. Through 2012, this scenario assumes the Grant remains at current levels. It is important to note that this is the financial incentive modeled in the 2011 IRP analysis. This simplifies the modeling as the grant is not a function of taxable income.

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.

[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.*

Sensitivities

Sensitivities change only one variable in the Base Case, so that we can isolate the effect that variable has on the portfolio. One analyzed how PSE would design a portfolio if the three regional coal plants were unavailable. Three were designed to investigate how peaking plants compared with CCCT plants with regard to cost and risk. Four tested how tax incentive extensions would affect portfolio decisions. One compared the cost-effectiveness of a 10-year ramp rate for DSR with the longer ramp rate in the NPCC's 6th Power Plan. Finally, one asked how electric vehicle adoption might affect decisions.

No Northwest Coal analyzes how PSE would design a portfolio if policy decisions forced the shutdown of the three regional coal plants, Centralia in Washington, Boardman in Oregon, and Colstrip in Montana. This is not an investigation of what policy changes would be required, just a focus on how such a condition would impact the least-cost mix of resources. PSE's analysis does not reflect important details, such as impacts on the regional transmission system. This is a first look – not the last look – that PSE will be taking at this issue.

Comparing peakers and CCCTs. This analysis recommended adding increasing numbers of natural gas-fired single-cycle peaking engines over the next 20 years, instead of combined-cycle combustion engines (CCCTs). This was a somewhat surprising result, as CCCTs had often been preferred in the past. Peakers operate for short periods of time, generally during load peaking events when demand is greatest, and they most often use fuel purchased on the short-term market. Although CCCTs have higher capital costs, they operate more efficiently and for longer periods of time. CCCTs usually depend on mid- to long-term fuel supply commitments. To better understand the benefits and costs are associated with selecting peakers versus CCCTs, PSE developed three sensitivities:

- No Peakers
- Thermal Mix
- Fixed (Firm) Gas Transport Cost for Peakers

"No Peakers" forces the optimization model to select CCCTs to meet need and does not allow it to select any peakers.

"Thermal Mix" forces the model to select a mix of CCCTs and peakers. It also places a limit of 40% on the amount of annual cost that can be met with market purchases.

"Fixed (Firm) Gas Transport Cost for Peakers" adds higher-priced, firm pipeline capacity costs to the peakers. This sensitivity also assumes that peakers are unable to use oil as a back-up fuel when natural gas is unavailable; the Base Case assumes that they can.

Extension of renewable resource financial incentives.

As part of the 2009 IRP and as part of the RFP process, PSE has consistently found that the lowest cost method for meeting the company's obligation under I-937 is to take advantage of expiring financial incentives and develop renewable resources ahead of the target deadlines in the law. However, we wanted to test how possible extensions to the financial incentives would affect portfolio decisions. To do this we analyzed the following sensitivities.

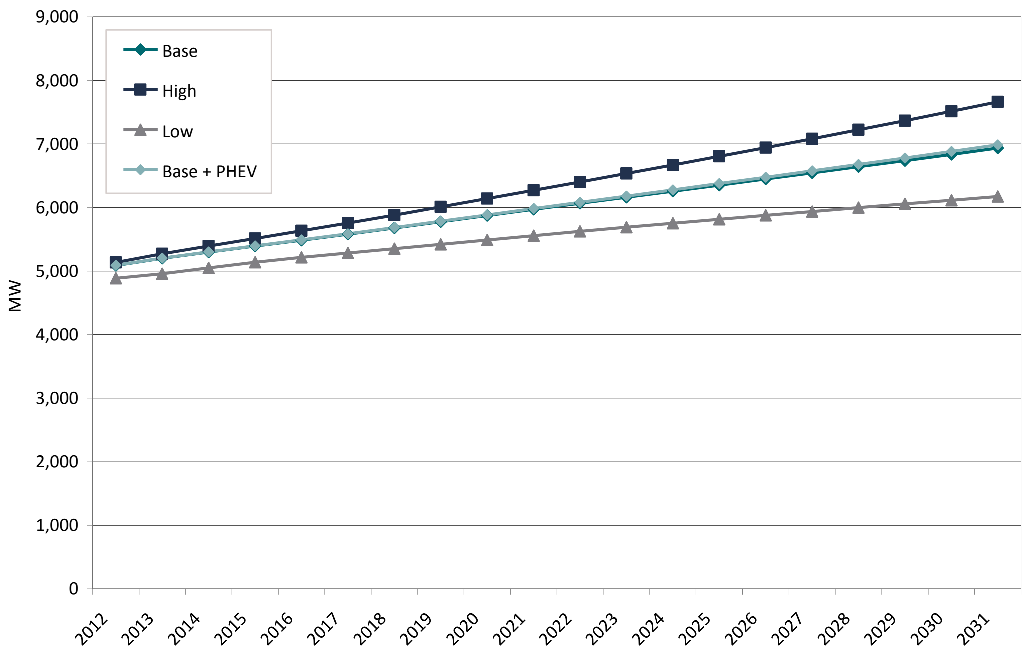
- Financial Incentives Credit extended to 2013
- Financial Incentives Credit extended to 2016
- Financial Incentives Credit extended to 2020
- Financial Incentives Credit extended to 2031

DSR Ramp Rates.

To investigate ramp rates, PSE had Cadmus develop two detailed alternatives. One was based on a detailed, measure-by-measure analysis of ramp rates used in the NPCC's 6th Power Plan, which generally tended to spread some discretionary measures over 12-16 years. The other modeled a more aggressive pace of acquisition, using a 10-year ramp rate for acquiring discretionary measures. .

Plug-in vehicles. As in the last IRP, PSE developed a sensitivity to test how adding electric plug-in vehicle load on a mass scale would affect portfolio decisions. To the Base Case scenario, we added a vehicle load forecast based on the 2010 AEO study. The figure below compares the Base Case forecast with the Base Case forecast plus vehicle loads. While PSE considered this sensitivity important enough to test, the chart below clearly demonstrates that the electric vehicle load is well with in the tolerances of a High load forecast and that these results will be replicated in the other scenarios. Even in 2031 Peak load due to vehicles is only expected to be about 51 MW.

Figure 4-8
Comparison of Peak Forecast with and with out Vehicle load



3. Input Matrices

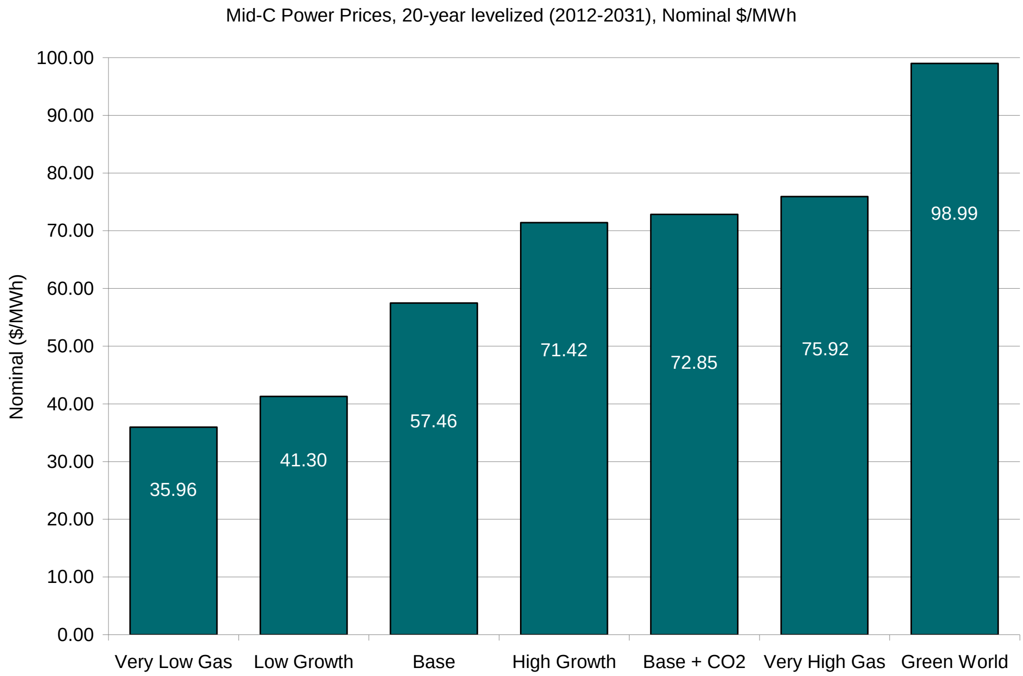
Power Prices

One of the primary reasons for conducting scenario analysis is to develop the power prices used in the optimization model.

From a modeling standpoint, a key difference between scenarios and sensitivities is how they are used to develop power prices. For the Base, Base + CO2, Green World, and No Northwest Coal scenarios, PSE used a stochastic method to develop power price curves. For each of these scenarios, we ran Aurora 250 times using a range of inputs to arrive at expected prices. The High Growth, Low Growth, Very High, and Very Low Gas Price scenarios, are effectively subsets of the Base scenario. Their power prices were calculated by focusing on specific ranges of the distribution used in the Base; for example, the High Growth expected power price is the mean of the 25 base draws with the highest prices and loads. The individual sensitivities do not require Aurora runs since they rely on the assumption in the Base Case; they are simply manipulations of the constraints and assumptions in the optimization model. Please see Appendix I for a discussion of how power prices and the stochastic model were used.

The following table shows the power prices used in each of the core scenarios.

Figure 4-9
Input Power Prices by Scenario



Resource Assumptions

In addition to the key inputs described already, PSE also uses the following resource assumptions in its analysis. Figure 4-10 shows the electric resource assumptions. In addition to these supply-side resources, PSE uses the demand-side resource assumptions indentified in Appendix K.

Figure 4-10

Electric Supply Side Resources

2010 $	Units	CCCT	Peaker	Wind	Biomass	Transmission
Winter Capacity	MW	334	213	100	25	500
Capital Cost	$/KW	$1,540	$1,010	$2,151	$4,330	$436
O&M Fixed	$/KW-yr	$22.00	$15.90	$29.90	$190.00	$15.25
O&M Variable	$/MWh	$0.44	$0.67	$3.50	$3.40	
Force Outage Rate	%	3%	3%		6.3%	
Wind Capacity Factor	%			30%		
Capacity Credit	%	93%	93%	1.8%	93%	100%
Heat Rate – GT	Btu/KWh	7,085	10,440		13,420	
Heat Rate – DF	Btu/KWh	9,350				
Fixed Gas Transport	$/KW-yr	$31.80	$0.00			
Variable Gas Transport	$/MWh	$2.00	$5.20			
Fixed Transmission	$/KW-yr	$0.00	$0.00	$34.30	$18.01	
Variable Transmission	$/MWh	$0.00	$0.00	$3.30	$1.71	
Water Consumption	Gallons/MWh	26				
Emissions:						
SO_2	lbs/MMBtu	0.010	0.010			
NO_x	lbs/MMBtu	0.007	0.009			
CO_2	lbs/MMBtu	115.9	115.9			
Location		PSE Control	PSE Control	WA/OR	PSE Control	Mid-C to PSE
First Year Available		2014	2014	2014	2014	2017

4. Summary Table of Scenario and Sensitivity Assumptions

Puget Sound Energy 20011 IRP (2012-2031)

		Reference Assumptions	Planning Scenarios								
			Base Case	Base + CO2	Low Growth	High Growth	Very High Gas	Very Low Gas	Green World	No Coal	Transport
Theme			Best estimate of current resource costs and characteristics, fuel prices, state and federal laws	Best estimate of current costs with moderate environmental policies	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.	Impact of very high gas prices	Impact of Very Low Gas Prices	Support for stronger environmental legislation at the federal level, with continuation of state level RPS	Impact of legislation shutting down regional coal plants	Impact of plug-in electric hybrid vehicles (PHEV) loads
WECC Demand (AURORA)		EPIS Averages: CA: 1.16% SW: 2.5% PNW: 0.4% RM: 2.4%	Reference	Reference	Low Growth	High Growth	Reference	Reference	Low Growth	Reference	Reference
PSE Demand		Base: 2.%	Base	Base	Low	High	Base	Base	Low	Base	Base + Transport load
Gas Price		Forward marks for 2012-2015, and WoodMac long-run fundamental forecast	Reference	Reference	Wood Mac long-run low forecast	Wood Mac long-run high forecast	Very High Gas price forecasts $11.57/MMBtu	Very low Gas price forecast $4.2/MMBtu	Wood Mac long-run high forecast	Reference	Reference
Coal Price		Global Insight	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Generic Resource Cost ($/KW) Escalation		PSE market based estimates	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Emissions (Nominal $/Ton)	CO2		RCW 80.70 - Carbon Mitigation Plan	EPA APA Analysis	RCW 80.70 - Carbon Mitigation Plan	RCW 80.70 - Carbon Mitigation Plan	RCW 80.70 - Carbon Mitigation Plan	RCW 80.70 - Carbon Mitigation Plan	High	RCW 80.70 - Carbon Mitigation Plan	RCW 80.70 - Carbon Mitigation Plan

Puget Sound Energy 20011 IRP (2012-2031)

		Reference Assumptions	Planning Scenarios: Base Case	Base + CO2	Low Growth	High Growth	Very High Gas	Very Low Gas	Green World	No Coal	Transport
			250 MW or greater	2013: $18	250 MW or greater	250 MW or greater	250 MW or greater	250 MW or greater	2012: $55	250 MW or greater	250 MW or greater
			$1.60/ton for 20% of total CO2	2020: $31 2031: $69	$1.60/ton for 20% of total CO2	$1.60/ton for 20% of total CO2	$1.60/ton for 20% of total CO2	$1.60/ton for 20% of total CO2	2020: $129 2029: $158	$1.60/ton for 20% of total CO2	$1.60/ton for 20% of total CO2
	SO2	Wood Mackenzie 2012: $283 2020: $1261 2031: $3981	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Nox	Wood Mackenzie 2012: $2221 2020: $1692 2031: $2478	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Financial Incentive: Treasury Grant		30% through 2012 For all eligible technologies	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
RPS		Meet Current State RPS through 2031	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Build Constraints		Limited amount of coal and IGCC builds to meet load growth only. No new nuclear builds.	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Renewable Energy Credit ($/MWh)		2010: $8.00 Increase at same rate as wind capital cost: 2012-2031	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

Electric Analysis

Contents

More than a million customers in Washington state depend on PSE for safe, reliable, and affordable electric services. The IRP analysis described in this chapter enables PSE to develop valuable foresight about how resource decisions may unfold over the next 20 years in conditions that depict a wide range of possible futures.

1. Resource Need

For PSE, resource need has three dimensions. The first is physical: Can we provide reliable service to our customers at peak demand hours and at all hours? The second is economic: Can we meet the needs of customers across all hours cost effectively? The third is policy-driven: Are there enough renewable resources in the portfolio to fulfill the state's renewable portfolio standard requirements? Each dimension is described below.

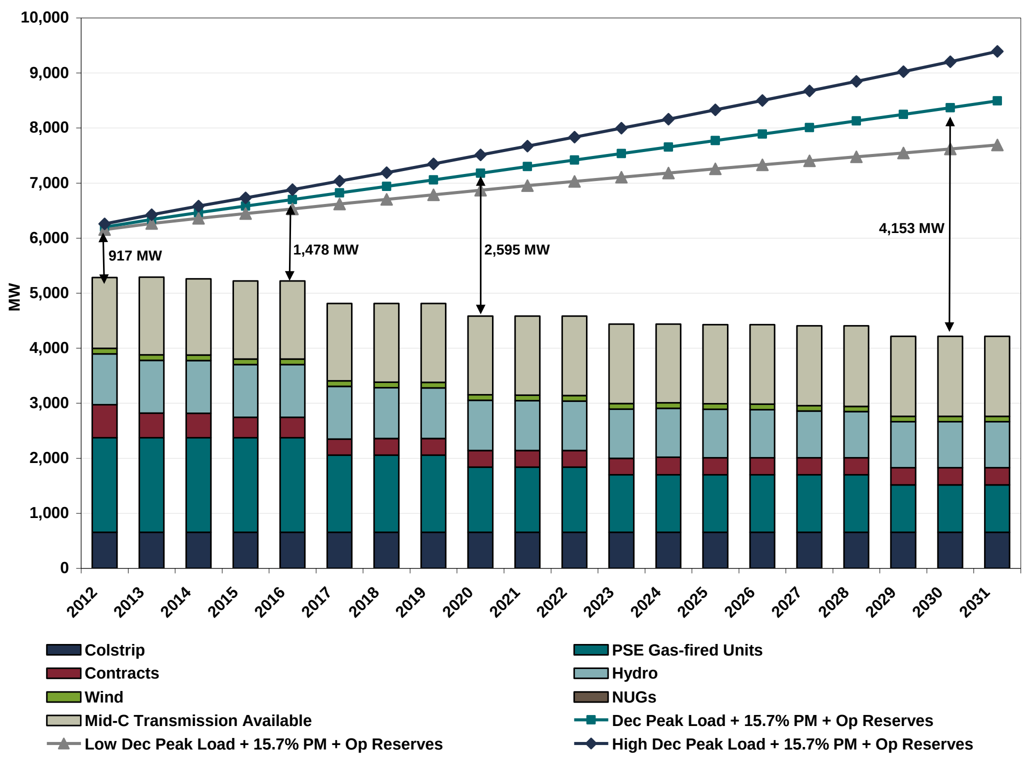
Physical Reliability Need

Physical reliability need refers to the resources required to ensure reliable operation of the system. This operational requirement has three components: customer demand, planning margins, and operational reserves. The word "load" – as in "PSE must meet load obligations" – specifically refers to the total of generated demand plus planning margins and operating reserve obligations. The reserves must be maintained in order to minimize interruption of service due to extreme weather or the unlikely event of equipment failure or transmission interruption.

Physical characteristics of the electric grid are very complex, so for planning purposes PSE simplifies physical resource need into a peak-hour capacity metric through a loss of load probability analysis. That is, if PSE has sufficient resources modeled in the IRP to meet its normal peak hour demand plus a 15.7% planning margin and the operating reserves required to dispatch those resources, the company will be able to maintain an adequate level of reliability across all hours. We can simplify physical resource need in this way because PSE is much less hydro-dependant than other utilities in the region, and because resources in the IRP are assumed to be available year-round. If we were more hydro-dependent, issues like the sustained peaking capability of hydro and annual energy constraints could be important; likewise, if seasonal resources/contracts were contemplated, supplemental capacity metrics may be appropriate to ensure adequate reliability in all seasons

Figure 5-1 shows physical reliability need for the three demand scenarios modeled in this IRP. The components of this "peak need" are described more fully following the chart.

Figure 5-1
Electric Peak Need (Physical Reliability Need)
Comparison of projected peak hour need with existing resources



Demand. PSE uses national, regional, and local economic and population data to develop a range of demand forecasts for the 20-year IRP planning horizon.[1] These forecasts are incorporated into the scenarios modeled in the electric analysis. (See Chapter 4 and Appendix H for a complete description of the forecasting methodologies and inputs used in demand forecasting.)

PSE is a winter-peaking utility, meaning that we experience the highest end-use demand for electricity when the weather is coldest, so projecting peak energy demand begins with a forecast of how much power will be used at a temperature of 23 degrees Fahrenheit at SeaTac (a normal winter peak for PSE). We also experience sustained strong demand during the summer air-conditioning season, although these highs do not reach winter peaks.

Planning margin. PSE incorporates a 15.7% planning margin in its description of resource need in order to achieve a 5% loss of load probability (LOLP). The 5% LOLP is an industry standard resource adequacy metric used to evaluate the ability of a utility to serve its load, and one that is used by the Pacific Northwest Resource Adequacy Forum.[2] The process has two steps. First, we perform an analysis on the likelihood that load will exceed resources on an hourly basis over the course of a full year. Included are uncertainties around temperature impacts, hydro conditions, wind, and forced outage rates (both their likelihood and duration). This analysis allows us to identify the amount of resources needed to achieve a 5% LOLP. In step two, the 5% LOLP is translated into the planning margin of 15.7%. The calculations used to determine the planning margin are described in Appendix I, Electric Analysis.

Operating reserves. North American Electric Reliability Council (NERC) standards require that utilities maintain a “reserve” in excess of end-use demand as a contingency in order to ensure continuous, reliable operation of the regional electric grid. PSE’s operating agreements with the Northwest Power Pool, therefore, require the company to maintain two kinds of operating reserves: contingency reserves and regulating reserves.

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[1] *The demand forecasts developed for the IRP are necessarily a snapshot in time, since the full IRP analysis takes more than a year to complete and this input is required at the outset. Forecasts are updated continually during the business year, which is why those used in acquisitions planning or rate cases may differ from the IRP.*

[2] *See* http://www.nwcouncil.org/library/2008/2008-07.htm

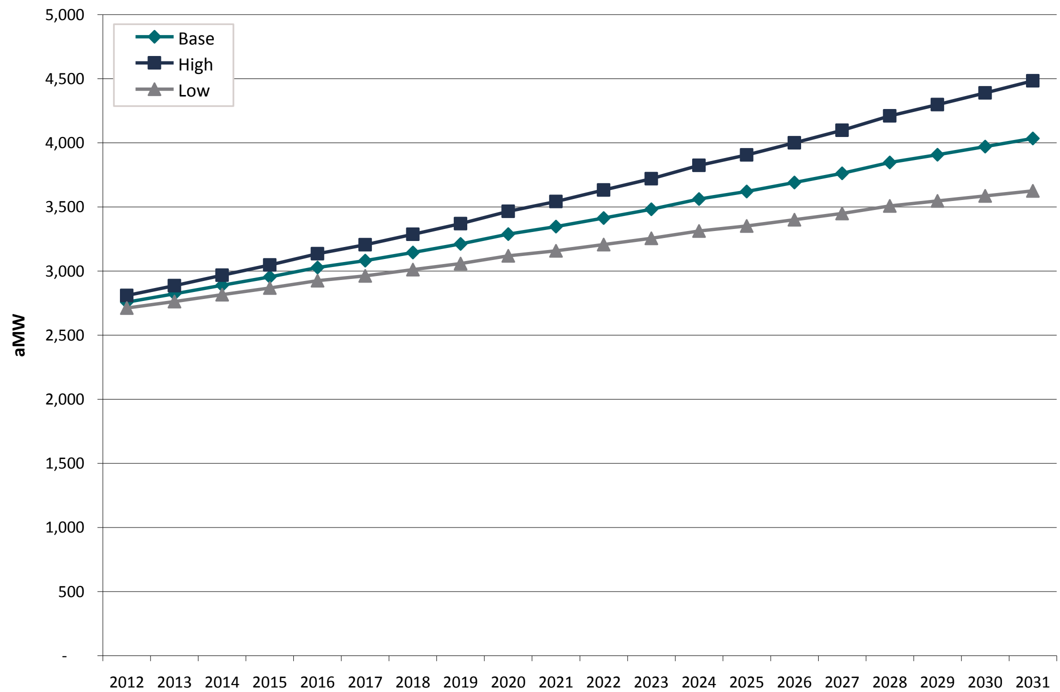
Contingency reserves. Contingency reserves are intended to bolster short-term reliability in the event of forced outages. Under the Northwest Power Pool's contingency reserve sharing agreement, generators must reserve an additional 5% of hydro or wind resources and 7% of thermal resources, when such units are dispatched to meet firm sales obligations. This capacity must be available within 10 minutes, and 50% of it must be spinning. For example, if a 100 MW thermal generator is dispatched to meet firm sales, the utility must have an additional 7 MW of resources available to meet the contingency reserve sharing obligation. Each member of the power pool maintains such reserves. If any member's generator experiences a forced outage, the contingency reserve sharing agreement is activated. Reserves from other members come online to make up for the lost generation. This is a very short-term arrangement. Contingency reserve sharing covers such forced outages for up to one hour. After that, the utility must balance its load (firm sales plus operating reserves) by either purchasing resources on the market or, if necessary, shedding load.

Regulating reserves. Utilities must also have sufficient reserves available to maintain a constant frequency on the system; in other words, they must be able to ramp up and down as loads and resources fluctuate instantaneously. For PSE, this amount is 35 MW. Regulating reserves do not provide the same kind of short-term, forced-outage reliability benefits as contingency reserves; they include frequency support, load forecast error, and actual load and generation changes.

Energy Need

Meeting customers' "energy need" is more of a financial concept that involves minimizing cost rather than a physical planning constraint for PSE. Portfolios are required to cover the amount of energy needed to meet physical loads, but our models also examine how to do this most economically. We do not have to constrain (or force) the model to dispatch resources that are not economical; if it is cheaper to buy power than dispatch a generator, the model will choose to buy. Similarly, if a zero (or negative) marginal cost resource like wind is available, the model will displace higher-cost market purchases and use the wind to meet the "energy need."   Figure 5-2, below, illustrates the company's energy need into the future, based on the energy load forecasts presented in Chapter 4.

Figure 5-2
Annual Energy Need



Renewable Resources

Washington state's renewable portfolio standard (RPS) requires PSE to meet specific percentages of our load with renewable resources or renewable energy credits (RECs) by specific dates. The main provisions of the statute (RCW 19.285) are summarized below.

Washington State RPS Targets

- 3% of supply-side resources by 2012
- 9% of supply-side resources by 2016
- 15% of supply-side resources by 2020

For all practical purposes, wind remains the main resource available to fulfill RPS requirements for PSE. Existing hydroelectric resources may not be counted towards RPS goals except under certain circumstances, and other renewable technologies are not yet capable of producing power on a large enough scale to make substantial contributions to meeting the targets.

Renewable resources influence supply-side resource decisions. Adding wind to the portfolio increases the need for stand-by back-up generation that can be turned on and off or adjusted up or down quickly. The amount of electricity supplied to the system by wind drops off when the wind stops, but customer need does not. As the amount of wind in the portfolio increases, so does the need for reliable back-up generation. Appendix G discusses PSE wind integration challenges in more detail.

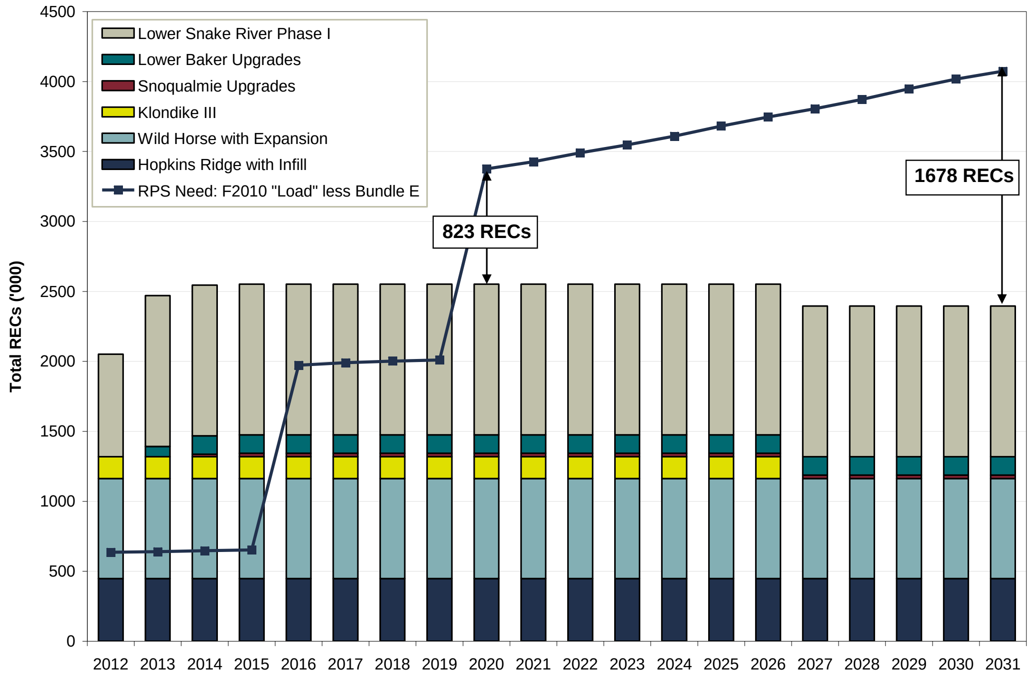
Demand-side achievements affect renewable amounts.

Washington's renewable portfolio standard calculates the required amount of renewable resources as a percentage of the supply-side resources used to meet load; therefore, if the amount of supply-side resources decreases, so does the amount of renewables we need to plan for. Achieving demand-side resources (DSR) has precisely this effect: DSR decreases the amount of supply-side resources needed, and therefore the amount of renewables needed.

Figure 5-3 illustrates the need for renewable energy after accounting for the savings from demand-side resources that were found cost effective for the 2011 IRP.

Figure 5-3

RPS Need Based on Achievement of All Cost-effective DSR



2. *Resource Alternatives*

Resources are divided into two categories, depending on where they originate. Supply-side resources originate on the company side of the meter, while demand-side resources (DSR) generally originate on the customer side of the meter.

With supply-side resources, power is generated by means of water, natural gas, coal, wind, etc., and then transmitted (or "supplied") to customers.

Demand-side resources include energy efficiency measures, demand-response, and other techniques that reduce the amount of power customers need (or "demand") in order to operate their homes and businesses.

In order to test if current conditions make it economical, this IRP also models transmission combined with short-term market power purchases as a resource.

Power Purchase Agreements (PPAs)
PPAs are contracts of varying lengths for purchasing electricity in the market. The IRP did not evaluate PPAs as a resource alternative because costs and commitment terms are market-driven and known only at the time of the offer, so they are not possible to model over a 20-year period. However, when actual acquisitions are made and terms and conditions *can* be known, they will certainly be considered and evaluated as alternatives.

Thermal resources

Coal. The coal resources that are part of PSE's existing portfolio provide a low-cost, stable fuel source and resource diversity. However, additional coal resources were not modeled because of the emissions restrictions set forth in Washington state law RCW 80.80. The IRP does, however, consider one scenario in which our existing coal resource – the Colstrip generating plant in Montana – is no longer available to us.

Natural gas. Additional long-term coal-fired generation is not a resource alternative. RCW 80.80 precludes utilities in Washington from entering into new long-term agreements for coal. New large-scale hydro projects would not practical to develop today. Therefore, natural gas generation is extensively modeled in this IRP analysis due to the following characteristics.

- Proximity. Gas-fired generators can often be located within or adjacent to PSE's service area, thereby avoiding costly transmission investments required for long-distance resources like coal or wind.
- Timeliness. Gas-fired resources are dispatchable, meaning they can be turned on when needed to meet loads, unlike "intermittent" resources that generate power sporadically such as wind and run-of-the-river hydropower.
- Versatility. Gas-fired generators have varying degrees of ability to ramp up and down quickly in response to variations in load and/or wind generation.
- Environmental burden. Natural gas resources produce significantly lower emissions than coal resources (approximately half the CO_2).

Three types of gas-fired generators are modeled in this analysis, because each brings particular strengths into the overall portfolio.

Combined-cycle combustion turbines (cccts). In CCCTs, 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. 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 emissions, CCCTs have been the resource of choice for power generation for well over a decade.

Simple-cycle combustion turbines (peaker). Simple-cycle combustion turbines are better at serving peak need than CCCTs because they can be brought online more quickly. They also have lower capital costs. However, simple-cycles are less efficient and have higher heat rates, which make them more expensive to run.

> **"Peaker"** is a term used to describe generators that can ramp up and down quickly in order to meet spikes in need.

Reciprocating engines (peaker). Like simple-cycle combustion turbines, 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 more efficient than simple-cycle combustion turbines, but have a higher capital cost. The small size of the units allows a better match with peak loads thus increasing operating flexibility relative to the simple-cycle combustion turbine.

Thermal resources not modeled: nuclear. Development and construction costs for nuclear power plants are so much higher than the next highest baseload 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.

Transmission

In this IRP, PSE modeled additional transmission capacity plus market power purchases. We wanted to test whether adding additional transmission and purchasing market power at times of peak need would result in lower portfolio costs than adding other resources. We modeled the addition of 500 MW of transmission capacity. PSE currently relies on approximately 1,200 MW of transmission to acquire electric energy and capacity from the market; during the planning period, this increases to over 1,400 MW.

Renewable Resources

Hydroelectric. Hydroelectric resources are valuable because of their ability to follow load, and because they cost less relative to other resources. Although water is a renewable resource, existing hydroelectric may not be counted toward fulfilling Washington's RPS requirement unless it is an efficiency upgrade to an existing project; this IRP does reflect upgrades in Snoqualmie and Lower Baker that qualify under RPS rules. For new hydroelectric to qualify, it must be a low-impact, run-of-the-river project.

Wind. Wind energy is the primary renewable resource that qualifies to meet RPS requirements in our region due to wind's technical maturity, reasonable lifecycle cost, acceptance in various regulatory jurisdictions, and large "utility" scale compared to other technologies. However, it also poses challenges. Because of its variability, wind's daily and hourly power generation patterns don't necessarily correlate with customer demand; therefore, more flexible thermal and hydroelectric resources must be standing by to fill the gaps. This variability also makes it challenging to integrate into transmission systems.

Finally, because wind projects are often located in remote areas, they frequently require long-haul transmission on a system that is already crowded and strained.

Biomass. Biomass fuels, fuels sources, and generation technologies vary widely. Fuels range from wood and agricultural field residues, to municipal solid waste and animal manure, to landfill and wastewater treatment plant gas. Most existing biomass in the Northwest is tied to steam hosts, typically in the timber, pulp, and paper industries, and use direct combustion or gasification technology. PSE has received several biomass proposals through its RFP process.

Renewable technologies not modeled for this IRP include solar, geothermal, tidal, long-haul wind, and unbundled REC contracts. At this time, these technologies are not capable of producing power on a scale and at a cost that would make sense for PSE customers. We completed the Wild Horse Solar Facility in 2008, a demonstration project that uses photovoltaic technology to produce electricity, and we continue to collect data from the facility to evaluate equipment performance and fit with our resource portfolio. We continue to monitor technology developments in geothermal as well, and entertain proposals for geothermal power projects. PSE has also supported two Northwest ocean energy studies, one tidal assessment and one wave demonstration project. Long-haul wind outside the Pacific Northwest was not modeled in this IRP. Analysis in the 2009 IRP demonstrated that the additional transmission costs for such resources rendered them uncompetitive with wind resources in Pacific Northwest; this finding was reinforced by analysis on actual resource/contract bids in the 2010 RFP process. Finally, unbundled REC contracts were not analyzed. Unbundled RECs are a form of a contract similar to PPAs. Just like other alternatives, if the acquisition process found unbundled REC contracts to be more cost effective and lower risk than self-building resources to comply with RCW 19.285, the company would pursue those alternatives. Our experience in the 2010 RFP process found very limited quantities of unbundled RECs available, but the Company will continue to consider such offers in the future acquisition processes.

Demand-side Resources

Energy efficiency measures. This label is used for a wide variety of measures that result in a smaller amount of energy doing the same work as a larger amount of energy. Among them are codes and standards that make new construction more energy efficient, retrofitting programs, appliance upgrades, and HVAC and lighting changes.

Demand-response. Demand-response 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.

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

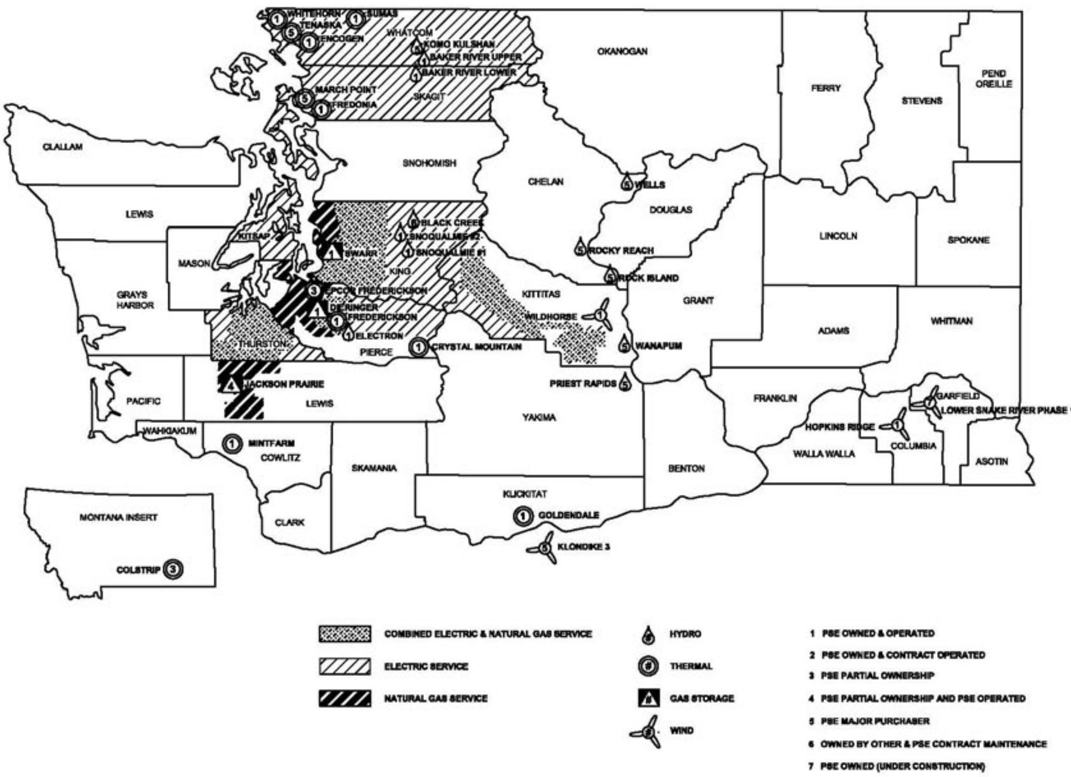
Distribution efficiency. This involves voltage reduction and phase balancing. Voltage reduction is the practice of reducing the voltage on distribution circuits to reduce energy consumption, as many appliances and motors can perform properly while consuming less energy. Phase balancing eliminates total current flow losses that can reduce energy loss.

Summary of Existing Resources

Existing supply-side resources. To build the portfolios for the IRP analysis, we begin with a snapshot of PSE's existing resources. The map and tables that follow summarize PSE's existing resources and their expiration dates as of January 2011. The location of PSE's existing supply-side generation resources is pictured in Figure 5-4.

Figure 5-4

Location of Supply-side Resources



PSE's supply-side resources are diversified geographically and by fuel type. 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. Wind facilities are located in central and eastern Washington. Coal-fired generation is located in eastern Montana.

Figure 5-5

Hydroelectric Resources

PLANT	OWNER	PSE SHARE %	NAMEPLATE CAPACITY (MW)[1]	EXPIRATION DATE
Upper Baker River	PSE	100	105	Not within study
Lower Baker River[2]	PSE	100	85	Not within study
Snoqualmie Falls[3]	PSE	100	49	Not within study
Electron	PSE	100	16	12/31/26
Total PSE-Owned			**255**	
Wells	Douglas Co. PUD	29.89	231	3/31/18
Rocky Reach	Chelan Co. PUD	25.0[4]	320	10/31/31
Rock Island I & II	Chelan Co. PUD	25.0[5]	156	10/31/31
Wanapum	Grant Co. PUD	.64[6]	6	04/04/52
Priest Rapids	Grant Co. PUD	.64[6]	6	04/04/52
Mid-Columbia Total			**720**[7]	
Total Hydro			**975**	

Notes

1) *Nameplate capacity reflects PSE share only.*
2) *Lower Baker Unit 4 will be completed in March 2013, adding 30 MW of nameplate capacity to this project.*
3) *Snoqualmie Falls is offline until March 2013 for repairs. The new capacity will be 49 MW.*
4) *Rocky Reach share is 38.9% through October 2011 and 25% thereafter.*
5) *Rock Island I & II share is 50% through June 7, 2012, and then 25% beginning July 1, 2012.*
6) *Based on Grant Co. PUD current load forecast for 2010; our share will be reduced to this level in 2012.*
7) *As indicated in the above notes, several of the expiring Mid-C contracts have been renegotiated. Figure 5-5 reflects PSE's share, capacity and the expiration dates that will take effect between publication of this IRP and mid-2012 as a result of the new contracts. Individual resource and Mid-Columbia totals are rounded to the nearest megawatt.*

Figure 5-6

Coal, CCCT, and Wind Resources

POWER TYPE	UNITS	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)[1]	ASSUMED RETIREMENT DATE
Coal	Colstrip 1 & 2	50%	330	Not within study period
Coal	Colstrip 3 & 4	25%	386	Not within study period
Total Coal			**716**	
CCCT	Encogen	100%	159	Dec 2028
CCCT	Frederickson 1[2]	49.85%	129	Not within study period
CCCT	Goldendale	100%	261	Not within study period
CCCT	Mint Farm	100%	305	Not within study period
CCCT	Sumas	100%	121	Jul 2023
Total CCCT			**975**	
Wind	Hopkins Ridge	100%	157	Not within study period
Wind	Lower Snake River, Phase 1[3]	100%	343	Not within study period
Wind	Wild Horse[4]	100%	273	Not within study period
Wind	Klondike 3 PPA	0%	50	Nov 2026
Total Wind			**823**	

Notes

1) *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).*
2) *Frederickson 1 CCCT unit is co-owned with Capital Power Corporation - USA.*
3) *PSE began construction of Lower Snake River Phase I in spring 2010. Located in Garfield County, Wash., the 343 MW wind project is scheduled to be completed in the first or second quarter of 2012.*
4) *Wild Horse includes the original 229 MW wind project and a 44 MW expansion.*

Figure 5-7

Simple-cycle Combustion Turbines

NAME	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)[1]	ASSUMED RETIREMENT DATE
Fredonia 1 & 2	100%	208	Dec 2019
Fredonia 3 & 4	100%	108	Not within study period
Whitehorn 2 & 3	100%	149	Dec 2016
Frederickson 1 & 2	100%	149	Dec 2016
Total		**614**	

[1] *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).*

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 below. Short-term contracts negotiated by PSE's energy trading group are not included in this listing.

Figure 5-8
Long-term Contracts for Electric Power Generation

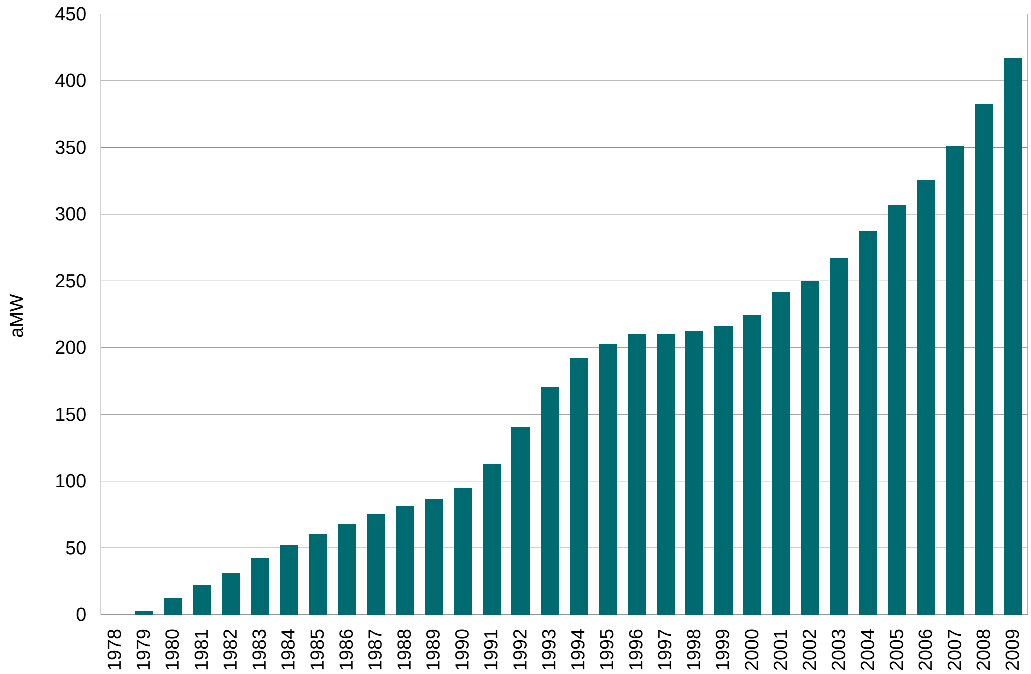
TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)[1]
NUG	Tenaska	Thermal	12/31/2011	245
NUG	March Point I	Thermal	12/31/2011	80
NUG	March Point II	Thermal	12/31/2011	62
Total NUG				**387**
Other Contracts	BPA- WNP-3 Exchange	System	6/30/2017	82
Other Contracts	Powerex/Pt. Roberts	System	9/30/2014	8
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	09/15/2024	-58
Other Contracts	Powerex	System	02/29/2012	150
Other Contracts	Shell Energy	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				**689**
Independent Producers	Twin Falls	Hydro	3/8/2025	20
Independent Producers	Koma Kulshan	Hydro	3/31/2037	14

TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)[1]
Independent Producers	North Wasco	Hydro	12/31/2012	5
Independent Producers	Nooksack Hydro	Hydro-QF	01/01/2014	2.5
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	2/22/2014	<1
Independent Producers	Port Townsend Paper	Hydro-QF	06/30/09	<1
Independent Producers	VanderHaak Dairy	Biomass	12/31/2019	<1
Independent Producers	Qualco Dairy	Biomass	12/11/2013	<1
Independent Producers	Farm Power Lynden	Biomass	1/31/2019	<1
Independent Producers	Farm Power Rexville	Biomass	1/31/2019	<1
Total Independent				**49**

[1] *Nameplate capacity reflects PSE share only.*

Existing demand-side resources. Demand-side resources are generally 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 2008-2009 tariff period, the 66.4 aMW contributed by these programs amounted to enough energy to power approximately 50,000 homes. Between 1978 and 2009, gains of 363 aMW have accumulated on an investment of $650 million – more than the annual output from our share of Colstrip 1 & 2 and equivalent to the electricity used by about 270,000 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.

Figure 5-9
Cumulative Electric Energy Savings from DSR, 1978 to 2009



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 2008-2009 biennial program period concluded at the end of 2009; current programs operate January 1, 2010 through December 31, 2011. The majority of electric energy efficiency programs are funded using electric "rider" funds collected from all customers.

For the 2010-2011 period, a two-year target of approximately 71 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 two largest programs offered by PSE to customers are the Commercial and Industrial Retrofit Program and the residential Energy Efficient Lighting 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 gave out grants totaling more than $22 million to over 1,000 business customers in 2010 to achieve a savings of over 80,000 MWh.

The Energy Efficient Lighting Programs offer instant rebates for residential customers and builders who purchase Energy Star fixtures and compact fluorescent light bulbs. This program provided incentives totaling more than $5 million, which resulted in the installation of over 2.2 million CFL lamps and fixtures in 2010 to achieve savings of over 56,000 MWh.

Figure 5-10
Annual Energy Efficiency Program Summary, 2008-2010
(Dollars in millions, except MWh)

Program	2008 - 2009 Actual	'08-'09 2-Year Budget./Goal	'08/'09 Actual vs. '08/'09 % Total	2010 Actual	'10-'11 2-Year Budget./Goal	'10 vs. '11/'09 % Total
Electric Program Costs	$ 123,000,000	$ 130,000,000	95.0%	$ 75,000,000	$ 167,000,000	45%
Megawatt Hour Savings	581,000	513,000	113%	295,000	622,000	47.5%

Figure 5-10 shows program performance compared to two-year budget and savings goals for the biennial 2008-2009 electric energy efficiency programs, and records 2010 progress against 2010-2011 budget and savings goals.

During 2008-2009, electric energy efficiency programs saved a total of 66.4 aMW of electricity at a cost of $123 million. The company surpassed two-year savings goals while operating at a cost that was under budget. In 2010, these programs saved 32 aMW of electricity at a cost of $75 million. The average cost for acquiring energy efficiency in 2008-09 was approximately $210 per MWh, compared to a budgeted cost of approximately $270 per MWh in the 2010-2011 program cycle.

3. Analytic Methodology

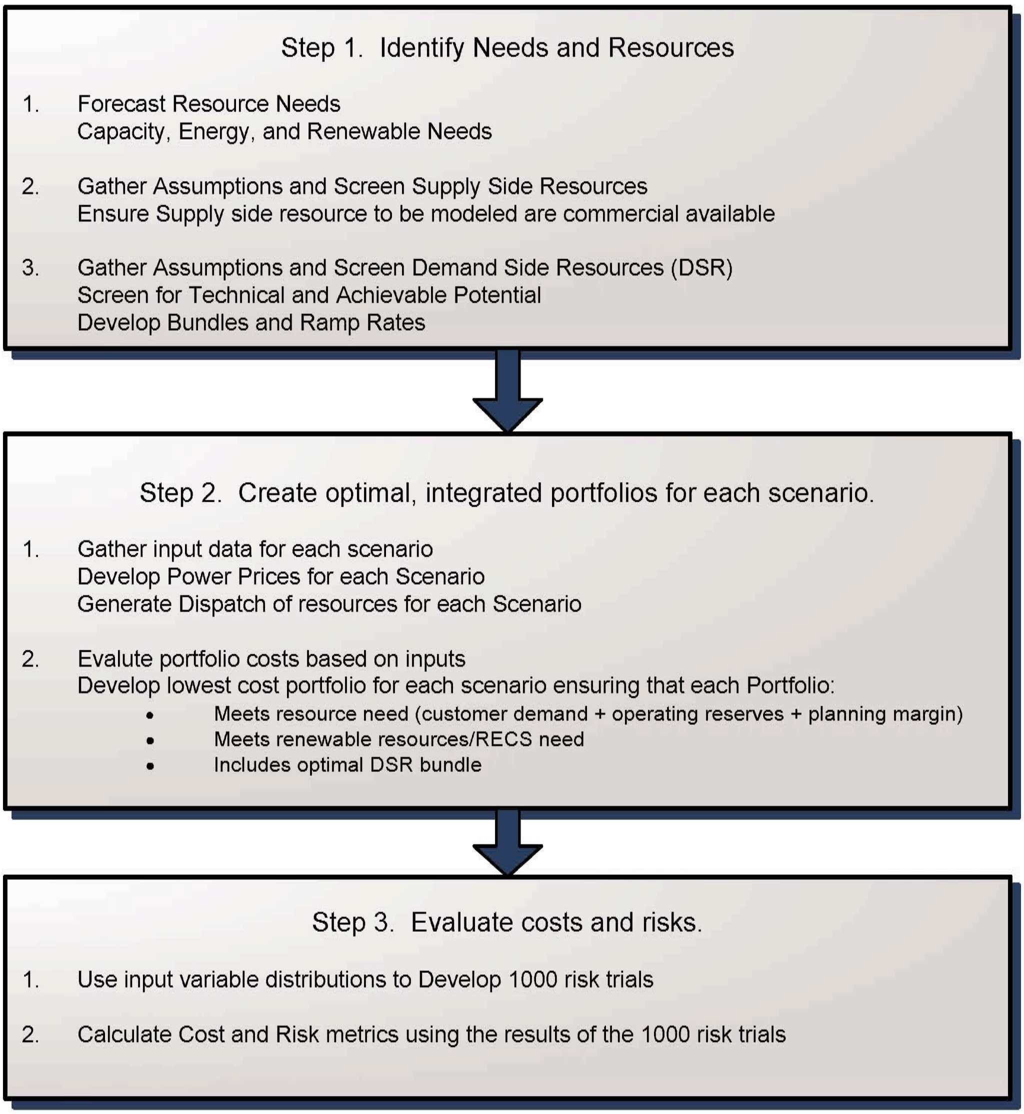
This section describes the quantitative analysis of electric demand- and supply-side alternatives. It explains how portfolios were created in response to a variety of key economic assumptions expressed as scenarios, and how these portfolios were evaluated for cost and risk. The resulting analysis allowed 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?
- What is the cost-effective level of energy efficiency?
- 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?
- How might future carbon regulation affect the relative value of resource alternatives?
- What carbon emissions are produced by portfolios under different scenarios?
- How do changes in financial incentive assumptions affect resource decisions?

Electric analytic methodology followed the three basic steps illustrated in Figure 5-11. (For a detailed technical discussion of models and methods, see Appendix I, Electric Analysis).

Figure 5-11

Methodology Used to Create and Evaluate Portfolios



Step 1: Identify needs and resources.

The analysis begins by using the most recently available forecast of customer demand. We use this load forecast to develop resource need assumptions.
Next, all resources that are available to fill unmet need are identified.

Supply-side resources included natural gas-fired generation, wind, and biomass.

Demand-side resource selection followed the three-step process illustrated in Figure 5-12.

- First, each demand-side measure was screened for technical potential.
- Second, a screen eliminated any resources not considered achievable.
- Finally, the remaining measures were combined into bundles based on levelized cost for inclusion in the optimization analysis.

Screening for technical potential assumed that all opportunities could be captured regardless of cost or market barriers, so the full spectrum of technologies, load impacts, and markets could be surveyed.

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 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.

This methodology is consistent with the methodology used by the Northwest Power and Conservation Council. A comparison of the two can be found in Appendix B.

For a more detailed discussion of demand-side resource evaluation and the development of DSR bundles, see Appendix K, Demand-side Resource Analysis.

Figure 5-12

General Methodology for Assessing Demand-side Resource Potential

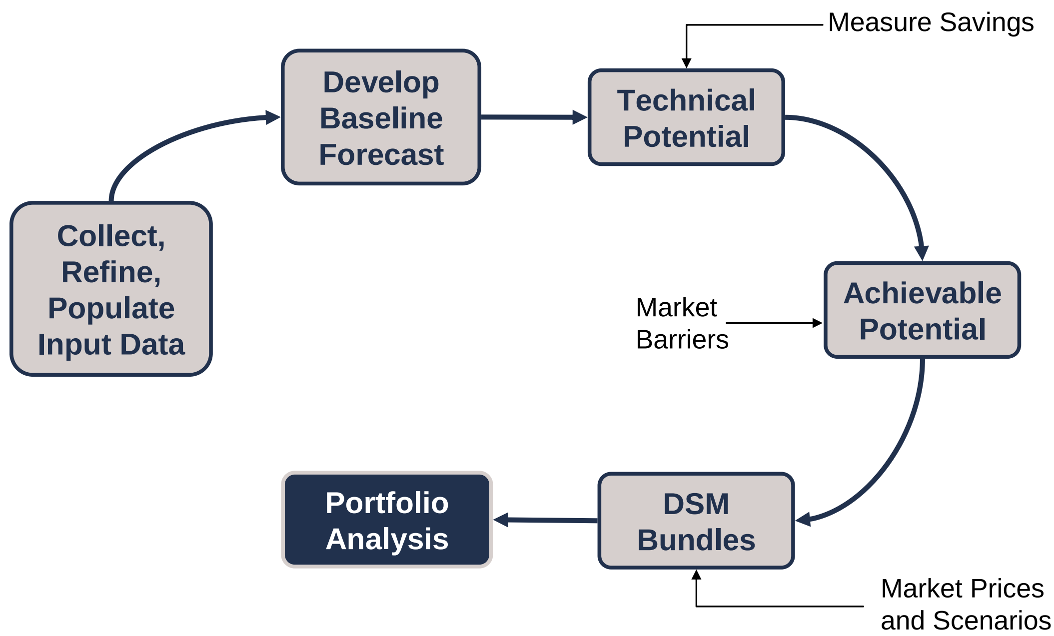
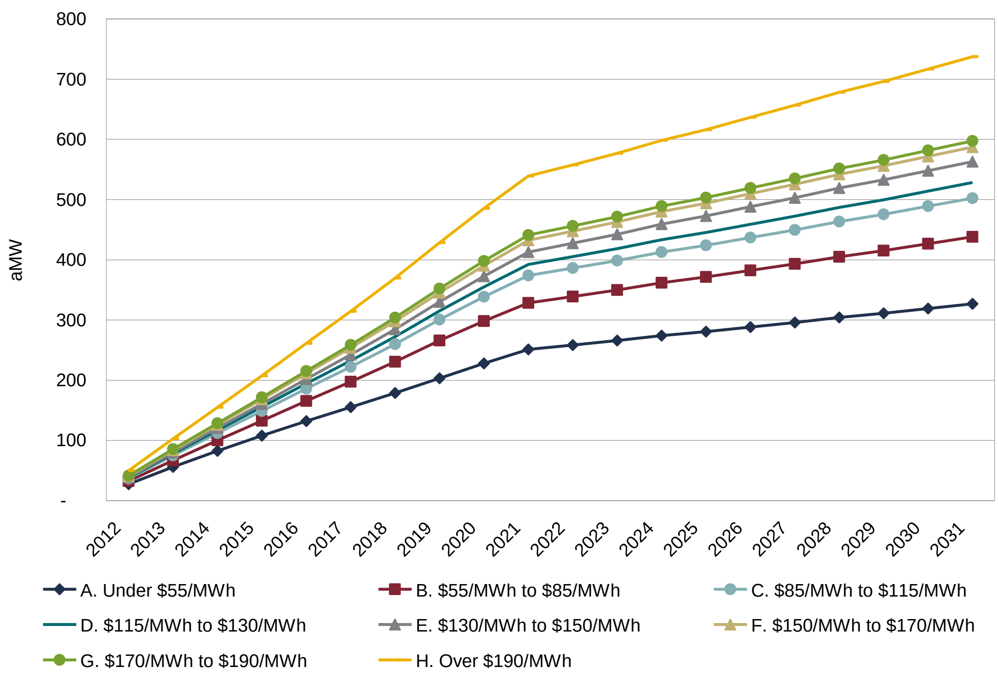


Figure 5-13 shows the achievable potential of all DSR bundles tested in the IRP. The effect of these bundles is to reduce load, so the costs of achieving the savings are added to the cost of the electric portfolios.

Figure 5-13

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 portfolio optimization model PSM III to combine supply-side resources with the demand-side bundles. The optimization model used the inputs provided to identify the lowest cost portfolio that:

- Meets capacity need
- Meets renewable resources/RECS need
- Includes as much conservation as is cost effective

PSE models lowest cost from the customer perspective, so it is measured in as the lowest net present value (NPV) revenue requirement of a portfolio. To arrive at this calculation the company aligns three analytical efforts:

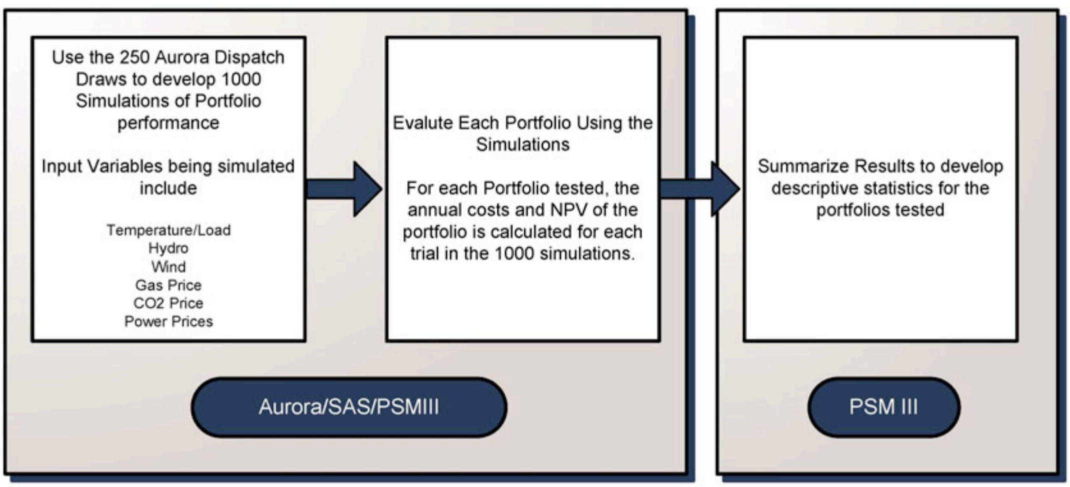
- An economic dispatch model that can provide a reasonable forecast of variable costs and wholesale market revenue from operating plants, given market assumptions. For this process, PSE uses Aurora.
- A revenue requirement model, to incorporate the costs of capital investments and other fixed costs the way customers will experience them in rates; the IRP uses the same financial model the general rate case uses for calculating revenue requirements.
- An optimization model, to develop and test different portfolios to find the lowest cost combination of resources; PSM III uses a linear optimization model.

Step 3: Evaluate costs and risks.

Once the optimal portfolio for each scenario was identified, PSE conducted risk analysis on select portfolios. The PSM III process illustrated in Figure 5-14 was used to calculate risk measures for each.

A Stochastic model was used to create 250 simulations of input variables for the Base Case scenario. The average, or expected, output from the 250 draws was used to find an optimal portfolio. We then fed the 250 draws into PSM III and used that tool to simulate 1,000 trials for the optimal portfolio. These trials allowed us to fully understand risks associated with differing gas prices, power prices, and weather conditions that affect loads, hydropower, and wind generation levels. For each trial, PSE could extract annual dispatch, costs, and loads for all the portfolios tested. (A full discussion of PSE's risk modeling approach appears in the "Stochastic Model" section of Appendix I, Electric Analysis).

Figure 5-14
Risk Analysis Process



4. Results

Figure 5-15 displays the MW additions for the optimal portfolios in 2016, 2020, and 2031. See Appendix I, Electric Analysis, for more detailed information.

Figure 5-15 below shows resource builds for the different scenarios. Note that with the exception of Green World all the portfolios end up looking very similar. The differences are described in the last section of this chapter.

Figure 5-15
Resource Builds by Scenario
Cumulative additions by nameplate

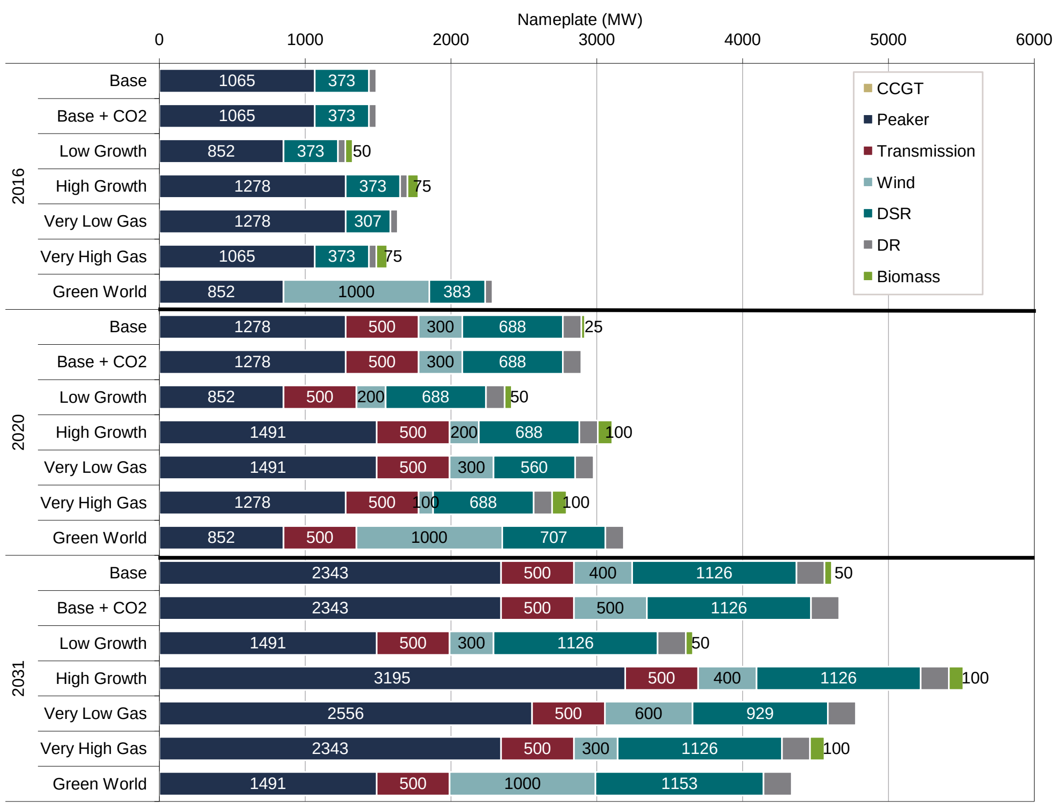


Figure 5-16 shows the 20-year net present value of costs for each of the portfolios.

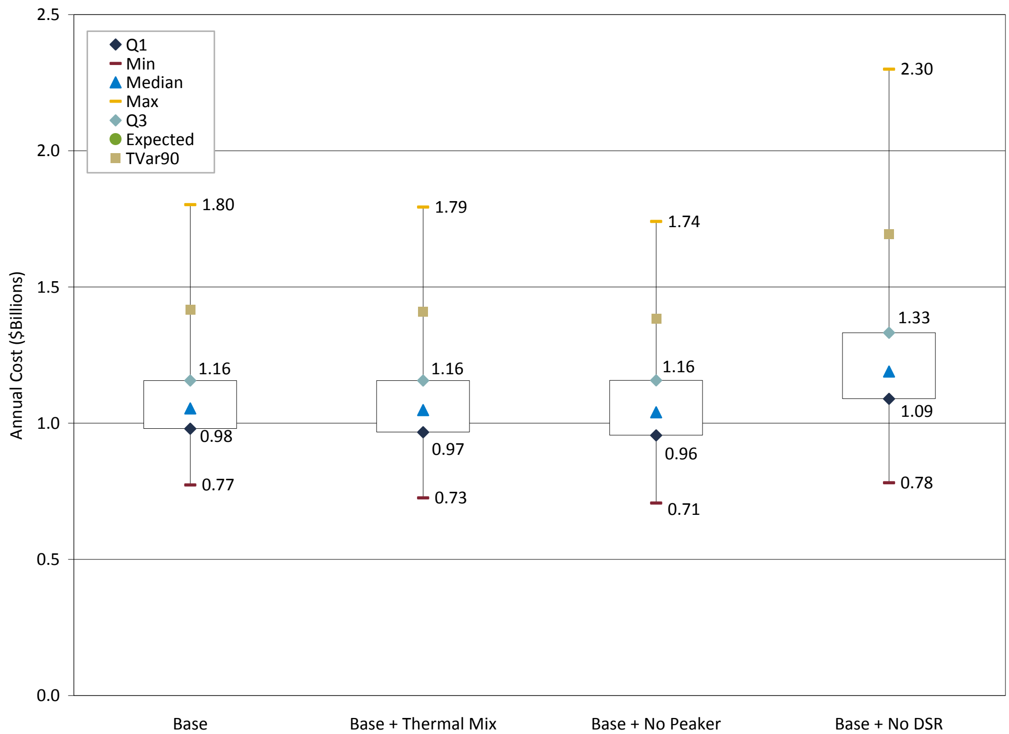
Figure 5-16
Net Present Value Expected Portfolio Cost

Scenarios	20-year NPV Expected Cost (Incremental Rev Req $Billions)
Base	$13.36
Base + CO2	$15.93
Low Growth	$9.83
High Growth	$18.58
Very Low Gas Prices	$10.87
Very High Gas Prices	$16.45
Green World	$21.06

NPV of costs shown above in Figure 5-16 represent the expected value of the least cost portfolio based on a comprehensive set of stochastic analyses. Results of the stochastic analysis can also be examined. Figure 5-17 represents the variability and the range of the portfolio costs of a few different portfolio sensitivities in the Base Case scenario. The different portfolios were designed to test cost versus risk trade-offs of demand-side resources and substituting combined cycle plants for some or all of the peakers (the peaker/CCCT portfolios are described in more detail below in the Key Findings and Insights section.) Figure 5-17 demonstrates that going from the No DSR portfolio to the Base portfolio—or any other portfolio—reduces both costs as well risk measured by Tail Var 90. However, there is no clear trade off between the cost and risk profiles of the Base, Thermal Mix, and No Peaker portfolios.

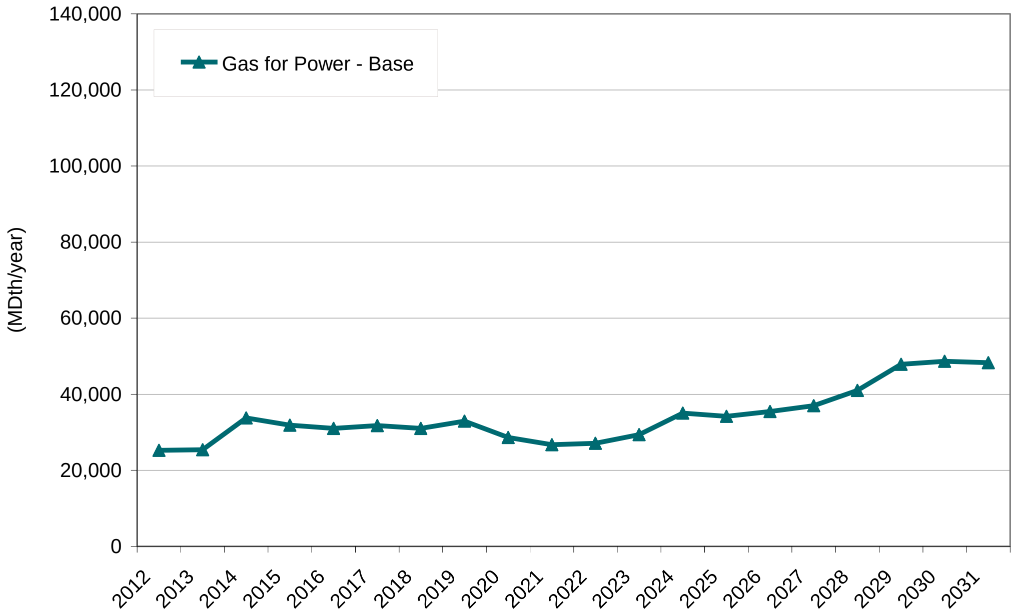
Figure 5-17

Variability and Range of Portfolio Costs in Base Case Scenario



Generation fuel requirements are shown in the following chart. A discussion on how the optimal portfolio affects gas planning can be found in Chapter 6, Gas Analysis.

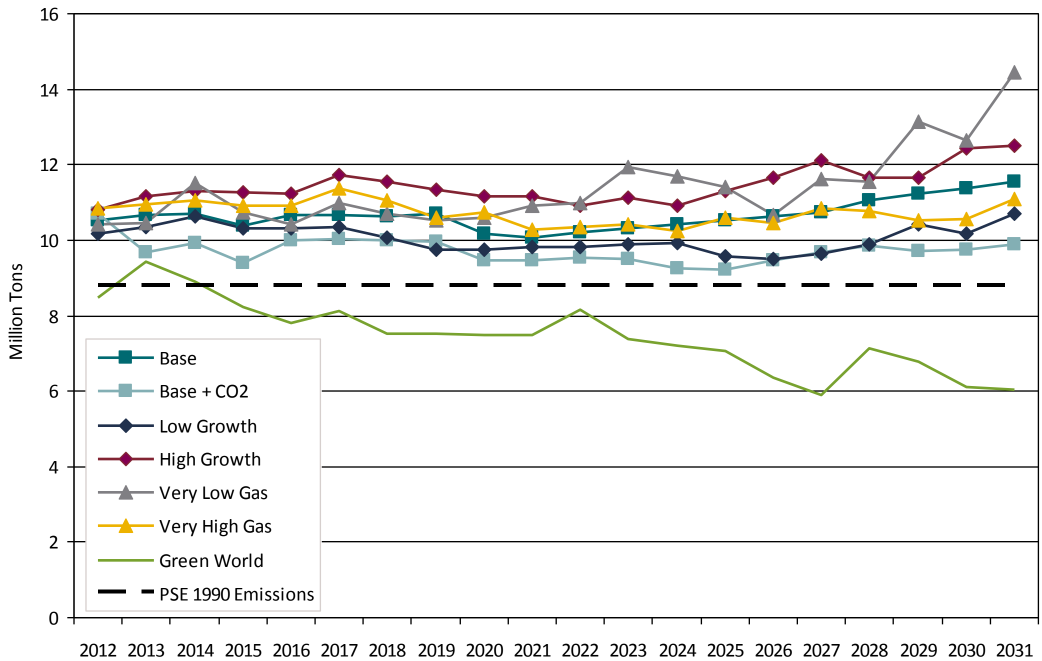
Figure 5-18
Generation Fuel Requirements



CO_2 emissions for each of the scenarios is shown in Figure 5-19

Figure 5-19

Emissions by Portfolio



5. 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.

1. Portfolio builds are similar across most scenarios.

Resource alternatives are so limited that the portfolio builds for all scenarios look very similar. For all but Green World, the optimal portfolio uses new transmission and peakers to meet physical reliability need, conservation and market power purchases to meet annual energy needs, and wind to meet RPS requirements. Small variations occur due to load variations and "right sizing" (building a small bio-mass unit rather than adding an entire peaker or wind farm, for example), but the similarities are striking.

Green World is the only exception. In this scenario, high gas, CO_2 and market power costs create a situation where wind power is cheaper than market power. Left unconstrained, Green World would have chosen an unlimited amount of wind. Because it is unrealistic for a load-serving utility to take such a speculative position, we constrained the amount of wind allowed to be developed in this scenario.

Figure 5-20
Relative Portfolio Builds and Costs by 2031
Energy in total MW, dollars in billions

	Base	LG	HG	GW	VLG	VHG
Demand-side Resources	1319	1319	1319	1345	1121	1319
Wind	400	300	400	1000	600	300
Biomass	50	50	100	0	0	100
Peaker	2343	1419	3195	1419	2556	2343
New Transmission	500	500	500	500	500	500
Costs	$13.36	$9.83	$18.58	$21.06	$10.87	$16.54

2. Peakers are lower cost than CCCT plants.

Peakers proved to be a lower cost resource alternative than CCCT plants across all planning scenarios. Figure 5-21 below compares the net revenue requirement of peakers and combined-cycle plants across selected scenarios. Net revenue requirements were calculated by taking all capital and fixed costs of a plant and then subtracting the margin (variable costs less market revenue). This calculation lets one quickly compare how these resources are evaluated by the model. PSE also performed a study that burdened the peaking units with the higher-priced, fixed fuel transportation costs that CCCTs are burdened with, but even under these conditions peakers resulted in a lower net cost than CCCTs.

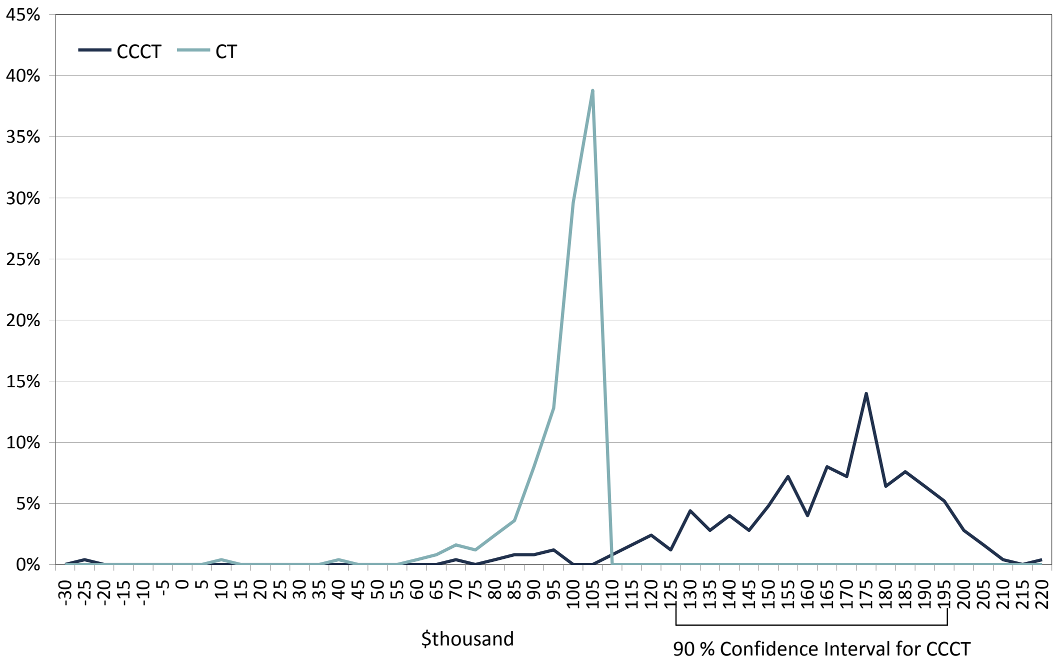
Figure 5-21
Peaker and CCCT Net Thermal Costs Compared

	Base	Base + CO2	Base No Coal	LG	GW
Peaker Rev Requirement (Capital + Fixed)	$242,369	$242,369	$242,369	$242,369	$242,369
Margin	$14,541	$61,876	$83,151	$37,812	$55,266
Net Cost of a Peaker	$227,828	$180,493	$159,218	$204,557	$187,103
$/MW	$1359	$1036	$1136	$1250	$1167

	Base	Base + CO2	Base No Coal	LG	GW
CCCT Rev Requirement (Capital + Fixed)	$812,971	$812,971	$812,971	$812,971	$812,971
Margin	$272,446	$335,292	$325,895	$228,492	$468,812
Net Cost of a CCCT	$540,525	$477,679	$487,076	$584,480	$344,160
$/MW	$1792	$1632	$1604	$1924	$1204

The net cost of a CCCT plant is significantly affected by the margin it generates, and that margin varies as market conditions change. Figure 5-21 illustrates that in the Base Case, the CCCT margin is about one-third of the capital and fixed costs; as market conditions change, so does the margin. Figure 5-22 illustrates the impact of margin on the net cost per MW of a peaker and CCCT plant in the Base Case scenario. This Figure uses a 250-draw Monte Carlo analysis for a single year (2016) to illustrate how the net cost per MW of peakers and CCCT plants are distributed under different market conditions. The cost distribution for peakers is very tight, because peakers do not dispatch or create much margin in many draws. On the other hand, the margin on CCCT plants is widely dispersed, which drives a more wide-spread distribution. That broader CCCT distribution is significantly higher than the distribution on the peaker. The distribution of the peaker lies entirely below the 90% confidence interval for the CCCT plant. This demonstrates that while CCCT plants are expected to operate more and generate margins from those operations, such margins are not expected to be large enough to offset the higher fixed cost of the CCCT.

Figure 5-22 Comparison of Net Cost Distribution: CCCT and Peakers



3. CCCTs do not reduce portfolio risk cost effectively.

Because the all-peaker result differed from past IRP analyses, PSE decided to test whether there were risk reduction benefits to building CCCTs instead, or to building a portfolio that blended CCCTs and peaking units. To do this, we developed two additional sensitivities using the Base Case scenario: The "Thermal Mix" sensitivity forced the optimization model to build enough CCCTs to ensure that the total dollar value of net market power purchases did not exceed 40% of total power cost in any year. The "No

Peakers" sensitivity forced the optimization model to create a lowest-cost portfolio without any peaking plants, with the result that all peakers were replaced with CCCT plants and a minor amount of biomass. Figure 5-23 through 5-26 below show the results of the analysis.

As figure 5-17 shows, adding CCCTs to the portfolio increased costs but did not significantly reduce risk. The two sensitivities observably reduced the portfolio's exposure to market power prices, but at the same time they increased exposure to market gas prices. Adding CCCT generation did not reduce the company's overall exposure.

Figure 5-23 below shows the resource builds by sensitivity. Note that the only measurable differences between the portfolios are the types of gas-fired plants being added. Additionally, the No Peakers sensitivity adds marginally more DSR.

Figure 5-23
CCCT Sensitivities, Builds vs. Base Case Build

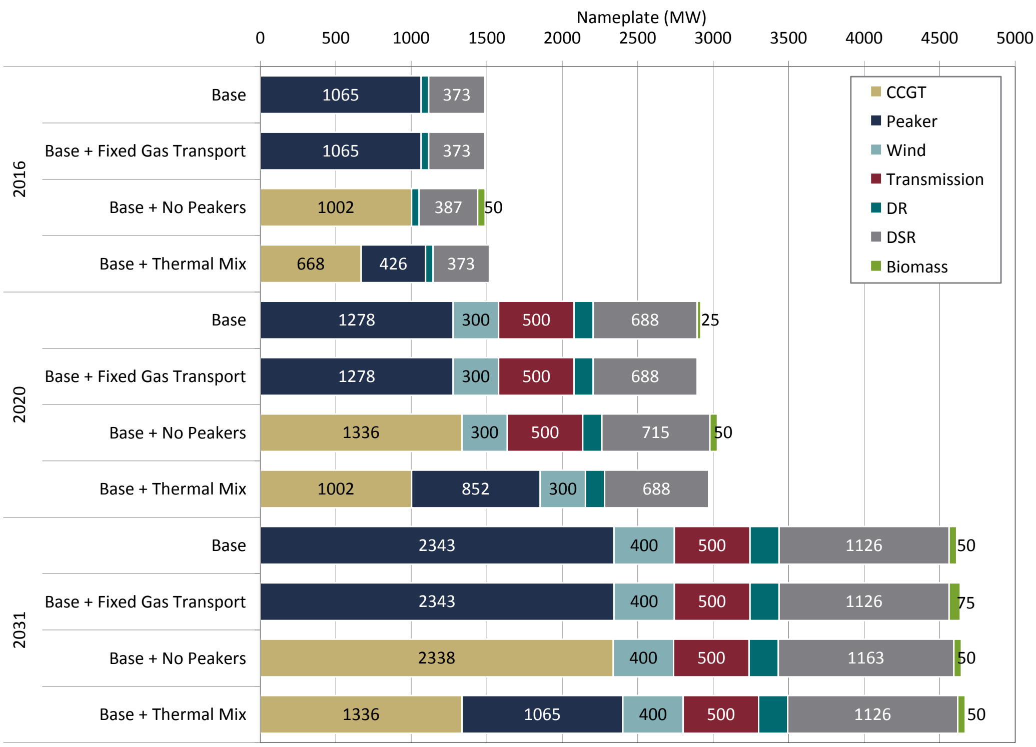


Figure 5-24 shows the costs of the various sensitivities.

Figure 5-24

CCCT Sensitivities, NPV Portfolio Cost Comparisons

Scenario	20-year NPV Expected Cost (Incremental Rev Req $Billiions)
Base	$13.36
Base + Peaker Fixed Gas Transport Cost	$14.10
Base + No Peaker	$14.54
Base + Thermal Mix	$14.26

Figure 5-25

Power Market Exposure

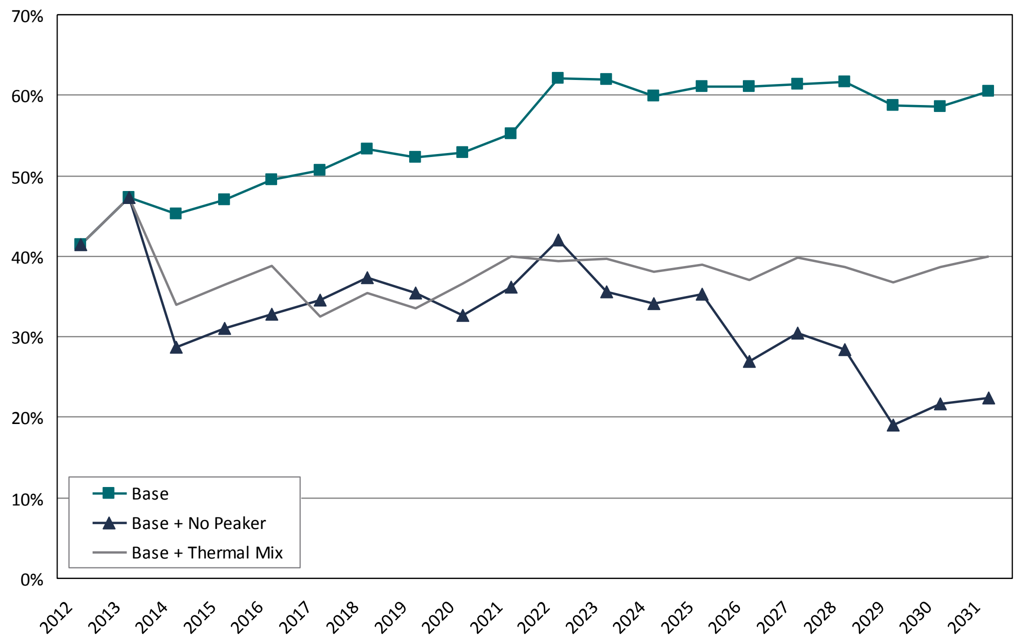
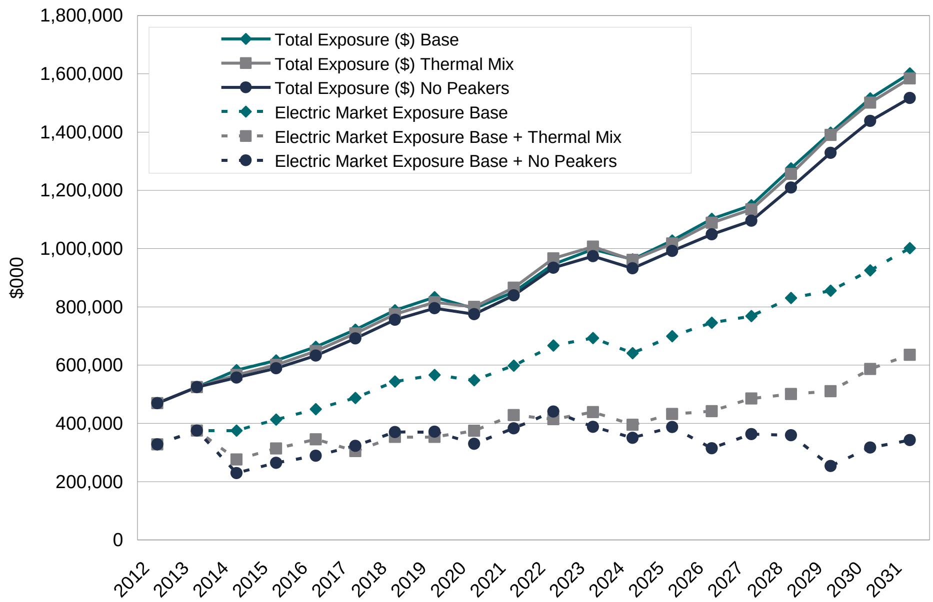


Figure 5-25, above, shows the power market exposure for the different sensitivities. Market exposure is calculated by dividing the dollar amount of net market purchases by the total variable costs of the portfolio. If power market exposure were the only consideration, adding CCCTs to the portfolio would appear to reduce the portfolio's exposure to risk. However, when gas market exposure is considered in addition to power market exposure, adding CCCTs does not reduce risk exposure, as Figure 5-26 illustrates.

Figure 5-26
Total Market Exposure



CCCT plants do reduce variable cost risk relative to peakers but at too high a price to be reasonable. The first part of the table in Figure 5-27 illustrates that the Tail Var 90[3] of variable costs for the portfolio with all CCCT plants instead of peakers is a little over $0.5 billion lower than the Base portfolio with all peakers. The second part of the table illustrates the CCCT portfolio's revenue requirement is $1.18 billion more than the Base Portfolio, which reflects the higher fixed costs of the CCCT plants. This is clearly not a reasonable cost/risk trade-off. The "insurance premium" of the CCCT portfolio costs twice as much as the risk being avoided.

Figure 5-27
Trade Off Table ($Billions) 20-Year NPV

Variable Costs				
	Base Portfolio	Fixed Gas Transport	Peaker/CCCT Blend	No Peaker
Tail Var 90 Variable Costs	$13.15	$13.14	$12.82	$12.60
Relative to Base		-0.01	-0.33	-0.55
Incremental Revenue Requirement[4]				
	Base Portfolio	Fixed Gas Transport	Peaker/CCCT Blend	No Peaker
Expected Incremental Rev Req	$13.36	$14.10	14.26	14.54
Relative to Base		+0.74	+.09	+1.18

[3] Tail Var 90 is a risk measure, calculated as the mean of the worst 10% of possible outcomes.
[4] Incremental Revenue Requirement includes fixed and variable costs for new resources and variable costs for existing resources.

4. RPS requirements drive renewable builds.

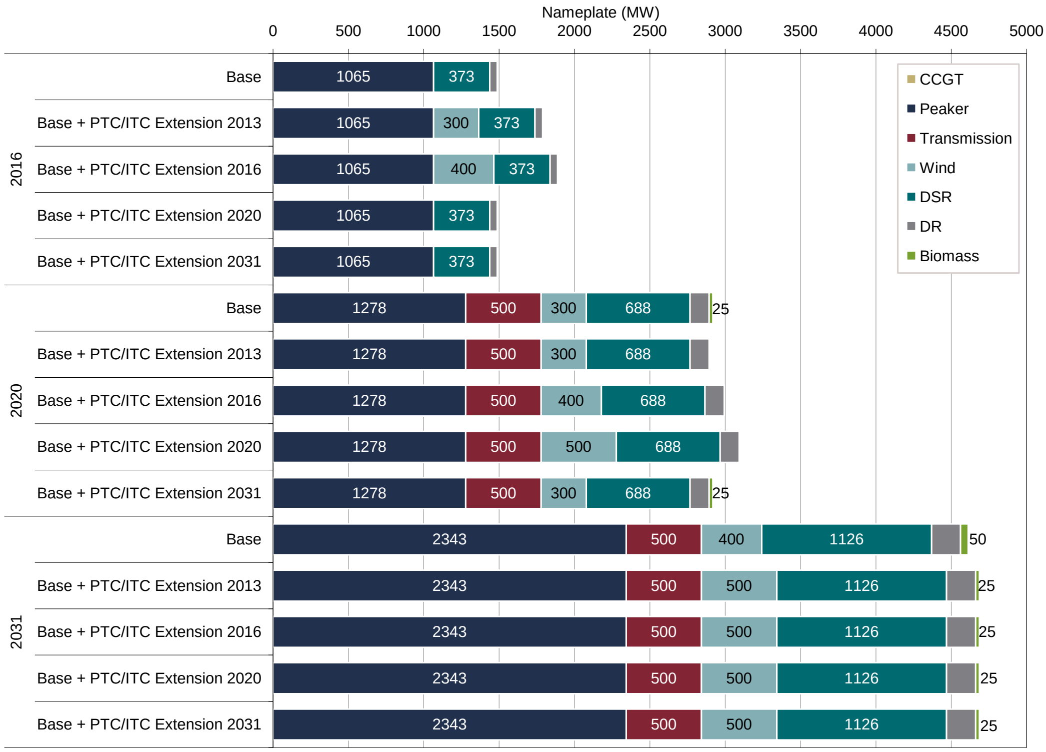
The amount of renewable resources included in portfolios is driven by RPS requirements. Figures 5-28 and 5-29 show results of portfolio comparisons performed to test how changes in CO_2 costs, load growth, demand-side resources, and financial incentives such as the cash grant or production tax credit (PTC) extensions, would affect wind additions to the portfolios. As explained in Chapter 4, this analysis assumed treasury grants were the financial incentive being used. Green World is the only scenario that increases wind more than required by the RPS.

Figure 5-28
The Effect of Variables on Wind Additions in 2029

Variable	Portfolio's to Compare	Effects of Change
CO_2 Cost Changes	Base Case Base + CO_2	The Base Case builds 400 MW of wind and 50 MW of biomass. Increased CO_2 costs in Base +CO_2 resulted in 500 MW of wind and no biomass.
Load Changes	Low Growth Base High Growth	At the low end of the spectrum, Low Growth adds 300 MW of wind and 50 MW of biomass. At the high end, High Growth adds 400 MW of wind and 100 MW of biomass.
DSR Changes	Base No DSR vs. Base	Adding the optimal amount of DSR in the Base Case reduced the amount of wind built.
Financial Incentive Changes	Financial Incentive extensions	Renewable additions coincide with the expiration of financial incentives. Extending the incentives farther out into the future results in similar pushing renewables into the future.

Figure 5-29

Financial Incentive Extension Comparison



The chart above shows how portfolios are optimized using different assumptions for financial incentive extensions. In the Base Case, PSE assumes no extension of financial incentives and that all wind additions coincide with filling REC need. The other portfolios extend financial incentives until 2013, 2016, 2020, and 2031. With the exception of the 2031 portfolio (which assumes such incentives are available during the entire planning period), renewable additions are accelerated to take advantage of the expiring incentives.

5. Limiting emissions will be difficult.

PSE examined how different carbon mitigation strategies will affect portfolio builds, costs, and emissions. Figure 5-30 illustrates that only two of the three carbon mitigation strategies modeled achieve emissions below 1990 levels – Green World and No Northwest Coal. However, both would lead to significant future costs; Figure 5-31 shows the annual revenue requirements for these portfolios. By 2021, No Northwest Coal increases the company's revenue requirement by about $196 million over the Base Case; Green World increases the revenue requirement by about $ 787 million. While both strategies achieve 1990 emissions levels, the costs are considerable.

It is important to consider the limitations of this analysis when considering the scenario in which all Northwest coal plants are forced to retire, as PSE used some simplifying assumptions to complete the IRP analysis in a timely manner. In reality, as these resources are forced to expire the region will be required to build additional CCCT plants to replace the lost energy and capacity of the coal plants. In the IRP analysis, Aurora assumed that "the region" would build them; then the optimization model took advantage of their "existence" and so did not recommend adding CCCT to PSE's portfolio. If the region were to retire all coal plants, PSE's options may indeed include the economic development of these plants. This highlights a need for the company to investigate updating our analytical frameworks to better address issues that may arise if regional coal plants are put out of service. .

Figure 5-30

Annual Emission Rates for Base, Base + CO2, No NW Coal and Green World Portfolios

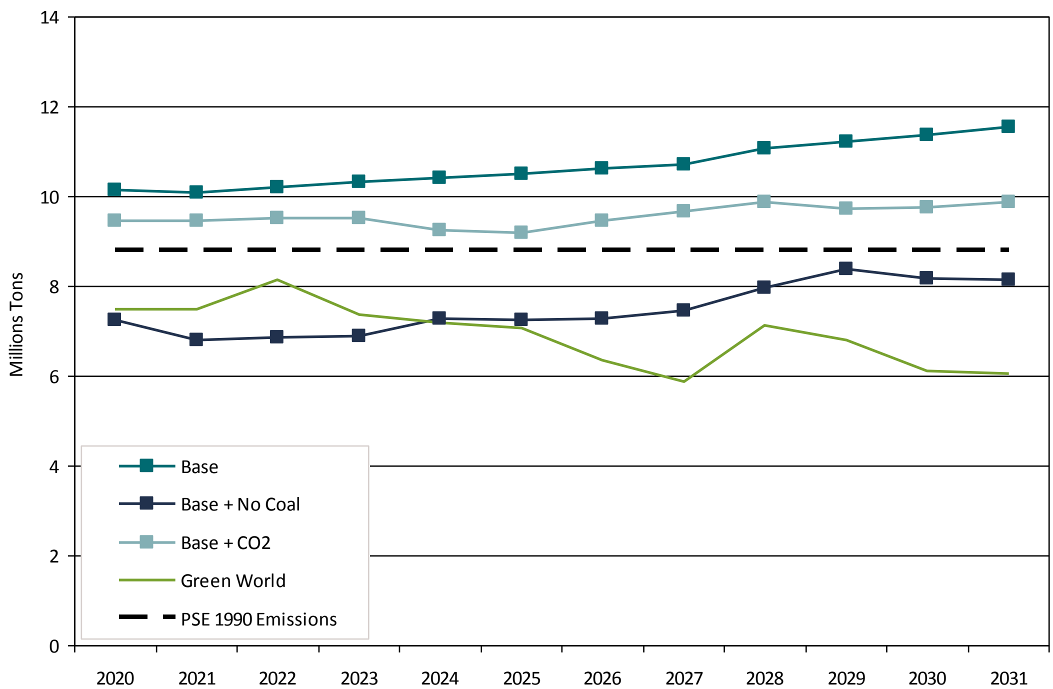
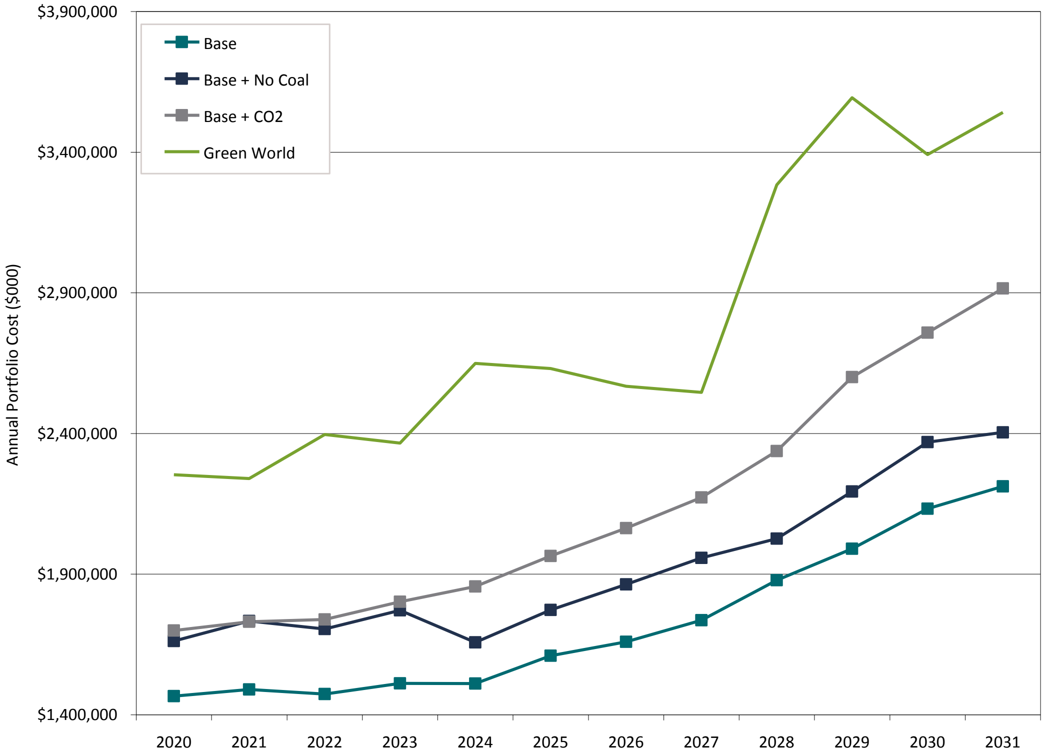


Figure 5-31
Annual Revenue Requirements for Base, Base + CO_2, No NW Coal, and Green World Portfolios



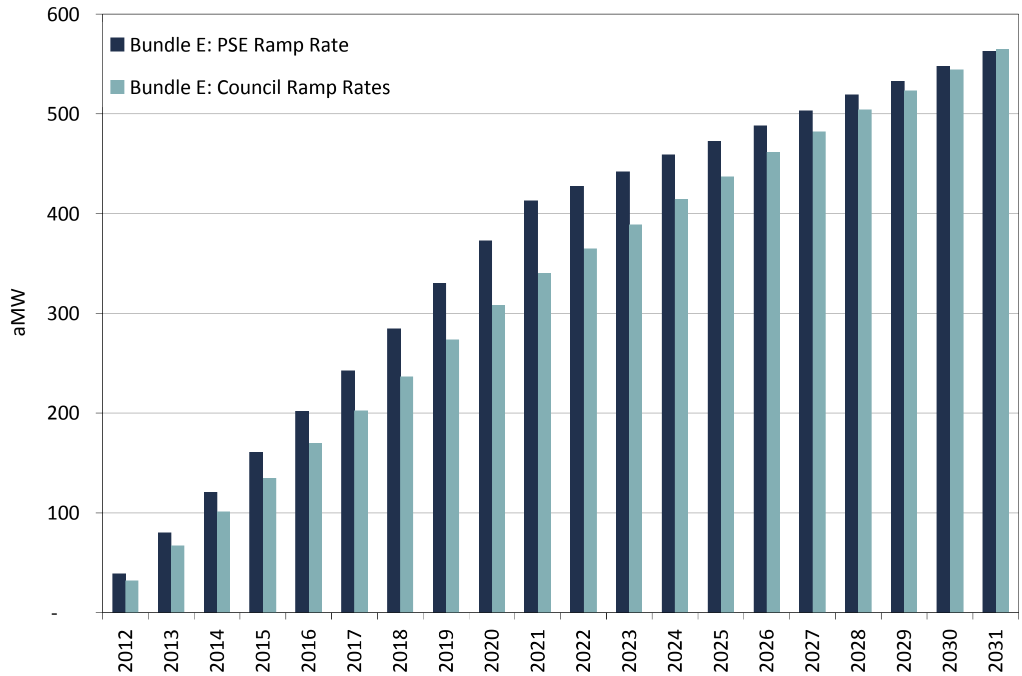
6. DSR is the only resource that reduces cost and risk – and the sooner it's acquired, the more cost-effective it is.

Demand-side resources are the only resources that reduce both cost and risk in portfolios. The amount of cost-effective conservation acquired is the same in all but one scenario (Green World). At minimum, all other scenarios identified DSR Bundle E to be cost effective. The cost-effective level of DSR remained fairly constant even though "avoided market costs" varied. We also found that a more rapid ramp rate for DSR improved the cost-effectiveness of these measures.

PSE's plan applies a 10-year ramp rate for DSR that is more aggressive than the rate applied in the NPCC's 6th Power Plan for similar measures. To compare the two, Cadmus developed a detailed, measure-by-measure assessment of the NPCC's ramp rates based on the customer mix and appliance/measure saturation for PSE's service territory.[5] Figure 5-33 uses Bundle E to compare the two. PSE's 10-year ramp rate acquires DSR more quickly than the NPCC's ramp rate, though by the end of the planning horizon the total amounts are the same.

Figure 5-33

DSR Sensitivity: NPCC's Ramp Rates from the 6th Power Plan applied to PSE's service territory



[5] *Note this was a more in-depth analysis than the NPCC's "calculator" which allocates conservation potential based on kWh sales.*

This IRP analysis also tested whether acquiring DSR more or less quickly affected the cost effectiveness of the measures. To test this, we first used portfolio optimization analysis to find the least-cost combination of demand-side and supply-side resources in the Base Case scenario. Then we applied the NPCC's ramp rate in one analysis and PSE's 10-year ramp rate in another. Figure 5-34 summarizes the result. Bundle E with the more aggressive, 10-year ramp rate proved more cost effective.

Figure 5-34

PSE's 10-year ramp rate is more cost effective than the ramp rate from the 6th Power Plan

Base Scenario	20-yr Expected Incr Rev Req ($Billions)	Bundle	DR
Base (PSE Ramp)	$13.36	E	Yes
Base + 6th Power Plan Ramp	$13.53	E	Yes

Demand-side resources are the only resources that reduce both cost and risk in portfolios. They must be cost effective to be included in the plan, so by definition they are also least cost resources. Figure 5-35 shows the expected power costs and risk ranges for a No DSR portfolio and the optimal Base Case portfolio, which includes 1,319 MW of DSR by 2031. Figure 5-36 compares their expected costs and cost ranges.

The amount of cost-effective conservation acquired is the same in all but one scenario. At a minimum, all scenarios identified DSR Bundle E to be cost effective; other bundles became cost effective only in Green World. Figure 5-37 shows the selected DSR bundle and the associated avoided market costs by scenario. It is interesting to note that the cost-effective level of DSR remains fairly constant even though "avoided market costs" vary. A full description of the bundles and the associated measures in each bundle can be found in Appendix K, Demand-side Resource Analysis.

Figure 5-35

Effect of DSR on Costs and Risk

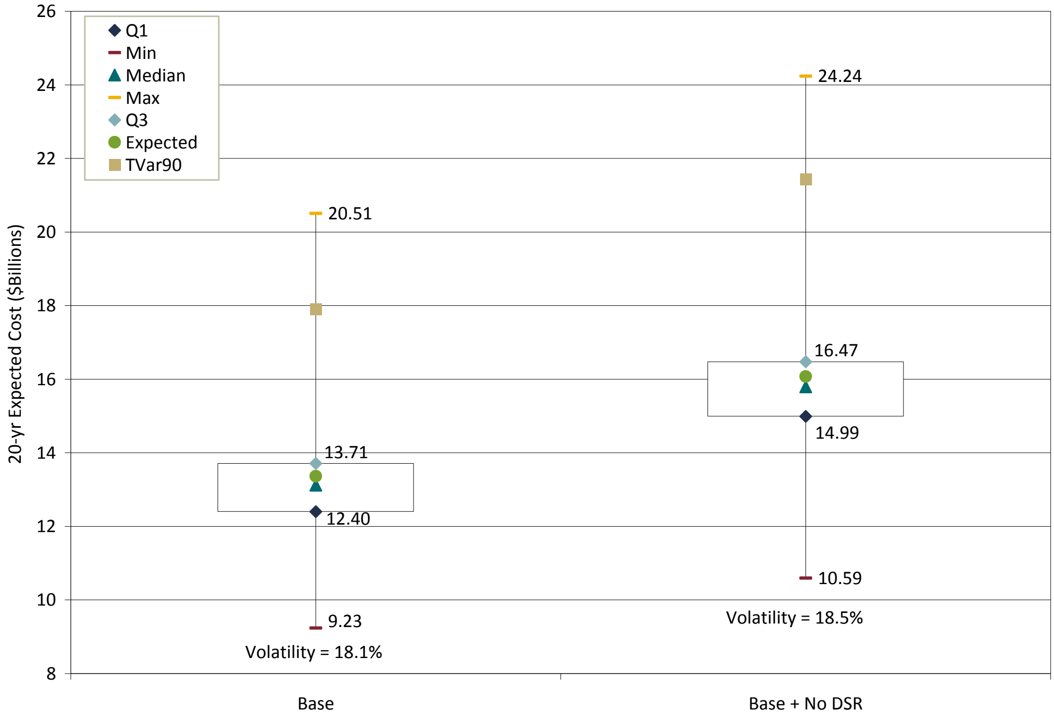


Figure 5-36

Comparison of Expected Costs and Cost Ranges for No-DSR and Base Case Portfolios

20-yr NPV Portfolio Cost (dollars in billions)

	Base	Base + No DSR	Difference
Expected Cost	13.36	16.07	2.71
TVar90	17.90	21.43	3.53

DSR reduces power cost risk relative to No DSR. Figure 5-36 illustrates that the Tail Var 90 of variable costs for the portfolio with No DSR would be a little over $3.53 billion higher than the Base portfolio with DSR. Figure 5-36 illustrates that the No DSR portfolio revenue requirement is $2.71 billion more than the Base Portfolio, which reflects the higher costs of adding peakers instead of DSR. This is clearly a reasonable cost/risk trade-off. Adding DSR to the portfolio reduces cost and significantly reduces risk at the same time.

Figure 5-37
Optimal DSR Bundles and Avoided Market Costs by Scenario

Scenarios	20-year Levelized Net Market Value	DSR Bundle
Base	$62.78	E
Base + CO2	$78.21	E
Low Growth	$49.35	E
High Growth	$90.94	E
Very Low Gas Prices	$45.48	B
Very High Gas Prices	$91.34	E
Green World	$127.57	G

Gas Analysis

Contents

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.

1. Gas Resource Need

This IRP develops an integrated resource plan for PSE's gas sales customers, and it also examines the utility's "gas-for-power" need. The former fulfills regulatory requirements, while the latter adds crucial context around a resource that has become increasingly important to meeting customers' electric demand. Here, we present three views of gas resource need – gas for sales, gas for power, and combined gas need – and discuss some of the important ways in which they are interrelated.

"Gas for sales"
refers to PSE's direct delivery of natural gas to end-use customers.

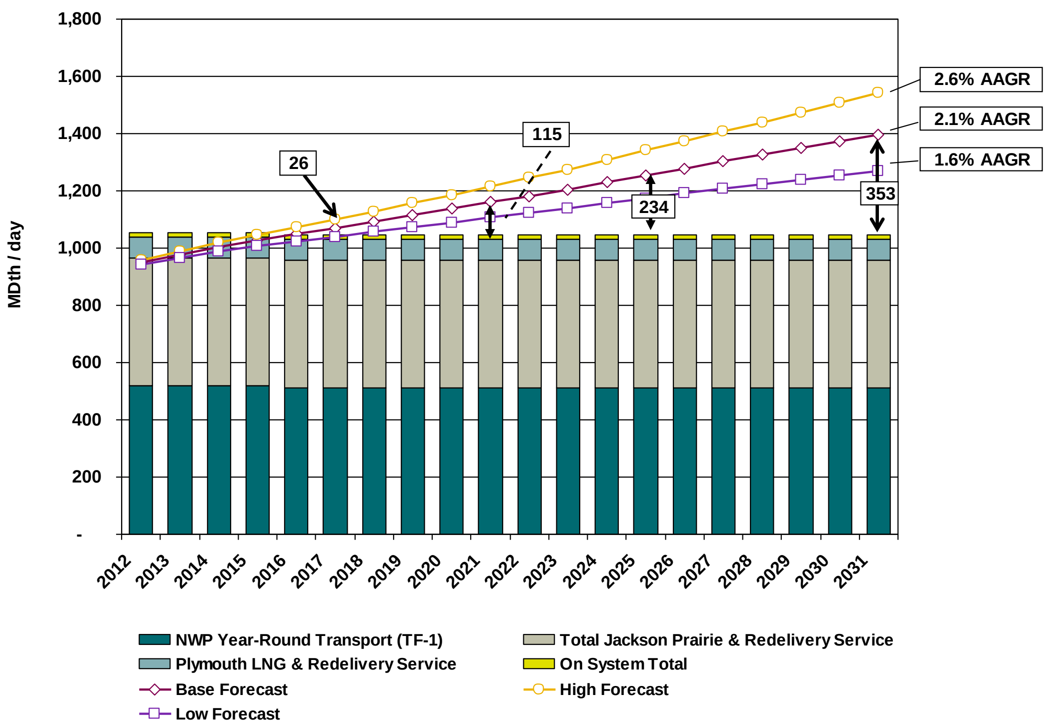
"Gas-for-power"
refers to the fuel needed to run generators that produce electricity.

"Combined gas need"
refers to the aggregate of "gas for sales" and "gas for power".

Gas Sales Need

Figure 6-1 illustrates gas sales resource need over the 20-year planning horizon. The lines rising toward the right indicate demand, and the bars below represent current contracts for the pipeline transportation, storage, and peaking capacity that enable PSE to transport gas from points of receipt to customers.

Figure 6-1
Gas Sales Resource Need
Existing Resources Compared to Peak Day Demand
Meeting need on the coldest day of the year



Gas sales need is driven by two factors: peak day demand per customer and the number of customers. For PSE, peak-day demand occurs in the winter, when temperatures are lowest and heating needs are highest. Since the heating season and number of lowest-temperature days[1] in the year remain fairly constant, customer count is the biggest factor

[1] *For gas peak day planning purposes PSE assumes a day with 52 Heating Degree Days (HDDs) or an average temperature of 13° F.*

in load growth. The analysis tested three customer growth forecasts over the 20-year planning horizon: the Base Case growth forecast assumes customer growth of 2.13% per year, the High forecast assumes 2.54%, and the Low forecast assumes 1.75%.

In the Base Case forecast, we currently have sufficient resources to meet peak day need until the winter of 2015-16. Under the High forecast, additional resources will be needed by the winter of 2014-15. Under the Low forecast, additional resources are not needed until 2017-18.

Gas-for-power Need

Natural gas for power generation is increasingly important to the electric side of the utility. Every IRP since 2003 has identified natural gas-fired generation as the most cost-effective supply-side resource to include in IRP portfolios. This planning cycle is no different: All of the electric portfolios produced by the analysis include the addition of substantial amounts of gas-fired generation as part of the solution to meeting future electricity demand.

Calculating gas-for-power need is not as straightforward, since different types of gas-fired generating plants require different types of natural gas resources and their dispatch is dependent upon the prevailing market heat rate. Combined-cycle combustion facilities (CCCTs) are assumed to need firm gas transportation. Simple-cycle combustion engines (peakers) are expected to operate with temporary pipeline capacity purchased from the gas sales book, the pipeline, or through the capacity release market – and rely on oil back-up when none is available.

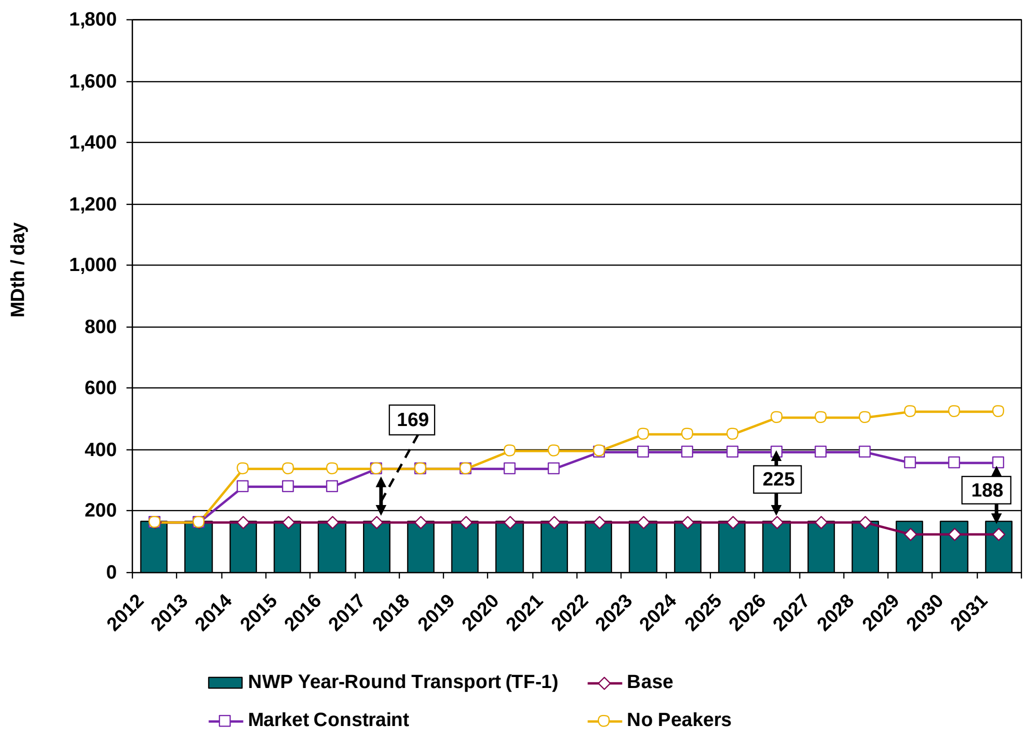
The chart below describes gas for power needs under three sets of circumstances. All use the Base Case scenario assumptions, but each uses a different combination of CCCT and peaking plants.

- The **Base** portfolio represents the all-peaker portfolio identified as lowest reasonable cost in the electric analysis.
- The **No Peaker** sensitivity represents a portfolio that essentially replaces peakers with CCCTs.
- The **Thermal Mix** sensitivity represents a portfolio in which market exposure is limited to 40% of total portfolio cost.

The primary difference among the three is the number of peakers and/or CCCTs and, as a result, the amount of firm gas transport capacity needed. In the Base Case scenario, all of the new gas-fired generating capacity is comprised of peakers, which do not require firm gas pipeline capacity. The other cases include CCCTs and more firm gas transport capacity.

Different generating plants require different gas resources.

Figure 6-2
Three Views of Gas-for-power Resource Need
Existing Resources Compared to Peak Day Demand
Different generating plants require different gas resources



Combined Gas Resource Need

The extreme peak for both gas sales and gas for power loads typically occurs on the very coldest days of the winter. To depict combined need, we added the peak gas sales need identified in the gas sales Base Case to each of three views of gas-for-power need: the electric Base Case scenario, the Thermal Mix sensitivity, and the No Peakers sensitivity. (Their differences are explained in the preceding two pages.) Extreme peak combined need is summarized in Figure 6-3 below. Combined need varies from 310 to 709 MDth per day by 2031, depending upon which gas-for-power scenario is assumed.

Figure 6-3
Combined Gas Resource Need (Net Need in MDth/day)
Extreme peak for gas sales and gas for power

Gas Sales Base plus . . .	2016-17	2020-21	2025-26	2030-31
Electric Base Case	20	109	228	310
(El.) Thermal Mix	194	284	459	541
(El.) No Peakers	195	342	572	709

Observations

The yearly demand curves for gas sales and gas for power differ in ways that create some interesting relationships. The very coldest winter days create short-term spikes in both portfolios, but in general, gas for sales demand is highest in the winter when heating needs are the greatest, while sustained high demand for gas for power occurs in the summer because the summer electric market is heavily influenced by California air-conditioning loads.

The gas sales portfolio purchases a substantial amount of firm pipeline capacity to make sure it can deliver all the gas customers need in the winter, but when summer comes and demand for gas sales subsides, it has surplus capacity. This means that the gas sales portfolio has excess capacity at the same time the electric utility needs to acquire capacity to meet its high-demand, summer season needs. Per WUTC requirements, short-term surplus capacity of the gas sales portfolio is made available to the generation portfolio at prevailing market rates similar to the rates that would result from release to a third party through FERC-regulated capacity release rules or available for purchase from the pipeline.

Firm, year-round pipeline capacity incurs demand charges whether the capacity is used or not and generally requires a multi-year commitment. Short-term firm and interruptible pipeline capacity, purchased from the pipeline and the short-term capacity release market (in which firm capacity holders sell excess capacity to others), is generally less expensive.

Figures 6-4 and 6-5 compare the 2009 and 2010 demand curves for the gas sales and gas-for-power portfolios.

Figure 6-4

2009 Daily Gas Sales and Gas for Power Loads

Comparing demand curves and volatility

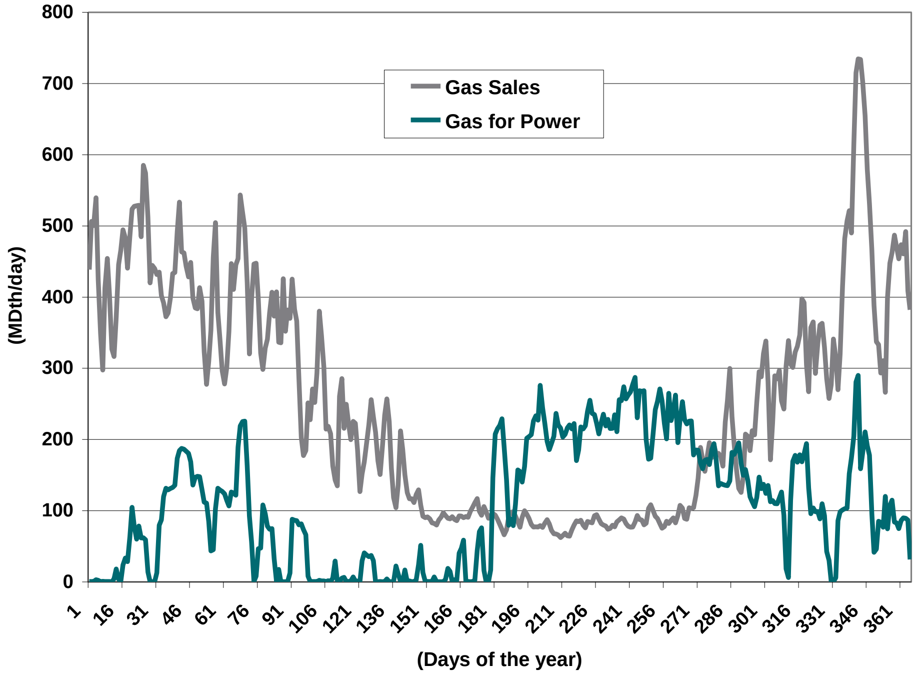
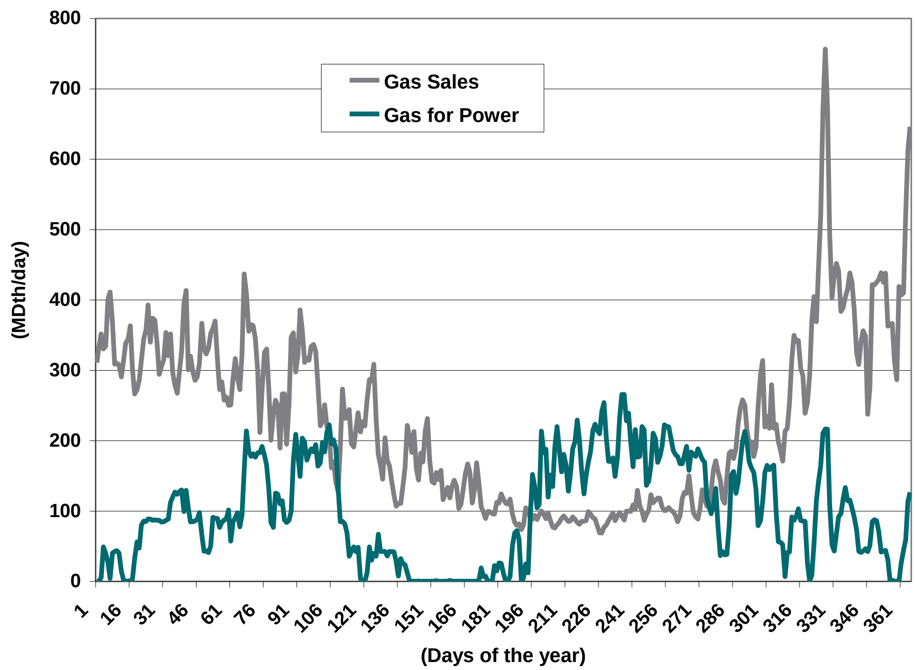


Figure 6-5

2010 Daily Gas Sales and Gas for Power Loads



The growing reliance on natural gas to generate electricity increases the need to add gas storage capacity in the electric resources portfolio.

Gas-for-power loads are much more variable than gas sales loads. Another look at the historical data pictured in Figures 6-4 and 6-5 shows that average gas-for-power loads are less than half the size of average gas sales loads – but their swings in volume (their maximum daily increase and decrease) are about the same. This is confirmed by volatility statistics, which are much higher for gas-for-power loads than gas sales.

Significant additions of gas-fired generation resources – as with the 2,343 MW of peaking plants added in the electric resource portfolio developed for this IRP – could create unprecedented swings in gas loads. As peakers are switched on to meet demand, a volume of gas equivalent to PSE's entire gas sales load on a typical winter day could be required, and by 2020, day-to-day swings in gas volumes for generation fuel could be three times greater than the swings PSE has seen with its entire gas utility load historically.

Near-term, using the gas sales portfolios excess capacity or the capacity release market to supply 2 or 3 additional peaking plants makes a great deal of sense, provided such plants can be permitted to use back-up fuel during peak periods; however, it is not at all clear that the capacity release market and pipeline system can handle the volume of activity required for the 11 peakers projected in the Base Case scenario by 2031. Increased storage would greatly improve the ability to manage those swings, and may become a crucial part of the supply chain for generation.

Figure 6-6
Variability of Gas Sales and Gas-for-power Loads Compared
Volatility and volumes

	Gas Sales	Gas for Power
Calendar Year 2009		
Maximum	735	290
Minimum	62	0
Average	252	110
Max Daily Increase	133	129
Max Daily Decrease	126	131
Volatility	0.13636	1.36582
Calendar Year 2010		
Maximum	757	266
Minimum	69	0
Average	229	99
Max Daily Increase	147	104
Max Daily Decrease	180	107
Volatility	0.13937	1.14443

Acquisition choices will affect the amount and type of gas resources needed in the electric portfolio. Additional peaking plants proved to be the lowest reasonable cost supply-side resource alternative in the electric portfolio developed for this IRP, but when the time comes to actually make acquisitions, purchased power agreements may be judged more cost-effective. Less likely but still possible, CCCT plants may be economically attractive because of their more efficient heat rate. These choices would have very different impacts.

- Choosing purchased power agreements would reduce the amount of natural gas resources needed.
- Choosing CCCTs would increase the need for firm gas transportation.
- Peaking plants without alternate back-up fuel capability would increase the need for firm gas transportation.

Gas transportation needs are also highly dependent on the specific location of generating plants.

For example, plants located near a gas trading hub or storage facility need less pipeline capacity to transport fuel but may need more transmission to transport power; conversely, plants located near PSE loads require less electrical transmission but may require more gas transport capacity.

2. Existing Gas Resources

Gas Sales Supply-side Resources

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 (Dth) per day of firm, year-round TF-1 (firm) 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

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 6-7

Pacific Northwest Regional Gas Pipeline Map

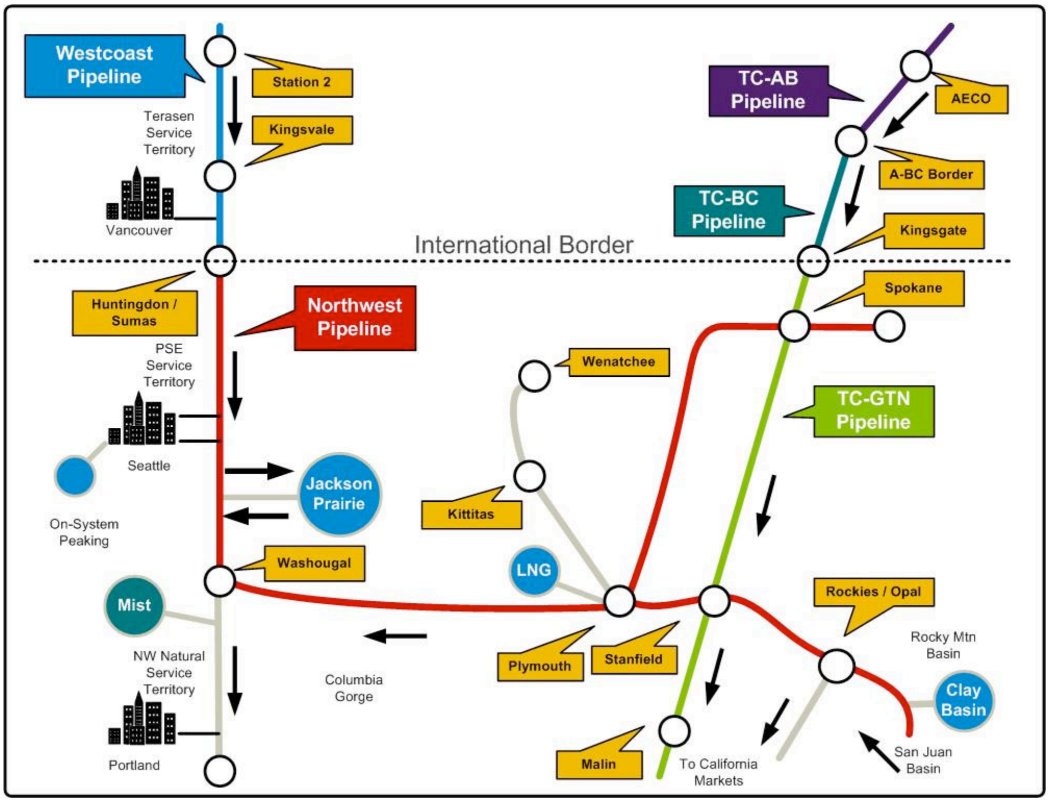


Figure 6-8

Gas Sales Pipeline Capacity (Dth/day) (as of 01/01/2011)

Pipeline/Receipt Point	Note	Total	Year of Expiration 2012	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				2015
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	129,851	11,246	-	75,482	25,675 (2017) 17,449 (2018)
Total Upstream Capacity	**8**	**378,618**				

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 supplies purchased at Sumas.*

It is helpful to understand the significant differences among transportation types, especially TF-1 and TF-2 service, and firm and interruptible capacity.

TF-1 and TF-2 service. TF-1 transportation contracts are firm contracts, available 365 days each year. TF-2 service is for delivery of storage volumes and is generally intended for use during the winter heating season only; contract costs are based on a quantity related to the storage capacity referenced by each respective agreement. Therefore, TF-2 service has significantly lower annual costs than the 365-day service provided under TF-1. The special winter-only TF-1 service has similar characteristics and pricing as TF-2 service.

Firm and interruptible capacity. Firm transportation capacity carries the right, but not the obligation, to transport up to a maximum daily quantity of gas on the pipeline. Firm transportation requires a fixed payment, whether or not that capacity is used. Interruptible service is subordinate to the rights of shippers who hold and use firm transportation capacity; the rate for interruptible capacity is negotiable, and is typically billed as a variable charge. When firm shippers do not use their firm pipeline capacity, they may release it on the capacity release market.

PSE releases capacity when we have a surplus of firm capacity 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 plays a limited role in PSE's resource portfolio, because it cannot be relied on to meet peak demand.

Existing storage resources. PSE's natural gas storage capacity is a significant component of the company's gas resource portfolio. Storage capacity improves system flexibility and creates 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 storage 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, generally at lower prices.
- Combining storage capacity with seasonal TF-2 (or special winter-only TF-1) transportation allows us to contract for less 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.

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 6-9 presents details about storage capacity.

Figure 6-9

Gas Sales Storage Resources[1]

	Storage Capacity (Dth)	Injection Capacity (Dth/Day)	Withdrawal Capacity (Dth/Day)	Expiration Date
Jackson Prairie – Owned[2]	8,220,000	199,334	398,667	N/A
Jackson Prairie – Owned[3]	(500,000)	(25,000)	(50,000)	2011
Jackson Prairie – NWP SGS-2F[4]	1,181,021	24,195	48,390	2012
Jackson Prairie – NWP SGS-2F[4]	281,242	4,789	9,577	2026
Clay Basin[5]	12,882,750	53,678	107,356	2013/20
Total	**22,065,013**		**513,990**	

Notes:

1) *Storage, injection, and withdrawal capacity quantities reflect PSE's capacity rights rather than the facility's total capacity.*
2) *Storage capacity at 12/31/2010. Storage capacity at this facility will continue to grow through 2012.*
3) *Storage capacity made available (at market-based price) from PSE gas sales portfolio. Renewal may be possible, depending on gas sales portfolio needs.*
4) *NWP contracts have automatic annual renewal provisions, but can be canceled by PSE upon one year's notice.*
5) *PSE expects to renew the Clay Basin storage agreements.*

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 minimize 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 (Jackson Prairie), 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 contracts for SGS-2F storage service from NWP. The NWP contracts are automatically renewed each year but we have the unilateral right to terminate the agreement with one year's notice.

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 12,882,750 Dth and withdraw up to 107,356 Dth per day under a FERC-regulated agreement.

We use Clay Basin for certain levels of baseload supply, and for backup supply in the case of well freeze-offs or other supply disruptions in the Rocky Mountains, during the winter. It provides a reliable source of supply throughout the winter, including 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. PSE also pays a variable charge for gas injected into and withdrawn from Clay Basin. 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.

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 6-10

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	15,750	3,000	5,250	On-system
Swarr LP-Air	128,440	16,680 (1)	10,000	On-system
Total	**385,890**	**20,888**	**85,750**	

Notes:

1) *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 of 241,700 Dth, a liquefaction Maximum Daily Quantity (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 satellite LNG facility ensures sufficient supply during peak weather events for a remote but growing region of our distribution system. The Gig Harbor plant receives, stores, and vaporizes LNG that has been liquefied at other LNG facilities; it represents an incremental supply source and is therefore included in the peak day resource stack. Although the 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.

Swarr LP-Air. The Swarr LP-Air facility has a net storage capacity of 128,440 Dth equivalent, and can vaporize the equivalent of 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. For peak-day planning purposes, we consider this facility capable of supplying only 10,000 Dth per day.

Existing gas supplies. Development of the means to economically extract natural gas from shale deposits has changed the picture with regard to gas supplies. Not only has development of shale beds in British Columbia directly increased the availability of supplies in the West, but the east coast no longer relies so heavily on Western supplies now that shale deposits in Pennsylvania and West Virginia are in production.

Within the limits of its 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. We can also mitigate price volatility to a certain extent; the company's capacity rights on NWP provide flexibility to buy from the lowest-cost basin. While we are heavily dependent on supplies from northern British Columbia, we also maintain pipeline capacity access to producing regions in the Rockies, the San Juan basin, 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 several years, but should be 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 and San Juan basin, there are various transportation receipt points, including Opal and Clay Basin; but alternate points, such as gathering system and upstream pipeline interconnects with NWP, allow some purchases directly from producers as well marketers. In fact, PSE has a number of supply arrangements with major producers in the Rockies to purchase supply near the 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 nearer producing areas 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. Longer-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. Near-term 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 and Clay Basin), day-ahead purchases, and off-system sales transactions, and balances intra-day positions using Jackson Prairie. PSE will continue to monitor gas markets to identify trends and opportunities to fine-tune our contracting strategies.

PSE’s low load-factor market is highly weather-dependent and, therefore, seasonal in nature. 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.

Gas Sales Demand-side Resources

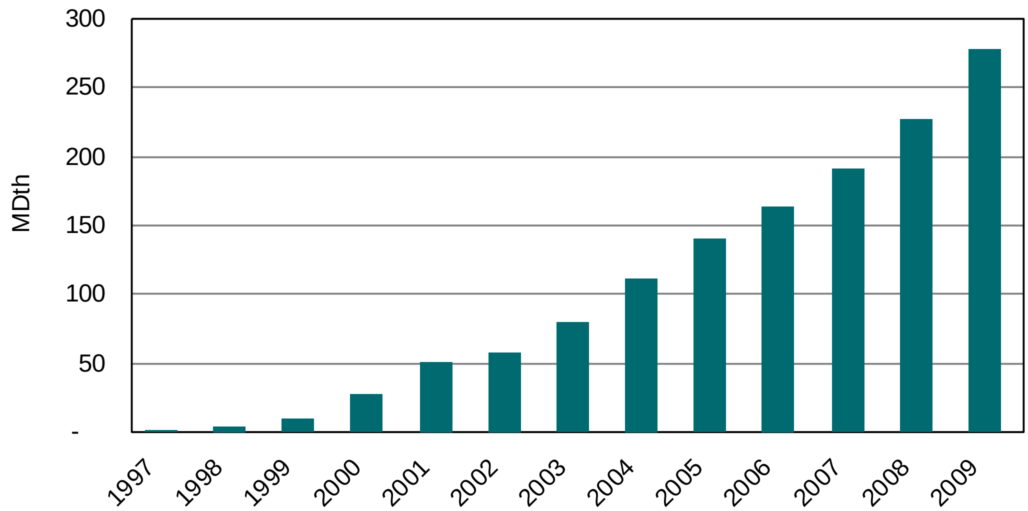
PSE has provided demand-side resources or DSR (that is, resources generated on the customer side of the meter) since 1993. Figure 6-11 shows that energy efficiency measures installed through 2009 have saved a cumulative total of 2.8 million Dth – more than half of which has been achieved since 2004. 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.

PSE's energy efficiency programs serve residential, low-income, commercial, and industrial customers. Energy savings targets and the programs to achieve those targets are established every two years. The 2008-2009 biennial program period concluded at the end of 2009; current programs operate January 1, 2010 through December 31, 2011. The majority of gas energy efficiency programs are funded using gas "tracker" funds collected from all customers.

For the 2010-2011 period, a two-year target of approximately 900,000 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).

Figure 6-11

Gas Sales Energy Efficiency Program Summary



Gas for Power Supply-side Resources

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, as of 01/01/2011)

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	2011	Yr. to Yr.
Encogen	Cascade Natural Gas	Firm	(2)	NWP (Bellingham) to Plant	2012	Yr. to Yr.
Fredonia	Cascade Natural Gas	Firm	(2)	NWP(Sedro-Wooley) to Plant	2021	Yr. to Yr.
Mint Farm	Cascade Natural Gas	Firm	(2)	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 (4)	2018	Yr. to Yr

Upstream Capacity						
Plant	**Transporter**	**Service**	**Capacity (Dth/day)**	**Primary Path**	**Year of Expiration**	**Renewal Right**
Various	Westcoast	Firm	21,829 (3)	Station 2 to Sumas	2014	Yes
Various	Westcoast	Firm	47,354 (3)	Station 2 to Sumas	2018	Yes
Various	NWP	Firm	2,128	Stanfield to Deer Island	2025	Assumed
Various	NWP	Firm	4,928	Stanfield to Bellingham	2025	Assumed
Various	NWP	Firm	21,872	Stanfield to Jackson Prairie	2025	Assumed
Various	NWP	Firm	2,000	Sumas to Tacoma	2013	Yes
Various	NWP	Firm	25,000	Sumas to Deer Island	2013	Yes
Various	NWP	Firm	25,000	Sumas to Longview	2012	No
Various	NWP	Firm	10,710	Sumas to Stanfield	2044	Yes
Various	NWP	Firm	500	Sumas to Longview	2044	Yes
Various	NWP	Firm	9,000	Sumas to Longview	2012	Yes
Storage Capacity						
Plant	**Transporter**	**Service**	**Deliverability (Dth/day)**	**Storage Capacity (Dth)**	**Year of Expiration**	**Renewal Right**
Jackson Prairie	PSE	Firm	6,704	140,622	2012	Yes
Jackson Prairie (5)	PSE	Firm	50,000	500,000	2011	No

Notes:

1) *50% of plant requirements*
2) *Full plant requirements.*
3) *Converted to approximate Dth/day from contract stated in cubic meters/day.*
4) *Gas transported from Everett to Goldendale under NWP flex rights, backed by exchange agreement with PSE's gas sales portfolio.*
5) *Storage capacity made available (at market-based price) from PSE gas sales portfolio. Renewal may be possible, depending on gas sales portfolio needs.*

PSE has firm NWP pipeline capacity to serve our combined-cycle generating plants that require NWP service (Encogen, Freddy 1, Goldendale, and Mint Farm); Sumas is directly connected to Westcoast. All of our simple-cycle combustion turbine generation units (Whitehorn, Fredonia, and Frederickson) have backup fuel-oil firing capability and thus do not require firm pipeline capacity on NWP.

Existing gas-for-power supplies.

As discussed earlier, 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. Longer-term contracts typically supply baseload needs and are delivered at a constant daily rate over the contract period. We estimate average load requirements for upcoming months and enter into transactions to balance load. PSE balances daily and intra-day positions using storage (from Jackson Prairie), day-ahead purchases, and off-system sales transactions. PSE will continue to monitor gas markets to identify trends and opportunities to fine-tune our contracting strategies.

Biogas supplies. PSE has purchased biogas from King County's wastewater treatment plant in Renton, Wash. since 1985. The daily output of this plant is approximately 750 Dth per day.

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 is delivered into NWP (which is adjacent to the landfill) and from there to the generating plants. Cedar Hills is expected to supply an average of approximately 3-5 MDth per day of methane.

3. Gas Resource Alternatives

The gas resource alternatives considered in this IRP address long-term capacity challenges rather than the shorter-term optimization and portfolio management strategies PSE uses in the daily conduct of business to minimize costs.

Combinations Considered

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. Within PSE's service territory, demand-side resources are a significant resource.

In this IRP, the alternatives have been gathered into five broad combinations for analyses. These combinations are illustrated in Figure 6-13. Note that, while not shown, DSR is included in all of the combinations.

- **Combination #1** 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. Gas supplies are also presumed available at the Sumas market hub.

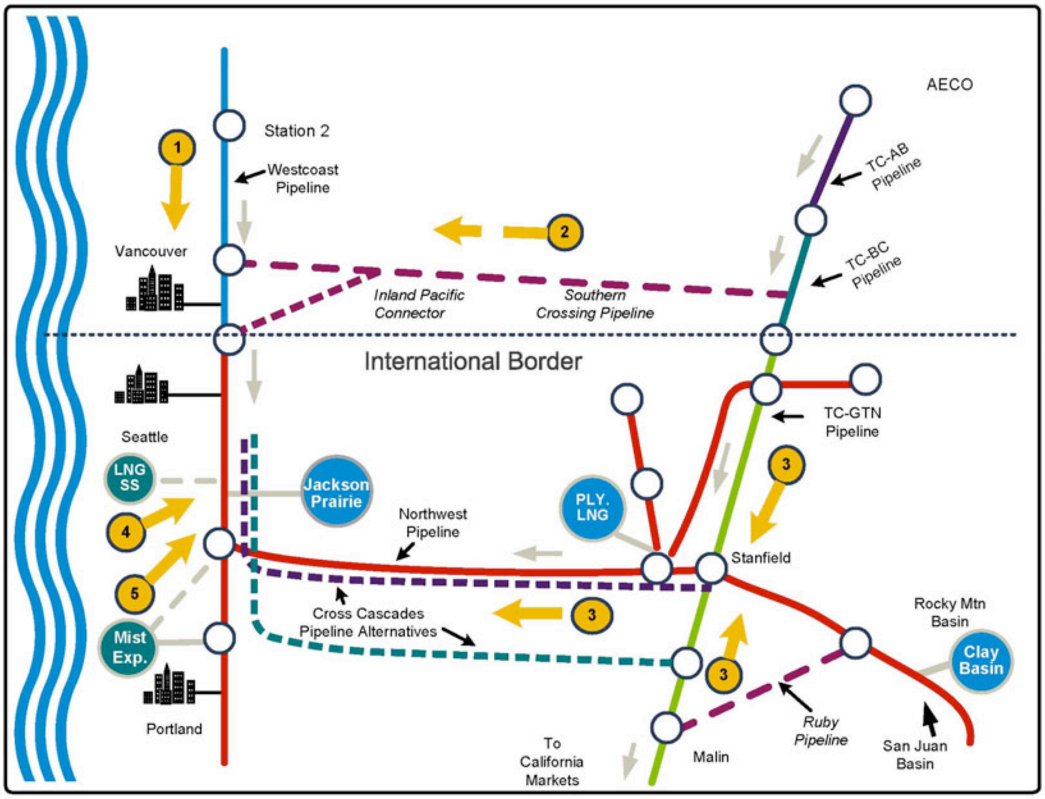
- **Combination #2** represents the Southern Crossing pipeline option. This option would allow delivery of AECO gas to PSE via existing or expanded capacity on the TC-AB and TC-BC pipelines, an expanded Southern Crossing pipeline across southern British Columbia to Sumas, and then on expanded NWP capacity to PSE.

- **Combination #3** provides for deliveries to PSE via a cross-Cascades pipeline. The increased gas supply could either come from of Alberta (AECO hub) via existing or expanded upstream pipeline capacity on the TC-AB, TC-BC, and TC-GTN; or from the Rockies hub on the Ruby pipeline to Malin and onto existing or expanded TC-GTN pipeline capacity with final delivery to PSE via the cross-Cascades pipeline.

- **Combination #4** provides for development of an LNG storage facility in proximity to the existing NWP route and located relatively close to PSE's service territory where it could take advantage of a discounted redelivery service.

- **Combination #5** provides for PSE to lease storage capacity from NW Natural after an expansion of the Mist storage facility. Delivery of gas would require some expansion of pipeline capacity from Mist to PSE's service territory but is assumed to have discounted redelivery service.

Figure 6-13
PSE Gas Transportation Map Showing Supply Alternatives



Pipeline Alternatives

Direct-connect pipeline capacity alternatives. The direct-connect pipeline alternatives considered in this IRP are summarized in Figure 6-14 below.

Figure 6-14
Direct-connect Pipeline Alternatives Analyzed

Name	Description
NWP - Sumas to PSE city gate	Expansions considered either independently or in conjunction with upstream pipeline/supply expansion alternatives (Southern Crossing or additional Westcoast capacity). Assumed to be available by 2014.
Cross-Cascades – Stanfield/TC-GTN to PSE city gate	Representative of costs and capacity of either an expansion of NWP from Stanfield or the proposed Palomar pipeline with delivery on NWP to PSE city gate. Assumed to be available by 2020.
NWP – Washougal to PSE city gate	Expansion considered in conjunction with a possible lease of expanded 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 Energy's BC Pipeline (Westcoast), which allows us to purchase gas at Station 2 rather than Sumas and take advantage of greater supply availability 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 6-15
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 a 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) bypassing Westcoast facilities upstream of Sumas, or a cooperative arrangement with Westcoast for deliveries from the Southern Crossing pipeline to 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 Spokane and then to the PSE city gate via NWP. The addition of a cross-Cascades pipeline in conjunction with the acquisition of additional capacity on these pipelines would increase access to AECO gas and increase supply diversity.

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, insufficient work has been done with respect to expanding Jackson Prairie to include in this analysis, and additional pipeline capacity from Clay Basin is not available. For this IRP, the company considered the following storage alternatives:

NW Natural Gas Company, 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. Participation in a Mist expansion may require expansion of firm pipeline access to PSE's city gate.

Participation in a regional LNG storage facility is also being considered. 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).

Figure 6-16
Storage Alternatives Analyzed

Name	Description
Expansion of Mist Storage Facility	Based on estimated cost and operational characteristics of expanded Mist storage. Assumes a 15-day supply at full deliverability.
Regional LNG Storage Facility	To be cost effective, such a facility should be located to allow firm delivery to PSE's city gate. The scale of LNG storage implies that joint participation might be attractive. These analyses assume a 10-day supply at full deliverability.

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. With the expansion of supplies from shale gas and other unconventional sources at existing market hubs, PSE anticipates that adequate gas supplies will be available to support pipeline expansion from northern British Columbia or from the Rockies basin.

Major pipeline projects have been proposed to transport gas from the Arctic to North American markets, but these projects are too distant and costly to provide short- or medium-term relief. The development of shale gas supplies in the lower 48 states and in Canada and the resulting lower gas prices have pushed these alternatives even further into the future (beyond 2025). The Alaska Natural Gas Transmission System would transport natural gas from the North Slope through Canada to North American markets, including Chicago and the east coast, and provide 4.5 Bcf per day starting between 2024 and 2029. 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.

Figure 6-17
Gas Supply Alternatives Analyzed

Name	Description
Conventional gas supply purchase contracts	Assume current mix of term contracts and spot purchases. Recent estimates of gas reserves indicate that supplies from western Canada and the Rockies will be sufficient to meet needs.

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 ordered 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 resources as quickly as possible.

The acquisition or “ramp rate” of gas sales DSR can be altered by changing the speed with which discretionary measures are acquired. In this IRP, two ramp rates were tested: a 20-year ramp rate (as in past IRPs), and a 10-year ramp rate, which is used in the electric resource analysis.

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/non-weather 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 6-18 illustrates the methodology described above.

Figure 6-19 & 6-20 shows the range of achievable technical potential among the eight 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 A (<$4.5 per Dth) used in the SENDOUT portfolio optimization model for all the bundles with the 10-year ramp rate.

Figure 6-18
General Methodology for Assessing Demand-side Resource Potential

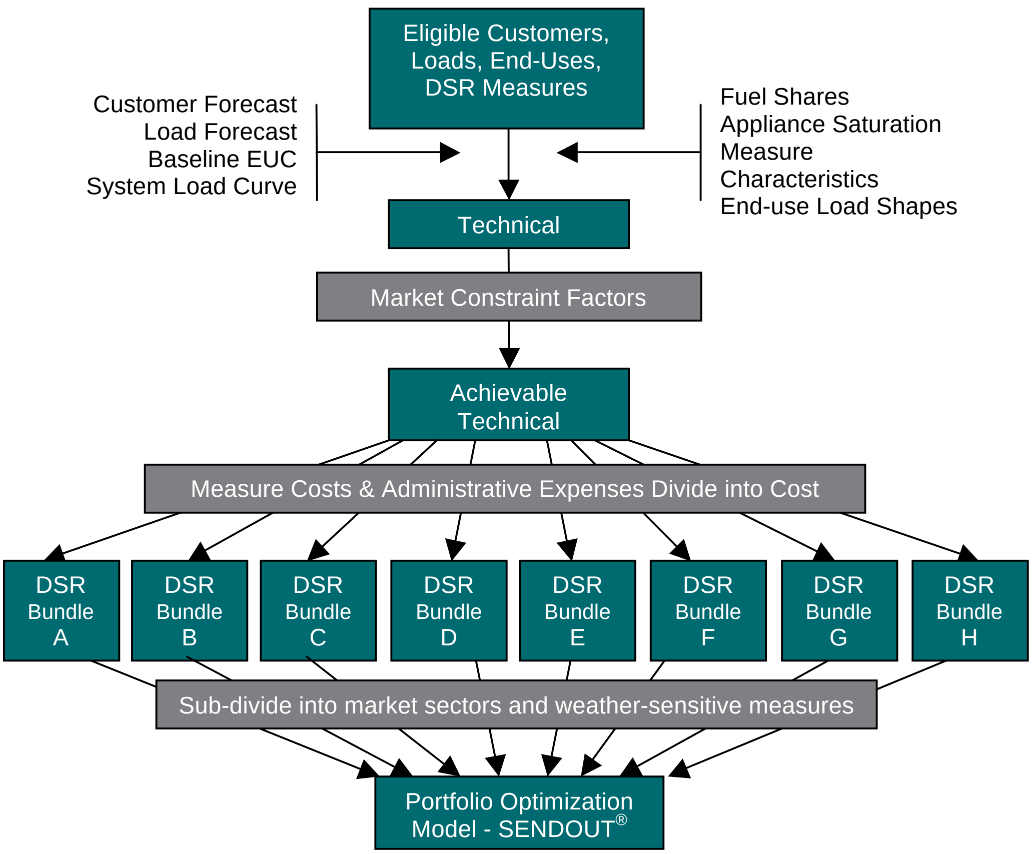


Figure 6-19

Achievable Technical Potential Bundles – 10-year Ramp for Discretionary Measures

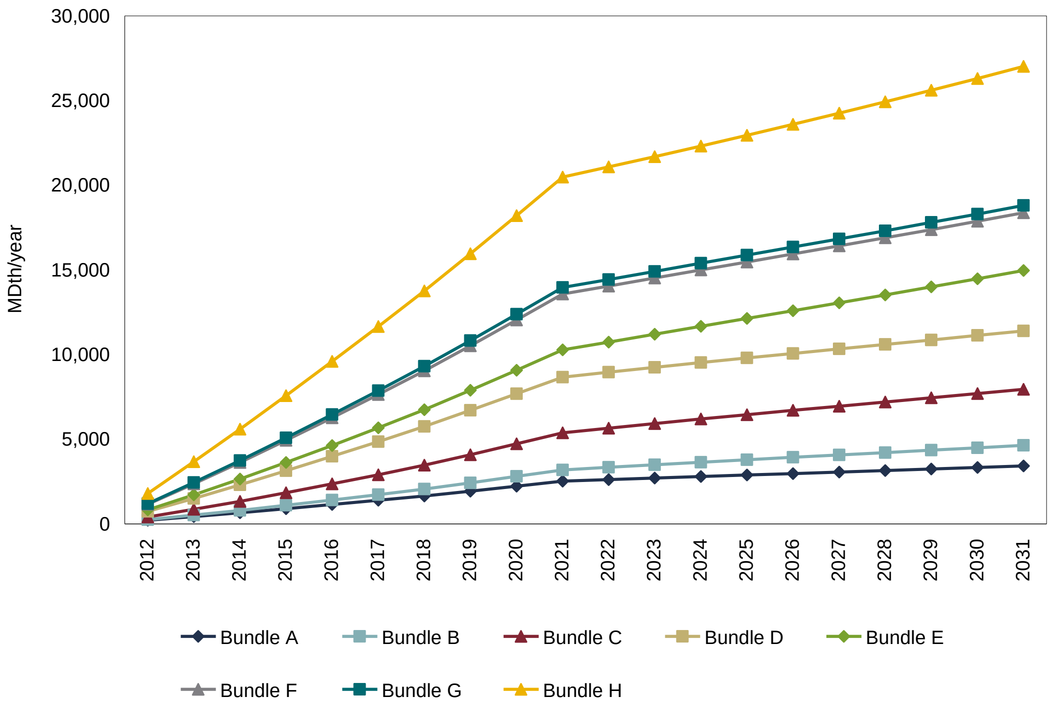


Figure 6-20

Achievable Technical Potential Bundles – 20-year Ramp for Discretionary Measures

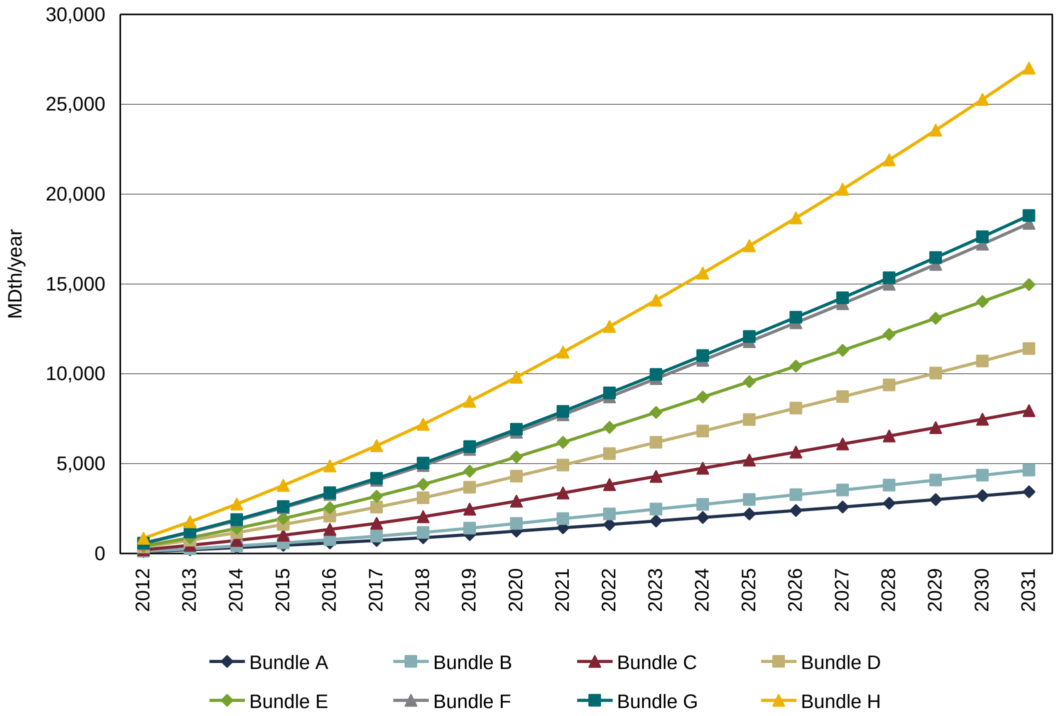
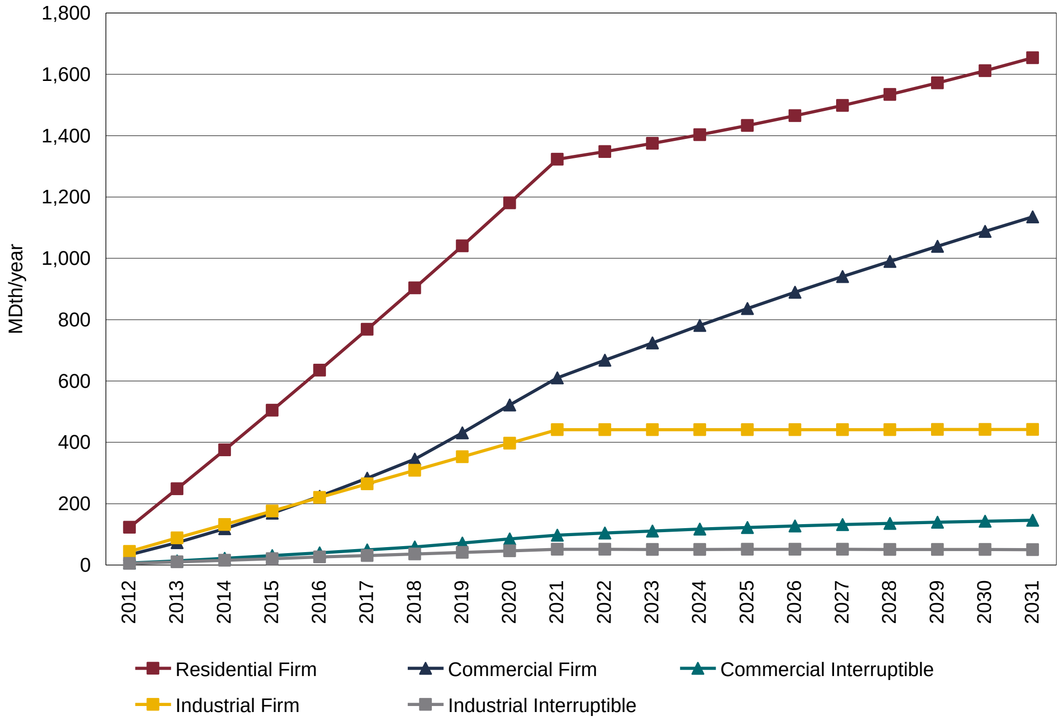


Figure 6-21

Savings Formatted for Portfolio Model Input – Bundle A (($99.00) to $4.50/Dth)



4. 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, scenarios, and sensitivities are explained in Chapter 4.

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. SENDOUT Version 12.5.5, which PSE currently uses, has 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.

Deterministic Optimization Analysis

As described in Chapter 4, PSE developed seven gas sales scenarios and three gas-for-power 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.

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.

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.

5. Gas Analysis Results

For the gas sales portfolio, PSE analyzed seven scenarios. For the combined portfolio (gas sales and gas for power), three sets of circumstances were examined, each with different assumptions regarding the amount of firm gas transport capacity required. Gas sales analysis results are presented first, then the combined portfolio results.

Gas Sales Portfolio Analysis and Results

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.

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

We evaluated two DSR program designs for the gas sales portion of this IRP: one with a 20-year ramp rate for discretionary measures, the other with a 10-year ramp rate.

Compared to the 20-year rate, the 10-year ramp rate increased the DSR acquired during the near- and mid-term years, and offset the need for acquisition of some supply-side resources. Both ramp rates resulted in similar amounts of DSR being acquired by 2031. The difference in resource builds that result from the two ramp rates by 2021 are shown in Figures 6-22 and 6-23, respectively.

Figure 6-22
2021 Resource Builds for 20-year Discretionary DSR Ramping

	DSR Total	Cross Cascades Pipeline	Regional LNG Storage	NWP Sumas to PSE Expansion
Base	34	0	20	121
Base + CO2	50	0	0	113
Low Growth	23	0	0	83
High Growth	60	74	22	93
Green World	84	0	0	0
Very Low Gas	11	0	48	121
Very High Gas	60	65	0	45

Figure 6-23
2021 Resource Builds for 10-year Discretionary DSR Ramping

	DSR Total	Cross Cascades Pipeline	Regional LNG Storage	NWP Sumas to PSE Expansion
Base	56	0	0	112
Base + CO2	105	0	0	74
Low Growth	38	0	0	71
High Growth	105	52	0	100
Green World	149	0	0	0
Very Low Gas	21	0	38	121
Very High Gas	105	65	0	9

At 2021, the amount of DSR acquired is noticeably higher with the 10-year ramp rate. In most scenarios, the amount of NWP Sumas to PSE expansion is reduced somewhat and the amount of regional LNG storage is reduced with the 10-year ramping.

Comparing the total portfolio costs of the scenarios assuming the 20-year ramp rate with the scenarios assuming the 10-year ramp rate indicates that the 10-year ramp rate results in a lower NPV in most scenarios. The 20-year ramp rate produces a lower NPV in the Low Growth and the Very Lower Gas Price scenarios. The NPV results are shown in Figure 6-24.

Figure 6-24
Net Present Value Portfolio Costs for Alternative Discretionary DSR Acceleration Rates ($ - millions)

	20-year Ramp Rate	10-year Ramp Rate
Base	10.18	10.16
Base + CO2	12.05	11.98
Low Growth	7.47	7.50
High Growth	13.15	13.06
Green World	15.81	15.64
Very Low Gas Prices	6.09	6.13
Very High Gas Prices	14.12	14.00

Based on these results, the 20-year ramp rate was assumed in the Low Growth and Very Low Gas Price scenarios while the 10-year ramp rate was included in the Base Case and other scenarios.

The optimal portfolio resource additions in each of the seven scenarios are illustrated in Figure 6-25 for 2016, 2020, and 2031.

Figure 6-25

Gas Resource Additions in 2016, 2020 and 2031

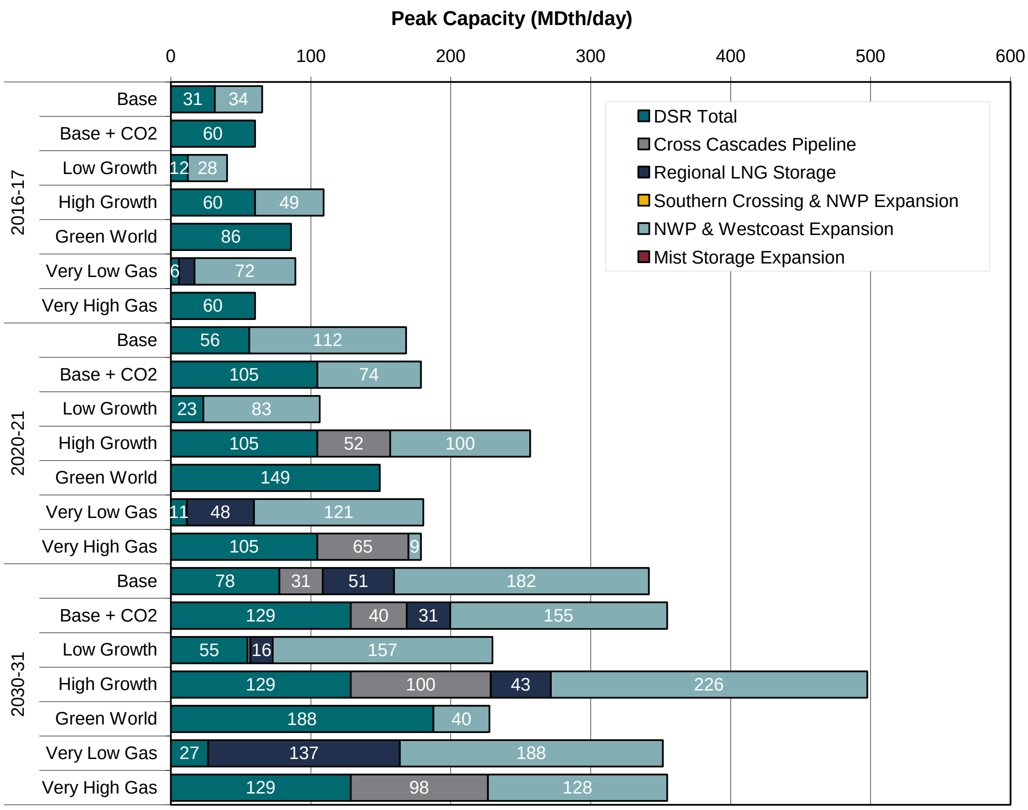
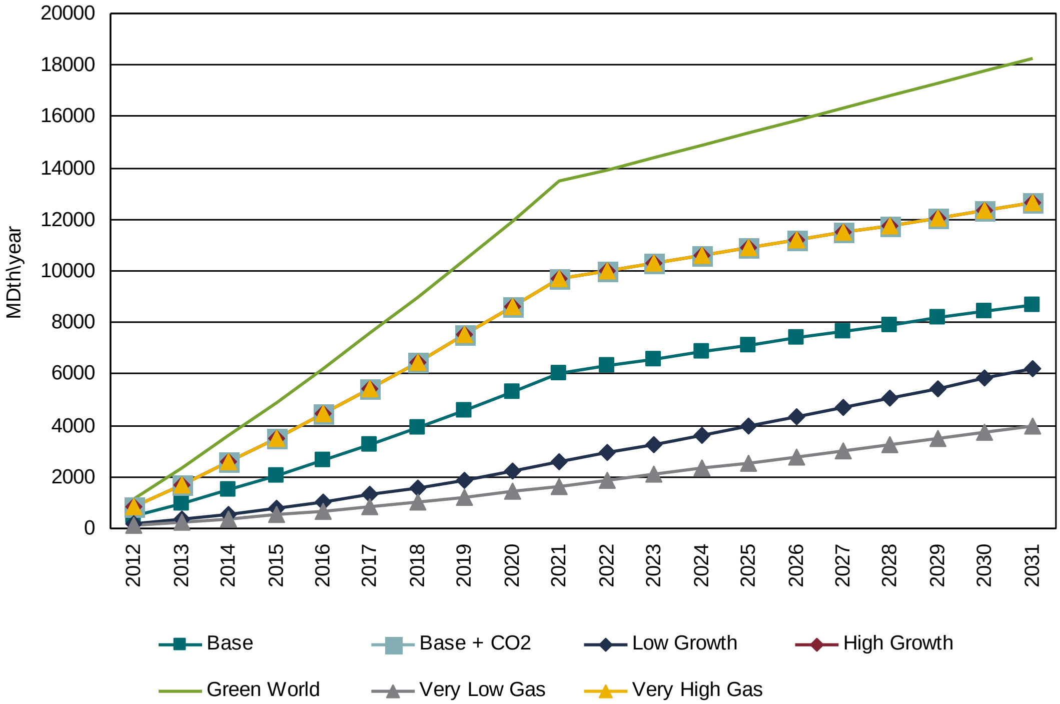


Figure 6-26

Gas Energy Efficiency Savings by Scenario



A downward shift in gas energy efficiency potentials is observable when comparing this IRP with the 2009 plan. This has more to do with changes in assumptions than changes in actual conditions. The 2011 Base Case assumptions do use somewhat lower gas prices than the 2009 Base Case, but CO_2 cost assumptions are much lower than 2009 assumptions. This is the biggest reason for the apparent downward shift. DSR remains very sensitive to avoided costs in the gas analysis. The amount of achievable energy efficiency resources selected by the SENDOUT analysis in this plan ranged from roughly 4,000 MDth in 2031 for the Very Low Gas Price scenario to more than four times that in Green World.

The optimal levels of demand-side resources, selected by market sector in the SENDOUT analysis, are shown in Fig 6-27, below. (For more information on demand-side bundles, see the "Demand-side Resource Alternatives" section in this chapter and Appendix K, Demand-side Resources Analysis.)

Figure 6-27
Gas Sales DSR Bundles by Sector and Scenario

	Base	Base + CO2	Low Growth	High Growth	Green World	Very Low Gas	Very High Gas
Residential Firm Bundle	C	D	B	D	G	A	D
Commercial Firm Bundle	D	F	D	F	F	B	F
Commercial Interruptible Bundle	B	D	A	D	D	A	D
Industrial Firm Bundle	C	E	C	E	E	C	E
Industrial Interruptible Bundle	C	E	C	E	E	C	E

Overall, the economic potential in this IRP is only slightly lower than in the 2009 gas sales Base Case when the 10-year ramp rate is applied.

Figure 6-28 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 savings of 500,000 to 2,300,000 Dth for the 2012-2013 period. The current target for the 2010-2011 period is within this range and the scenarios provide guidance to attain as much cost-effective gas efficiency resources as possible within the constraints of economic and market factors.

Figure 6-28
Short-term Comparison of Gas Energy Efficiency

Short-Term Comparison of Gas Energy Efficiency	Dth
2008-2009 Actual Achievement	880,000
2010-2011 Target (Updated Jan 2011)	980,000
2012-2013 Range of Economic Potential	500,000 – 2,300,000

Supply-side resource additions. As expected, based on lower costs, the predominant supply-side resource addition in all scenarios is the expansion of the Northwest and Westcoast pipelines which increases access to northern B.C. gas supplies. The cross-Cascades alternative is included by 2021 in the High Growth and Very High Gas Price scenario. In these scenarios the relatively higher cost of the cross-Cascades expansion is offset by the difference in prices between Northern B.C. and Rockies supply. The Southern Crossing alternative is not selected in any of the scenarios.

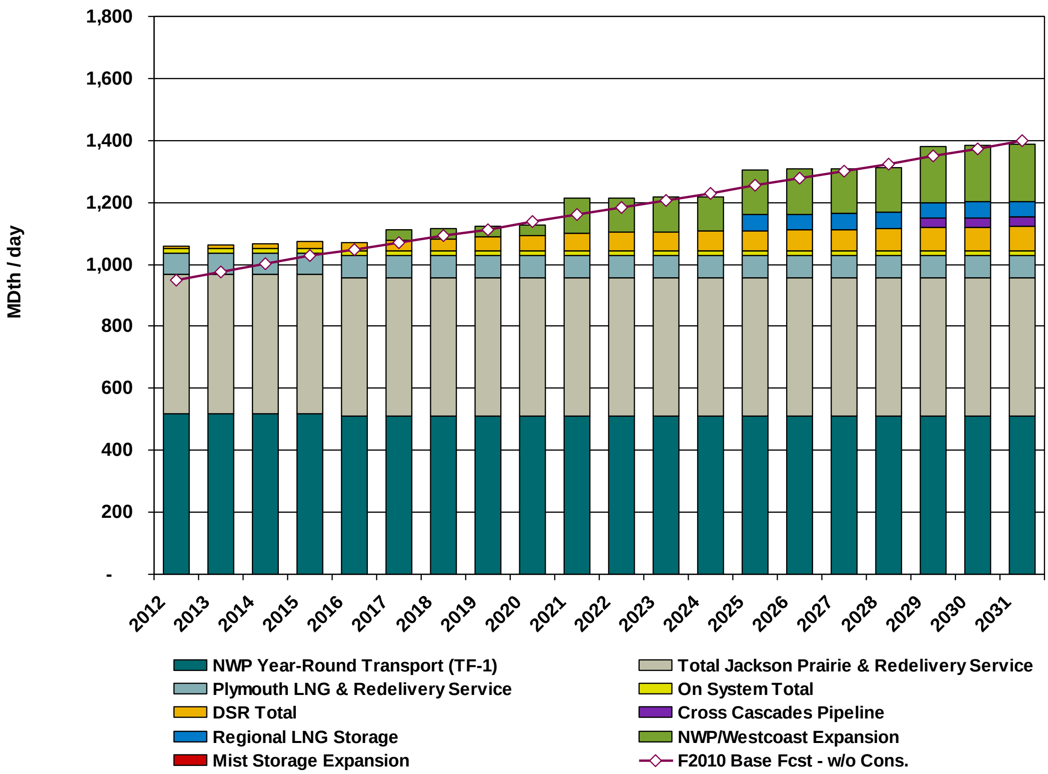
Storage additions. The results indicate that PSE should continue to consider a regionally located LNG storage facility. The Mist Storage alternative was not selected in any of the scenarios due to the cost of pipeline capacity required to redeliver the gas to PSE; discounted transportation capacity could change the conclusion.

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.

Complete Picture: Base Case Scenario

A complete picture of the Base Case scenario optimal resource portfolio is presented below in Figure 6-29. Additional scenario results are included in the Appendix J, Gas Analysis.

Figure 6-29
Base Case Scenario Gas Resource Portfolio



Average annual portfolio cost comparisons.

Figure 6-30 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 6-30

Average Portfolio Cost of Gas for Gas Scenarios

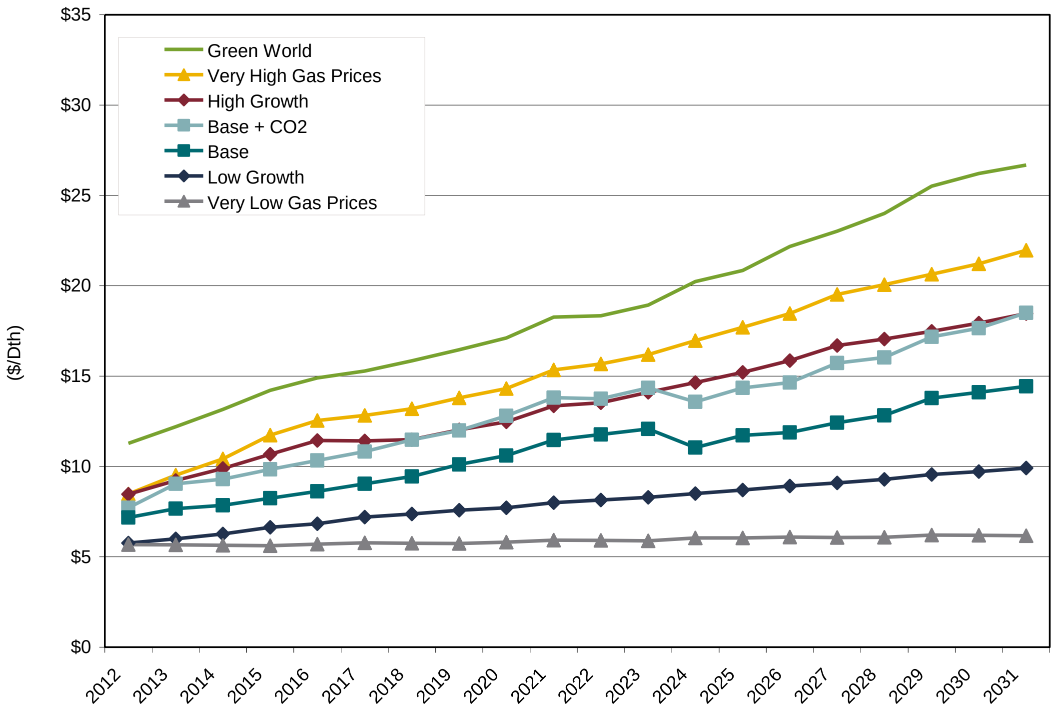


Figure 6-30 shows that average optimized portfolio costs are largely based on the gas price and CO_2 cost assumptions included in each scenario.

- Base Case scenario portfolio costs are about $7.15 per Dth in 2012 and increase to about $14.50 per Dth by 2031.
- The Base + CO_2 scenario costs start at about $7.70 per Dth, but rise to about $18.80 per Dth by 2031. (The only difference from the Base Case is CO_2 emissions cost.)
- The Very Low Gas Price and Low Growth scenarios have the lowest portfolio prices; these reflect lower gas price assumptions and minimal CO_2 costs.
- Green World costs are the highest, reflecting high CO_2 cost assumptions and a high gas price forecast.
- High Growth costs are somewhat lower than the Green World scenario, reflecting minimal CO_2 costs but retaining high gas prices.

Results of Monte Carlo Analysis

Monte Carlo analyses on the Base Case 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 Base Case 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 Base Case scenario. Analyses examined five specific resource addition alternatives: the regional LNG storage alternative, the Southern Crossing/Inland Pacific connector pipeline alternative, the cross-Cascades pipeline alternative, the Mist storage option as well as the various DSR bundles. This discussion compares the results from the deterministic analysis with the results from the Monte Carlo resource optimization analysis.

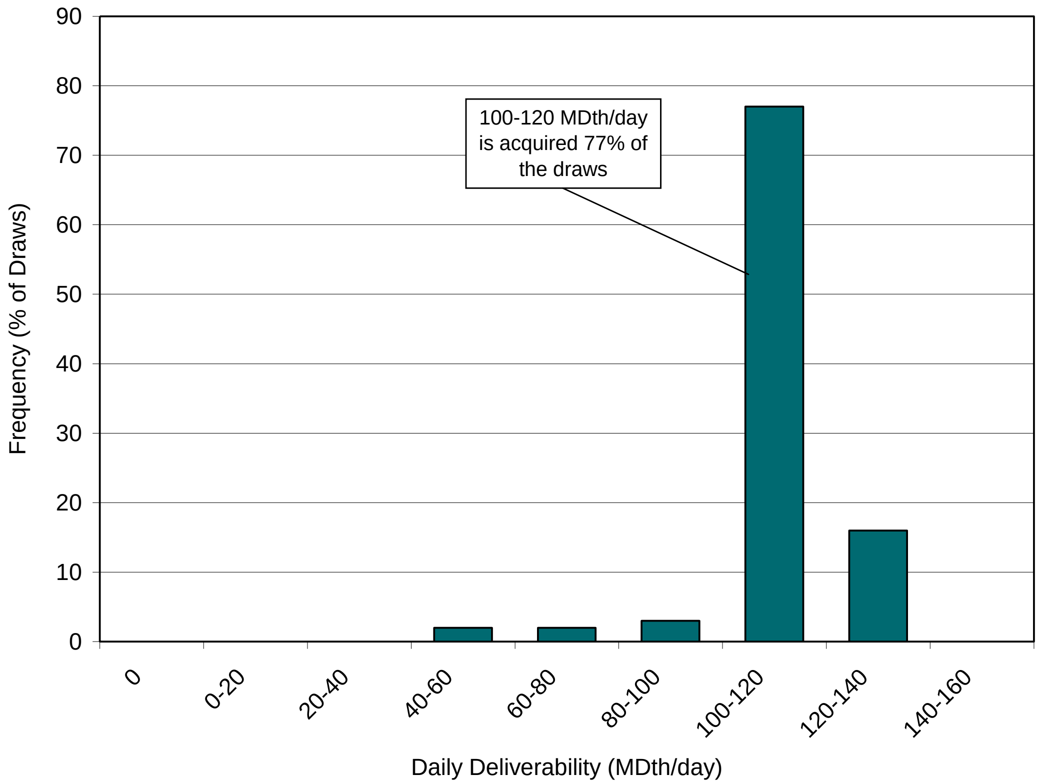
The Monte Carlo results were evaluated to check the resources selected as of January 2017 and January 2021. As of January 2017, essentially all of the Monte Carlo draw resource selections were the same as in the deterministic results. The results of the deterministic analysis was consistent with the stochastic analyses: both selected a mix of

DSR with 31 MDth per day of peak savings and a 34 MDth per day expansion of NWP between Sumas and PSE's service territory.

In January 2021, there is more variation among the Monte Carlo draws. As is the case for 2017, the DSR bundles selected in the deterministic case are essentially the same as in the stochastic results. There are only 2-3 draws with minor differences.

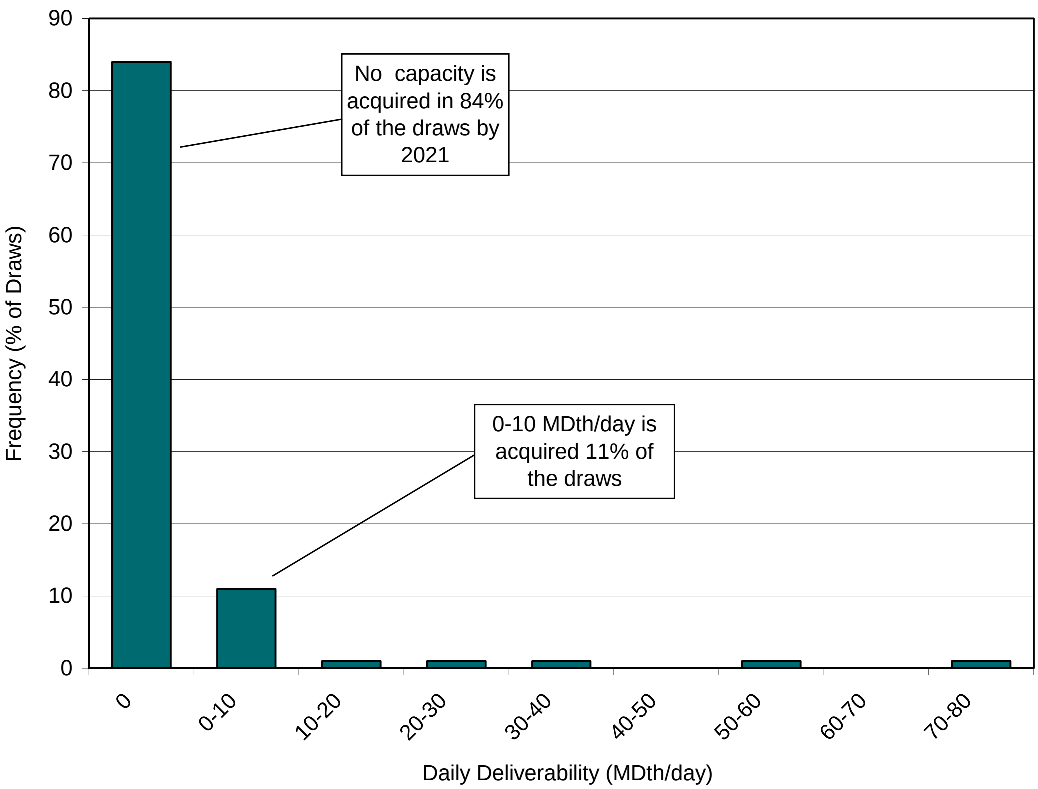
NWP from Sumas to PSE service territory. Figure 6-31 shows the frequency distribution with which the NWP pipeline alternative is selected across the 100 draws by the year 2021. As shown, between 100 and 120 MDth per day of capacity is selected in 77% of the draws. In the deterministic analyses, 112 MDth per day of capacity was selected.

Figure 6-31
Frequency Distribution of NWP Pipeline Development by 2021



Cross-Cascades pipeline. Figure 6-32 illustrates the frequency distribution for the cross-Cascades pipeline alternative. As shown, in approximately 84% 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 11% of the draws. Note that this option was not selected in the deterministic analyses.

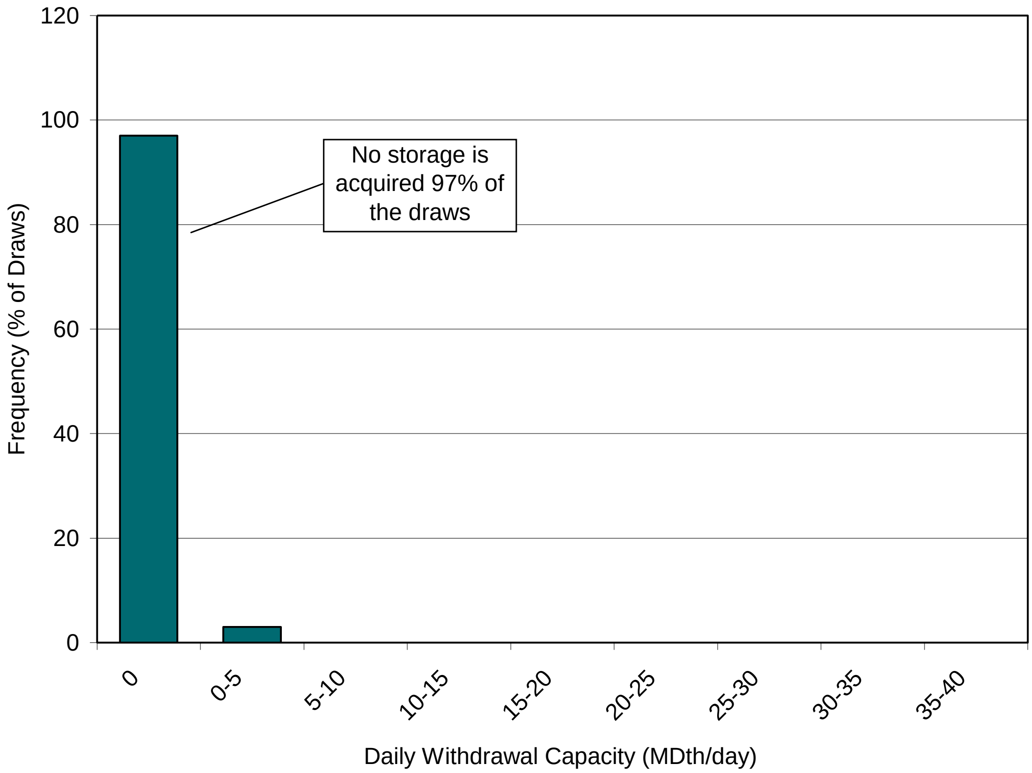
Figure 6-32
Frequency Distribution for Cross Cascades Pipeline by 2021



Regional LNG storage. Figure 6-33 shows the frequency distribution for the regional LNG storage alternative. In 97% of the Monte Carlo scenarios, no regional LNG storage capacity was selected. No capacity is included in the deterministic analysis.

Figure 6-33

Frequency Distribution for Regional LNG Storage Development by 2021

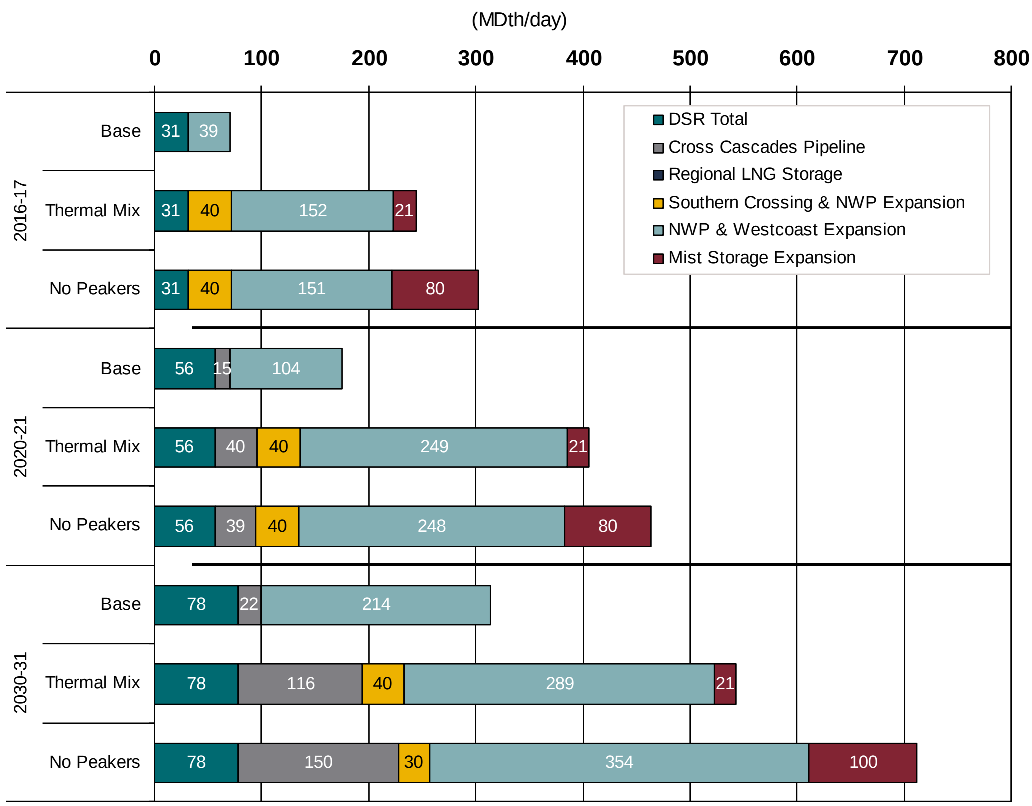


Combined Portfolio Analyses Results

The focus of the combined portfolio analyses was to evaluate the resource additions required to meet the supply needs of the combined gas sales and gas-for-power portfolios. For these analyses three sets of gas-for-power resource builds were modeled in SENDOUT: the Base Case portfolio, the Thermal Mix portfolio, and the No Peakers portfolio. The gas load for each of these was combined with the gas load forecasts from the Base Case gas sales scenario to represent the combined gas portfolio.

The resulting gas portfolio resource additions for each variation for 2017, 2021, and 2031 are shown in Figure 6-34.

Figure 6-34
Combined Portfolio Resource Additions Compared



The quantitative analyses presented in this chapter are based on the results of the SENDOUT 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.

6. 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 provide background information for resource development activities over the next two years.

1. In the Base Case scenario, the gas sales portfolio has adequate resources until the winter of 2015-16.

Under the High forecast additional resources will be needed by the winter of 2014-15. Under the Low forecast additional resources will not be needed until 2017-18.

2. No firm gas pipeline capacity is needed in any of the electric scenarios. Some additional pipeline capacity may be necessary in later years depending on gas and electric market conditions.

All new gas-fired generating plants in the electric portfolio developed in this IRP analysis are peakers with oil back-up. Additional firm pipeline capacity or storage may be necessary in the event that an all-peaker portfolio proves to place an unacceptable reliance on day-to-day gas market purchases or non-firm gas pipeline capacity. It also may be prudent to include a combination of peakers and CCCT plants to reduce the reliance on electric market purchases and on non-firm transmission capacity.

3. Continue to investigate the least-cost ramp rates for gas energy efficiency programs.

Experience from the 2010-2011 DSR acquisition programs indicates that accelerated ramp rates are feasible. Accelerating the acquisition of the discretionary measures over 10 years reduces the portfolio costs in the Base Case scenario.

4. The level of DSR varies significantly by scenario.

The level of DSR is sensitive to the gas costs and customer growth rates. DSR economic potential nearly quadruples from its lowest level in the Very Low Gas Price scenario to its highest level in Green World, and this impacts the timing of gas supply side alternatives.

5. Investigate the relative merits of a regional LNG storage facility compared to leasing additional storage from an expanded Mist facility.

Continued expansion of PSE's gas-fired generating resources will increase the need for gas storage resources. Using peakers to address fluctuations caused by wind integration and the need to "level-out" variations in gas loads due to day-to-day changes in power market prices may make additional storage attractive. Both alternatives are included in some of the scenario and sensitivity test results. The two types of storage have different advantages. LNG storage has more flexibility as to location and provides high withdrawal rates, but few days of storage and very low liquefaction (injection) rates; this limits the ability to quickly store gas. Underground storage facilities such as Mist offer much higher injection rates, more days of storage, and reasonably high withdrawal rates, but require longer-haul pipeline capacity.

Key Definitions and Acronyms

Abbreviation	Meaning
ACQ	annual contract quantities
AECO	gas hub in Alberta, Canada
AFUDC	allowance for funds used during construction
AGC	automatic generation control
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
ASM	ancillary service model
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
BOP	balance of plant (work inclusive of project substations, turbine foundations, collection system, roads and the operations and main building)
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)
CATR	clean air transport rule (owned by the EPA)
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)

KEY DEFINITIONS AND ACRONYMS

Abbreviation	Meaning
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
COL	construction and operating license
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
DSO	dispatch standing order (BPA's protocol to manage a growing amount of wind on its system)
EA	environmental assessment
EC	engineering consulting firms retained by PSE to determine resource cost and performance assumptions
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
EPC	engineer, procure and construct
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)

KEY DEFINITIONS AND ACRONYMS

Abbreviation	Meaning
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
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

KEY DEFINITIONS AND ACRONYMS

Abbreviation	Meaning
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)
MACT	maximum achievable control technology (emissions rate limitations for coal-fired units)
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 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
OC	owner's cost
OPS	Office of Pipeline Safety
OSU	Oregon State University

Abbreviation	Meaning
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
PEFA	ColumbiaGrid's planning and expansion functional agreement, which defines obligations under its planning and expansion program
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
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

Abbreviation	Meaning
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
TGC	total dissolved gas
TIG	Transmission Issues Group
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
WCI	Western Climate Initiative
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

Delivery Infrastructure Planning

Contents

This chapter addresses planning for the PSE-owned delivery system that delivers electricity and natural gas within our local service area to more than 1.7 million customers. Merchant-based delivery systems that involve arrangements with outside companies and organizations to transport power and natural gas to our service area are discussed in Chapter 5, Electric Analysis.

1. System Overview

Responsibilities

PSE's delivery system is responsible for delivering natural gas and electricity through pipes and wires safely, reliably, and on demand. We are also responsible for meeting all regulatory requirements that govern the system. To accomplish this, we must do the following.

- Operate and maintain the system safely and efficiently on a year-by-year, day by-day, and hour-by-hour basis.
- Accomplish timely maintenance and reliability improvements.
- Meet state and federal regulations and complete compliance-driven system work.
- Ensure that gas and electric systems meet both peak demands and day-to-day demands.

- Ensure that localized growth needs are addressed when they differ from overall system growth needs.
- Meet the interconnection needs of independent power generators that choose to connect to our system.
- Plan for future needs so that infrastructure will be in place when the need arrives.

Some of these are regional responsibilities. For instance, all PSE facilities that are part of the Bulk Electric System and the interconnected western system must be planned and designed in accordance with the latest approved version of the North American Electric Liability Corporation (NERC) Transmission Planning Reliability Standards. These standards set forth performance expectations that affect how the transmission system – 100 kV and above – is planned, operated and maintained. PSE also must follow Western Electricity Coordinating Council (WECC) reliability criteria; these can be more stringent than NERC standards at times.

PSE must also ensure that the system is flexible enough to adapt to coming changes. Smart Grid components, electric vehicles, customer distributed resources, and demand response programs are some of the effective solutions the industry is moving toward in the near future, and we need to be prepared to integrate them for the benefit of our customers.

The goal of PSE's planning process is to help us fulfill these responsibilities in the most cost-effective manner possible. Through it, we evaluate system performance and bring issues to the surface. We identify and evaluate possible solutions. And we explore costs and consequences of potential alternatives. This information helps us make the most effective, and cost-effective decisions going forward.

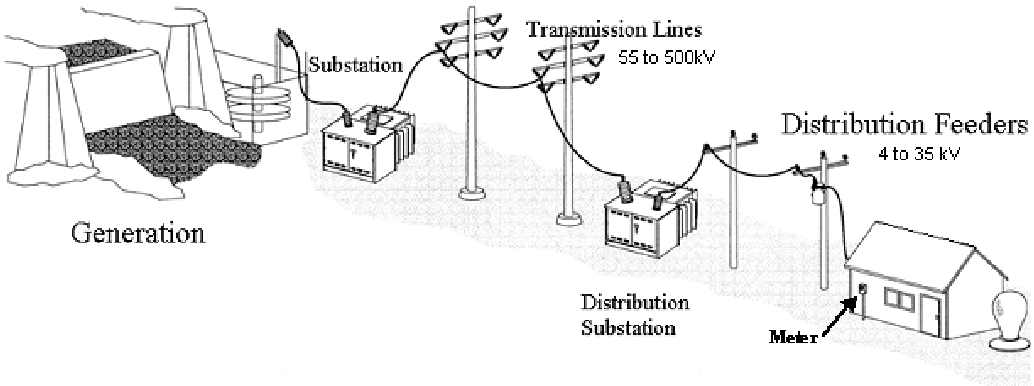
Existing System

The table below summarizes PSE's existing delivery infrastructure as of December 31, 2010. Electric delivery is accomplished through wires, cables, substations and transformers. Gas delivery is accomplished by means of pipes and pressure regulating stations.

Figure 7-1
PSE-owned Transmission and Distribution System as of December 31, 2010

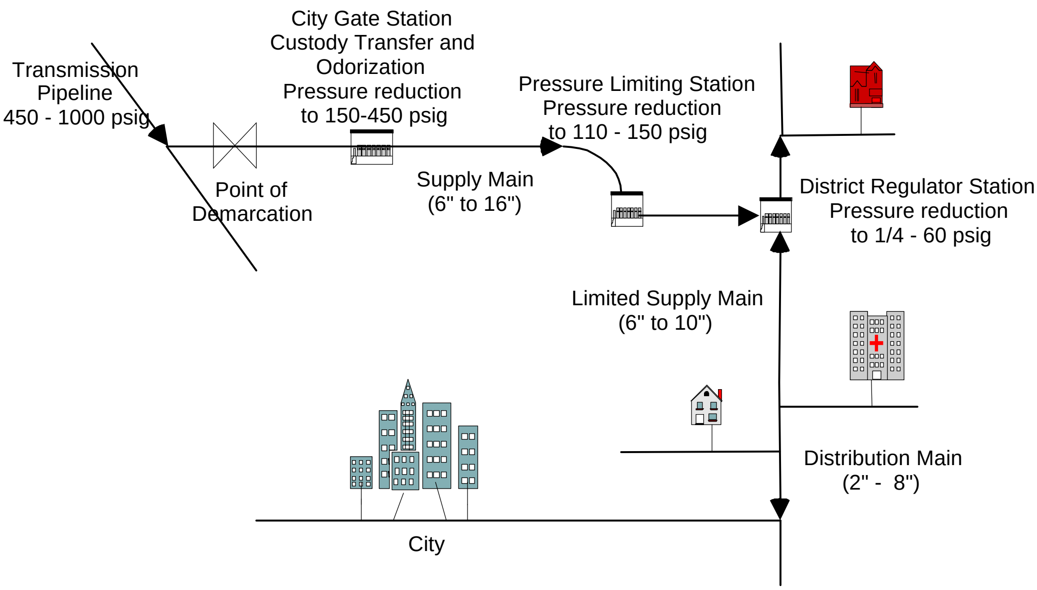
Electric	Gas
Customers: 1,074,992	Customers: 748,835
Service area: 4,500 square miles	Service area: 2,800 square miles
Substations: 354	City gate stations: 40
Miles of transmission line: 2,571	Pressure regulating stations: 652
Miles of overhead distribution line: 10,429	Miles of pipeline: 12,006
Miles of underground distribution line: 9,960	Supply system pressure: 150–550 psig
Transmission line voltage: 55-500 kV	Distribution pipeline pressure: 45-60 psig
Distribution line voltage: 4-34.5 kV	Customer meter pressure: 0.25 psig
Customer site voltage: less than 600 V	

How electric delivery systems work



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 carry electricity from one place to another. Substations and transformers change voltage to the appropriate level. Circuit breakers prevent overloads, and meters measure how much power is used.

How natural gas delivery systems work



Natural gas is transported at a variety of pressures through pipes of various sizes. Large transmission pipelines deliver gas under high pressures (generally 450 to 1,000 pounds per square inch gauge [psig]) to city gate stations. City gate stations reduce pressure to 150 to 450 psig for travel through supply main pipelines. Then district regulator stations reduce 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 where 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.

2. What drives infrastructure investment?

Despite a slow economy and minimal load growth, infrastructure expenditures may stay the same or even increase. This is because load growth is only one of the drivers of infrastructure investment. Aging equipment must be maintained or replaced; regulatory requirements may require spending on upgrades or alterations; public projects can necessitate equipment relocation; and we are required to integrate new generation resources. Below, we describe the six factors that drive infrastructure investment. Some can be known in advance, others can be forecasted, and some circumstances arise from external events.

Load Growth

PSE's first and foremost obligation is to serve the gas and electric loads of our customers; when customers turn on the switch or turn up the heat, sufficient gas and electricity need to be available. Load drives system investment in three ways: We must meet overall system loads. We must meet short-term peak loads. And we must meet point (block) loads

Overall system growth. Demands on the overall system increase as the population grows and economic activity increases in our service area even given the increasing role of demand-side resources. PSE regularly evaluates economic and population forecasts in order to stay abreast of where and when additional infrastructure, including electric transmission lines, substations, and high-pressure gas lines, may be needed to meet growing loads.

Peak Loads. Peak loads occur when the weather is most extreme. To prepare for these events, PSE carefully evaluates system performance during periods of peak loading each year, updates its system models, and compares these models against future load and growth predictions. This prepares us to determine where additional infrastructure investment is required to meet peak loads.

Electric delivery design is based on an expected winter peak of 23 degrees F[1] (which we expect to experience once every two winters), and a summer peak of 86 degrees F (which is a planning criteria used uniformly by electric utilities through western Washington). The gas system is designed to operate on a day with an average temperature of 10 degrees F. The gas system is designed more conservatively than the electric system because during a peak event the gas system pressure is drawn to zero as loads increase. Once gas pressure reaches zero, customers lose gas to pilot lights in their appliances. For this reason, gas outages have much greater public and restoration impacts than electric outages, and must be avoided for all but extreme conditions. The electric system is more flexible. For short periods of time components can often carry more current than their nameplate ratings call for with no adverse effects, and restoration is achieved instantly when power is rerouted and switches are reset.

Point Loads. System investments are sometimes required to serve specific "point loads" that may appear at a specific geographic location in our service territory. Electrical infrastructure to serve a computer server facility is one example, gas infrastructure to serve an industrial facility such as an asphalt plant is another.

Reliability

The energy delivery system is reviewed each year to improve the reliability of service to existing customers. Past outages, equipment inspection and maintenance records, customer feedback, and PSE field input help identify areas where improvements should be made. Additional consideration is given to system enhancements that will improve redundancy (such as being able to provide a second power line from one substation to another). Some of the investments to improve reliability include replacing aging conductors, installing covered conductors (tree wire), and converting overhead lines to underground.

Regulatory Compliance

PSE is committed to operating our system in accordance with all regulatory requirements. The gas and electric delivery systems are highly regulated by several state and federal

[1] *We also evaluate the electric system at 13 degrees F (a one-in-twenty-year condition) for operational planning considerations such as load shifting, the use of a mobile substation, etc., but this lower temperature is not used to justify infrastructure investments.*

agencies including NERC, FERC (Federal Energy Regulatory Commission), the WUTC (Washington Utilities and Transportation Commission), and various safety regulations. Infrastructure investments driven by compliance requirements include electric transmission projects that are aimed at preventing cascading power outages that could extend outside PSE's system. Gas regulations drive very specific inspection and maintenance activities and often require the replacement of assets based upon age and/or condition.

External Commitment

PSE must respond to city, county, and state jurisdictions within our service area when government-sponsored projects impact our facilities. Where PSE gas and electric facilities are installed in public rights of way, we must relocate them to accommodate public projects such as road widening or underground conversion of electrical facilities. We look for opportunities to minimize costs and disruptions in the future when this happens, by using these construction events to install larger or additional infrastructure that will accommodate anticipated load growth.

Aging Infrastructure

With continued maintenance, gas and electric infrastructure can provide safe, reliable service for decades. PSE has a number of programs in place that address aging infrastructure by replacing poles, pipes, and other components that are nearing the end of their useful life. Our goal is to maximize the life of the system and at the same time minimize customer interruptions by replacing major infrastructure components prior to unplanned failure.

Integration of Resources

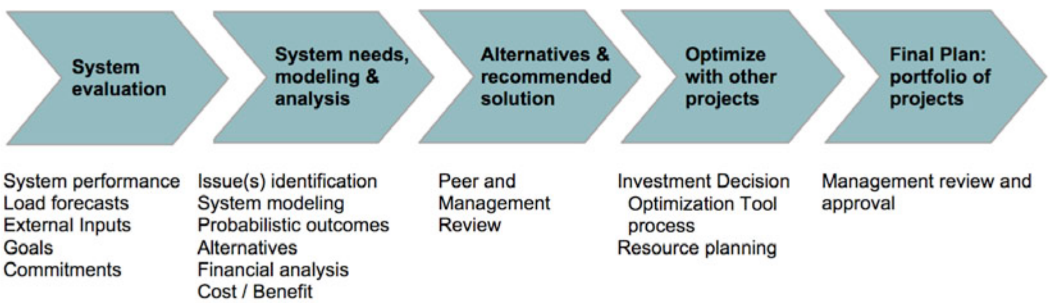
FERC and state regulations require PSE to integrate generation resources into our electric system per processes outlined in federal and state codes. A new generation plant, whether it is owned by PSE or operated by others, can require significant electric infrastructure investment to integrate and maintain appropriate electrical power flows within our system and across the region.

3. Planning Process

The planning process begins with an evaluation of the system's current performance. Next alternatives are developed, those alternatives are vetted and reviewed, and projects are compared against one another. Performance criteria comprises factors including, but not limited to, reliability, compliance, and customer expectations. Finally, a portfolio of projects is adopted. The process is the same for both long-term and short-term planning.

The IRP produces a long-term view, a general 10-year projection of infrastructure investments that can be expected based on today's conditions and forecasts. As the horizon shortens and the actual plan year approaches, those projections are refined based on new developments and actual rather than hypothetical conditions. Even after the portfolio for a given year is approved, we continue to monitor changing conditions and make alterations as necessary.

Figure 7-2
Delivery System Planning Process



System Evaluation

System evaluation begins with an evaluation of system performance, a review of existing operational challenges, and consideration of load forecasts and known commitments and obligations. Performance is measured by the system's ability to maintain quality and continuous service during normal and peak loads throughout the year while meeting the regulatory requirements that govern them.

Performance criteria for electric and gas delivery systems lie at the heart of the process and are the foundation of PSE's infrastructure improvement planning.

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 level of reliability that customers are willing to pay for	The target levels of performance that customers are willing to pay for
The interconnectivity with other utility systems and resulting requirements; including compliance with NERC Planning Standards	

PSE collects 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 to normalize the effect of variables like weather that can change significantly from year to year. For near-term load forecasting at the local city, circuit, or neighborhood level, we use system peak-load and customer growth trends augmented by permitted construction activity for the next two years. For longer-term forecasting, we use an econometric forecasting method that includes population growth and employment data by county (see Appendix H). External inputs such as new regulations, municipal and utility improvement plans, and customer feedback, as well as company objectives, are also included in the system evaluation.

System Needs, Modeling, and Analysis

PSE relies on several tools to help identify and weigh the benefits of alternative actions. Figure 7-3 provides a brief summary of these tools, the planning considerations (inputs) that go into each, and the results (outputs) that they produce.

Figure 7-3
Delivery System Planning Tools

Tool	Use	Inputs	Outputs
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; load growth scenarios	NPV; income statement; load growth vs. capacity comparisons; EUE

PSE's **gas system** model is a large integrated model of the entire delivery system. It uses a software application (SynerGEE® Gas) that is continually updated to reflect new customer loads and system and operational changes. This model helps predict capacity constraints and subsequent system performance on a variety of degree days and under a variety of load growth scenarios. Results are compared to actual system performance data to assess the model's accuracy. Where issues surface, the model can be used to evaluate alternatives and their effectiveness. PSE augments potential 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 SynerGEE software. Here, the feeder systems within PSE's service territory are modeled rather than the entire system at once, because of the limited connectivity between regions and the complexity of modeling such a large system. As with gas, 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 is a three-step process. First, we build a 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, we identify customer loads, either specifically (for large customers) or as block loads for address ranges. Existing customer loads come from PSE's customer information system or actual circuit readings. Finally, we vary temperature conditions, types of customers (interruptible vs. firm), time of daily peak usage, and the status of components (valves or switches closed or open) to model scenarios of infrastructure or operational adjustments. The goal is 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 Siemens Power Technologies International), 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 Columbia Grid 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.

System Alternatives

The alternatives available to address delivery system capacity and reliability issues are listed below. Each has its own costs, benefits, challenges, and risks.

Figure 7-4

Alternatives for Addressing Delivery System Capacity and Reliability

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 / Demand Response
  - 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

The same alternatives can be used to manage short-term issues like peaking events or conditions created by a construction project. For example:

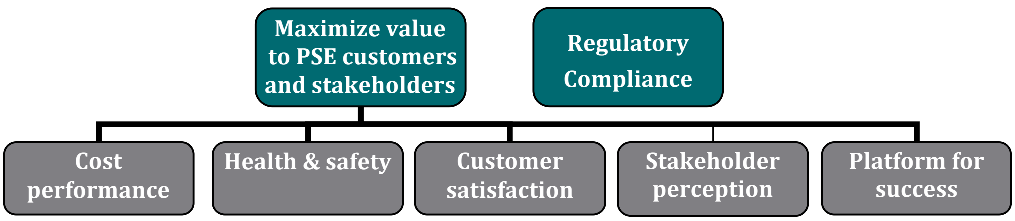
- Temporary adjustment of regulator station operating pressure, as executed through PSE's Cold Weather Action Plan.
- Temporary adjustment of substation transformer operating voltage, as done using load tap changers to alter turn ratios.
- Automatic capacitor bank switching to optimize VAR consumption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

Evaluating Alternatives and Recommended Solutions

When it's time to evaluate alternatives, PSE compares the relative costs and benefits of various solutions (i.e. projects) using the Investment Decision Optimization Tool (iDOT). iDOT allows us to capture project criteria and benefits and score them across multiple factors including reliability, safety, capacity addition, deferred future costs, and external stakeholder inputs. iDOT makes it easier to conduct side-by-side comparisons of projects of different types, thus helping us evaluate infrastructure solutions that will be in service for 30 to 50 years

Figure 7-5

Benefit Structure to Evaluate Delivery System Projects



Project costs are calculated using a variety of tools, including historical cost analysis and unit pricing models based on service provider contracts. Cost estimates are refined as projects move through detailed scoping. Through this process, alternatives are reviewed and recommended solutions are vetted and undergo a peer review process. Further minor adjustments are made to ensure that the portfolio addresses resource planning and other applicable constraints or issues.

In the case of the IRP, a general, long-term projection of likely infrastructure expenditures is produced. Annual plans approved by operations management provide a specific portfolio of projects for the year. While annual plans are considered final, throughout the year they continue to be adjusted based on changing factors (e.g. public improvement projects that arise or are deferred; changing forecasts of new customer connections; project delays in permitting) so that we can ensure the total portfolio financial forecast remains within established budget parameters.

4. 2011-2021 Infrastructure Plans

PSE develops both short-range and long-range infrastructure plans based upon economic, population, and load growth projections, as well as information from large customers and government stakeholders. 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.

The infrastructure additions described below are intended to indicate the scope of investment that will be required over the next ten years in order to serve our customers reliably and fulfill regulatory requirements. They are expressed in general terms and accompanied by a list of sites where the work is most likely to occur. Previous IRPs listed specific projects, but we felt that presentation was of extremely limited value because specific projects are so dependent on localized economic and physical circumstances that they are likely to be quite different by the time they are implemented.

Electric Infrastructure Plan

Transmission lines. In the next decade, PSE anticipates building approximately 200 miles of new transmission lines (100 kV and above) and upgrading over 300 miles of existing transmission lines to carry greater loads.

Distribution substations. Distribution infrastructure additions are highly dependent on localized patterns of load increases. In the next decade, PSE anticipates the need to build approximately 15 new distribution substations. Many of PSE's existing substations are designed so that additional capacity can be added at a later date. We anticipate that we will upgrade approximately 12 existing substations in the coming decade.

Ongoing maintenance. Based upon current projections and past experience, PSE expects to replace 500 to 1,000 miles of underground cable, approximately 2,000 transmission poles, and up to 10,000 distribution poles over the next 10 years. Additionally, PSE replaces many major substation components on a continuous basis as a result of ongoing inspection and diagnostics.

Gas Infrastructure Plan

Gate stations. PSE plans to build or upgrade approximately 7 gate or limit stations where we take gas from the Northwest Pipeline.

Pipelines and mains. We expect to add approximately 30 miles of high pressure main and 50 miles of intermediate pressure main as loads grow in our service area.

Ongoing maintenance. As with the electric system, PSE is always addressing aging gas infrastructure within the system in accordance with regulatory requirements and prudent operating practices. In the next decade, PSE plans to replace over 100 miles of gas main that is reaching the end of its useful life.

Figure 7-6 lists the potential sites for these upgrade and maintenance projects.

Figure 7-6
Summary of 2011-2021 Infrastructure Plans

Asset	Name	Location
Substations	Boeing Aerospace	King County
	Mt. Si	King County
	Ardmore	King County
	Jenkins	King County
	Grand Ridge	King County
	Autumn Glen	King County
	Lake Holm	King County
	Briscoe Park	King County
	Lakemont	King County
	Bainbridge	Kitsap County
	Lakeland	Pierce County
	Blackburn	Skagit County

Asset	Name	Location
	Carpenter	Thurston County
	Spurgeon	Thurston County
	Maxwelton	Island County
New Transmission	200 miles	Systemwide
Upgraded Transmission	300 miles	Systemwide
Cable Replaced	500 – 1,000 miles	Systemwide
Distribution Poles Replaced	Up to 10,000	Systemwide
Transmission Poles Replaced	1,000	Systemwide
New High Pressure Pipe	30 miles	Systemwide
New Intermediate Pressure Pipe	50 miles	Systemwide
Gate or Limit Station Upgrades	Lake Stevens Gate Station	Snohomish County
	Redmond Gate Station	King County
	East Olympia Limit Station	Thurston County
	Lynnwood Limit Station	Snohomish County
	North Seattle Gate Station	Snohomish County
	East Olympia Gate Station	Thurston County
	Machias Gate Station	Snohomish County
Gas Main Replaced	100 miles	Systemwide

5. Challenges and Opportunities

New Regulations

Regulatory compliance is a significant driver of PSE infrastructure investment, but it is difficult to anticipate what rules may be adopted in the future or to predict how they may impact spending on our delivery systems. NERC, FERC, and the WUTC are among the agencies and organizations that regulate our businesses. Examples from the last decade illustrate the kind of expenditures that regulatory activity can necessitate.

Gas system. Beginning with the Pipeline Safety Improvement Act (PSIA) of 2002 and again in 2006 with the Pipeline Inspection, Protection, Enforcement, and Safety (PIPES) Act, Congress has directed the Pipeline and Hazardous Materials Safety Administration to increase the strength of integrity management programs covering natural gas transmission and distribution pipelines. These programs require PSE to perform detailed inspections and analysis of pipeline systems to gain more knowledge of pipeline integrity risks and to devise measures to mitigate these risks. Numerous actions have resulted from this effort, including expanded pipe replacement programs, enhanced damage prevention activities, and increased inspection intervals. Recent pipeline safety incidents have occurred across the country, and this continues to focus the attention of state and federal regulators and lawmakers on improving pipeline and public safety performance. Proposed legislation includes:

- expanding the mileage of pipelines subject to more rigorous inspection and testing,
- requiring the use of automatic and remote controlled shut-off valves,
- expanding the use of excess flow valves, and
- requiring more timely notification of pipeline incidents.

All require additional investment in processes and infrastructure to support compliance with new regulations.

Electric system. In 2007, new regulations mandated by The Energy Policy Act of 2005 became effective and enforceable by regional electric reliability organizations. This act was triggered by concern about the robustness and reliability of nation's electrical grid, and it moved the industry into an era where system planning, performance, and operating requirements are mandated by law, audited, and enforced by fines and sanctions. Complying with these new reliability standards has required PSE to make significant investments in both hardware and software assets for the portions of our system operating above 100 kV.

Emerging Alternatives

PSE and the region's utilities have a vested interest in finding optimal solutions to transmission constraints and bulk power delivery problems, and we are studying several emerging alternatives that have the potential to help meet today's transmission and distribution challenges. Among them are the following.

Distributed generation. Distributed generation is the name for incorporating small-scale generation into the electric grid close to where the users are (close to load). 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 move electricity in only one direction – typically from large, remote generating plants to far-away end users.

Conservation voltage reduction. Reducing the voltage at an end-user's site by a small percentage can result in significant energy savings without compromising the operation of customers' equipment. In 2006, PSE began a conservation voltage reduction pilot program 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 resulted 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. As technology for two-way communication over the electric grid advances, making it easier to implement this technique, conservation voltage reduction has the potential to play a much larger role in the delivery system. PSE continues to evaluate locations where conservation voltage reduction may be practical to implement and similar energy savings may be realized.

Demand response alternatives. When demand for power is at its highest and customers reduce their energy use in response, utility delivery system planners call it "demand response." PSE estimated demand response capacity for residential, commercial, and industrial customer sectors in its 2009 IRP, and two small-scale, voluntary, demand response pilots are currently in progress. One involves residential loads and the other industrial loads. PSE's primary focus is to direct load control during times of high peak system loads. We expect to gain knowledge about the customer communication and equipment needed, as well as the information and incentives needed to achieve customer participation. We will evaluate the pilots based on how they affect the electric system and how receptive and responsive customers are.

Electric vehicles. PSE's customers are adopting electric and plug-in hybrid vehicles. We have developed estimates of expected energy needs, performed initial assessment of distribution impacts on select circuits, and performed some tests of the effectiveness of curtailed charging. All of these studies determined that initial adoption of electric vehicles and plug-in hybrids would not have significant effects on PSE's energy needs or distribution system. As the trend continues, PSE will expand data collection efforts to develop better models based on real-world conditions. Simulations will be performed to determine when system upgrades are needed.

Smart grid technologies. Smart grid is a term used to describe the integration of 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 demand response technologies, but has the potential to connect all parts of the electric power system – production, transmission, and distribution – in ways that would be very beneficial to customers. PSE recently submitted a Smart Grid report to the Washington Utility & Transportation Commission detailing the company's plans for Smart Grid technology and development. The report can found at the following link:

http://wutc.wa.gov/rms2.nsf/vw2005OpenDocket/4E9780AC62CF7D9888257792005A2398

2011 INTEGRATED RESOURCE PLAN

May 30, 2011

APPENDICES A - K

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PUGET SOUND ENERGY

Appendices

2011 Integrated Resource Plan

Public Participation

Contents

PSE is committed to public involvement in the planning process. Stakeholder meetings generated valuable constructive feedback, and the suggestions and practical information we received from both organizations and individuals helped guide the development of this 2011 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: seven formal Integrated Resource Plan Advisory Group (IRPAG) meetings, numerous 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 IRPAG 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 the two groups meet separately, they have many members in common.

1. 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 2011 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 2010 Request for Proposals (RFP). 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 more 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 PSE in our planning process. Additionally, these interactions enhance our thinking by bringing a variety of perspectives to the process. Following are specific examples of significant factors that were influenced by conversations with the IRP Advisory Group:

- No Northwest Coal Sensitivity: Conversations with stakeholders about the costs of reducing emissions via carbon pricing and coal plant closure prompted PSE to develop this sensitivity.
- Capacity Contribution of Wind: As we have done in the past, PSE initially planned to rely on regional studies for estimates of how wind contributes to capacity needs. Stakeholders suggested PSE could benefit from performing our own analysis, the results of which are presented and used in this IRP.

- Regional 10 percent Credit and Non-Energy Benefits for Conservation: PSE included these factors in the value of demand-side resources, as suggested by stakeholders.
- "Incremental Cost" of Renewables Analysis and 4 percent Revenue Requirement Cap: PSE had performed analysis to estimate whether the company would hit the cost cap under I-937 before the physical target. Stakeholders suggested this analysis be discussed in the IRP (Appendix I). Discussions with stakeholders results in some revision to the analysis.
- Additional Reports/Information: Stakeholders suggested that PSE provide a comparison between PSE's IRP methodology and that of the Northwest Power and Planning Council. Also after their suggestion, we included the coversheet report from the Department of Commerce's reporting requirements. Both can be found in Appendix B.

Summary of IRPAG Meetings

A. IRPAG Kick-off Meeting, April 20, 2010

PSE's 2011 IRPAG kick-off began with a discussion of lessons learned from the 2009 IRP process. We discussed key uncertainties, scenarios and sensitivities, and resource alternatives. PSE shared highlights from the IRP work plan. The company's Resource Acquisition department gave a presentation on the status of the evaluation process for PSE's Request for Proposals for All Generation Sources, which was underway at the time.

B. IRPAG Meeting, July 22, 2010

PSE invited the IRPAG to its Wild Horse Wind and Solar facility near Ellensburg, Wash. for an update on the IRP process followed by a tour of the facility. The meeting began with a discussion of current climate considerations, challenges and proposed legislation. This was followed by a continuation of the April discussion of proposed assumptions, scenarios, and sensitivities. PSE wrapped up the meeting portion of the day with a discussion about flexibility needs and wind integration.

C. IRPAG Meeting, October 7, 2010

This meeting began with an overview of our IRP analysis process and the methodology used for the demand side resources analysis. PSE presented an update on scenarios and sensitivities, resource alternatives and assumptions including gas prices, CO2 costs and the load forecast. PSE also presented draft electric price forecasts.

D. IRPAG Meeting, November 18, 2010

PSE began by presenting a review of the load forecast. A discussion of resource need for both electric and gas followed. On the electric side, this included a discussion of renewable and capacity need, as well as the methodology for determining the appropriate value of wind power's contribution toward meeting capacity need. On the gas side, PSE discussed resource need to meet the needs of its gas sales book. The latter portion of the meeting focused on demand-side resources analysis process and potentials.

E. IRPAG Meeting, January 13, 2011

The discussion began with a review of PSE's process for selecting a long-term resource plan, including a review of the scenario assumptions used in quantitative modeling. PSE presented both its electric and gas portfolio modeling results and next steps. The meeting concluded with a brief preview of the overall organization of the plan document.

F. IRPAG Meeting, March 15, 2011

The March meeting offered a first look at PSE's draft electric and gas resource plans. PSE presented a review of the electric and gas analysis results. The resource planning team also offered a summary review of its electric and gas scenarios and sensitivities, its analytical approach to electric planning and its gas resource alternatives.

G. IRPAG Meeting, April 19, 2011

PSE opened the April meeting with a request for feedback on its draft IRP. The draft was posted for public review on the company's web site on April 1, 2011. Afterward, PSE led a discussion of the incremental cost of renewable resources, followed by a detailed discussion of natural gas-fired peaking plants compared to combined cycle combustion turbines (CCCTs) in its planning analysis.

2. 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.

The CRAG participated in the development of the 2011 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.

Legal Requirements and Other Reports

Contents

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. Section I of this chapter outlines the regulatory requirements for electric and gas integrated resource plans, and where each of these requirements are addressed within the IRP. Section II reports on the electric and gas resources action plans put forward in the previous IRP. Section III offers two additional reports. The first is a table illustrating the consistency of PSE's electric demand-side resources assessment with the Northwest Power Planning Council's methodology. The second is a table summarizing the load-resource balance information presented in this 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.

1. Regulatory Requirements

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.

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, Key Analysis Components • Appendix H, 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 Analysis • Appendix K, 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 Analysis • Appendix D, Electric Resources
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 E, Regional Transmission Resources
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 Analysis • Chapter 2, Developing the Plan • Appendix E, Regional Transmission Resources • Appendix I, Electric Analysis

Statutory/Regulatory Requirement	Chapter
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 Analysis • Chapter 2, Developing the 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 1, Executive Summary
WAC 480-100-238 (3) (h) A report on the utility's progress towards implementing the recommendations contained in its previously filed plan.	• Appendix B, Legal Requirements
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.	• 2011 Integrated Resource Plan Work Plan filed with the WUTC in May 2010 • Chapter 1, Executive Summary (Action Plans section)
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, Key Analysis Components • Appendix H, 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, Gas Analysis • Appendix K, Demand-side Resources Analysis
WAC 480-90-238 (3) (c) An assessment of conventional and commercially available nonconventional gas supplies.	• Chapter 6, Gas Analysis
WAC 480-90-238 (3) (d) An assessment of opportunities for using company-owned or contracted storage.	• Chapter 6, Gas Analysis
WAC 480-90-238 (3) (e) An assessment of pipeline transmission capability and reliability and opportunities for additional pipeline transmission resources.	• Chapter 6, Gas Analysis • Chapter 2, Developing the 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, Gas Analysis
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, Gas Analysis • Chapter 2, Developing the Plan

Statutory/Regulatory Requirement	Chapter
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 1, Executive Summary
WAC 480-90-238 (3) (i) A report on the utility's progress towards implementing the recommendations contained in its previously filed plan.	• Appendix B, Legal Requirements
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.	• 2011 Integrated Resource Plan Work Plan filed with the WUTC in May 2010 • Chapter 1, Executive Summary (Action Plans section)
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

2. Report on Previous Action Plans

A. 2009 Electric Resources Action Plan

The following section includes each item from the electric resource plan from the 2009 IRP, along with the progress that was made in implementing recommendations included in that plan, per WAC 480-100-238 (3) (i).

2009 IRP Action Plan Item: 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 percent 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 percent loss of load probability and interaction of operating and planning reserve margins.

Progress Made to Address Recommendations

- Active Participation in Northwest Regional Resource Adequacy Forum: PSE has been actively engaged in both the steering committee and technical committee of this organization. This included draft reports and analysis indicating the region will not appear to be falling short of established adequacy metrics for the next five years.
- White paper titled "Reserves in Capacity Planning, a Northwest Approach," available on the Pacific Northwest Utilities Conference Committee's (PNUCC) website: PSE spearheaded an effort to coordinate with other utilities in the region with respect to alternatives for reflecting operating reserves in calculation of planning margins[1].

[1] *The white paper is available on PNUCC's website at:* http://www.pnucc.org/documents/ReservesinCapacityPlanningFinal.pdf

- IRP Addendum Filed: After working with others in the region via PNUCC System Planning Committee on the white paper mentioned above, PSE updated our LOLP analysis and planning margin calculation to accurately reflect the impact of operating reserves. Results were included in the Addendum to the 2009 IRP, filed with the WUTC in January 2010.

2009 IRP Action Plan Item: Electric 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.

Progress Made to Address Recommendations

Development of Electric and Gas Demand-side Resources Programs and Targets: PSE involved commission staff and the public in the development of the company's ten-year conservation potential and the two-year conservation target over the period of several years. Public discussions of development of conservation potentials and targets have taken place since April 2008. The form of discussions has been varied: public meetings, public IRPAG meetings, CRAG meetings, WUTC Open Meetings, WUTC-hosted public meetings, meeting with WUTC Staff, and emails to interest groups. The table below summarizes the various meetings and identifies the participation by commission staff and the public in those meetings.

Figure B-3
WUTC Staff and Public Involvement in Development of Ten-year Conservation Potential and Two-year Conservation Target

Type of Meeting/Communication	Date	Commission Staff	Public
Public IRPAG meeting	April 3, 2008	X	X
Public IRPAG meeting	Nov. 20, 2008	X	X
Public IRPAG meeting	Jan. 22, 2009	X	X
Public IRPAG meeting	April 23, 2009	X	X
Public IRPAG meeting	June 25, 2009	X	X
CRAG meeting	June 25, 2009	X	
Public WUTC meeting	Sept. 3, 2009	X	X
CRAG meeting	Sept. 15, 2009	X	
IRP comment period	Aug. 28, 2009	X	X
Public Open Meeting	Sept. 10, 2009	X	X
CRAG meeting	Sept. 15, 2009	X	
CRAG meeting	Oct. 14, 2009	X	
Draft Tariff Program Schedules provided to CRAG	Nov. 2, 2009	X	
Meeting with WUTC staff	Nov. 17, 2009	X	
Program Tariff Schedule Filing	Nov. 30, 2009	X	X
Public IRPAG meeting	Dec. 15, 2009	X	X
Email to IRPAG and CRAG	Dec. 31, 2009	X	X
Program Tariff Schedules go into effect	Jan. 1, 2010	X	X
Email to IRPAG and CRAG	Jan. 25, 2010	X	X
Conservation Council provides updated 5th Plan Calculator on its public website	Jan. 27, 2010	X	X
Public meeting to review development	Jan. 27, 2010		X

- Updated Avoided Costs Inputs: As indicated in Figure B-3, PSE distributed a draft of our 2010 - 2011 Program Tariff Schedule Filing to the CRAG for review in November 2009, prior to filing it with the WUTC. A description of PSE's avoided cost inputs was included in Appendix C of the filing. No comments about avoided costs were received from the CRAG.

2009 IRP Action Plan Item: 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 explore cost-effective opportunities as they appear during the formal RFP process, as well as other market opportunities that may present themselves.

Progress Made to Address Recommendations

- Move Deeper Into Development Process: PSE acquired development rights to the Lower Snake River wind project in 2008 and 2009.
- Acquisition Process: PSE requested offers for renewable energy and unbundled Renewable Energy Credits (RECs) in its 2010 All Source RFP. The company received 31 proposals for renewable generation resources and two proposals for RECs in response to the RFP process. The company also considered a wide range of unsolicited proposals and other projects through commercial activity outside the formal RFP process.
- Development of Lower Snake River Phase I (LSR Phase I) Wind Project: Development of LSR Phase I, on a timeline sufficient to qualify for a Section 1603 U.S. Treasury grant, was found to be the lowest reasonable cost way to meet the company's renewable energy needs. PSE began construction of LSR Phase I in spring 2010. Located in Garfield County, Wash., the 343 MW wind project is scheduled to be completed in the first or second quarter of 2012.

2009 IRP Action Plan Item: 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.

Progress Made to Address Recommendations

- Acquisition Process: PSE is pursuing negotiations with counterparties for contracts from the formal RFP process. We're also pursuing several contracts that were not submitted through the RFP. The company is expecting to execute contracts with a few of these counterparties within the next few months.
- Monitoring Policy, Regulatory, and Technology Developments: PSE continually monitors developments at the federal, state and local levels for changes in policy

or regulation that could affect the operation and development of future thermal

generating resources. PSE also investigates and explores new technologies that may provide new methods for generating energy with thermal and renewable resources. Examples include investigations into biomass and new technologies for peaking products.

B. 2009 Gas Resources Action Plan

The following section includes each item from the gas resource plan from the 2009 IRP, along with the progress that was made in implementing recommendations included in that plan, per WAC 480-90-238 (3) (i).

2009 IRP Action Plan Item: 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.

Progress Made to Address Recommendations

- See ***2009 IRP Action Plan Item: Electric Demand-side Resources*** on pages seven and eight of this appendix. This information provided in this section applies to both electric and gas demand-side resources.

2009 IRP Action Plan Item: Diversity of Supply Considerations and Pipeline Expansions

PSE is currently exposed to a single supply basin for the majority of our natural gas supplies, a situation that places the company and our 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.

Progress Made to Address Recommendations

- Study on Regional Impact of Increased Supplies from Rockies/GTN: PSE contracted with Global Insight to develop a gas price forecast to examine the impact on relative market prices by expanding pipeline capacity from GTN to PSE's service territory to access incremental Rockies or Alberta supplies. That study demonstrated that while such increased access to additional supplies would put downward pressure on gas prices at Sumas, the lower prices did not appear to be sufficient to offset the higher expansion pipeline costs. However, PSE continues to work with regional entities to evaluate infrastructure projects that will be required to meet long-term forecasted demand, including a cross-Cascades pipeline project.

2009 IRP Action Plan Item: 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.

Progress Made to Address Recommendations

- Discussion on Existing Resources: PSE has discussed potential expansion of the Mt. Hayes project in Terasen's service territory on Vancouver Island. This could be a viable peaking alternative, with gas supplies delivered to PSE's system via displacement or Northwest Pipeline.
- Initial Self Build Activity: Some alternative locations for LNG storage have been scoped. Since LNG storage is a resource further out into the planning horizon, additional commercial work was not necessary.

3. Other Reports

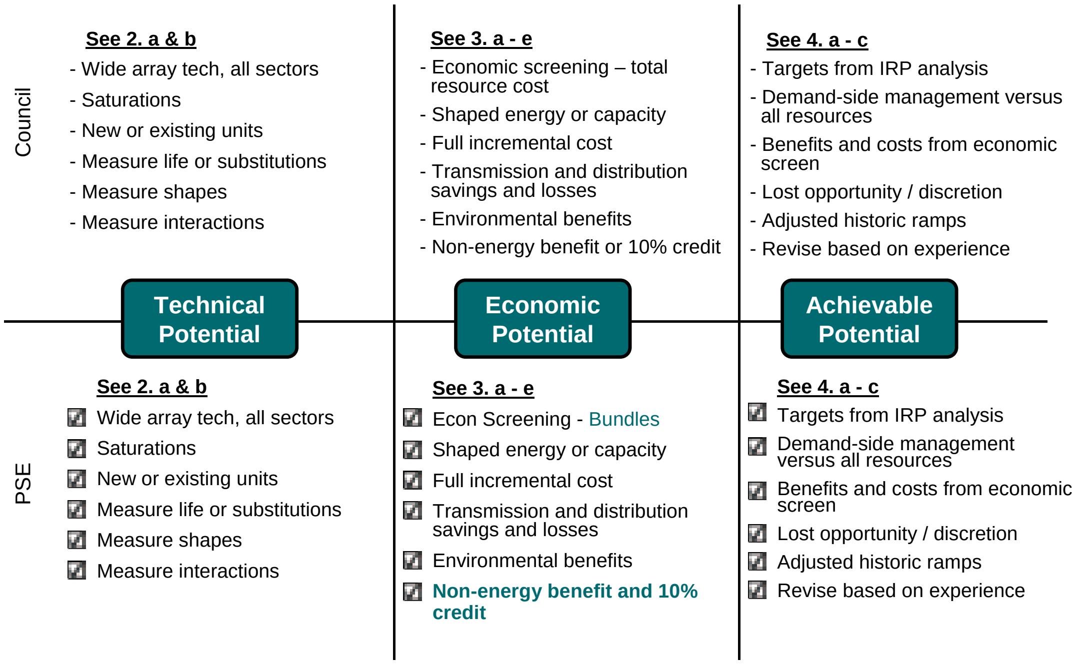
A. Electric Demand-side Resource Assessment: Consistency with Northwest Power Planning Council Methodology

There are no legal requirements for the IRP to address the Northwest Power Planning Council's (Council) methodology for assessing demand-side resources. Such comparison, however, may be useful for PSE and stakeholders in implementing sections of WAC 480-109. PSE has worked closely with Council staff on several aspects of our analytical process, including approaches to modeling demand-side resources. We're most grateful for the dialogue, and very much appreciate the opportunity to work with Council staff. WAC 480-109 does not define "methodology." PSE developed the detailed checklist that follows to demonstrate that our process in the IRP is consistent with the Council's methodology[2]. This checklist was used in IRP Advisory Group meetings. It was particularly useful in discussions as to whether it was appropriate for PSE to include non-energy benefits (NEB) and the 10 percent conservation credit, which, as the checklist illustrates, PSE did implement. Additional information on consistency with Council methodology can be found in Cadmus report, attached as Appendix K to the IRP.

[2] *References in Figure B-4 refer to the Council's assessment of its methodology, found at:* http://www.nwcouncil.org/energy/powerplan/6/supplycurves/I937/default.htm

Figure B-4

PSE is consistent with NW Power and Conservation Council's Conservation Assessment Methodology



B. Integrated Resource Plan Cover Sheet: Department of Commerce

The WUTC is required to provide summary information about IRPs of investor owned utilities to the Department of Commerce. Information for the cover sheet is included in Table B-5, below.

Figure B-5

Load-Resource Balance Summary

Resource Plan Year: 2012
Base Year Start: 1/1/2012
Base Year End: 12/31/2012
Five-year Report Year: 2017
Ten-year Report Year: 2022

Report Years	*Base Year*			*2017*			*2022*		
Period Units	*Winter (MW)*	*Summer (MW)*	*Annual (MWa)*	*Winter (MW)*	*Summer (MW)*	*Annual (MWa)*	*Winter (MW)*	*Summer (MW)*	*Annual (MWa)*
Loads	5,090	3,272	2,755	5,582	3,647	3,078	6,067	4,024	3,410
Exports		300	47		300	47		300	47
Resources									
Conservation/ Efficiency	68		44	447		296	749		554
Demand Response	10			52			144		
Cogeneration									
Hydro	924		542	958		544	901		527
Wind	101		222	101		254	106		344
Other Renewables							25		21
Thermal - Gas	1,717		905	2,466		905	2,462		905
Thermal - Coal	657		597	657		597	657		597
Long Term: BPA Base Year or Tier 1									
Net Long Term Contracts: Other	12		4	-16		-5	-5		-6
Net Short Term Contracts	1,287			1,907			1,942		
Other									
Imports	508		201	308		50	308		50
Total Resources	5,283	-300	2,469	6,880	-300	2,595	7,289	-300	2,946
Load Resource Balance	-193	3,572	286	-1,298	3,947	483	-1,222	4,324	464

Environmental Matters

Contents

This appendix contains a wide range of information that relates to the environmental concerns PSE faces and seeks to address.

1. Washington State Regulatory Consideration

Energy Independence Act. Washington is among 29 states with a renewable portfolio standard (RPS) mandate. Approved by voters in November 2006, Initiative 937 (I-937) requires utilities to acquire 15 percent of electricity from renewable resources by 2020, and undertake cost-effective energy conservation. In order to satisfy the annual RPS requirements, utilities can use eligible renewable resources, acquire renewable energy credits, or a combination of both.

In 2012, Washington state utilities will begin compliance with I-937, codified as the Energy Independence Act (Chapter 19.285 RCW). As mandated by the law, Washington's three investor-owned utilities will submit compliance reports to the Washington Utilities and Transportation Commission.

Measures to Limit and Reduce. Revised Code of Washington (RCW) 70.235 sets the timing and targets for reducing in-state greenhouse gas (GHG) emissions. It tasks the Washington state departments of Ecology and Commerce to benchmark certain emission sources, develop reduction strategies, track progress, and report results. Both agencies have provided the governor with recommendations, and some policies have already been implemented.

The strategies cataloged by the Washington state departments of Ecology and Commerce with direct impacts on energy supply and consumption include the following:

- The Electric Utility Energy Efficiency & the Renewable Portfolio Standard provisions of Initiative-937 (Effective 2006)
- The Washington State Building Code Council Revisions of 2009
- The School Energy Efficiency Grant of 2009/2010 ($117 MM)
- The Electric Utility Emissions Performance Standard (Effective 2008)
- The High-Performance Public Buildings Act of 2005

Most notably absent from this list of strategies is a GHG emissions cap-and-trade program. Washington is a member of the Western Climate Initiative (WCI), a regional effort between states to reduce GHG emissions through a number of policies including the establishment of a cap-and-trade market. However, the Washington legislature has not yet endorsed a bill that would commit our state to the WCI's cap-and-trade program. While the governor has intended for Washington to become party to the WCI cap-and-trade program, at this point, California is the only state on track to participate when the program begins in 2012 (although the four Canadian provinces are working steadily on their cap-and-trade plans).

Emission Performance Standard. Washington's Emissions Performance Standards (EPS) (WAC 173-407, effective June 19, 2008) requires new and modified baseload electric generation to meet a greenhouse gas limit of 1,100 pounds per megawatt hour (lbs/MWh). The EPS applies to all baseload electric generation for which electric utilities enter into long-term financial commitments on or after July 1, 2008. It restricts PSE's ability to enter into contracts of five or more years when the supply is from unspecified sources, coal generation or other resources that emit above the greenhouse gas limit. PSE's portfolio screening model incorporates these limitations by restricting new coal construction. Since PSE does not model long-term contracts in the IRP, the contract clause does not affect the IRP, although it does affect the contracts that the company could enter into.

2. Regional Regulatory and Policy Issues

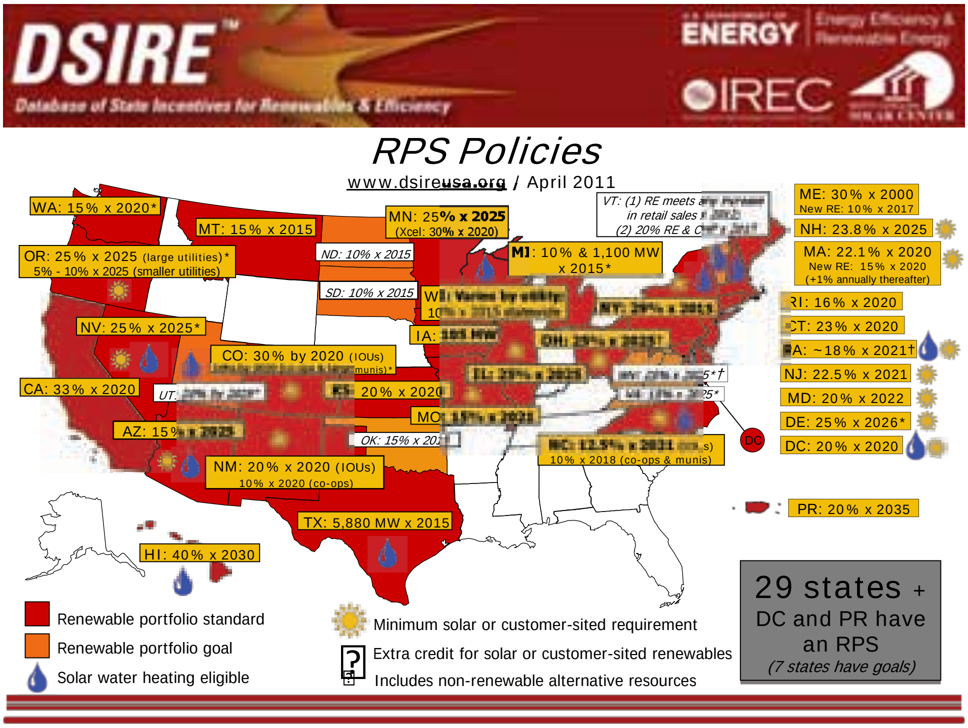
Washington is one of seven states and four Canadian provinces participating in the WCI. However, so far only California and New Mexico are legally committed to participate in the WCI cap-and-trade program, and New Mexico legislation is allowing a postponement of its trading commitments until more states join the partnership. Washington's involvement in the WCI was one way it planned to meet its own emissions reductions commitments set forth in Executive Order 09-05 and RCW 70.235. However, without legislative support to formally commit to the WCI cap-and-trade program, Washington's Governor, Christine Gregoire, has directed the Department of Ecology (DOE) to provide the Legislature by 2011 with recommendations for what a reductions program using statewide sector-by-sector caps would look like. Given the current budget shortfalls, it is uncertain if Washington will pursue the DOE's recommendations, or even if the legislature will ratify cap-and-trade in the WCI anytime soon.

Policy Requirements

Renewable Portfolio Standards. RPS requires utilities to obtain a specific portion of their electricity from renewable resources. Currently, 29 states, the District of Columbia and Puerto Rico have RPS mandates, and an additional seven states have renewable portfolio goals. Because there is currently no federal RPS mandate, each state RPS mandate can be unique in many ways, and variation with respect to the following is not uncommon: the specific portion of renewable resources required, a timeline to meet the requirements, the types of resources that qualify as "renewable," the geographic location renewable resources can be sourced from, eligible commercial on-line dates, and any applicable technology carve-outs (i.e. solar). The result: a patchwork of regulatory mandates, evolving regulations, and segregated environmental markets. Managing these moving parts is complex both from a resource acquisition perspective and an environmental markets perspective. Figure C-1 below illustrates the diversity of the RPS requirements in different jurisdictions.

Figure C-1

RPS Requirements by State



Pacific Northwest. In addition to the RPS mandate that PSE is subject to, we also actively monitor other RPS requirements throughout the West, as they are instrumental in shaping the market for renewable energy and Renewable Energy Credits. In particular, PSE pays close attention to the RPS requirements in Oregon and California, as well as Idaho, which currently does not have an RPS requirement. At first glance, one could observe that these state policies are distinct from one another in many ways; but as we have observed first hand, changes made to one can have a pronounced impact on the other. This can largely be attributable to the interconnected nature of the electric grid.

As an example, for nearly the past decade, the state of California has had an RPS mandate. Over the past several years, significant efforts have been made to consummate legislation requiring a 33 percent mandate by 2020. In 2011, those efforts were successful. I(In March 2011, the California House and Senate passed the 33 percent by 2020 RPS bill, and it was signed into law by Governor Jerry Brown in April 2011.)

Because of California's nearly decade long commitment to an RPS mandate and its relentless efforts to increase the state's renewable requirements, California utilities have been extremely active in acquiring renewable resources located both in and out-of-state, effectively increasing competition for renewable resources, Renewable Energy Credit products, and available transmission.

On the flip side, Idaho does not currently have an RPS mandate. Therefore, Idaho utilities are not required to purchase environmental attributes associated with the acquisition of the underlying energy, effectively bringing additional Renewable Energy Credits to the Pacific Northwest market. Should Idaho adopt an RPS mandate in the future, one would expect to see additional heightened competition for renewable resources (and thus their associated environmental attributes).

Given the market dynamics associated with an interconnected electric grid and intertwined regulatory policies, it is important to understand the policy requirements throughout the Pacific Northwest. In the current environment, however, California policy requirements are the primary driver with respect to renewable resource availability and cost, Renewable Energy Credit product availability and cost, transmission and integration.

California's Renewable Portfolio Standard. California has one of, if not *the* most aggressive RPS mandate in the nation. Senate Bill 1078 established the California RPS program in 2002. After Governor Schwarzenegger assumed office, he called for an acceleration of the RPS, asking for 20 percent by 2010. This later became law when he signed Senate Bill 107. In 2008, Governor Schwarzenegger signed Executive Order S-14-08 to increase the RPS requirement to 33 percent by 2020. Two RPS bills were passed at the end of the 2009 legislative session. However, the governor elected not to sign either. Instead, he signed Executive Order S-21-09, which would allow the California Air Resources Board (CARB), under its AB 32 authority, to adopt a regulation consistent with the 33 percent RPS target established in Executive Order S-14-08. In 2010, the CARB adopted its Renewable Electricity Standard (RES), requiring 33 percent by 2020.

Governor Schwarzenegger's term expired December 31, 2010, without the successful legislative passage of a 33 percent by 2020 RPS bill. Governor Jerry Brown was elected and sworn into office January 2011. In March 2011, the California House and Senate passed the 33 percent by 2020 RPS bill. It was signed into law by Governor Jerry Brown in April 2011. It is not clear yet how the new RPS mandate will impact renewable resource development and acquisition, and the tradable REC market.

The California Public Utilities Commission (CPUC) has been grappling with its own policies on tradable Renewable Energy Credits (RECs) for the past several years. The policies in question include what percentage of the annual procurement target could be sourced from tradable RECs, cost limitations, the definition of REC-only transactions, and grandfathering provisions. After numerous proposed decisions, the CPUC approved a new tradable REC decision in January 2011. It is not yet clear how this new policy will impact renewable resource development and acquisition, and the tradable REC market.

California – Assembly Bill 32

On December 16, 2010, the California Air Resources Board (CARB) adopted final rules to enact cap-and-trade provisions in accordance with California's Global Warming Solutions Act of 2006 (Assembly Bill 32). The final rule defines the ground rules for participating in the cap-and-trade program, including enforcement and linkage to outside programs like the WCI. California estimates that 85 percent of its total emissions will be covered under the cap-and-trade program. The program is scheduled to go into effect on January 1, 2012. The cap will be designed to reach 1990 levels by the year 2020 in two phases. Beginning in 2012, electricity generation, electricity imports and large industrial polluters must comply with the cap. Beginning in 2015, transportation fuels and all other fuel distributors will be brought into the program. The proposal includes a number of mechanisms designed to minimize the costs of reducing GHGs. Some of the mechanisms include three-year compliance periods, banking, offsets, an allowance price containment reserve, and linkage to other trading systems.

Earlier this year, lawsuits were filed against the CARB, alleging that the CARB did not adequately explore alternatives to a cap-and-trade market to regulate carbon emissions. In March 2011, the court ruled that the CARB had not sufficiently considered alternatives to the cap-and-trade initiative and that it must amend its documents to comply with the court's decision. It is not clear yet if the court's ruling will delay the implementation of the program.

3. Federal Intervention

The 111th Congress ended without enacting a major law to limit or reduce GHGs, compelling the Environmental Protection Agency (EPA) and many states to move towards utilizing existing regulatory authority under the Clean Air Act (CAA) and other laws to reduce GHG emissions. Some in Congress have been working to suspend or expel EPA’s authority to proceed in this direction, but at this time those efforts have failed.

At present, EPA is issuing several new standards directed at electric generation. They include new permitting requirements for GHG emissions (Tailoring Rule), standards to improve the National Air Ambient Quality Standards (NAAQS) for smog, reductions in toxic air emissions (mercury), water discharge restrictions, and new standards for solid waste disposal (coal ash). Because many of these rules are still in development, it is difficult to assess their expected outcomes, particularly with respect to resource cost and potential retirements. Many of the rules will require retrofits at existing facilities and more stringent pollution controls for new facilities, and collectively could impact resource decision making.

With a Republican majority in the House of Representatives, it appears any attempt to move new climate change legislation in the 112th will be blocked. Hearings held in the first half of 2011 by the House Energy and Commerce Subcommittee on Energy and Power only reinforced the Republican sentiment on the issue. Likewise, many in Congress are working to prevent EPA from implementing GHG regulation (Tailoring Rule) and other regulations (described above) that would impact the utility sector. The Energy Tax Prevention Act introduced in the House and backed by Republican senators would block EPA's regulation of GHG emissions from coal plants, manufacturing facilities and other stationary sources.

Congressional resistance is leading some legislators towards clean energy legislation as a way of reducing GHG emissions indirectly. The Senate Energy and Natural Resources Committee is likely to resume work on a national renewable energy standard that passed out of the Committee in June 2009 as part of the American Clean Energy Leadership Act. That renewable energy standard would have required utilities to generate 15 percent of their total electricity from either renewable energy or energy efficiency.

Greenhouse Gas Regulation

In the absence of congressional action, EPA is addressing GHG emissions from large sources through its Tailoring Rule and through the development of New Source Performance Standards (NSPS).

The Tailoring Rule took effect on January 2, 2011 and sets permit levels for GHG emissions in two phases for power plants and other large stationary sources. The ruling intends to limit the amount of GHG emissions a facility can emit by requiring installment of best available control technology (BACT). The ruling goes into effect in phases. In Phase I, existing facilities that emit more than 100,000 tons of emissions per year are required to comply with the new BACT rules when they renew their air permits or make any major changes after January 2011. After July 2011, the second phase of the rule kicks in, requiring preconstruction permits using BACT for new projects that emit 100,000 tons of emissions per year or existing projects that make major modifications and that emit more than 75,000 tons per year. At this time, EPA has only released BACT guidance for coal technology. The agency's work to determine gas turbine BACT guidance is ongoing. Many in the industry believe BACT for natural gas technologies will focus primarily on efficiency improvements to turbine plant design and operating techniques.

On December 23, 2010, EPA entered into a settlement agreement requiring the agency to incorporate GHG emissions into the NSPS for natural gas, oil, and coal-fired electricity-generating units and petroleum refineries. The agreement requires EPA to set new emission limitation standards of performance for new and modified sources. Performance standards set by EPA will require emissions-generating units to meet a specific performance level, but do not impose a specific method by which this level must be achieved. In crafting the performance standards and emissions guidelines, EPA will take the cost and availability of control options into account. EPA is required to set performance standards at a level that has been “adequately demonstrated” by an existing technology. EPA is required to propose new power plant standards by July 26, 2011.

NAAQS for Ozone Smog and Fine Particulates

EPA is reconsidering the National Ambient Air Quality Standards (NAAQS) for ozone smog and fine particulates, although at this point that effort has been delayed another six months. In the meantime, EPA is working towards final issuance of its Clean Air

Transport Rule (CATR) to address ozone and fine particulate releases in the eastern states, where ambient standards are at risk. EPA issued a notice of data availability (NODA) on January 11, 2011 to provide information and an opportunity to comment on alternative allowance allocation approaches for potential use in the CATR. EPA is expected to propose a rule that will apply to fossil-fired electric generating units (EGUs) in 31 eastern states. Three new cap-and-trade programs – SO_2, Annual NOx, and Seasonal NOx - would be integrated into the current trading system administered by the EPA. This rule will not have direct impacts to EGUs located in the western power market.

Mercury

Under current court proceedings, the EPA is required to propose a standard that will limit the amount of toxic mercury a coal- and oil-fired power plant can emit. The proposal deadline is March 16, 2011. The standard must be finalized in rule by November 16, 2011. EPA will determine the maximum achievable control technology (MACT) emission rate limitations for coal-fired units based on coal type. EPA estimates the standards will apply to about 1,200 existing coal-fired electric generating units and will cost the electric sector $10.9 billion annually beginning in 2015.

Cooling Water Intake and Discharge

On March 28, 2011, EPA proposed a new standard under Section 316(b) of the Clean Water Act affecting the intake and discharge of cooling water at steam electric generating units that withdraw water from a body of water through cooling water intake structures. These standards will reflect the best technology available (BTA) to protect water quality from cooling water intake and discharges. This standard, known as Section 316(b), will affect all existing and new fossil steam and nuclear steam electric generating units. EPA estimates BTA will apply to 444 power plants (327 GW) at a cost of $65 billion, but because 316(b) permits are written on a case-by-case basis, the actual number of retrofits to meet compliance is difficult to estimate. Forced retrofits are expected between 2015 and 2018.

Solid Waste Disposal – Coal Ash

On October 21, 2010, EPA formally called for comment on how best to regulate coal ash residuals from electric generation units. Early in 2010, EPA proposed two regulatory options: one where coal ash is regulated as a solid waste under the Subtitle D provisions of the Resource Conservation and Recovery Act (RCRA), and one where coal ash is regulated as a hazardous waste under the Subtitle C provisions of RCRA. Subtitle C would create a comprehensive program of federally enforceable requirements for waste management and disposal. Subtitle D would give authority to the states to oversee a less stringent set of performance standards for handling and disposal. Subtitle C is the stricter of the two, as coal ash would be listed hazardous and as such would require the phase-out of wet handling and surface impoundments. Subtitle D would be less onerous, as it would allow wet handling to continue, and it would allow continued use of surface impoundments provided they are equipped with protective liners. EPA estimates over 500 surface impoundments would be affected by this ruling. The agency expects a final ruling in 2011.

Electric Resources

Contents

Section one of this appendix is designed to provide additional information about PSE's existing fleet of electric resources. Section two offers context related to a variety of electric resource alternatives, including a brief technology summary, information about the viability and availability of each resource for PSE, and estimated ranges for anticipated capital and operating costs.

1. Existing Resources

- **Supply-side resources.** These include power generated by PSE-owned and contracted facilities, primarily hydroelectric power and power from coal-fired plants, natural gas-fueled turbines, and wind-powered 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 to support additional development of renewable energy through voluntary bill payments, and one for customers who produce their own power from small-scale renewables.

A. Supply-side Resources

Hydroelectricity

While operating restrictions to protect endangered species limit the operational flexibility of hydroelectric resources, these generating assets remain valuable because of their ability to track customer load, and because of their lower cost relative to other power resources. High precipitation levels generally allow more power to be generated, while low-water years produce less power. During low-water years, the utility must rely on other, more expensive self-generated power or market sources to meet 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 purchased-power 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 D-1

Hydroelectric Resources

PLANT	OWNER	PSE SHARE %	NAMEPLATE CAPACITY (MW)[1]	EXPIRATION DATE
Upper Baker River	PSE	100	105	Not within study period
Lower Baker River[2]	PSE	100	85	Not within study period
Snoqualmie Falls[3]	PSE	100	49	Not within study period
Electron	PSE	100	16	12/31/26
Total PSE-Owned			**255**	
Wells	Douglas Co. PUD	29.89	231	3/31/18
Rocky Reach	Chelan Co. PUD	25.0[4]	320	10/31/31
Rock Island I & II	Chelan Co. PUD	25.0[5]	156	10/31/31
Wanapum	Grant Co. PUD	.64[6]	6	04/04/52
Priest Rapids	Grant Co. PUD	.64[6]	6	04/04/52
Mid-Columbia Total			**720**[7]	
Total Hydro			**975**	

NOTES
1 Nameplate capacity reflects PSE share only.
2 Lower Baker Unit 4 will be completed in March 2013, adding 30 MW of nameplate capacity to this project.
3 Snoqualmie Falls is offline until March 2013 for repairs. The new capacity will be 49 MW.
4 Rocky Reach share is 38.9% through October 2011 and 25% thereafter.
5 Rock Island I & II share is 50% through June 7, 2012, and then 25% beginning July 1, 2012.
6 Based on Grant Co. PUD current load forecast for 2010; our share will be reduced to this level in 2012.
7 As indicated in the above notes, several of the expiring Mid-C contracts have been renegotiated. Figure D-1 reflects PSE's share, capacity and the expiration dates that will take effect between publication of this IRP and mid-2012 as a result of the new contracts. Individual resource and Mid-Columbia totals are rounded to the nearest megawatt.

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 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-’99, 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.

Electron Hydroelectric Project. Located about 25 miles southeast of Tacoma in the western foothills of Mount Rainier, this facility has a 16 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 29.89 percent 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 percent 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 at Wanapum in November 2009. PSE receives a combined share of power from both projects; this share declines over time as the PUDs’ loads increase. The new agreements with Grant County PUD will continue through the term of any new FERC license, which is through April 4, 2052.

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 subsequently sold the Lake Tapps reservoir to the Cascade Water Alliance. The lake will be used to support a new regional source of drinking water.

Coal

The coal-fueled generating plants located in Colstrip, Mont., provide low-cost, baseload energy to PSE. PSE owns a 50 percent share in Colstrip 1 & 2, and a 25 percent share in Colstrip 3 & 4.

Gas-fired Combined-cycle Combustion Turbines (CCCTs)

PSE has five CCCT resources with a combined nameplate capacity of 975 MW. 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.

PSE's CCCT fleet includes **Mint Farm** in Cowlitz County, **Frederickson 1** in Pierce County, **Goldendale** in Klickitat County, and **Encogen** and **Sumas** in Whatcom County. We also own 49.85 percent 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. **Hopkins Ridge**, located in Columbia County, Wash., 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 273 MW and came online in December 2006 (The facility originally had a 229 MW capacity, but was expanded by 44 MW in 2010.) 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).

PSE's wind portfolio includes a power-purchase agreement with Iberdrola Renewables for a 50 MW share of electricity generated at the **Klondike III** wind farm in Sherman County, Ore. The wind farm has 125 turbines with a project capacity of 224 MW total. This agreement remains in effect until November 2026.

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[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).*

PSE also began construction of **Lower Snake River Phase I** in spring 2010, a 343 MW wind farm located in Garfield County, Wash. The project is scheduled to be completed by mid 2012.

Figure D-2 presents details about the company's coal, CCCT, and wind resources.

Figure D-2
Coal, CCCT and Wind Resources

POWER TYPE	UNITS	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)[1]	ASSUMED RETIREMENT DATE
Coal	Colstrip 1 & 2	50%	330	Not within study period
Coal	Colstrip 3 & 4	25%	386	Not within study period
Total Coal			**716**	
CCCT	Encogen	100%	159	Dec 2028
CCCT	Frederickson 1[2]	49.85%	129	Not within study period
CCCT	Goldendale	100%	261	Not within study period
CCCT	Mint Farm	100%	305	Not within study period
CCCT	Sumas	100%	121	Jul 2023
Total CCCT			**975**	
Wind	Hopkins Ridge	100%	157	Not within study period
Wind	Lower Snake River, Phase 1[3]	100%	343	Not within study period
Wind	Wild Horse[4]	100%	273	Not within study period
Wind	Klondike 3	n/a	50	Nov 2026
Total Wind			**823**	

NOTES
1 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).
2 Frederickson 1 CCCT unit is co-owned with Capital Power Corporation - USA.
3 PSE began construction of Lower Snake River Phase I in spring 2010. Located in Garfield County, Wash., the 343 MW wind project is scheduled to be completed in the first or second quarter of 2012.
4 Wild Horse includes the original 229 MW wind project and a 44 MW expansion.

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 east Pierce County, is comprised of two combustion turbine units with a combined nameplate capacity of 149 MW. Details are shown in Figure D-3 below.

Figure D-3
Simple-cycle Combustion Turbines

NAME	PSE OWNERSHIP	NAMEPLATE CAPACITY (MW)[1]	ASSUMED RETIREMENT DATE
Fredonia 1 & 2	100%	208	Dec 2019
Fredonia 3 & 4	100%	108	Not within study period
Whitehorn 2 & 3	100%	149	Dec 2016
Frederickson 1 & 2	100%	149	Dec 2016
Total		**614**	

[1] 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).

Other Long-term Contracts

Long-term contracts consist of agreements with independent producers and other utilities to supply electricity to PSE. Fuel sources include hydropower, gas, waste products, and system deliveries without a designated supply resource. These contracts are summarized in Figure D-4. Short-term contracts negotiated by PSE's energy trading group are not included in this listing.

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 percent 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.

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.

BPA Baker Replacement. Under a 20-year agreement signed with the U.S. Army Corps of Engineers (COE) 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 provides rather than receives, so it is a negative number (-56 MW for 2010).

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 D-4

Long-term Contracts for Electric Power Generation

TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)[1]
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	BPA- WNP-3 Exchange	System	6/30/2017	82
Other Contracts	Powerex/Pt.Roberts	System	9/30/2014	8
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	09/15/2024	-58
Other Contracts	Powerex	System	02/29/2012	150
Other Contracts	Shell Energy	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				**689**
Independent Producers	Twin Falls	Hydro	3/8/2025	20
Independent Producers	Koma Kulshan	Hydro	3/31/2037	14
Independent Producers	North Wasco	Hydro	12/31/2012	5
Independent Producers	Nooksack Hydro	Hydro-QF	01/01/2014	2.5
Independent Producers	Weeks Falls	Hydro	12/1/2022	4.6

TYPE	NAME	POWER TYPE	CONTRACT EXPIRATION	NAMEPLATE CAPACITY (MW)[1]
Independent Producers	Hutchison Creek	Hydro-QF	9/30/2016	1
Independent Producers	Cascade Clean Energy- Sygitowicz	Hydro-QF	2/22/2014	<1
Independent Producers	Port Townsend Paper	Hydro-QF	06/30/09	<1
Independent Producers	VanderHaak Dairy	Biomass	12/31/2019	<1
Independent Producers	Qualco Dairy	Biomass	12/11/2013	<1
Independent Producers	Farm Power Lynden	Biomass	1/31/2019	<1
Independent Producers	Farm Power Rexville	Biomass	1/31/2019	<1
Total Independent				**49**

1 Nameplate capacity reflects PSE share only.

B. 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 2008 and 2010, the number of subscribers increased from 21,509 to 29,398, and the number of megawatt-hours purchased increased from 291,167 to 314,893.

To supply green power, the program purchases renewable energy credits (RECs) from a variety of sources. The primary supplies are the Bonneville Environmental Foundation (BEF), a nonprofit environmental organization in Portland, Ore.; Acciona Energy, a broker of national wind RECs; and 3Degrees, a REC broker based out of San Francisco. These suppliers provide PSE's Green Power Program with a portfolio of resources including wind, biomass, low-impact hydropower, biogas and biomass. In addition, the Green Power Program purchases RECs directly from small, local producers in order to support the development of new small renewable resources. Examples include the Vander Haak Dairy (now FPE Renewables), Farm Power Rexville, Farm Power Lynden, Qualco Energy, and the Nooksack Hydro Facility.

The Green Power Program has also provided grant funding for several solar demonstration projects. For example, in 2009, the Green Power Program provided a $20,000 grant to the Vashon Island Community, which has the highest rate of participation of any community in our service territory. The grant was leveraged by additional community funds and in-kind support for the installation of two separate solar PV projects, each approximately two kW in size, and located on non-profit facilities. In addition, the Green Power Program awarded a $25,000 grant to the Council of Governments on Whidbey Island after a successful Green Power Challenge, where the

Island residents increased participation in the program by 50 percent during 2009. The funds will be used toward a community solar project at Greenbank Farm. Finally, the program provided a $20,000 grant to Phase IV of the Ellensburg Community Solar Project, which is looking at the difference in output from thin-film vs. crystalline silicon PV modules. The Green Power Program is receiving the RECs generated from PSE's share of that project.

Increased pressure on west coast REC pricing, due to expanding compliance requirements, means the Green Power Program is now purchasing the majority of RECs for our large volume customers (those purchasing a minimum of 1,000,000 kWh a year under our large volume tariff) from outside the WECC region. Over 90 percent of the large volume portfolio will come from wind RECs generated in the mid-west. If prices continue to rise, PSE may also consider purchasing a small percentage of our standard portfolio wind RECs from outside of the WECC region.

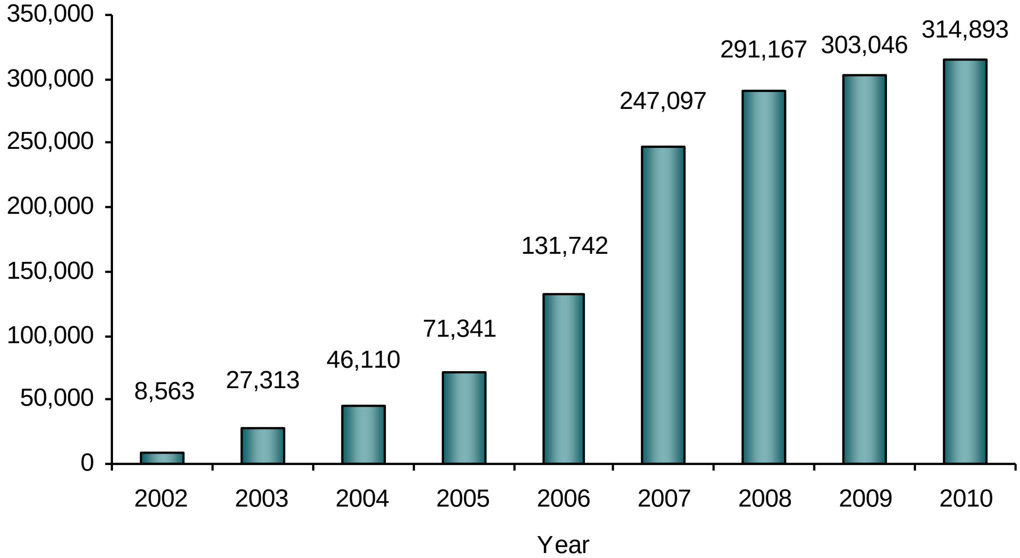
Rates. The standard rate for green power is $0.0125 per kWh. Customers can purchase 160 kWh blocks for $2 per block with a two-block minimum, or they can choose to participate in the "100% Green Power Option." Introduced in 2007, this option adjusts the amount of the customer's monthly green power purchase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

The large-volume green power rate—0.6 cent per kWh for customers who purchase more than 1,000,000 kWh annually—has attracted 25 customers since it was introduced in 2005.

In 2008, PSE agreed to increase participation in the Green Power Program to 5 percent of all electric customers by the end of 2013. To help achieve that goal, PSE contracted with 3Degrees, a third party REC marketer. 3Degrees has developed and refined education and outreach techniques while working with other utility partners across the country. Since their contract was initiated with PSE in January 2009, customer growth has increased by 20 percent and 14 percent in 2009 and 2010, respectively. As of December 31, 2010, nearly 3 percent of electric customers are participating in the program.

Figure D-5

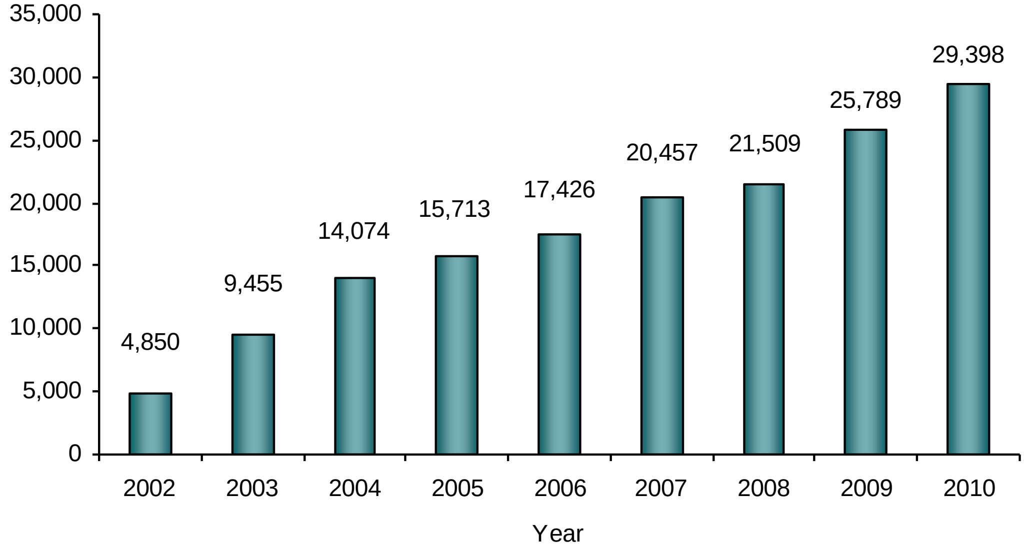
Green Power Kilowatt-Hours Sold, 2002-2010



In 2010, the average residential customer purchase was 704 kWh per month, and the average commercial customer purchase was 2,305 kWh. The average 2010 large-volume purchase, by account, under Schedule 136 was 29,480 kWh per month.

Figure D-6 illustrates the number of subscribers by year. Of our 29,398 Green Power subscribers at the end of 2010, 28,524 were residential customers, 541 accounts were commercial accounts, and 333 accounts were assigned under the large volume commercial agreement. Cities with the most residential and commercial participants include Olympia with 3,633, Bellingham with 3,563, Bellevue with 1,869, Kirkland with 1,266, and Bainbridge Island with 1,073. Vashon Island has the highest percentage of participants, with over 12 percent of customers enrolled.

Figure D-6
Green Power Subscribers, 2002-2010

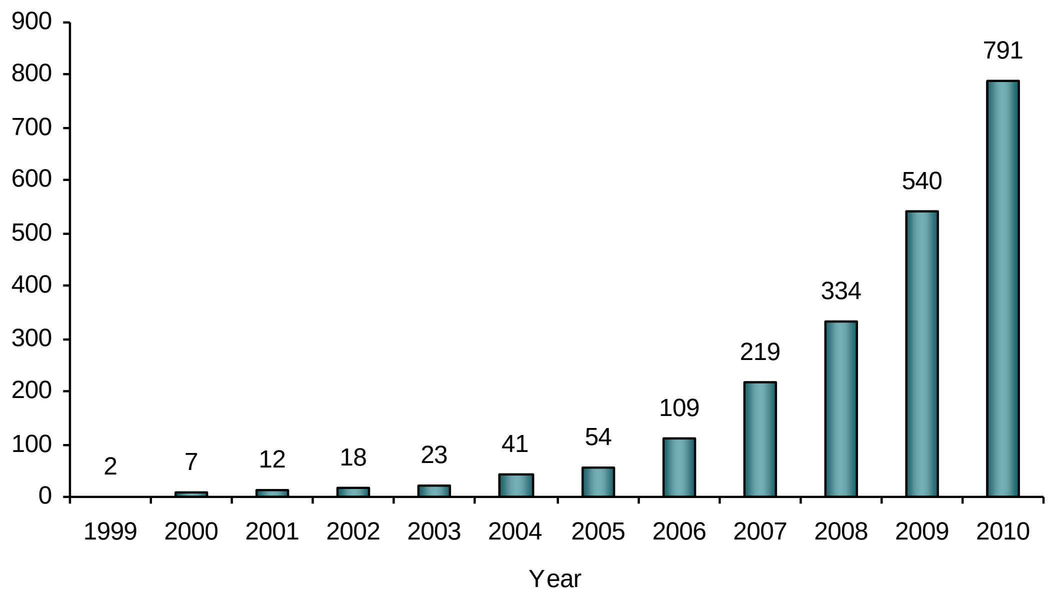


Customer Renewables Programs

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 is 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 ten years, as Figure D-7 shows. For 2010, PSE added 251 new net metered customers for a total of 791.

Figure D-7
Net Metered Customers Total Per Year, 1999-2010



The vast majority of customer systems (95 percent) are solar photovoltaic (PV) installations with an average generating capacity of 4.3 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 4.2 kW. Overall, the program was capable of producing more than 3.3 MW of nameplate capacity at the end of 2010.

Figure D-8
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/hydro	1	1.02	1.02
Hybrid: solar/wind	4	3.76	15.06
Micro hydro	4	4.63	18.50
Solar array	747	4.30	3215.22
Wind turbine	35	2.72	95.10
Total Number of Systems	**791**	**Total Capacity of All Systems**	**3344.90**

Figure D-9
Net Metered Systems by County

County	Number of Net Meters
Whatcom	98
King	221
Jefferson	91
Skagit	85
Island	75
Kitsap	90
Thurston	78
Kittitas	26
Pierce	27

Renewable Energy Cost Recovery. In 2005, PSE launched Production Metering 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 hydroelectric customers are not eligible under the current law). Annual amounts range from 12 cents to $1.08 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 2010, PSE had paid $283,000 to 641 customers eligible for production payments. The PSE tariff governing Production Metering is Schedule 151.

2. 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.

A. Biomass

Technology Summary

Biomass in this context refers to the burning of woody biomass in boilers. Most existing biomass in the Northwest is tied to steam hosts (aka 'cogeneration' or 'combined heat and power'), most typically in the timber, pulp, and paper industries. This dynamic has limited the size of power available for export to date. With the extension of the ITC and Treasury Cash Grant to biomass projects of various types, PSE has observed a bout of activity in biomass generation development plans, both for cogeneration and standalone facilities. The typical plant size we have observed is 25 MW, but plants up to 50 MW are being proposed. One major advantage to biomass plants is that they provide firm capacity and can operate as a base load resource and do not impose generation variability on the grid, unlike wind and solar.

Commercial Availability

This technology is commercially available. Greenfield development of a new biomass facility would require approximately five years and consist of the following activities: two and a half years for development and permitting; one year for major equipment lead-time; and one year for construction.

Cost and Performance Assumptions

Cost and performance assumptions derive mainly from PSE's experience in reviewing recent biomass proposals and input from The Shaw Group (engineering, construction, and technology consultants). Plant output is not significantly affected by temperature and is assumed to be the same in winter as throughout the year, and the typical size was chosen to be 25 MW. The plant heat rates are approximately 13,420 but can vary depending on fuel moisture content. The typical expected capacity factor for a biomass plant is approximately 90 percent. Assuming two weeks pear year of routine maintenance, the implied forced outage rate is approximately 6.3 percent. It would be typical for a biomass plant to operate at base load to cover fixed costs under a PPA, but it should be noted that biomass plants are technically capable of being turned down during off-peak hours, or turned off entirely during periods of low market demand and pricing. Emissions assumptions are based on a mix of proposals and from estimates by The Shaw Group. The greatest source of uncertainty is whether CO_2 emissions will be considered fully or even partially carbon-neutral by the EPA.

All development and capital costs, and fixed and variable O&M are based on preliminary estimates provided by The Shaw Group, and assumed to be for a plant that would be constructed in Washington with estimated accuracy of +/- 20 percent. Fixed O&M is substantially higher than wind facilities or combustion turbines due to the high number of staff required to operate the plant and a large amount of maintenance that needs to be performed to keep the various systems (fuel storage, handling, combustion, ash removal, etc.) operating. Fuel cost estimates are the most difficult to forecast given that centralized markets do not exist. Pricing is primarily dependent on bilateral agreements, and can be both highly regionally specific and highly volatile. The expected fuel price is based on historical pricing at the Pt. Townsend mill from 2000 to 2009.

The majority of the plants that have been proposed in this region would interconnect with BPA. As such, the generic biomass plant is assumed to interconnect with BPA and incur the typical thermal wheeling rate.

B. Coal

Technology Summary

Coal is the fuel used to produce a significant portion of the electricity generated in the United States. Most coal-fired electric generating plants combust the coal in a boiler to produce steam which drives a turbine-generator. There are a small number of U.S. coal-fueled power plants which gasify coal to produce a synthetic gas that is used to fuel a combustion turbine. Coal gasification is still in a state of development and all currently operating plants are demonstration projects built with federal grants or other government subsidies.

Of the fuels commonly used to produce electricity, coal produces the most greenhouse gases (GHGs) per MWh of electricity. Technologies for reducing or capturing some of the GHGs produced are currently in the research and development phase. A report recently released by the National Energy Technology Laboratory of the U.S. Department of Energy indicates it may take 20 years for carbon capture and storage (CCS) technology for power generating plants to become commercially available.

Commercial Availability

RCW 80.80 sets a generation performance standard for electric generating plants and prohibits Washington utilities from building plants or entering into long-term electricity purchase contracts from units that emit more that 1100 pounds of GHGs per MWh. With currently available technology, coal-fired generating plants produce GHGs, primarily carbon dioxide, at a level two or more times greater than the performance standard. This regulation makes it unlawful for PSE to build a new coal-fired power plant or enter a long-term purchase agreement to buy electricity produced by coal unless the plant includes CCS technology to reduce GHG emissions to a level below the RCW 80.80 standard. The status of CCS development makes it impossible to accurately estimate the cost of electricity from a coal-fired generating plant that meets these requirements.

There are no new coal-fired power plants under construction or development in the Pacific Northwest, and the owner of one of the three existing coal-fired plants in the region has announced plans to shut down the plant in 2020.

Cost and Performance Assumptions

No technologies are currently commercially available to allow a coal-fired generating plant to meet the requirements of RCW 80.80. Likewise, there are no accurate estimates of either the cost or performance for a coal-fired generating unit that would meet those requirements.

C. Fuel Cells

Technology Summary

Fuel cells combine fuel, typically carbon based, and oxygen to create electricity, water, and potentially other byproducts through a chemical process. The benefit of fuel cells over traditional combustion technologies is that they have high conversion efficiencies from fuel to electricity, on the order of 25 percent to 60 percent, which can be boosted higher using heat recovery and reuse. Fuel cells operate or are being developed at scales from several hundred watts, such as those to power portable electric equipment, up through several MW to power equipment, buildings, or provide backup power. Some of the largest differentiators amongst the types of fuel cells are the materials used as a membrane to separate fuels, the electrode and electrolyte materials, the operating temperature, and the scale of the fuel cells. There are five major types of fuel cells (Department of Energy, Fuel Cell Technologies Program).

Figure D-10

Comparison of Fuel Cell Technologies

Fuel Cell Type	Common Electrolyte	Operating Temp	Typical Stack Size	Efficiency	Applications	Advantages	Disadvantages
Polymer Electrolyte Membrane (PEM)	*Perfluoro sulfonic acid*	*50-100° C 122-212° F*	*<1 kW - 100 kW*	*60% transport-tation* *35% stationary*	• Backup power • Portable power • Distributed generation • Transportation • Specialty vehicles	• Solid electrolyte reduces corrosion & electrolyte management problems • Low temperature • Quick start-up	• Expensive catalysts • Sensitive to fuel impurities
Alkaline (AFC)	*Aqueous solution of potassium hydroxide soaked in a matrix*	*90-100° C 194-212°F*	*10-100 kW*	*60%*	• Military • Space	• Cathode reaction faster in alkaline electrolyte leads to high performance • Low cost components	• Sensitive to CO_2 in fuel and air • Electrolyte management
Phosphoric Acid (PAFC)	*Phosphoric acid soaked in a matrix*	*150-200°C 302-392° F*	*400 kW 100 kW Module*	*40%*	• Distributed generation	• Higher temperature enables CHP • Increased tolerance to fuel impurities	• Pt catalyst • Long start up time • S sensitivity
Molten Carbonate (MCFC)	*Solution of lithium, sodium, and/or potassium carbonates, soaked in a matrix*	*600-700° C 1112-1292° F*	*300 kW - 3 MW* *300 kW module*	*60%*	• Electric utility • Distributed generation	• High efficiency • Fuel flexibility • Can use for a variety of catalysts • Suitable for CHP	• High temperature corrosion and breakdown of cell components • Long start up time • Low power density
Solid Oxide (SOFC)	*Yttria stabilized zirconia*	*700-1000° C 1202-1832° F*	*1 kW-2 MW*	*60%*	• Auxiliary power • Electric utility • Distributed generation	• High efficiency • Fuel flexibility • Can use a variety of catalysts • Solid electrolyte • Suitable for CHP & CHHP • Hybrid/GT cycle	• High temperature corrosion and breakdown of cell components • HT operation requires long start up time and limits shutdowns

Commercial Availability

Fuel cells have been growing in both number and scale, but are not yet operating at a gross generation scale. The largest fuel cell project underway in the United States is a 4.5 MW project being built in Connecticut, at a cost of over $5,000/kW. In some states, incentives are serving to drive fuel cell pricing to be competitive with retail electric prices, especially where additional value can be captured from waste heat. Washington does not currently have any incentives specific to fuel cells.

Cost and Performance Assumptions

Fuel cell costs are estimated to be at least $5,000/kW, and some projects appear to be as high as $10,000/ kW before subsidies.

Fuel cell performance is very reliable, provided that feedstocks are kept clean of impurities. Fuel cells are in relatively common use as a backup power source in many telecommunications and data center applications, which require very high reliability. In addition, fuel cells are starting to be used for commercial combined heat and power applications, though most are in states with significant programs or subsidies for fuel cell deployment.

D. Geothermal

Technology Summary

Geothermal generation technologies use steam trapped in the earth, or generate steam using heat from the earth and a circulating fluid system. Geothermal energy production falls into four major types.

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 degrees Celsius) hydrothermal fluids that are predominantly steam.[2]

[2] *Renewable Energy Policy Project,*
http://repp.org/geothermal/geothermal_brief_power_technologyandgeneration.html

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 degrees Celsius).[3]

Binary Cycle Power Plants can use lower temperature (107 degrees Celsius to 182 degrees Celsius) 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.[4]

The United States, Japan, England, France, Germany and Belgium are testing Enhanced Geothermal or "hot dry rock" technologies.[5] 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, and several commercial facilities are under development in Australia. The U.S. Department of Energy has funded a test project in the United States.

Commercial Availability

Currently, approximately 3,086 MW of geothermal generating capacity is online in the United States, with 97 percent of that capacity in California or Nevada[6]. The only operating geothermal plants in the Northwest are the 0.28 MW plant in Klamath Falls, Ore., and the 15.8 MW Raft River plant in Idaho.

The Northwest has been subject to considerable exploration activity over the past several years, with at least 700 MW in some stage of development[7]. Most of this is very early development, and may or may not have obtained site access and drilled exploratory wells. Most projects have not yet proven their output, though several are in testing at this time. Currently, three projects in the Northwest, a total of approximately 70 MW in capacity, are reported to be under construction, Neal Hot Springs and Crump Geyser in Oregon, and an expansion of the Raft River project in Idaho.

[3] *EERE,* http://www1.eere.energy.gov/geothermal/gerthermal_basics.html
[4] *Ibid*
[5] *Geothermal Education Office, 2000,* http://geothermal.marin.org/pwrheat.html
[6] *Geothermal Energy Association*
[7] *U.S. Geothermal Power and Production Update, April 2010.*

Other Northwest projects are planned in Oregon and Idaho, but are further behind in development and would take at least four years before commercial operation, if the resources prove viable.

Cost and Performance Assumptions

Geothermal plants typically run with high uptime, often exceeding 85 percent. However, plants sometimes do not reach their full output capacity due to lower than anticipated production from the geothermal resource. This issue affected the largest geothermal complex in the United States, the Geysers projects in California, due to resource depletion, but has been improved in recent years because of additional water recycling.

Geothermal energy plants are capital intensive, with estimated capital costs of approximately $3,650/kW (U.S. Department of Energy, 2008) for traditional geothermal steam plants. Other large scale technologies, including binary plants, are similar in cost. Overall, site specific factors including resource size, depth, and temperature can significantly affect costs. Generally, operating costs are relatively low due to a zero fuel cost, but this can vary due to site conditions as well.

E. Natural Gas – Combined Cycle Combustion Turbine (CCCT)

Technology Summary

Combined-cycle combustion turbine power plants consist of one or more combustion turbine generators equipped with heat recovery steam generators that capture heat from the CT exhaust. This otherwise wasted heat is then used to produce additional electricity via a steam turbine generator. Many plants also feature 'duct firing' which can produce additional capacity from the steam turbine generator, although at less efficiency than the primary unit. CCCT plants currently entering service can convert about 50 percent (HHV) 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 a popular power generation resource for well over a decade.

Commercial Availability

This technology is commercially available. Greenfield development of this type of plant would require approximately five years and consist of the following activities: two years for development and permitting; two years for major equipment lead-time; and one year for construction. PSE does not take the risk of contracting for major equipment before permits are in hand. Private developers, on the other hand, are often willing to take that risk and can accelerate the development timeframe by about one year.

Cost and Performance Assumptions

Cost and performance assumptions were provided to PSE by the engineering consulting firm (EC) as described above. Winter capacity (MW) is based on the average January temperature at Sea-Tac Airport and the heat rate is based on ISO conditions, which are similar to typical annual average temperatures for this region. The heat rate (both primary and duct firing) is degraded by 2 percent to simulate degradation typically experienced between major maintenance events.

The capital cost estimate is provided by the EC as previously described. The EPC cost is supported by a preliminary cost estimate provided June 30, 2010. EPC costs are developed to approximately +/- 20 percent. Owner's Costs were estimated using the EC's recommended 40 percent of EPC adder.

Non-fuel O&M costs were also estimated by the EC as previously described. PSE provided projected operating characteristics of 55 percent primary unit and 10 percent duct fire capacity factor and 100 primary unit starts per year. The EC assumed 21.25 FTE's would be needed, and PSE increased the estimated overhead to reflect PSE's standard overhead adder. To be consistent with trade floor dispatch and with AURORA modeling practices at PSE, the team allocated major maintenance as a fixed expense instead of a variable cost as provided by EC.

Natural gas supply is assumed to be firm year round and based on projected Northwest Pipeline firm rates. The unit is assumed to be connected to the PSE transmission system and as such does not incur any direct transmission cost, but the capacity contribution to peak load should be reduced by 7 percent to account for reserves.

F. Natural Gas – Simple Cycle Resources

The principal simple-cycle technologies for 'peaking' applications consist of 'frame' CTs, aeroderivative (aero) CTs, and reciprocating (recip) engines. Frame CTs are also known as 'industrial' or 'heavy-duty' CTs, and are generally larger in capacity and feature frames, bearings, and blading of heavier construction. In 2010, PSE performed a review of typical cost and performance characteristics across these technology categories and determined that frame and aero CTs are the best fit economically for the Pacific Northwest market and PSE's needs.

1 - Frame Combustion Turbine

Technology Summary

Conventional frame CTs are a mature technology. Our generic frame CT is based on a typical modern F-class machine in the 200 MW range. It can be fueled by natural gas, distillate, or a combination of fuels (dual fuel). Typical turbine units have efficiencies in the range of 15 percent to 35 percent (HHV) at full load. These units are typically less flexible than their aero and recip counterparts, meaning they cannot reduce output beyond about 50 percent to 60 percent, have slower ramp rates on the order of 15 MW/min, and though some can start in ten minutes, the output achieved in ten minutes is typically not baseload.

Commercial Availability

This CT is commercially available. Greenfield development of this type of plant would require approximately four years and consist of the following activities: two years for development and permitting; one and a half years for major equipment lead-time; and a half year for construction. Again, PSE does not take the risk of contracting for major equipment before permits are in hand. Private developers, on the other hand, are often willing to take that risk and can accelerate the development timeframe by about one year.

Cost and Performance Assumptions

Again, cost and performance assumptions were provided to PSE by a respected EC firm retained by PSE. The EC models performance and emissions characteristics under various ambient conditions and plant output levels. Winter capacity (MW) is based on the average January temperature at Sea-Tac Airport and the heat rate is based on ISO conditions, which are similar to typical annual average temperatures for this region. The heat rate is degraded by 2 percent to simulate degradation typically experienced between major maintenance events.

The capital cost estimate provided by the EC is composed of the Engineer, Procure, and Construct (EPC) cost and ‘Owner’s Costs’ components. The EPC cost is supported by a definitive cost estimate provided June 15, 2010. EPC costs are developed to approximately +/- 15 percent accuracy and are based on national and international vendors for major equipment and take into consideration information on local labor rates and productivity. The capital cost includes an estimate for a 1 million gallon oil storage tank, land, containment berm, forwarding equipment, etc.

Owner’s Costs (OC) such as development, permitting, engineering, site preparation, public relations, legal, construction management, O&M staff training, spares, acceptance testing, contingency, and AFUDC were estimated using the EC’s recommended 40 percent of EPC adder. According to the EC, owner’s costs are typically about 40 percent[8] of the EPC cost.

Non-fuel O&M costs were estimated by the EC using a proprietary model which estimates a levelized cost for routine and major maintenance, labor, other maintenance items, and consumables. These rates are levelized based on PSE-provided operating characteristics of 8 percent capacity factor and 85 starts per year. Staffing levels and rates are determined by PSE and assume staffing levels for a new standalone facility. To be consistent with trade floor dispatch and with AURORA modeling practices at PSE, the team allocated major maintenance as a fixed expense instead of a variable cost as provided by EC.

Natural gas supply is assumed to be interruptible and based on estimate of gas transport rates available in the capacity release market. Fixed O&M includes an estimate for the cost of distillate fuel backup for approximately 48 hours per year when natural gas supply may be curtailed. The unit is assumed to be connected to the PSE transmission system and as such does not incur any direct transmission cost, but the capacity contribution to peak load should be reduced by 7 percent to account for reserves.

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[8] *The EC notes that owner’s costs vary widely (30-70% of EPC), primarily depending on the site, technology, and the developer’s cost of capital.*

2 – Aeroderivative Combustion Turbine

Technology Summary

Aeroderivative (aero) combustion turbines are a mature technology but new features and designs are continually being introduced. This generic resource is based on a relatively new design that features an intercooler following the compressor and which improves overall efficiency and hot weather power output. It can be fueled by natural gas, oil, or a combination of fuels (dual fuel). Typical aero units have efficiencies in the range of 25 percent to 38 percent (HHV) at full load. Aero units are typically more flexible than their frame counterparts and many can reduce output to nearly 30 percent. Most can start and achieve full output in less than ten minutes and start multiple times per day without maintenance penalties. Ramp rates range from 50 to 90 MW/min. Another key difference between aero and frame units is size. Aero CTs are typically smaller in size, from 40 to 100 MW each. This small scale allows for modularity and reducing shaft risk, but also tends to reduce economies of scale.

Commercial Availability

This technology is commercially available. Greenfield development of this type of plant would require approximately four years and consist of the following activities: two years for development and permitting; one and a half years for major equipment lead-time; and a half year for construction. PSE does not take the risk of contracting for major equipment before permits are in hand. Private developers, on the other hand, are often willing to take that risk and can accelerate the development timeframe by about one year.

Cost and Performance Assumptions

Cost and performance assumptions were provided to PSE by the EC previously mentioned. The EC models performance and emissions characteristics under different ambient conditions and at various output levels. Winter capacity (MW) is based on the average January temperature at Sea-Tac Airport and the heat rate is based on ISO conditions, which are similar to typical annual average temperatures for this region. The heat rate is degraded by 2 percent to simulate degradation typically experienced between major maintenance events.

The capital cost estimate was provided by the EC using the methodology previously described. The EPC cost is supported by a preliminary cost estimate provided January

14, 2010. This EPC cost was developed to approximately +/- 20 percent accuracy based on their in-house proprietary database of recently obtained budgetary quotes for other recent projects, adjusted for current market pricing conditions, escalation factors, and local labor rates and productivity. The capital cost includes an estimate for a 1 million gallon oil storage tank, land, containment berm, forwarding equip, etc. Owner's Costs were estimated using the EC's recommended 40 percent of EPC adder.

Non-fuel O&M costs were estimated by the EC as previously described. PSE provided an operating profile estimate of 18 percent capacity factor and 130 starts per year. Staffing levels and rates are determined by PSE and assume staffing levels for a new standalone facility. To be consistent with trade floor dispatch and with AURORA modeling practices at PSE, the team allocated major maintenance as a fixed expense instead of a variable cost as provided by BV.

Natural gas supply is assumed to be interruptible and based on an estimate of gas transport rates available in the capacity release market. Fixed O&M includes an estimate for the cost of distillate fuel backup for approximately 48 hours per year when natural gas supply may be curtailed. The unit is assumed to be connected to the PSE transmission system and as such does not incur any direct transmission cost, but the capacity contribution to peak load should be reduced by 7 percent to account for reserves.

G. Nuclear

Technology Summary

The thermal cycle
Like other types of thermal generating resources (coal-, oil-, and gas-fired), nuclear power plants produce electricity by boiling water into steam at elevated temperature and pressure. The thermal energy of the steam is converted to mechanical energy in a steam turbine driving an electrical generator to produce electricity. Instead of burning fossil fuels, the nuclear power plant uses solid ceramic pellets of uranium, developing heat in a process called "fission" or the splitting of uranium atoms in a nuclear reactor.

The fission reaction
Nuclear fuel consists of two types of uranium, U-238 and U-235. The atomic nucleus of uranium is composed of 92 protons and 143 neutrons. When split, the uranium nuclei break up, releasing high energy neutrons and heat. As these neutrons impact other

uranium atoms, those atomic nuclei also split, releasing neutrons of their own, along with additional heat. These neutrons in turn strike other atoms, splitting them and triggering other such collisions in a chain reaction. When that happens, a self-sustaining fission reaction has begun.

To control the nuclear fission reaction, control rods are inserted into the reactor vessel that absorb neutrons without contributing to the fission reaction. These control rods may be inserted or withdrawn to varying degrees, slowing or accelerating the reaction.

Commercial Availability

The nuclear fleet

Today, there are 104 nuclear plants operating in the United States, the largest of which is Palo Verde in Arizona, whose three nuclear reactors together produce 3,942 MW[9]. The performance of the 104 U.S. nuclear plants has been excellent, with a combined energy output of 799 million MWh in 2009[10]. The total number of kWh produced by the reactors has steadily increased over the last five years. The fleet-averaged capacity factor since 2003 has been maintained at about 90 percent[11]. Approximately two-thirds of U.S. nuclear plants are pressurized water designs while the remaining one-third are boiling water designs.

Worldwide, there are 65[12] nuclear plants under construction, including in China (27), Russian Federation (11), India (5), Korea (5), Bulgaria (2), Taiwan (2), Ukraine (2), Japan (2), Argentina (1), Finland (1), France (1), Iran (1), Pakistan (1), and the United States (1). The lone U.S. plant is Watts Bar 2, located in Tennessee, with an electric capacity of 1,177 MW and a scheduled date for commercial operation of the year 2013. Initial site work is well under way at two additional plants, Vogtle in Georgia and Virgil C. Summer in South Carolina.

[9] *Source: Nuclear Energy Institute – Resources & Stats*
[10] *Source: World Nuclear Association – Nuclear Power in the U.S. – December 2010*
[11] *Source:* http://www.nrc.gov/reading-rm/doc-collections/huregs/staff/sr1350/v19/sr1350v19.pdf
[12] *Source: European Nuclear Society - Nuclear power plants, world-wide – January 2011*

Select U.S. nuclear construction update[13]

- Watts Bar 2

While the focus is on new technology, The Tennessee Valley Authority (TVA) undertook a detailed feasibility study which led to its decision in 2007 to complete unit 2 of its Watts Bar nuclear power plant. The 1,177 MWe reactor is expected to come on line in 2013 at a cost of about $2.5 billion. Construction was suspended in 1985 at 80 percent completion, and resumed in October 2007 under a still-valid permit. It is progressing on time and within budget. Its twin, unit 1, started operation in 1996. Completing Watts Bar 2 utilizes an existing asset, thus saving time and cost relative to alternatives for new baseload capacity. It was expected to provide power at 4.4 ¢/kWh, which is 20 percent to 25 percent less than coal-fired or new nuclear alternatives, and 43 percent less than natural gas.

- South Texas Project 3 & 4

This is to be a merchant plant with two 1,356 MWe Advanced Boiling Water Reactors. NRG Energy already operates two reactors at the site, and works are under way preparing for the new units. With Toshiba, NRG is part of Nuclear Innovation North America (NINA), which awarded the EPC contract to The Shaw Group and Toshiba America Nuclear Energy in November 2010. The construction and operating license (COL) review by the Nuclear Regulatory Commission (NRC) is expected to be completed in the first half of 2012, and the units are expected on line in 2016 and 2017. One reactor pressure vessel was ordered from IHI in May 2010.

- Vogtle 3 & 4

Site works are largely complete in preparation for two 1,200 MWe Westinghouse AP1000 reactors. Some of the reactor steelwork is on site. In April 2008, Georgia Power signed an EPC contract with Westinghouse and The Shaw Group consortium. Southern Nuclear has been awarded government loan guarantees, the COL review by the NRC is due to be complete early in 2011, and a license is expected mid 2012. The units are expected on line in 2016 and 2017.

- Summer 2 & 3

Site works are well advanced for two 1,200 MWe Westinghouse AP1000 reactors. In May 2008, South Carolina Electricity & Gas and Santee Cooper signed an EPC contract with

[13] *Source: World Nuclear Association - Nuclear Power in the USA – December 2010*

Westinghouse and The Shaw Group consortium. The total cost of $9.8 billion includes forecast inflation and owners' costs for site preparation, contingencies and project financing. The COL review by the NRC is due to be completed early in 2011 and the units are expected to enter commercial operation in 2016 and 2019.

Policy Considerations

The Energy Policy Act of 2005 provided financial incentives for the construction of advanced nuclear plants. The incentives include a 2.1 ¢/kWh tax credit for the first 6,000 MWe of capacity in the first eight years of operation, and federal loan guarantees for the project cost. After putting this program in place in 2008, the Department of Energy (DOE) received 19 applications for 14 plants involving 21 reactors. The total amount of guarantees requested is $122 billion, but only $18.5 billion has been authorized for the program. In light of the interest shown, industry has asked that the limit on total guarantees be raised to $100 billion. There are three other regulatory initiatives which enhance the prospects for building new nuclear plants. First is the streamlined design certification process, second is provision for early site permits (ESPs), and third is the combined construction and operating license process. All have some costs shared by the DOE.

Following the requirements of the Nuclear Waste Policy Act, the DOE submitted a license application for the Yucca Mountain repository in 2008. Congress mandated and is providing the funding for the NRC to complete a license review. The Obama administration has stated that Yucca Mountain is no longer an option for nuclear waste disposal. There is no plan for high-level wastes, but the administration has committed to a comprehensive review of waste management. In conclusion, the progress on high-level waste disposal has not been positive.

Cost and Performance Assumptions

There is little hard data from recent U.S. nuclear developments from which reasonable cost estimates can be made. The construction costs track record for nuclear plants completed in the United States during the 1980s and early 1990s was certainly poor. Actual costs were far higher than had been projected and construction schedules experienced long delays, which, together with increases in interest rates at the time, resulted in high financing charges. Changing regulatory requirements also contributed to project cost increases, and in some instances, the public controversy over nuclear power contributed to some of the construction delays and cost overruns.

The plants in Korea and Japan remain on schedule. However, the construction and scheduling experiences of other plants such as the one in Finland are not encouraging. Whether the lessons-learned from the past have been adequately considered in the permitting, design, cost estimating, and construction of future nuclear plants remains to be seen. These factors will have a significant impact on the risk facing investors and/or utilities financing new projects. For this reason, the most recent update to the Massachusetts Institute of Technology "Future of Nuclear Power" report applied a 2.2 percent higher weighted cost of capital to the construction of a new nuclear plant as a risk premium compared to the construction of a new coal or new natural gas facility.

Figure D-11

Cost and Performance of New Central Station Electricity Generating Technologies[14]

Technology	Online Year	Size (MW)	Lead Time (Years)	Overnight Cost in 2009 (2008 $/kW)	Variable O&M ($2008 Mills/kWh)	Fixed O&M ($2008/kW)	Heat Rate in 2009 (Btu/kWh)
Scrubbed Coal	2013	600	4	2,223	4.69	28.15	9,200
Integrated Coal Gasification (IGCC)	2013	550	4	2,569	2.99	39.53	8,765
IGCC with Carbon Sequestration	2016	380	4	3,776	4.54	47.15	10,781
Conv Gas/Oil Combined Cycle	2012	250	3	984	2.11	12.76	7,196
Adv Gas/Oil Combined Cycle	2012	400	3	968	2.04	11.96	6,752
ADVCC W/ Carbon Sequestration	2016	400	3	1,932	3.01	20.35	8,613
Conv Cobustion Turbine	2011	160	2	685	3.65	12.38	10,788
Adv Combustion Turbine	2011	230	2	648	3.24	10.77	9,289
Fuel Cells	2012	10	3	5,478	49	5.78	7,930
Advanced Nuclear	2016	1350	6	3,820	0.51	92.04	10,488
Distributed Generation - Base	2012	2	3	1,400	7.28	16.39	9,050
Distributed Generation - Peak	2011	1	2	1,681	7.28	16.39	10,069
Biomass	2013	80	4	3,849	6.86	65.89	9,451
Geothermal	2010	50	4	1,749	0	168.33	32,969
MSW - Landfill	2010	30	3	2,599	0.01	116.8	13,648

[14] *Source: U. S. Energy Information Administration/Assumptions to the Annual Energy Outlook 2010*

Technology	Online Year	Size (MW)	Lead Time (Years)	Overnight Cost in 2009 (2008 $/kW)	Variable O&M ($2008 Mills/kWh)	Fixed O&M ($2008/kW)	Heat Rate in 2009 (Btu/kWh)
Gas							
Conventional Hydro power	2013	500	4	2,291	2.49	13.93	9,884
Wind Onshore	2009	50	3	1,966	0	30.98	9,884
Wind Offshore	2013	100	4	3,937	0	86.92	9,884
Solar Thermal	2012	100	3	5,132	0	58.05	9,884
Solar Photovoltaic	2011	5	2	6,171	0	11.94	9,884

In 2009 Moody's wrote: "From a credit perspective, the risks of building new nuclear generation are hard to ignore, entailing significantly higher business and operating risk profiles, with construction risk, huge capital costs, and continual shifts in national energy policy. Moody's is considering taking a more negative view for those issuers seeking to build new nuclear power plants. The longer-term value proposition appears intact, and, once operating, nuclear plants are viewed favorably due to their economics and no-carbon emission footprint. Historically, however, most nuclear-building utilities suffered a ratings downgrade - and sometimes several - while building these facilities."[15]

As indicated in Table 1, the capital cost of developing a new nuclear power plant is higher than most conventional and renewable technologies. It carries significant technology, credit, permitting, policy, and waste disposal risks. Its high cost and high uncertainty make nuclear technology an undue risk for PSE at this time. As Moody's explains in its report, nuclear power represents a "bet-the-farm risk" to companies pursuing development. PSE will continue to follow emerging trends in this technology, and may include it in future resource plans if evolving national policies and the technological maturity of newer designs sufficiently reduce project risks and cost uncertainty for our customers.

[15] *Source: Moody's Global Infrastructure Finance – New Nuclear Generation: Ratings Pressure Increasing - June 2009*

H. Solar Energy

Technology Summary

Solar energy uses the light and radiation from the sun to directly generate electricity with photovoltaics, or to capture the heat energy of the sun for either heating water or for creating steam to drive electric generating turbines.

- Photovoltaics are semiconductors which generate direct electric currents. These are then run through an inverter to create alternating current. Photovoltaics have been in use for decades, but only recently have started to grow significantly as costs of production have dropped. Most photovoltaics are based on silicon imprinted with electric contacts, much like computer chips, but other technologies, notably several chemistries of thin-film photovoltaics, have gained substantial market share. Thin film photovoltaics offer lower costs of production, but have lower efficiencies (3 percent to 12 percent efficiency) than silicon based photovoltaics (12 percent to 20 percent efficiency), requiring greater areas for the same amount of electric generation. All technologies of photovoltaics have significant ongoing research efforts, which have been increasing sunlight to electricity conversion efficiencies and decreasing costs. Photovoltaics are generally installed in arrays ranging from a few watts for sensor or communication applications, up through hundreds of MW for bulk power generation.
- Concentrating photovoltaics use lenses to focus the sun’s light onto specialty high-efficiency photovoltaics, creating higher amounts of generation for the given area. Because of the use of concentrating lenses, these technologies must be more precisely oriented towards the sun.
- Solar thermal plants focus the direct irradiance of the sun to generate enough heat to produce steam, which in turn drives a conventional turbine generator. Two general types are in use or development today, trough-based plants and tower-based plants. Trough plants use horizontally mounted parabolic mirrors or Fresnel mirrors to focus the sun onto a horizontal pipe that carries water or a heat transfer fluid. Tower plants use a field of mirrors that focus sunlight onto a central receiver. A heat transfer fluid is used to collect the heat and transfer it to make steam.

As of late 2010, there were approximately 1,780 MW of installed photovoltaics in the United States, and 400 MW of operating solar thermal plants.

Commercial Availability

Currently, renewable portfolio standards (RPS) are the driver behind most solar development in the United States, as well as generous state and federal incentives. As of the end of 2009, Washington had only 5.2 MW of solar equipment installed, Idaho 0.2 MW, and Oregon 14 MW. Collectively, these amount to approximately a 2.5 aMW output over a year. Oregon is experiencing growth in solar development because the state's RPS requires the installation of about 20 MW of solar photovoltaics, and because of the state's Business Energy Tax Credit. In comparison, California had over 750 MW installed photovoltaics as of the end of 2009, and approximately 300 MW of solar thermal plants.

With less sunlight than other areas of the country, and incentive structures that limit development of smaller systems, photovoltaic development has been slow here in the Northwest. Likewise, concentrating PV and Concentrating Solar Thermal systems have not been developed, again because of the Northwest's relatively low percentage of direct sunlight, which these systems require for generation.

Cost and Performance Assumptions

PSE has had a positive experience with the performance of our 500 kW Wild Horse Solar Demonstration Project, which has outperformed its pre-construction production estimates. PV systems in Western Washington are expected to have capacity factors of approximately 10 percent to 11 percent, while those in Eastern Washington could achieve capacity factors as high as 18 percent.

Since PSE built the Wild Horse Solar Demonstration Project in 2007, costs have declined considerably, reaching national averages of approximately $6.50/ Watt-dc for residential systems, $5.75/ Watt-dc for commercial systems, and $4.00/ Watt-dc for utility scale systems (Solar Electric Industry Association, 2010). PSE's calculations of the lowest levelized cost for utility-scale solar systems have ranged from $0.18 - $0.25/kWh, significantly exceeding costs for other renewable energy sources, such as wind.

Solar thermal plants have proven reliable over time, with the SEGS plants in California operating since the 1980s. While the limited number of recent developments makes it difficult to estimate current costs, best known current costs are shown below.

Figure D-12
Solar Facility Cost Estimates

Technology	Capital Cost ($/kW)	Levelized Cost ($/MWh)	Typical Installation Size (kW)	Expected Life (years)
Solar Thermal Trough[16]	$4,950	$220	25-50,000	20

I. Waste-to-Energy Technologies

Technology Summary

Converting wastes to energy is a means of capturing the inherent energy locked into wastes. Generally, these plants take several forms:

- Waste Combustion Facilities. These facilities combust waste in a boiler, and use the heat to generate steam for a steam turbine to use in electric generation. This is a well established technology, with 86 plants operating in the United States, representing 2,500 MW in generating capacity.
- Waste Thermal Processing facilities (includes Gasification/Pyrolisis/Reverse Polymerization). These facilities add energy to waste and control the oxygen available to break down the waste into components without combusting it. Typically, a syngas is generated, which can be combusted for heat or to produce electricity. A number of pilot facilities once operated in the United States, but only a few remain today.
- Landfill Gas and Municipal Wastewater Treatment Facilities. Most landfills in the United States collect methane from the decomposition of wastes in the landfill. Many larger municipal wastewater plants also operate anaerobic systems to produce gas from their organic solids. Both of these processes produce a low quality gas with approximately half the methane content of natural gas. This low quality gas can be collected and scrubbed to remove impurities or improve the heat quality of the gas. The gas can then be used to fuel a boiler for heat recovery, or a turbine or reciprocating engine to generate electricity. Approximately 553 U.S. landfills generate electricity today, with a combined capacity of 1,831 MW.

[16] *Based on Nevada Solar One and Solar Tres announced capital costs*

Commercial Availability

Under Washington's RPS, landfill gas does qualify as a renewable energy resource, but municipal solid waste does not. Under revisions to the RPS, the definitions of wastes and biomass would be clarified to allow some new wastes, such as food wastes, to qualify as renewable energy sources.

Currently, several waste-to-energy facilities are operating in or near PSE's electric service area. There are two landfills using landfill gas for electric generation in Washington state, with a combined output of approximately 12.4 MW. The largest landfill in PSE's service territory, the Cedar Hills landfill, currently purifies its gas to meet natural gas quality, then sells that gas to PSE rather than using it to generate electricity. There are two waste combustion facilities operating in the Northwest: the 13.1 MW Covanta facility in Brooks, Ore., and the 26 MW Spokane Waste to Energy Facility. The Spokane facility currently holds a Purchased Power Agreement (PPA) with PSE. The only waste thermal processing facility known in the Northwest is a test facility operated by InEnTec in Richland, Wash. Several wastewater treatment plants in PSE's electric service area use gas from their digestion processes to generate electricity, but this is typically not enough to offset facility electric use and would therefore not be available for PSE to meet resource needs.

No waste-to-energy facilities are currently planned or under construction in the Northwest.

Cost and Performance Assumptions

While there were 87 waste combustion facilities and 553 landfill gas-to-energy facilities operating in the United States by the end of 2010, relatively few have been built in recent years, making reliable cost data difficult to obtain. The U.S. Department of Energy estimates that landfill gas projects cost approximately $2,400/kW in capital costs. Waste Combustion projects are similar to biomass projects, which have a construction cost of approximately $3,400/kW.

In general, waste-to-energy facilities are highly reliable, as they've used proven generation technologies and gained considerable operating experience over the past 30 years. Some variation of output from landfill gas facilities and municipal wastewater plants is expected due to uncontrollable variations in gas production. For waste combustion facilities, output is typically more stable, as the amount of input waste and heat content can be controlled.

J. Water-based Generation – Wave and Tidal

Technology Summary

The natural movement of water is used to generate energy through the flow of tides, or the rise and fall of waves.

Tidal generation technologies use rotors which are spun by tidal flow, which in turn turns a generator. Two major plant layouts exist: barrages, which use artificial or natural dam structures to accelerate flow through a small area; and in-stream turbines, which are placed in natural channels. Currently, the largest operating tidal generation facility in the world is the Rance Tidal Power barrage system in France, which has a generating capacity of approximately 240 MW. In-stream turbines up to 1.2 MW in size have been tested in Canada, Scotland, and South Korea.

Wave generation technologies use the rise and fall of waves to drive hydraulic systems, which in turn fuel generators. Technologies tested include floating devices, such as the Pelamis, and bottom mounted devices such as the Oyster. The largest wave power plant in the world was the 2.25 MW Agucadoura Wave Farm off the coast of Portugal, which opened in 2008. It has since been shut down because of the developer's financial difficulties. Significant testing has occurred off of Scotland, and developments are underway in Scotland, Australia, and England.

Commercial Availability

Currently, only one tidal power site is under development in the Northwest, Snohomish PUD's Admiralty Inlet site. Plans call for the installation of two to three test turbines, producing a total of 1 MW by 2013. Snohomish PUD also holds preliminary permits for developments of other sites in Puget Sound, though Admiralty Inlet is by far the largest. Tacoma Power considered development in the Tacoma Narrows, but ultimately abandoned the project. A small system has been tested off Vancouver Island, B.C, but no further development is planned at this time.

Several sites have been tested for wave power in the Northwest. Currently, the furthest along in development is off of Reedsport, Ore. Current plans are for 10 buoy-type floating tidal power generators, with a combined capacity of 1.5 MW. Past tests included a floating buoy-type generator tested off of the Oregon coast.

In general, the limiting factors in development of wave and tidal power projects have been long permitting timelines and relatively little experience with siting and the generation technologies. Permitting processes for tidal power projects are overseen by FERC, and also have state stakeholders. After permits are obtained, studies of the site water resource and aquatic habitat must be made prior to installation of test equipment. This process, from initial permit application until equipment installation, can take two to three years.

Even after the resource is proven, few technologies have more than a few years of in-water operational experience and limited production volumes, so costs remain high and longevity of equipment uncertain.

Cost and Performance Assumptions

Tidal and wave generation technologies are very early in development, making cost estimates difficult. Most developers have not produced more than one full scale device, and some have not yet reached that point. The best known cost estimates for development at scale are shown below. These are subject to considerable uncertainty, as they assume a certain scale-up in the respective industries, with the attending decrease in costs.

Figure D-13
Tacoma Narrows Tidal Plant Cost Estimates

Capital Cost ($/kW)	Levelized Cost ($/MWh)	Commercial Installation Size (kW)	Expected Life (years)	Typical Capacity Factor
$2,300 / kW	$112	16,000	20	35 %

Source: Electric Power Research Institute, EPRI

Figure D-14
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

K. Wind Energy – Off-shore Resources

Technology Summary

Offshore wind generation uses versions of horizontal axis wind turbines specifically designed for use in marine environments. Approximately 2,300 MW are currently in operation, mostly in the North Sea and Baltic Sea. Existing installations have mainly been via driven pile foundations in water depths of less than 30 meters, though some gravity foundations exist and a number of new designs are under development for tripod platforms and floating platforms. One floating platform wind turbine is currently in operation off Norway.

Commercial Availability

Currently, within the United States no offshore wind projects are under development on the West Coast (U.S. Offcoast Wind Collective - http://www.usowc.org/). Most U.S. projects have been proposed for the East Coast and Great Lakes region. The nearest proposed project to PSE’s service territory is the Naikun Offshore Wind Project in British Columbia. This project has not received development permits or secured a power purchase agreement at this time.

Cost and Performance Assumptions

Due to the higher winds offshore, offshore wind is expected to operate at higher capacity factors than onshore wind projects, helping decrease prices. However, costs of marine construction considerably exceed those of on-shore construction. As no projects have been developed in the United States at this time, costs of offshore wind development are not well known, but are estimated to be at least $4,000/kW (Large Scale Offshore Wind Power in the United States, Opportunities and Barriers, 2010).

L. Wind Energy – On-shore Resources

Technology Summary

Wind turbine generator technology is mature and the dominant form of new renewable energy generation in the Pacific Northwest. While the basic concept of a wind turbine has generally remained constant over the last several decades, the technology is continuously evolving, yielding larger towers, wider rotor diameters, greater nameplate capacity, and increased wind capture. New commercially available machines are pushing into the 2.0 to 3.0 MW range with hub heights of 80 to 100 meters and blade diameters topping out around 100 meters. These changes have come about largely in response to the development of premium high wind resource sites that were close to existing transmission. The current generation of turbines is pushing the physical limits of existing transportation infrastructure. In addition, if nameplate capacity and turbine size continue to increase, the industry must explore creative solutions, such as concrete tower foundations poured on site.

Commercial Availability

This resource is commercially available, and the market for turbines appears to be in favor of buyers at the moment. Greenfield development of a new wind facility would require approximately five to as many as ten years, and consist of the following activities, at a minimum: three years for development and permitting; one year for major equipment lead-time; and one year for construction.

Cost and Performance Assumptions

Assumptions, unless noted otherwise, are based on actual and anticipated figures from the Lower Snake River Wind Project (LSRWP), Phase II. These assumptions are based on known and best available information at the time of this writing.

Capital Cost

Development Rights: PSE purchased the LSRWP Development Rights from RES Development in December 2008 and August 2009. With the Development Rights purchase, PSE acquired all the work completed to date, including: real property and lease agreements, BPA prepayments, project studies, project agreements, wind resource assessment reports, project permits, met masts; and other assets. LSRWP, Phase II carries a portion of the total asset purchase price, allocated based on the value of the assets at the time of the Development Rights purchase.

Development Costs: This category encompasses incremental costs incurred to develop all phases of LSRWP subsequent to the purchase of Development Rights. Like the Development Rights, the Development Costs benefit the development of all phases and are allocated based on the relative value of the assets at the time of purchase. Examples of costs included here are: ongoing real estate work, permitting, wind resource assessments, legal costs, communications / advertising, telecommunications and PSE labor and expenses.

Interconnection Costs: In addition to the prepaid transmission expense discussed in the following section, the Bonneville Power Administration (BPA) identified specific communications equipment that PSE must install in our project substation(s) in order for LSRWP, Phase II to interconnect into the BPA Substation.

Prepaid Transmission Expense: LSRWP will interconnect to the new BPA Central Ferry Substation. BPA requires PSE to prefund the Central Ferry Substation, which BPA will refund to PSE through credits based upon contracted monthly point-to-point expenses each LSRWP Phase will incur to transmit power across BPA's transmission system to PSE's territory. Items to note: First, the prepaid amount is allocated to each phase of LSRWP based on the relative value of the assets at the time of purchase. Second, while these expenditures are included in the development and construction budget, these expenditures are not depreciable assets that PSE can place into rate base and are therefore excluded from generic capital cost assumptions.

Wind Turbine Generators: This category includes one or more informal quotes from the three different turbine suppliers that participated in the LSRWP, Phase I bidding process: Siemens, Vestas, and General Electric. Scope typically includes manufacture, port delivery, commissioning, and some form of substantial and/or final completion. However, each vendor quote included scope nuances that are reflected in increased or decreased balance of plant (BOP) costs (e.g. Siemens' scope included turbine erection resulting in lower BOP costs).

Balance of Plant: Work inclusive of project substations, the turbine foundations, the collection system, the roads and the operations and maintenance building. Generally the BOP work will serve to "wrap" or fully complete the wind project. This estimate is based upon PSE's past experience in dealing with RES.

Construction Management: The category includes costs associated with managerial oversight of the construction phase, ongoing real estate work, required environmental assessments, wind resource monitoring, power performance testing, engineering work for roads, collector systems and substations, internal overhead, and construction insurance.

Other relevant costs included in this estimate include project communications equipment, credit for test power, turbine service and maintenance service prior to COD, PSE radio equipment, sales tax (100 percent exempt from sales tax through June 30, 2011), contingency, and AFUDC (rate of return of 8.1 percent for book purposes).

Generic Wind Turbine Generator O&M Costs

Operating costs are based on LSRWP, Phase I vendor pricing and predicted escalation rates. These costs were considered scalable for the different sized projects.

Generic Wind Turbine Generator Transmission Costs

Twenty-year cost estimates were generated based on historical and current tariff information supplied by BPA. These estimates were then escalated to take into account projected inflation.

Long-haul Wind Resources

PSE received several offers for long-haul wind resources sited in Montana during our 2010 RFP process. The overall economics of these resources were unfavorable when compared to PSE's other renewable alternatives due to the high cost of the transmission required to bring the power to PSE's service territory. Additionally, all of these resources were located outside of the Northwest boundary. This presents challenges related to Washington's RPS, which requires that such resources be delivered to Washington state on a "real-time" basis to qualify as renewable under the standard.

Regional Transmission Resources

Contents

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 create a complicated challenge. Recently, there have been signs that new processes and collaborations may help address some longstanding problems.

1. Introduction

The Pacific Northwest's regional transmission situation is marked by an increasing frequency and duration of transmission constraints and curtailments frequently brought about by insufficient transmission. 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,
- Timing and duration of transmission study process and construction, and
- No central permitting and siting authority.

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

- The Bonneville Power Administration (BPA) has instituted a Network Open Season (NOS) process to facilitate planning and construction of new transmission lines.
- Other regional utilities are planning large transmission projects to interconnect generation, particularly renewable resources, from outside the Pacific Northwest.

A number of new projects are in the development and study stage, sponsored by utility members of the two regional planning groups, ColumbiaGrid and Northern Tier Transmission Group (NTTG), and by merchant developers.

- 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.

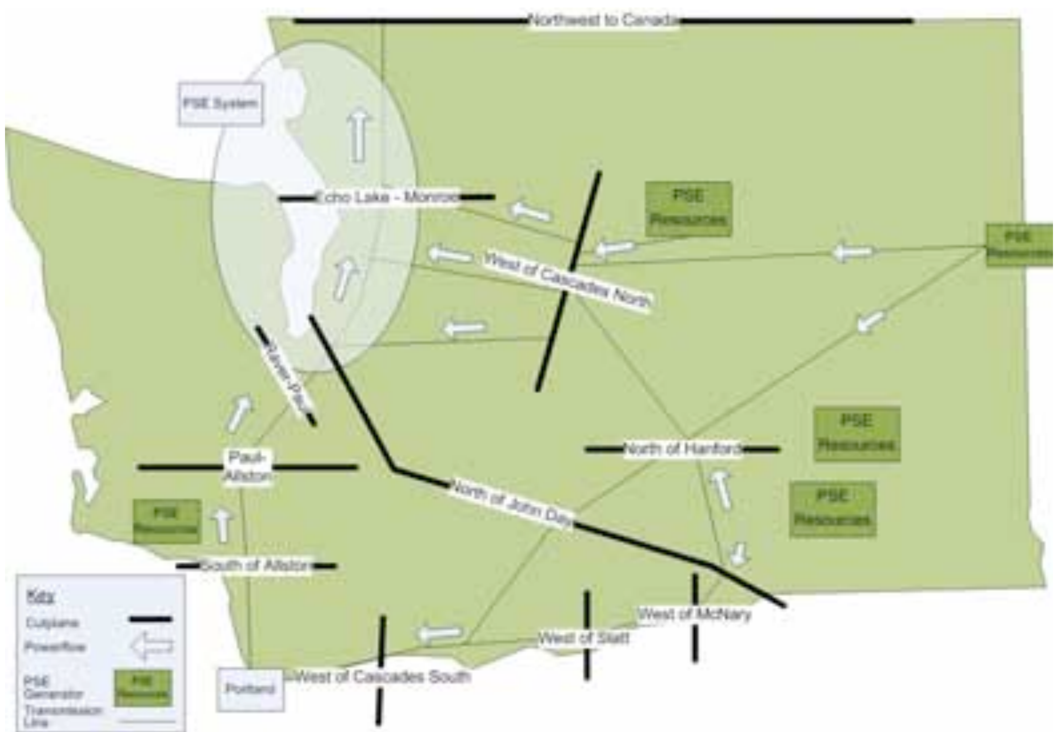
This section describes PSE's current transmission situation, and discusses the efforts to improve the Northwest's regional transmission situation.

2. The State of PSE's Current Transmission System

BPA provides roughly 70 percent of the high voltage transmission in the Pacific Northwest region. 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 and renewable energy standards, 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, resulting in curtailments of firm contractual transmission rights. This situation is a growing challenge for PSE, in particular as we move significant amounts of energy and capacity resources to the west from eastern Washington (east of the Cascades) and from the south through the I-5 corridor.

Figure E-1 below illustrates how power is transmitted from remote resources, generally located south of Seattle and east of the Cascades, to PSE's service area. The thick, black bars in Figure E-1 represent a cutplane or path, often consisting of several transmission lines or sets of lines in parallel to each other. The flow of power is indicated by the arrow symbol and typically flows 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 North of John Day, West of McNary, and the I-5 corridor. Most of the paths in the Northwest are constrained, in the sense that there is little to no capacity available to sell, and under certain operating conditions they need to be monitored by system operators to ensure they do not exceed system operating limits. 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 E-1
BPA Transmission System Constraint on PSE Remote Resource Delivery



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 NOS process.
b) Develop transmission projects that meet the projected resource additions.

Transmission development by PSE, however, is limited to projects connected to our system because of BPA's reluctance to enjoin joint development transmission projects. A joint project would be more than likely "islanded," or remote from PSE's transmission system, yet still require BPA transmission to deliver energy to PSE's load. West of Cascades North is the primary flowgate PSE could relieve congestion on through transmission development. The Echo Lake – Monroe and Raver – Paul flowgates could be improved through PSE transmission development as well, but are better addressed by BPA system improvements. Any transmission developments must be coordinated with BPA, as it manages all of the cutplanes shown in Figure E-1.

PSE's need for additional transmission is driven primarily by increasing loads and the necessity and location of new generating resources. This requirement for additional resources results from a combination of continued load growth, loss of contracted generation, the potential retirement of existing resources, and compliance with the state's renewable portfolio standards (RPS). Our 2009 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 and the natural gas pipelines, 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 resources on the west side are close to PSE's load center and usually connect to the company's transmission system, requiring simpler and less expensive transmission solutions. However, resources located east of the Cascades typically rely on transmission capacity from or through the Mid-Columbia area, which involves complex solutions 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 Role in PSE's Future Resources

One option for acquiring additional transmission is to work through BPA. While this has historically involved submitting an OASIS (Open Access Same-time Information System) request to BPA, the agency now requires participation in NOS, which was designed to obtain financial commitments from utilities to purchase transmission from BPA. Currently, NOS is held annually, though BPA has recently proposed to extend the process to 18 to 24 months. It is expected that the NOS will assist BPA's transmission customers in acquiring incremental transmission. NOS enables BPA to more efficiently augment its transmission system through better planning and financial commitments. 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 requests received. From the 2008 NOS, BPA proposed five transmission reinforcement projects and is currently constructing the West of McNary Reinforcement projects. No additional transmission reinforcement projects have been approved since the 2008 NOS. In order to accommodate PSE's Lower Snake River wind projects in eastern Washington, BPA also is planning to 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 5,000 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 renewable electricity from these new wind projects often located in remote areas. 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.

One operational protocol BPA has implemented in order to manage the growing amount of wind energy on its system is Dispatcher Standing Order (DSO) 216. The purpose of DSO 216 is to either curtail generation schedules altogether, or to limit generation to the scheduled amount when there is insufficient regulating capacity on the federal hydroelectric system. Regulation is an ancillary service that BPA provides to integrate wind. However, that service is not always available, as shown by DSO 216 curtailments. Curtailments may result in lost energy and/or Renewable Energy Credits, without compensation.

PSE's future resources – especially renewables – 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.

PSE Transmission Development

PSE may need to design, permit and build our own transmission to accommodate the development or acquisition of new resources, in the event that other options do not meet the need. Again, BPA's reluctance to enjoin joint development and "islanded" transmission projects has traditionally limited PSE transmission projects that connect to BPA's system. One potential transmission project is the reinforcement of the West of Cascades North path, which would increase PSE's transmission capacity at the Mid-Columbia market. This project requires both coordination with BPA and additional studies before any decision is made to proceed.

3. 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 ColumbiaGrid does not own transmission, PSE, other members, and additional parties to ColumbiaGrid's agreements *do* own and operate an extensive network of transmission facilities. ColumbiaGrid's members are PSE, Avista, BPA, Chelan County PUD, Grant County PUD, Seattle City Light, Snohomish PUD, and Tacoma Power.

ColumbiaGrid has substantive responsibilities for transmission planning, reliability, 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 December 2010, ColumbiaGrid completed its second cycle of planning and produced a draft of the 2011 Biennial Transmission Expansion Plan. In support of the Biennial Plan, there are four main Study Teams active within ColumbiaGrid addressing specific regions. These study teams include: Puget Sound Area Study Team (PSAST), Northern Mid-Columbia Area Study Team, Wind Integration Study Team (WIST), and the Cross Cascades Study Team. PSE has actively participated in all four teams. The PSAST group worked on several issues over the last year, including a review of seasonal operating limit studies, creating a transmission expansion plan, and analyzing an increased path rating on the Northern Intertie. Currently, PSAST is finalizing the long-term transmission expansion plan that includes the following projects:

- Rebuild the Bothell-SnoKing 230 kV double circuit line.
- Add series inductors to the Broad Street-Massachusetts and Broad Street-East Pine 115 kV underground cables.
- Extend the Northern Intertie Remedial Action Scheme (RAS) for the combined loss of Monroe-SnoKing-Echo Lake and Chief Joseph-Monroe 500 kV lines.
- Reconductor the Maple Valley-SnoKing 230 kV double circuit line with high temperature conductor.
- Add a third Covington 500/230 kV transformer.

- Add a second Portal Way 230/115 kV transformer.

The Northern Mid-Columbia Area Study Team has developed a one-utility plan to resolve the system deficiencies in the greater Wenatchee area. These deficiencies were identified in the 2008 ColumbiaGrid System Assessment and individual utility studies for high generation scenarios during summer conditions. These plans have also been tested during other seasons and with potential wind development in the Central Washington area.

The Wind Integration Study Team (WIST) was formed to facilitate the integration of Renewable Generation into the northwest transmission grid. The current focus of the group is on two issues:

- Technical evaluation of dynamic transfer limits (the amount of variable energy that can be transferred across a transmission path without impacting reliability or degrading equipment)
- Develop a planning methodology that seeks a balance between the cost of transmission capacity and the value of delivered wind energy

The Cross Cascades Study Team is currently investigating the extent of system problems on the Cross Cascades North and South paths, and is evaluating the performance and interaction of various potential transmission projects. These paths deliver remote resources from east of the Cascade Mountains to west-side load areas. Critical outages on these paths during a winter cold snap could result in voltage stability limits.

ColumbiaGrid OASIS

ColumbiaGrid provides program participants with a common OASIS portal, which is a single OASIS interface website, to facilitate transmission service requests within and across member and qualified non-member systems.

This ColumbiaGrid portal displays information common to those participants that have their own OASIS, and provides links to those OASIS systems for the actual transmission requests. Additionally, the OASIS portal allows 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. 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.

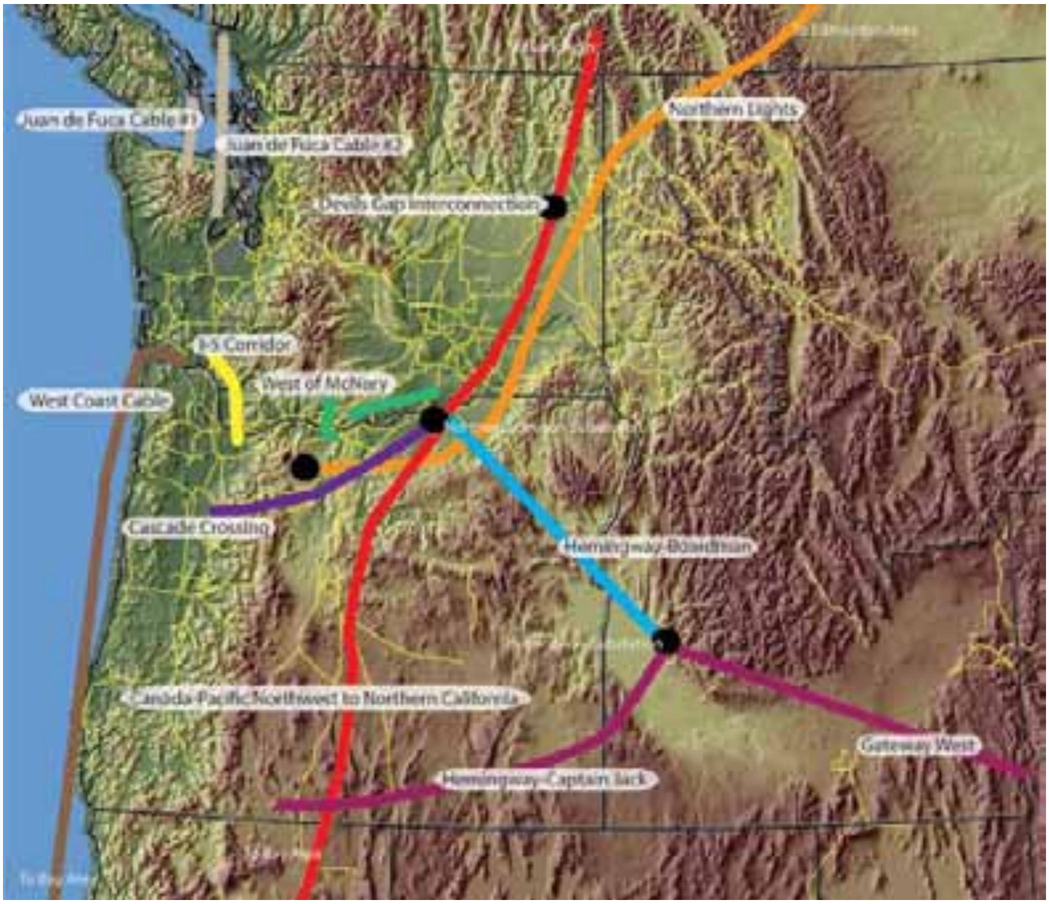
Major Regional Transmission Projects

There are several major transmission projects proposed for the Pacific Northwest. These projects may impact each other as well as the existing Western Electric Coordinating Council (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 in 2008 through the Northwest Power Pool (NWPP) to aid the project sponsors with coordinating the planning studies and project communications.

Nine major regional projects with project sponsor, name, estimated cost, timeframe, and status are listed below. These projects are shown in Figure E-2.

1. PacifiCorp's Gateway West: ~ $2.7 billion, 2014, WECC rating process
2. TransCanada's Northern Lights: ~ $2 billion, 2014, unknown
3. Idaho Power's Boardman to Hemmingway: ~ $600 million, 2013, WECC rating process
4. PG&E's Canada-Pacific Northwest to Northern California: ~ $billions, 2015, re-evaluating
5. PGE's Southern Crossing: ~ $100's million, 2013, WECC rating process
6. See Breeze's Cable Projects: ~ Costs unknown, timeframes unknown,
7. PacifiCorp's Hemmingway to Captain Jack: ~ $750 million, 2014, re-evaluating
8. BPA's West of McNary: ~ $362 million, 2012, under construction
9. BPA's I-5 Corridor Reinforcement: ~ $342 million, 2015, environmental review

Figure E-2
Regional Proposed Transmission Projects



Source: "2011 Biennial Transmission Expansion Plan," ColumbiaGrid

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. However, none of the proposed transmission projects terminates in the Puget Sound area with the exception of the Juan de Fuca Cable projects, as the intention of many merchant project developers is to deliver renewables to the California market.

BPA Network Open Season

As mentioned above, BPA's 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 transmission 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 TSR 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 – Knight (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/MW. The 20-year average rate impact is projected to be 2.02 percent 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. Lower Snake River (LSR) Wind Project – 600 MW

BPA has awarded PSE the Hopkins Ridge Infill, Cross Cascades, and Goldendale transmission, and 250 MW of the 600 MW for the LSR Wind Project that begins in the requested month of December 2011. The additional 350 MW of transmission for the LSR Wind Project is contingent upon the completion of BPA's proposed Little Goose and West of McNary Reinforcement projects.

PSE requested 12 MW for Mint Farm Duct Firing in the 2009 NOS and was awarded Conditional Firm transmission with up to 400 hours of potential curtailment. The 12 MW will be converted to long-term firm once BPA completes the I-5 Corridor Reinforcement.

PSE did not request transmission in the 2010 NOS since there was no new off-system resource development that required a transmission request.

4. 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 and 2009 NOS processes. 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. 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.

Financial Considerations

Contents

1. Resource Specific Financial Considerations

Power Purchase Agreement (PPA). As mentioned in Chapter 5, PPAs were not considered in this IRP since the costs and terms of individual PPAs are not know until the time they are offered. However, since PSE expects to receive PPAs during our RFP process, it is important to understand how they will be evaluated. The following section describes what Imputed Debt is, and how it is calculated and used in evaluation.

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:

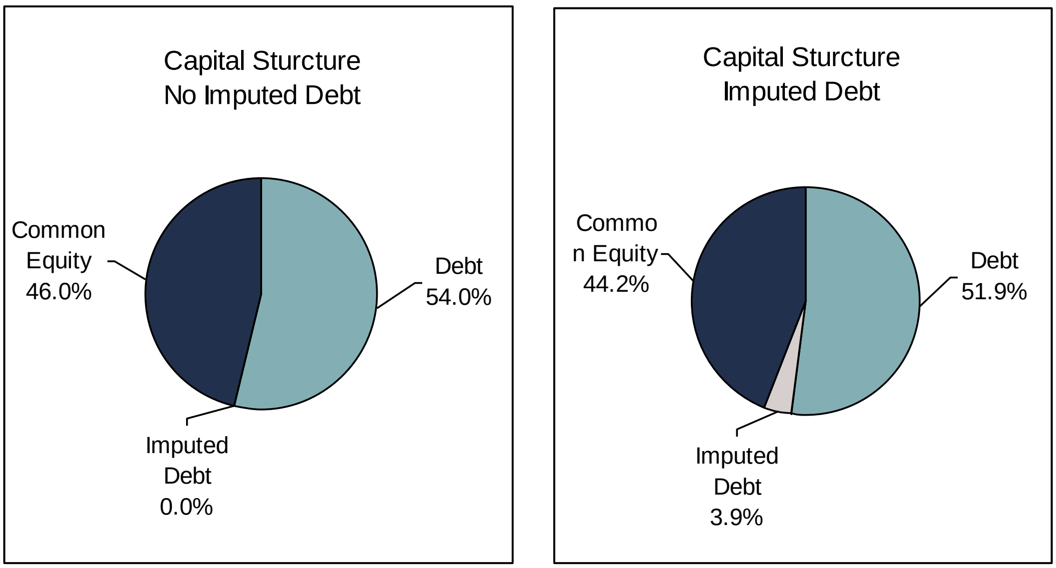
To analyze the financial impact of purchased power, S&P employs the following financial methodology. The net present value of future annual capacity payments (discounted at 10 percent), multiplied by a "risk factor" (which in PSE's case is 30 percent) represents a potential debt equivalent—the off-balance 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 percent 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 percent, as assessed by S&P. Imputed debt is the sum of the present value, using a 6.7 percent discount rate (the company's current average cost of long-term debt), and a midyear 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 F-1 shows that the capital structure with imputed debt is eroding PSE's financial strength as measured by the credit rating agencies. Total capitalization is equal to forecast year-end 2010, but the percentage mix of debt and equity is as allowed in the April 2010 General Rate Case order from the Washington Utilities and Transportation Commission (WUTC) in DOCKETS UE-090704 and UG-090705 (consolidated). The level of imputed debt shown in the 2009 IRP was about $300 million. The reduction to about $266 million in the 2011 IRP reflects the roll-off, or shorter remaining term of several large PPAs.

Figure F-1
Capital Structure With and Without Imputed Debt



2. Other Financial Considerations

Discount Rate

PSE uses a discount rate to present value the various portfolio costs in this plan, and the same discount rate to evaluate the present value of portfolio costs and benefits of alternative resources considered for actual acquisition. PSE uses its allowed regulatory return on rate base as the discount rate. The WUTC decided on a capital structure and allowed cost of capital of 8.1 percent in Order 11 to DOCKETS UE-090704 and UG-090705 (consolidated) issued April 2, 2010 (page 93, table 9).

DSR Financial Considerations

Slow economic recovery and the reduction of federal tax incentives and economic stimulus funding 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. Also, as a result of the high efficiency tax credits and grants, PSE experienced increases in customer demand for certain energy efficiency equipment. Now that federal tax credits have been reduced significantly and most federal stimulus funds have been allocated, the increased demand for these measures may prove to have been temporary. This could mean that PSE may have to increase incentives, customer education, and promotional efforts to achieve energy efficiency goals. While the increase in energy savings may reduce costs over the long run, customers will continue to face increased rate pressure from higher program costs in the short run. The reduction of revenues due to reduced energy sales from conservation also creates pressure on PSE's financial performance.

Integration of Variable Energy Resources

Contents

The purpose of this appendix is to provide an update on the advances in the area of variable energy resource integration and assess the system's ability to meet ancillary service requirements for PSE system load and wind within the PSE balancing authority (BA). This appendix includes a broad discussion of PSE wind assets and their characteristics, and introduces key concepts around ancillary services. Modeling results are discussed in some detail to address the ancillary service requirements for wind projects considered in the 2020 IRP base case portfolio.

1. Overview

Wind Development in the Pacific Northwest

As of December 2010, there are over 4,700 MW of installed wind capacity in the Pacific Northwest including Washington, Oregon, Montana, and Idaho. Over 3,000 MW of installed wind capacity is interconnected to BPA's BA. There are also significant amounts of wind in various stages of permitting and approval process as well as under construction. The majority of installed wind capacity within the Northwest exists within Washington and Oregon and is heavily concentrated along the Washington-Oregon border in the Lower Columbia region. PSE's wind assets, however, are located in central and southeast Washington.

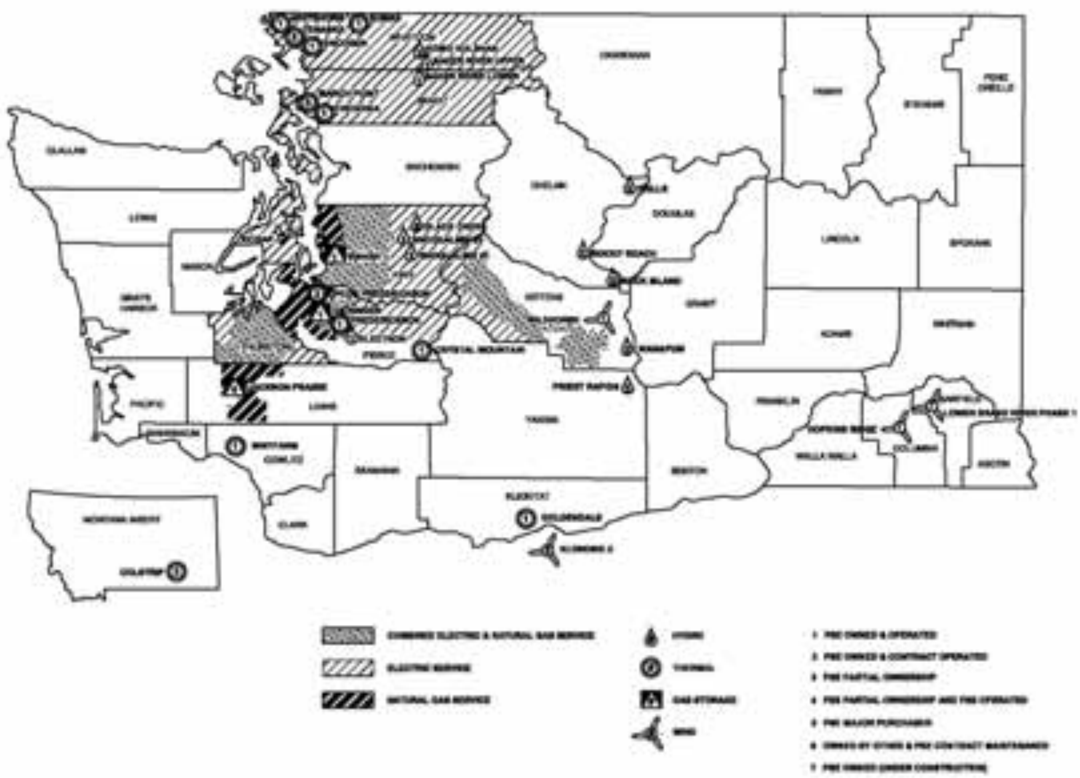
PSE Wind Resources

PSE currently owns and operates two wind projects, Hopkins Ridge and Wild Horse, with a combined capacity of 430 MW. The Hopkins Ridge wind project, located in southeast Washington, has a nameplate capacity of 157 MW and began commercial operation in November 2005. The Wild Horse wind project is located near Ellensburg in Central Washington and is comprised of 149 turbines with a nameplate capacity of 273 MW. The Wild Horse wind project has been online since late 2006. The capacity factors of both Hopkins Ridge and Wild Horse wind projects are around 30 percent. Additionally, PSE entered into a long-term power purchase agreement (PPA) for 22.1 percent (50 MW) of the Klondike III wind plant located in the Lower Columbia River Gorge region. PSE is currently in the process of constructing the 343 MW Lower Snake River Phase I (LSR I) wind facility located in Columbia and Garfield counties in Washington state. LSR I is scheduled to come online in 2012. Figure G-1 shows the proximity of PSE wind projects relative to PSE's service territory.

The Wild Horse wind project is interconnected to the PSE BA, and PSE is responsible for managing the variable output. Both Hopkins Ridge and Klondike III wind projects are interconnected to BPA's BA and 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.

Figure G-1

Map of PSE Service Territory



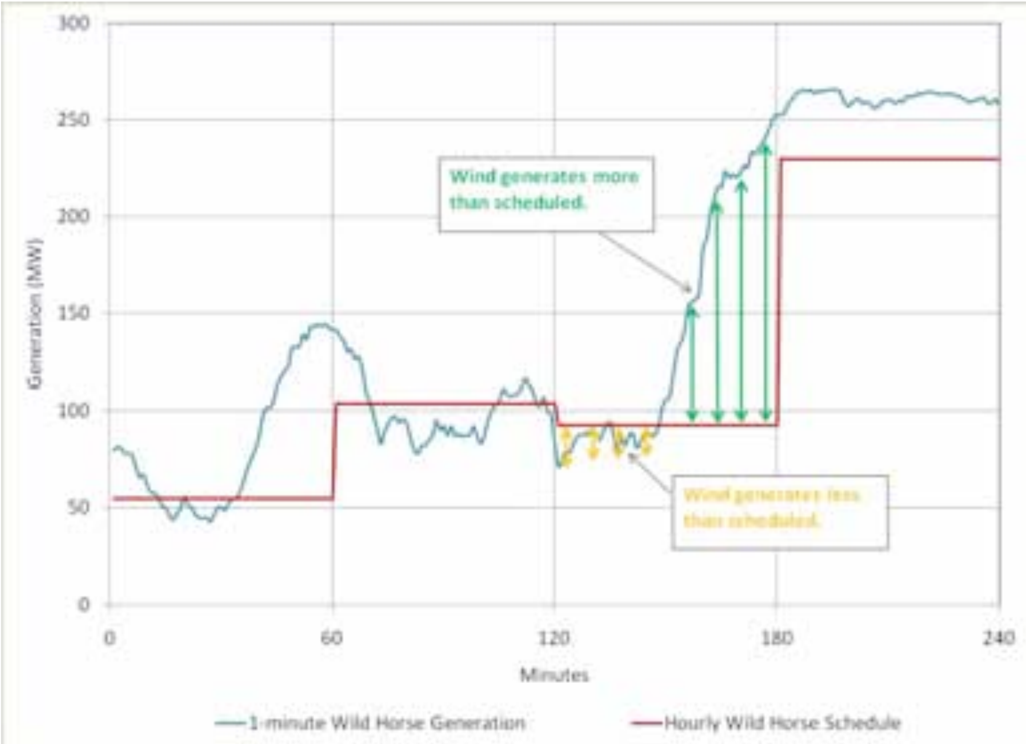
Third-Party Wind Resources

In addition to balancing the output from the Wild Horse wind project, PSE must also manage the output from third-party wind projects. Third-party wind projects are owned and operated by other entities and although they are interconnected to the PSE BA, they serve load outside the BA. PSE is responsible for delivering the scheduled amount of third-party wind to the sink BA regardless of actual wind power output. Effectively, third-party wind in the PSE BA is operationally indistinguishable from PSE-owned wind assets. The Vantage wind project, located in Central Washington, with a nameplate capacity of 96 MW, is the only third-party wind project interconnected to the PSE BA. PSE is currently in the process of ensuring full cost recovery of all wind integration services provided to third-party wind under the Open Access Transmission Tariff (OATT).

2. Variability and Uncertainty of Wind Output

Wind generation is an intermittent and non-dispatchable generation resource. The two primary challenges associated with integrating wind power into the bulk power system are the variability derived from the minute-to-minute natural volatility of wind as well as the uncertainty associated with accurately forecasting the wind output. While the variability can be managed similarly to managing PSE's load, the unpredictable nature of wind creates uncertainty. There can be large differences between the short-term wind generation forecast for the hour-ahead and day-ahead time frames compared to actual generation. Like short-term deviations in actual load, the natural variability inherent in minute-to-minute wind speed contributes to the need for instantaneous balancing of the output. Even with a perfect forecast for the hour such that the hourly forecast equals the hourly average generation, the output within the hour may vary above and below the hourly forecast. An example of the interaction between the one-minute Wild Horse wind generation output in comparison to its hourly scheduled output is presented in Figure G-2. The data used in the graph represent actual project output from December 14, 2010.

Figure G-2
Wild Horse Actual and Scheduled Generation from 12/14/10



To help manage the uncertainty in wind generation output, PSE constracts with a vendor to provide real-time wind generation forecasts across different time horizons. The vendor utilizes the latest state-of-the-art forecasting techniques and latest data feeds from the wind projects to ensure that the forecast error is minimized. The error associated with forecasting generally increases across the next several hours into the day-ahead time frame, which makes unit commitment decisions difficult and drives the need to carry ancillary services capable of making up for deviations in forecasted and actual generation.

3. Characteristics of Variable Energy Resources

Temporal and Seasonal Wind Characteristics

Wind generation varies year to year, by season as well as hour of day. Figure G-3 depicts the average monthly capacity factor for the Wild Horse and Hopkins Ridge wind projects from 2007 to 2010. For much of the year, their monthly capacity factor shapes track one another fairly closely. Both projects show higher generation for March through June.

Figure G-3
Wild Horse and Hopkins Ridge Monthly Capacity Factors

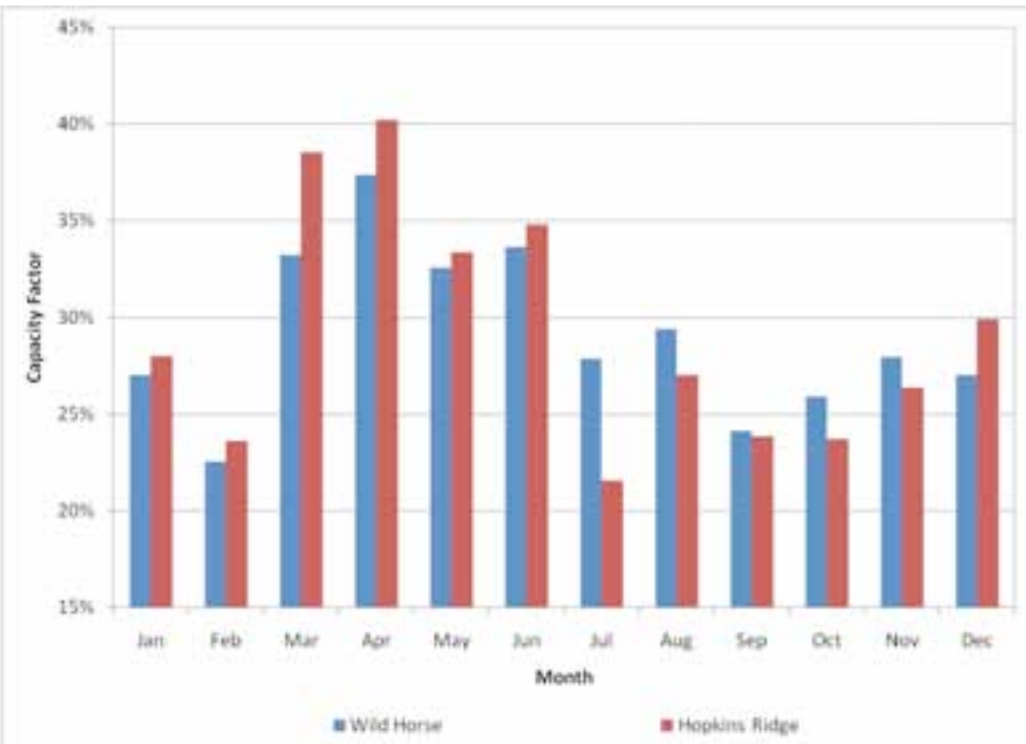
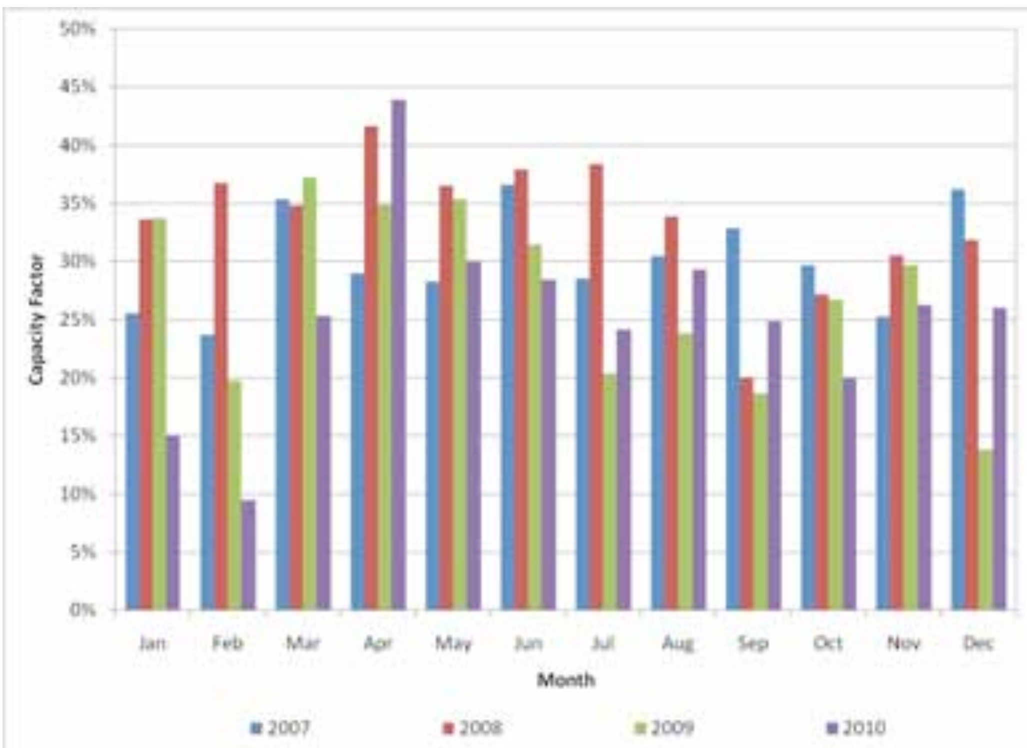


Figure G-4 shows the variability in monthly capacity factors at the Wild Horse wind project. The monthly generation varies from month to month within each year and it can also vary significantly for a given month between years. February is a good example with a range of capacity factors from below 10 percent to above 35 percent. Wind generation tends to peak in March and April and typically exceeds the annual capacity factor through the spring and into early summer. 2010 was a notable year because PSE experienced its worst month (February) and best month (April) on record. Annual capacity factors for 2007, 2008, 2009, and 2010 were 30 percent, 34 percent, 27 percent, and 25 percent, respectively.

Figure G-4
Wild Horse Average Monthly Capacity Factor by Year



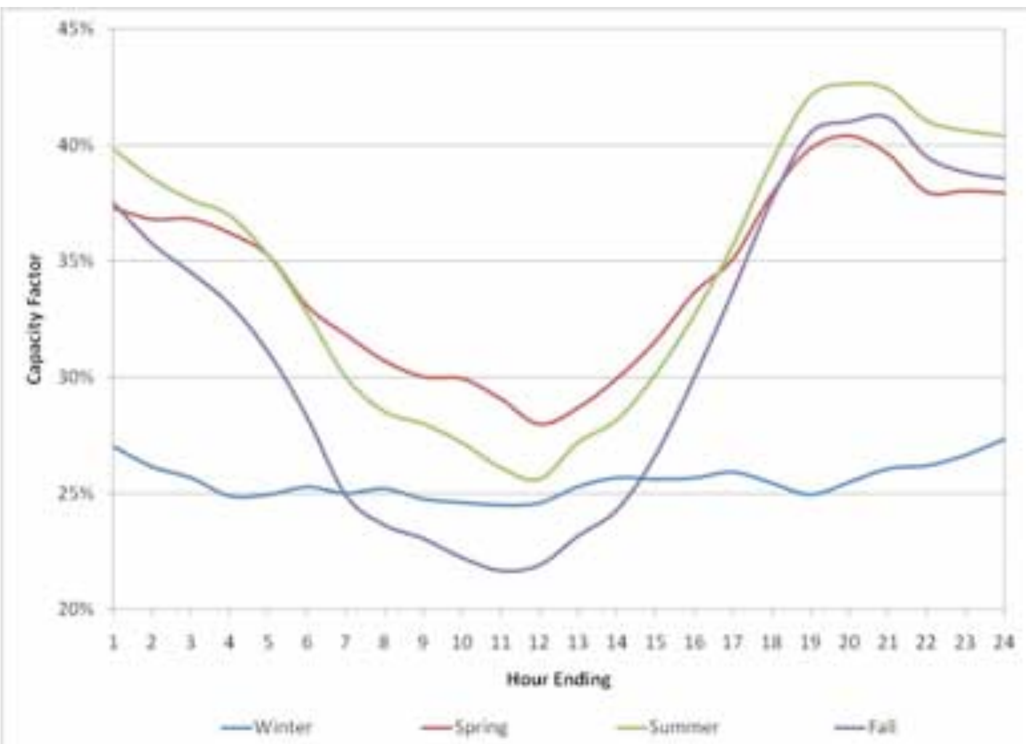
Wind also varies by time of day and between seasons. For the purpose of this analysis, the year was divided into four seasons as defined in Figure G-5.

Figure G-5
Seasonal Break Down

Season	Months
Winter	December, January, February
Spring	March, April, May
Summer	June, July, August
Fall	September, October, November

The four-year average hourly capacity factor for the Wild Horse wind project is shown in Figure G-6. During the spring, summer and fall, a very prominent shape emerges where wind output is strongest in the early evening hours and drops off significantly in the morning hours. The winter capacity factors are generally flat across the day.

Figure G-6
Average Hourly Wild Horse Capacity Factor



Ramping of Wind Output

While there is no one consistent definition of a wind ramp, it is important to study the output across various time horizons as they all have different impacts on system operation. To date, the PSE system has successfully managed all observed ramping events.

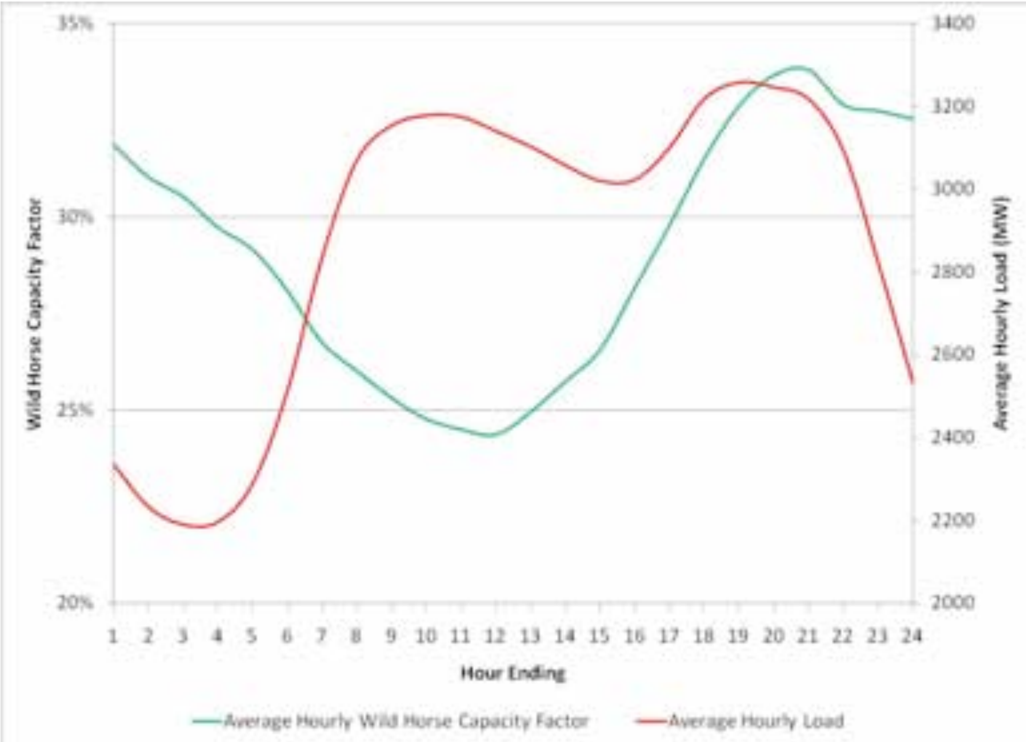
Large wind output changes over minute-to-minute intervals are rare at both Hopkins Ridge and Wild Horse wind projects. Over a 10-minute horizon, the standard deviation at both projects is approximately 4 percent of plant capacity. Over a thirty-minute window, about 1 percent of observed output changes are greater than 50 MW for Hopkins Ridge and 75 MW for Wild Horse, or approximately 30 percent of plant capacity. Across the hour, the 1 percent extreme ramp threshold is roughly 50 percent of installed capacity at each wind project.

Another approach to quantify ramp events, which has been used by some organizations in the Pacific Northwest, is to count wind output changes of 20 percent or more of capacity, over a 30-minute window. This method reveals that low capacity factor months generally have fewer ramping events relative to other months while the consistently high capacity factor months have the most ramp occurrences, and is true at both farms.

Wind Interaction with Load

The wind and load relationship is important because the direction and timing of wind ramp events and forecast deviations can have positive or negative impacts on the ability to match power generation to consumer demand. For example, as shown in Figure G-7, PSE load generally peaks twice every day, once in the morning and the second time in the later afternoon/early evening. This dual peaking phenomenon is stronger in the winter compared to summer. Wind generation typically peaks in the late evening to early morning and then ramps down during the morning load peak.

Figure G-7
Average Hourly Net Capacity Factor and Load



Net Load

Net load is equal to load minus wind generation and is a critical component to accurately plan for increasing wind penetration. When assessing system requirements, net load is analyzed rather than wind or load alone. The overall magnitude of the wind or load alone is less important than the magnitude and direction of the change in wind and load relative to each other.

Diversity of Wind

Diversity of wind generation output can play a role in system operations but at this time does not drive the wind project acquisition process. There is noticeable wind diversity between the Wild Horse wind project and the Hopkins Ridge wind project, especially over shorter time horizons. The diversity between the two projects is generally not due to one farm decreasing in wind output while the other ramps up, but rather when one farm experiences a large change in output the other farm experiences little to no output change.

Similar diversity effects are found when comparing load and wind volatility. This effect varies throughout the year. In winter months, there is greater diversity. However, the winter months are when load is also most volatile compared to the least volatile summer months. The relative impact of wind on net load volatility declines at longer time horizons due to the changes in load volatility being much greater than the changes in wind volatility. However while the changes in load are much larger over one hour time intervals than those of wind, the load changes are more predictable as well.

4. Integration of Hopkins Ridge Wind Project

As already mentioned, PSE's 157 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 the PSE 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. BPA's current wind integration rate is $1.29 per KW-month or $5.97 per MWh assuming a 30 percent capacity factor. BPA is currently in the process of the 2012 BPA Power and Transmission Rate Cases, which will set a new wind integration rate effective October 1, 2011.

5. Ancillary Services

Overview

North American Electric Reliability Corporation (NERC) defines ancillary services as "those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice"[1]. This section focuses on two ancillary services that fall under this broad NERC ancillary service definition: regulating reserves and net load following.

Regulating Reserves

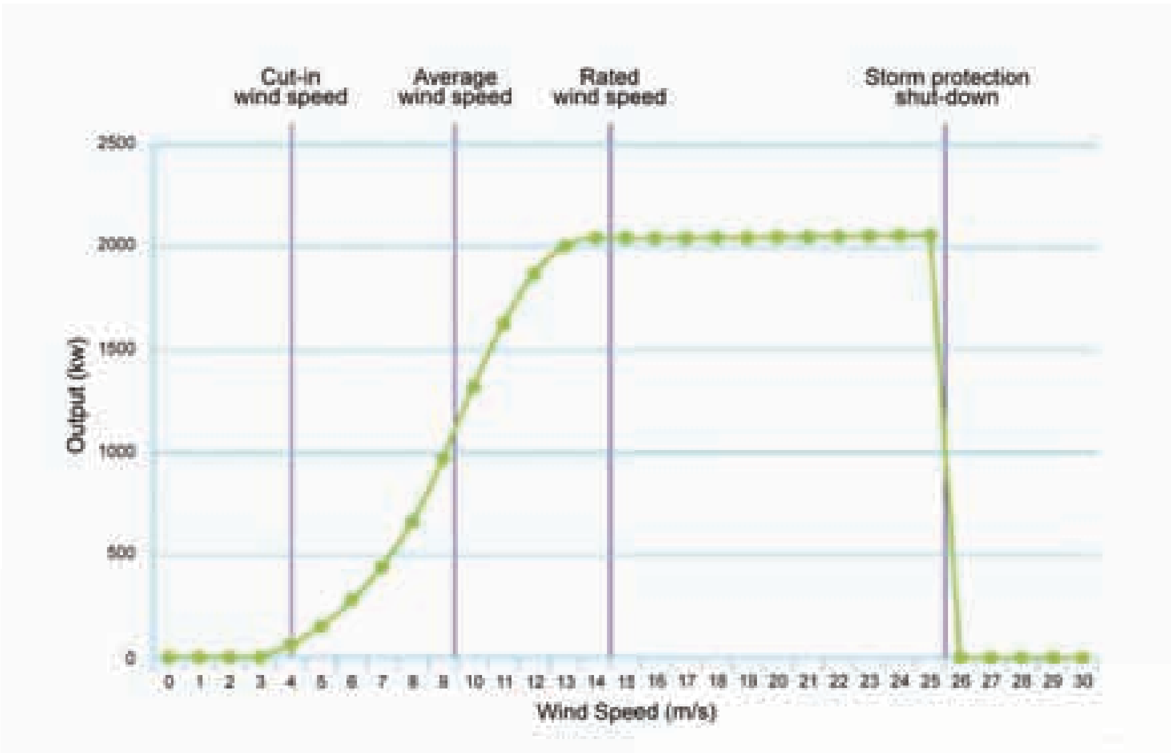
Within the regulation time frame, which corrects for the moment-to-moment fluctuations in wind and load, wind is relatively more volatile than load. However, since the wind penetration in PSE's system is relatively low in comparison with load, the current amount of regulating reserves is driven primarily by load volatility. As wind penetration levels increase, wind volatility may become more influential within the regulation time frame.

The regulating reserves needed to manage the wind output from the Wild Horse wind project alone is approximately 30 percent of the regulating capacity needed to manage load alone. When the wind output and load are netted together, the incremental increase in regulation capacity due to wind is only marginally higher (4.8 percent) than load alone.

As already mentioned, regulating reserve requirements are driven by load and wind variability. For wind alone, the variability in the wind output is dependent on the wind speed. The power curve of a generic wind turbine, shown in Figure G-8, illustrates the relationship between wind speed and the associated power output. The graphs shows that changes in wind output, when the wind speed is low or high, are relatively small in comparison to the changes in output that can be observed when the wind speed is the middle of the range, between 5 m/s and 13 m/s. The distinction of where on the power curve a turbine is currently generating is important because, at the regulation timeframe of moment-to-moment, wind speeds can only change so much, placing the emphasis on how a change in wind speed translates to a change in power output.

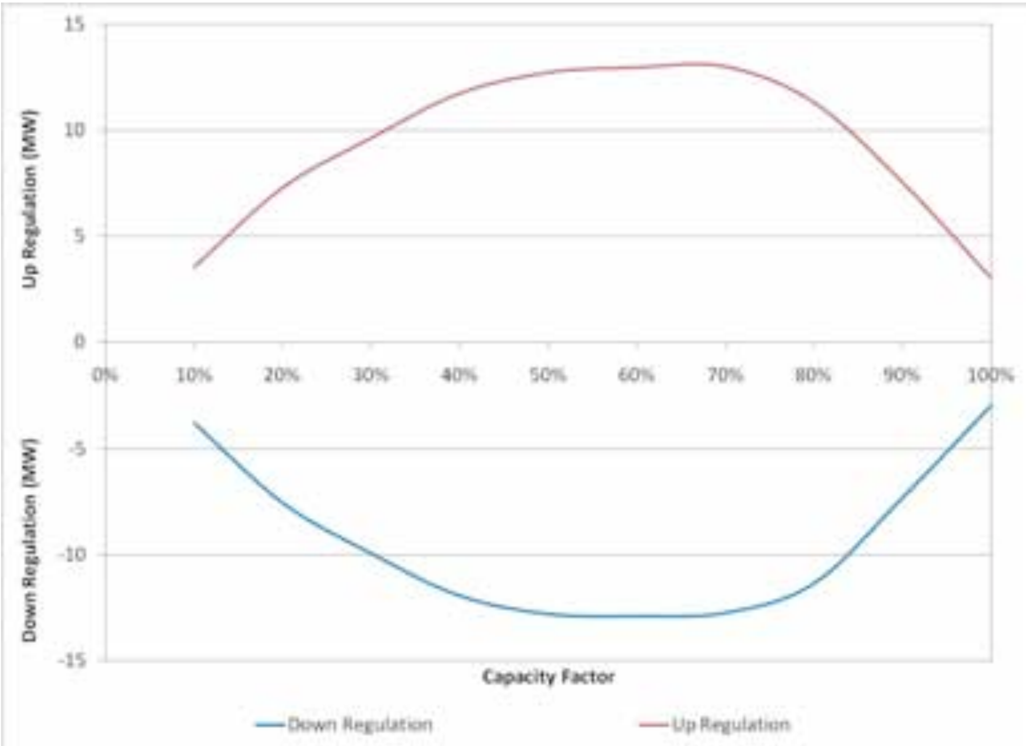
[1] http://www.nerc.com/docs/standards/rs/Glossary_of_Terms_2010April20.pdf

Figure G-8
Generic Wind Turbine Power Curve



As per the wind speed and wind output relationship, the regulation requirements follow the same pattern. Figure G-9 confirms that the relative amount of up regulation (to balance decreases in wind output) and down regulation (to balance increases in wind output) needed to balance Wild Horse wind output is small when the percentage of output to nameplate capacity, or capacity factor, is low or very high - but the need is larger when the capacity factor is between 40 percent and 70 percent. Although the up and down regulation appear similar in shape and magnitude, they are not identical.

Figure G-9
Wild Horse Regulation Requirements by Capacity Factor

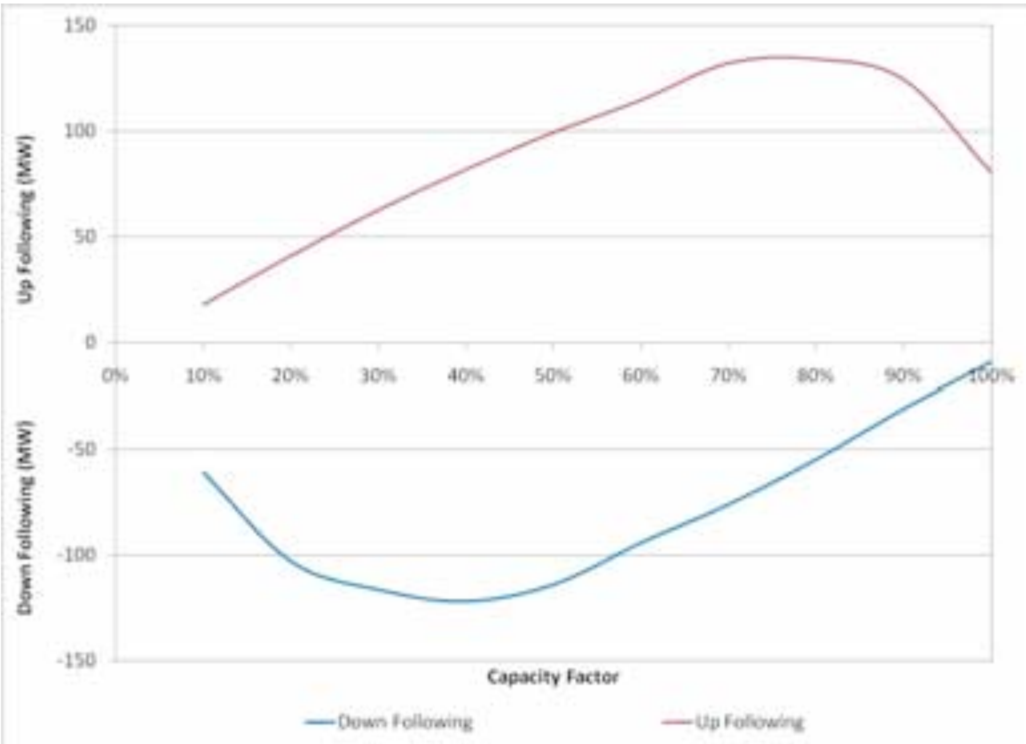


Net Load Following

Load following is not specifically defined by NERC, but it is understood to correct for differences across 10-minutes and up to the next hour, between scheduling windows. The assessments of following requirements focus on net load following or the net impact of load and wind. Similar to regulation, the level of wind output also disproportionately impacts the net load following requirements.

Figure G-10 provides an example of the up and down following requirements for Wild Horse wind generation alone. The up and down following requirements are not symmetrical. Up following is needed when the wind output decreases and therefore, at higher wind output levels, there is the potential for a substantial decrease in output over the course of an hour, requiring other resources to provide larger quantities of up following reserves. The reverse occurs for down following. For example, when a wind project is generating at its maximum output, only up following is needed because the generation can only go down while at mid-generation the output could potentially increase or decrease, requiring similar amounts of both up and down following reserves.

Figure G-10
Wild Horse Up and Down Following by Capacity Factor



6. Managing Ancillary Services

Existing Ancillary Services

If actual real-time generation output diverges from the hourly scheduled wind output, as shown in Figure G-2, 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 hydro generation, which is on automatic generation control (AGC) and can respond instantaneously. Large, unanticipated ramping events must be managed within the hour with a combination of AGC and dispatcher actions. Net load following corrects for differences over longer time increments of 10 to 50 minutes between hourly scheduling adjustments. Wind variability and uncertainty drive PSE's need to carry additional reserves for the purpose of balancing net load.

For most of the calendar year, PSE's share of Mid-Columbia hydro generation is sufficient to manage the instantaneous load and wind variability and any within-hour deviations from their respective schedules. During the spring runoff period, however, when the Columbia River flows are high, the Mid-Columbia hydro 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.

During times when the Mid-Columbia hydro system does not provide the necessary flexibility to manage net load, PSE uses its thermal resources and market transactions to balance the system. During spring 2008, PSE experienced insufficient Mid-Columbia hydro flexibility and had to use its thermal resources and market transactions to support system operations. The thermal resources were dispatched and operated at minimum, mid-point and base load to provide the flexibility to either increase or decrease generation depending on the nature of net load deviations. For this period, Mid-Columbia hydro supported all of its regulating reserve requirements but the following requirements were supported less than 20 percent of the time. Typically, Mid-Columbia hydro supports the majority of the regulation and following requirements.

PSE also has had limited success procuring ancillary products in the forward market. During the spring 2008 high runoff event, PSE 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 are considered a viable option for wind integration.

Future Ancillary Services

Due to expiring Mid-Columbia hydro generation contracts, by the year 2020 PSE's share of the Mid-Columbia hydro, including Upper Baker hydro, is expected to be 795 MW, or 261 MW less than today's capacity. This loss of hydroelectric generating capacity may require PSE to have other assets available to provide ancillary services.

All of the regulating reserves are currently provided by the AGC from PSE's share of Mid-Columbia hydro generation. Even as our contractual rights of the Mid-Columbia hydro projects change and PSE's total capacity decreases through to 2020, we will be able to continue to reliably satisfy the regulating reserve requirements for future portfolio needs and wind penetration changes. In actual operations, we may decide to manage the system differently and utilize different sources of AGC.

A likely combination of combined cycle (CCCT) and simple cycle (CT) natural gas turbines may be needed to provide net load following during times of high demand or flow-constrained Mid-Columbia hydro conditions. In 2020, the 2011 IRP Base Case scenario estimates that PSE's gas-fired thermal fleet will consist of the same four CCCT units currently in operation, while all but two CT units will be replaced. PSE's ability to provide the required ancillary services to manage net load following and maintain system reliability will undoubtedly require a more integrated operational strategy in which some of the ancillary service capacity currently being provided by the Mid-Columbia hydro will be shifted to PSE's thermal units as well as available market alternatives. Should we determine that long-term power purchase agreements are the least cost option to meet load, other options of providing ancillary services may need to be identified.

Modeling Future Ancillary Service Capability

This assessment of PSE's ability to provide future ancillary services focuses on net load following requirements. Regulating reserve capacity is provided by Mid-Columbia hydro and effectively reduces the Mid-Columbia hydro's capability for net load following.

To determine the future impacts of reduced Mid-Columbia hydro capacity and a different thermal resource portfolio to meet ancillary service requirements, the Aurora model was used to set the dispatch of hydro and thermal units based on the 2020 Base Scenario. Aurora sets the hydro generation and it also provides baseline operating characteristics for the thermal fleet in terms of operating hours, starts, and total generation. The Ancillary Service Model (ASM) evaluates the PSE system's capability to meet net load following. The ASM utilizes the dispatch from Aurora as inputs and adjusts the generation of units capable of providing net load following: Mid-Columbia hydro, Upper Baker hydro, CCCT and CT thermal units.

Net load following is entered into the ASM as an hourly input which represents the hourly capacity required to manage the uncertainty in load and wind. Most production cost models may not account for reserves and ancillary service requirements, so treating these requirements in another model as a secondary step is a reasonable approach and may significantly change the operating behavior of some resources. The ASM takes a least-cost approach to meeting net load following by utilizing hydro resources first and then the thermal resources. PSE resources are considered sufficiently flexible if the available capacity meets all of the net load following requirements at the 95 percent confidence interval. The model also calculates the changes in output since all resources start from economic dispatch and are then adjusted to a less optimal or efficient generation to meet the net load following.

Model Assumptions

Below is a list of the major modeling assumptions driving the ASM to meet net load following using the capabilities of the hydro and thermal resources:

- 795 MW of hydro capacity;
- Resource portfolio includes four CCCT and eight CT resources;
- Various wind penetration levels were analyzed: 273 MW of Wild Horse wind capacity, 430 MW of total capacity from Wild Horse and Hopkins Ridge and 773 MW of total capacity from Wild Horse, Hopkins Ridge and LSRI; and
- Hourly electric and gas price data were used in conjunction with net load following derived from historical deviations in hour-ahead forecasts.

The general modeling approach follows these steps:

- Net load following is provided first by reshaping the hourly hydro generation.
- If additional net load following is needed and combined cycle units are economically dispatched, their output is adjusted to hold back net load following capacity.
- Finally, if additional net load following is still required, the output from simple cycle plants is adjusted if economically dispatched, or they started to meet the remainder of the following requirement.

Summary of Results

It is important to note that this analysis utilizes only one of many possible future resource portfolios. The assumptions made represent the best estimate of the likely resources available to the utility in the year 2020 capable of providing ancillary services. However, PSE's acquisition strategy may result in a different portfolio, ancillary services markets could develop, or PSE's anticipated balancing area responsibility may change.

Figure G-11 provides several statistics on how hourly net load following is being met by PSE's resource portfolio. Results for the following three wind scenarios are provided:

1. 273 MW Wild Horse wind project (identified as WH);
2. 430 MW of Wild Horse and Hopkins Ridge installed capacity (identified as WH+HR);
3. 773 MW of Wild Horse, Hopkins Ridge and LSRI installed capacity (identified as WH+HR+LSR).

Most of the up and down following will be provided by the Mid-Columbia hydro, as is currently the case. However, as wind penetration increases, the thermal resources will be used increasingly more to provide net load following. All of the net load following requirements are met in the three scenarios shown in Figure G-11. In the WH+HR+LSRI scenario, as much as 20 percent of the up following and 30 percent of the down following may be provided the thermal resources.

In the WH scenario, the results may not exactly reflect historical operating statistics because the dispatchers and operators may take a different approach to managing net load following. However, the incremental impact of additional wind may be indicative of what may occur in reality and may provide useful information for system operators and planners.

Figure G-11
Ancillary Service Modeling Results

Wind Scenario	% Up Following met by Hydro	% Down Following met by Hydro	% Up Following met by Thermals	% Down Following met by Thermals	Average Annual Starts per CT	Average Additional CT Starts per Month	Incremental Increase in CT Starts per Month per CT
WH	91%	88%	9%	12%	139	12	12
WH + HR	90%	86%	10%	14%	176	15	3
WH + HR + LSR	80%	70%	20%	30%	234	20	5

To provided hour-ahead ancillary services for load net Wild Horse alone, each of the eight CTs would be called upon to start 12 additional times per month. The annual number of starts per CT per month will vary seasonally. The ancillary service requirements for incremental wind are not additive because of wind diversity. When the Wild Horse and Hopkins Ridge wind projects are modeled together, the percent change in CT starts above economic dispatch only increases 27 percent above starts required to support the Wild Horse project alone, while wind capacity increases over 58 percent. The percent change in CT starts needed to balance all three wind plants only increases 33 percent while wind capacity increases 73 percent.

Figure G-12 shows the impact hourly net load following has on CCCT and CT generation. The annual amount of CCCT generation decreases when providing net load following. This is a function of how the model utilizes CCCTs to provide net load following. A CCCT unit can only provide following if it is already online and running. If a unit is running based on economic dispatch, then most likely it is running at base load, which means that the plant is already providing down following. If, however, up following is needed, the unit must reduce its generation to have sufficient capacity available to provide up following. This operational assumption results in a very small decrease in CCCT generation initially and a slight increase in generation to support the three wind projects. On the other hand, results show a large change in CT generation. The 12 to 20 additional CT starts described above result in increases in CT generation anywhere from 42 percent to 180 percent.

Figure G-12
Percent Change in Annual Generation by Thermal Resource

Wind Scenario	% Change in CCCT Generation	% Change in CT Generation
WH	-0.15%	42%
WH + HR	-0.26%	52%
WH + HR + LSR	0.21%	180%

Based on these results, PSE is confident that the 2020 anticipated resource stack is capable of meeting the ancillary service requirements for wind and load projections in the year 2020. While the exact number and capacity of wind plants within PSE's BA is unknown, the above results indicate that the system may have enough ancillary service benefits to support the requirements for the wind shown here. In actual operations, PSE may decide to manage the system differently and as a result will use different resources and process to provide the ancillary services.

Demand Forecasts

Contents

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."

1. 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, televisions, computers, and various other plug loads. Commercial and industrial customers use energy for production processes, space heating, ventilation, and air conditioning (HVAC), lighting, computers and other office equipment.

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 an 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.

2. 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 throughout the period. These included a series of abrupt declines throughout the second half of 2008, and an uncertain and slow recovery process during 2009 and early 2010.

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, PSE's service area forecast begins with assumptions about what is happening in the broader U.S. economy. PSE relies on Moody's Analytics U.S. Macroeconomic Forecast, a long-term forecast of the U.S. economy, for this information. 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

For the purpose of creating the baseline load forecast used in this IRP, PSE used the March 2010 Moody's Analytics U.S. Macroeconomic Forecast. Moody's predicted the recovery would not be firmly under way until 2011, when real GDP was expected to be rising at 4 percent and unemployment would finally be on a sustainable path downward, though still averaging over 9.5 percent for the year. As the economy reaches a sustainable path of expansion, Moody's expects the Federal Reserve to begin raising interest rates, and that inflation will return to target levels.

Short-term risks to the economy include a weaker housing market as foreclosures increase, reduced consumer spending as households reduce debt, and persistently high unemployment that causes further deterioration in workforce skills. Long-term concerns exist over federal fiscal policy and the budget when considering the costs of Medicare, Medicaid, and Social Security in combination with the retirement of the baby boomer generation.

Globally, the dollar is expected to strengthen against the euro and other currencies in the near term, and to strengthen against the yuan over a longer period, as policymakers in China allow it to revalue more naturally.

Regional Economic Outlook

PSE's regional economic and demographic forecast is prepared internally using econometric models whose primary input is a macroeconomic forecast of the United States. Although the Puget Sound region has its own economic and demographic characteristics, it is part of a national and global economy and its pattern of growth is highly correlated with that of the rest of the nation. As mentioned above, the baseline analysis in the current IRP is based on a regional economic forecast derived using the March 2010 Moody's Analytics U.S. Macroeconomic Forecast, with other sources providing input and context where appropriate. The assumptions from this regional forecast were used to create the forecast scenario identified as the 2010 Base Case.

According to PSE's regional forecast model base case, the projected employment in the electric service territory is expected to grow at an annual rate of 1.4 percent between 2009 and 2029, compared to the prior 15-year historical rate of 1.1 percent. The main factor contributing to the slightly faster long-term growth in employment is recovery from the effects of the latest recession that depress the end point of the historical sample. Overall long-term regional growth is moderated by slower national employment growth due to lower national population growth, lower regional population growth resulting from space constraints, and the expectation that The Boeing Company's strong historical employment growth will not necessarily persist into the future. Manufacturing employment is expected to decline at a 0.8 percent annual rate of change in this scenario. The base case scenario projects that local employers will create more than 560,000 jobs between 2009 and 2029 and that an inflow of more than 920,000 new residents will increase the population of PSE's electric service territory to almost 4.6 million by 2029.

Four alternate scenarios were developed for the analysis, two based on business cycle variations ("Cyclical" Alternate Low and High) and two based on population growth variations ("Structural" Alternate Low and High).

The "Cyclical" Alternate Low and High scenarios were developed using varied assumptions provided by Moody's Analytics. "Cyclical" is used as a descriptor in this case because Moody's alternative scenarios are based in large part on assumptions about near-term business cycles in the national economy. To derive the Low assumptions, PSE calculated the ratio between Moody's 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 Cyclical Low scenario load forecast. A similar approach was taken to calculate the Cyclical High scenario load forecast, with a ratio calculated between Moody's optimistic and baseline projections for each economic variable.

"Structural" Alternate Low and High scenarios were developed using variations on long-term population growth provided by the Washington state Office of Financial Management. "Structural" is used in this case as a descriptor to indicate that the scenarios are based on alternative assumptions of long-term regional population growth, rather than business cycles. The regional forecast model was used to determine how other related economic variables would change given the adjusted population growth. The final set of variables related to both the high and low population estimates were then used to calculate the Structural Low load forecast and the Structural High load forecast.

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.

Electricity

PSE projects that over the next 20 years, nominal retail electric rates will experience an increase of between 3.7 percent and 6.2 percent annually through 2014. Following a decline in the rate of increase, nominal long-term annual growth rates level off between 2.1 percent and 2.6 percent. 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 Seattle's consumer price index based on PSE's regional economic and demographic forecast.

Natural Gas

PSE expects the rise in nominal retail gas rates to be slightly higher than the long-term rate of inflation: approximately 2.2 percent 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 and General Rate Case considerations. Forecasted gas costs reflect Kiodex gas prices for the 2010-2014 period and inflation projections beyond that. The distribution margin is based on PSE’s projection for the near term and inflation projections for the longer term.

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 2009.

Loss Factors

Based on updated analysis, the electric loss factor was adjusted from 6.7 to 6.8, while the gas loss factor remains at 0.8 percent.

Major Accounts

The 2010 Base Case forecast assumed that several large corporations and entities within PSE’s service area planned to add facilities starting in 2010, which would eventually increase electric consumption by approximately 15 aMW.

3. Electric and Gas Demand Forecasts

Demand forecasts starting in 2010 serve as the basis for establishing resource need in this IRP. The charts and tables included herein incorporate demand-side resources implemented through March 2010 (primarily energy efficiency), 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.

2010 base case. This scenario assumes that the U.S. economy grows over time at an average annual real GDP growth rate of 2.5 percent from 2009 to 2029, with no major shocks or disruptions. It projects employment in the electric service territory to grow at an annual rate of 1.4 percent, and manufacturing employment growth to decline by an annual rate of 0.8 percent. With a faster rate of growth than the 15-year historical rate of 1.1 percent, it projects that local employers will create more than 560,000 jobs between 2009 and 2029, and that the inflow of more than 920,000 new residents will increase the population of our service territory to almost 4.6 million.

2010 "cyclical" alternate low assumes a double-dip recession and lower short-term growth. This scenario is based on pessimistic assumptions of the current business cycle. Long-term growth is almost identical to the 2010 Base Case scenario and the scenario differences occur primarily during the 2010- 2017 period. For PSE's service territory, this scenario projects that employment will be 5.2 percent lower than the 2010 Base Case scenario in 2012, with most of the recovery to the 2010 Base Case scenario complete by 2016. Unemployment will peak at 11.8 percent in 2012 in this scenario, and personal income, households, and housing permits assumptions are also lower than in the 2010 Base Case.

2010 "cyclical" alternate high assumes a 2 percent faster national GDP growth rate during 2010 and an earlier return to the pre-recession GDP growth rates. For PSE, this scenario includes an increase in the rate of employment growth through 2015 and a more aggressive return to pre-recession housing permit rates. In addition, upward adjustments were made to assumptions about personal income growth and the speed of the unemployment rate's decline.

2010 "structural" alternate low assumes lower long-term population growth and determines the subsequent effect on customer growth and other parameters instead of modeling near-term differences in the business cycle. Final population in 2029 is approximately 9 percent lower than the 2010 Base Scenario, leading to substantially reduced levels of employment and total personal income.

2010 "structural" alternate high assumes higher long-term population growth and determines the subsequent effect on customer growth and other parameters instead of modeling a shorter business cycle forecast process. Final population in 2029 is just over 10 percent higher than the 2010 Base Scenario, leading to substantially increased levels of employment and total personal income.

Figure H-1

Forecast of Electric Service Area Household Growth Rate by Scenario

Scenario	2010	2011	2012	2013	2014	2015	2016	2017
2010 Baseline	1.0%	1.1%	1.2%	1.3%	1.4%	1.4%	1.3%	1.3%
2010 "Cyclical" Alternate Low	0.9%	0.8%	1.0%	1.1%	1.3%	1.4%	1.4%	1.3%
2010 "Cyclical" Alternate High	1.1%	1.3%	1.2%	1.3%	1.4%	1.4%	1.3%	1.3%
2010 "Structural" Alternate Low	0.8%	0.7%	0.7%	0.8%	0.9%	0.9%	0.9%	0.9%
2010 "Structural" Alternate High	1.3%	1.6%	1.7%	1.8%	1.9%	1.8%	1.8%	1.8%

Figure H-2

Forecast of Electric Service Area Unemployment Rate by Scenario

Scenario	2010	2011	2012	2013	2014	2015	2016	2017
2010 Baseline	9.2%	8.5%	7.0%	6.0%	5.7%	5.6%	5.6%	5.6%
2010 "Cyclical" Alternate Low	10.2%	11.8%	11.1%	10.0%	8.7%	6.8%	5.7%	5.6%
2010 "Cyclical" Alternate High	8.5%	7.1%	6.5%	6.0%	5.7%	5.6%	5.6%	5.6%
2010 "Structural" Alternate Low	9.3%	8.7%	7.2%	6.2%	6.0%	5.9%	6.0%	6.1%
2010 "Structural" Alternate High	9.2%	8.5%	6.9%	5.9%	5.5%	5.4%	5.3%	5.3%

A. Electric Forecast

Figures H-3 and H-4 show electric sales and peak growth forecasts for all five scenarios over the first 10 years of the planning horizon. Highlights with reference to the 2010 Base Case scenario are discussed on the following pages.

Figure H-3

Annual Electric Load Forecasts 2010-2019

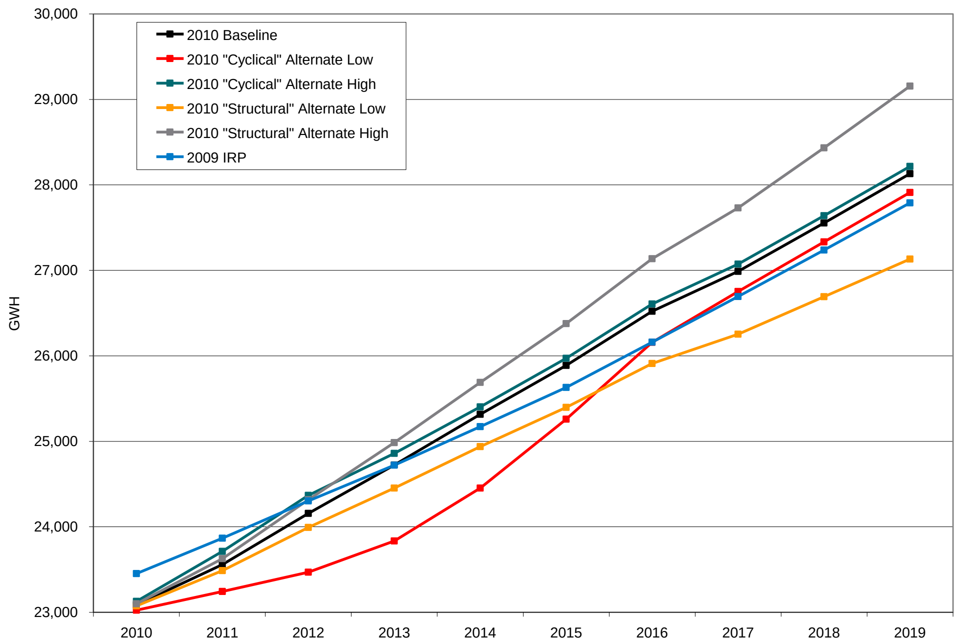
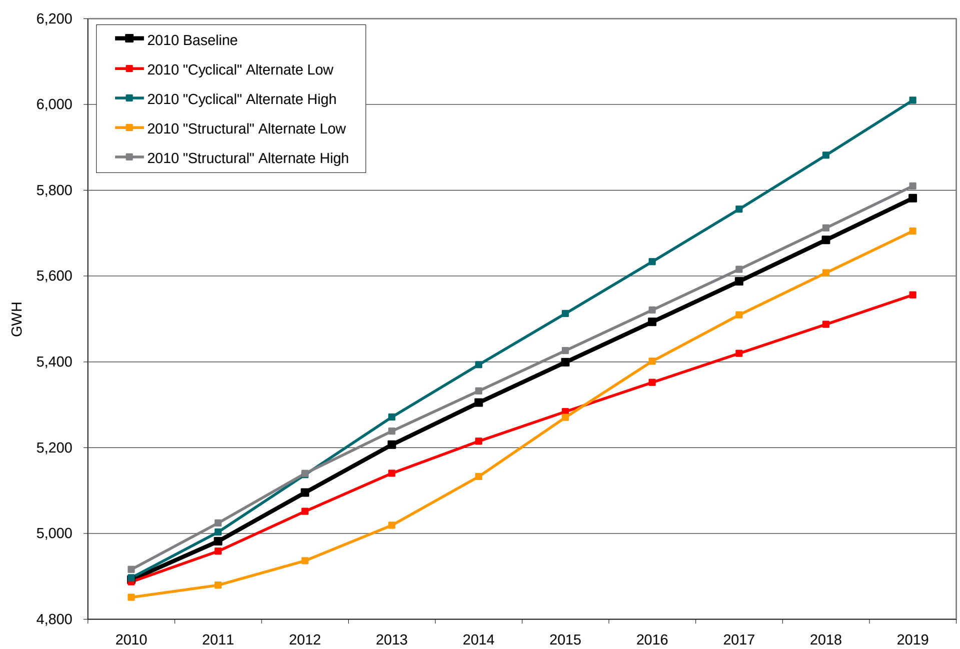


Figure H-4

Electric Peak (Normal: 23°F) Forecast 2010-2019



Electric Forecast Highlights (2010 Base Case)

1. Average electric firm loads are expected to grow at an average annual rate of 2 percent per year, from 2,455 aMW in 2009 to 3,642 aMW by 2029.

The average annual growth rate is projected to be approximately 1.9 percent between 2009 and 2014 due to reduced near-term economic growth. The long-term growth rate of sales returns to slightly above 2 percent per year for the remainder of the period, 2014-2029.

2. Commercial loads are expected to grow faster than residential loads, increasing from 44 percent of total loads in 2009 to 48 percent of total loads in 2029.

Commercial loads related to nonmanufacturing employment are expected to grow the fastest in the future, while industrial loads are expected to continue to decline gradually.

Slower growth in residential loads 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 relatively flat average residential use per customer during the forecast period. Residential loads as a percentage of total sales are projected to decline from 51 percent in 2009 to 49 percent in 2029.

3. The number of electric customers is predicted to grow at an average rate of 1.7 percent per year, reaching approximately 1.5 million by 2029.

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 2009, residential customers accounted for 88 percent of PSE's total customer base.

4. Peak hourly loads for electric are expected to grow by 1.6 percent per year over the next 20 years to 6,746 MW from 4,905 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 temperature-driven peak load events) are growing more slowly than commercial sales.

In general, compared to the 2009 IRP, the 2010 Base Case forecast of energy load is higher by about 278 aMW by 2027. The load forecast has a lower starting point for 2010 due to the impacts of the recession. Changes to the way PSE accounts for how historical investments in programmatic demand-side resources have reduced historical load growth have led to a slightly higher forecast of future load growth, prior to the impact of new programmatic demand side-resources.

The following tables summarize electric demand forecast results.

Figure H-5[1]

Electric Load Forecast Scenarios in aMW

Scenario	2010	2011	2012	2017	2022	2027	2029	AARG
2010 Baseline	2,456	2,507	2,570	2,871	3,182	3,507	3,642	2.1%
2010 "Cyclical" Alternate Low	2,450	2,473	2,497	2,846	3,158	3,480	3,615	2.1%
2010 "Cyclical" Alternate High	2,461	2,523	2,593	2,880	3,191	3,517	3,653	2.1%
2010 "Structural" Alternate Low	2,455	2,499	2,553	2,793	3,029	3,264	3,358	1.7%
2010 "Structural" Alternate High	2,458	2,514	2,587	2,950	3,343	3,773	3,958	2.5%
2009 IRP	2,542	2,591	2,639	2,905	3,222	3,570	NA	2.0%

Figure H-6[1]

Electric Load Forecasts by Class in aMW (2010 Base Scenario)

2010 Base Scenario	2010	2011	2012	2017	2022	2027	2029	AARG
Total	2,456	2,507	2,570	2,871	3,182	3,507	3,642	2.1%
Residential	1,233	1,254	1,289	1,432	1,574	1,714	1,770	1.9%
Commercial	1,080	1,106	1,136	1,302	1,472	1,659	1,739	2.5%
Industrial	132	135	133	123	119	114	113	-0.8%
Other	12	12	13	15	17	19	20	2.9%

Figure H-7[1]

Annual Average Electric Customer Count Forecast by Class (2010 Base Case)

2010 Base Scenario	2010	2011	2012	2017	2022	2027	2029	AARG
Total	1,079,475	1,089,860	1,105,021	1,212,168	1,325,430	1,443,843	1,492,208	1.7%
Residential	953,237	961,872	974,476	1,066,523	1,164,222	1,265,622	1,306,748	1.7%
Commercial	119,104	120,659	122,990	136,945	151,421	167,172	173,855	2.0%
Industrial	3,673	3,664	3,655	3,589	3,519	3,449	3,421	-0.4%
Other	3,461	3,665	3,900	5,111	6,268	7,600	8,184	4.6%

Figure H-8[1]

Annual Electric Peak Forecast (2010 Base Case)

2010 Base Scenario	2010	2011	2012	2017	2022	2027	2029	AARG
Normal	4,892	4,982	5,095	5,588	6,073	6,552	6,746	1.7%
Extreme	5,313	5,411	5,537	6,083	6,623	7,159	7,375	1.7%
2009 IRP	4,987	5,067	5,149	5,628	6,165	6,747	NA	1.8%

Figure H-9[1]

Residential Electric Use per Customer in MWh,

Current IRP (2010 Base Case) compared to 2009 IRP (Base Case)

	2010	2011	2012	2017	2022	2027	2029	AARG
Current IRP	11.327	11.416	11.589	11.762	11.845	11.863	11.868	0.2%
2009 IRP	11.019	10.991	10.974	11.008	11.029	11.044	NA	0.0%

[1] AARG means average annual rate of growth.

B. Gas Forecasts

Figures H-10 and H-11 map the gas forecasts for all five scenarios to show load and peak day forecasts, excluding demand-side resources, for the first 10 years of the planning horizon. Highlights are discussed on the following pages.

Figure H-10
Annual Gas Load Forecast Scenarios, 2010-2019

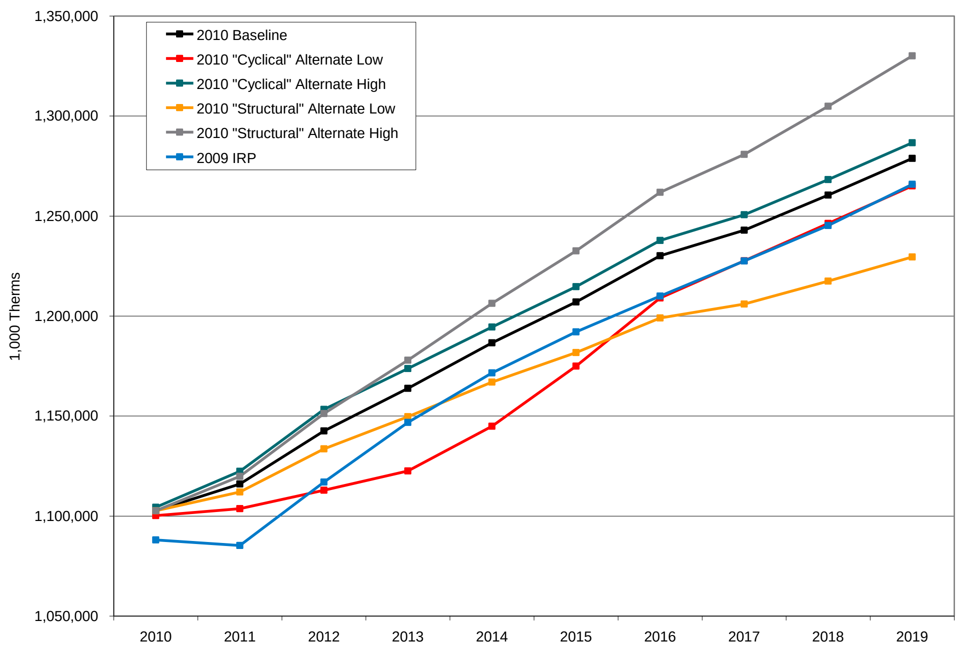
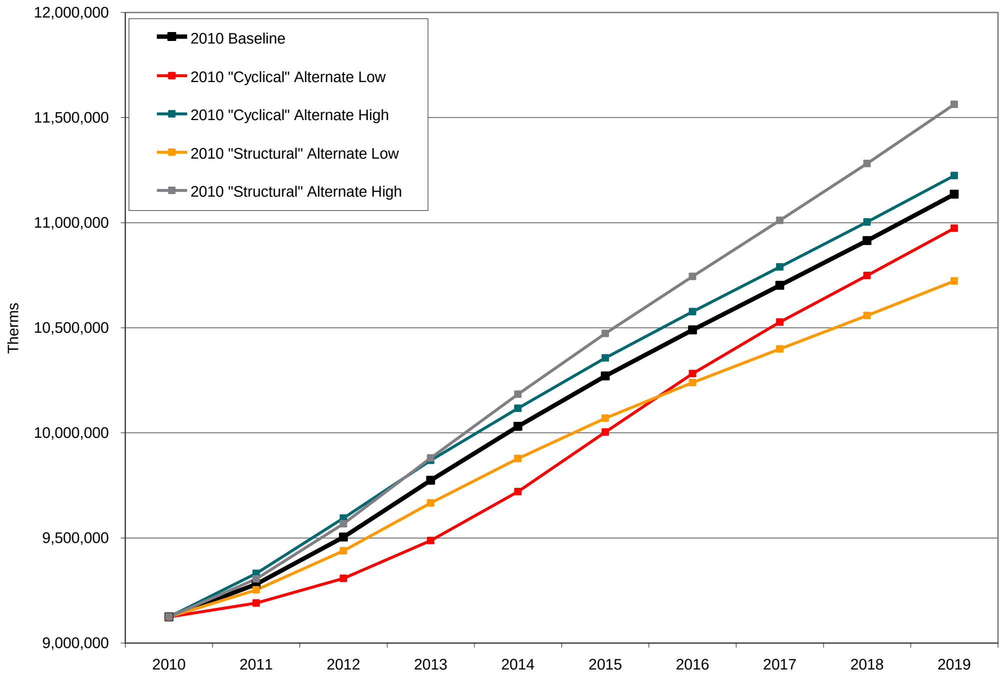


Figure H-11

Firm Gas Peak Day Forecast Scenarios 2010-2019



Gas Forecast Highlights (2010 Base Case)

1. Natural gas load is expected to grow at an average rate of 1.5 percent per year over the next 20 years, from 1.1 billion therms in 2009 to just under 1.5 billion therms in 2029.

For 2010-2013, we expect a lower growth rate in gas load due to a lower rate of customer growth. Customer growth is expected to be weak in the near term due to lower household formation stemming from high unemployment and a weak housing market. As long-term gas retail rates approach the rate of inflation and economic conditions normalize, load is expected to grow at a long-term rate of 1.5 percent per year.

While overall sales volume will increase over the long term, some sectors (industrial, interruptible, and transportation) are expected to decline slightly, continuing more than a decade-long trend of slowing manufacturing employment and increasing retail prices. In the residential class, a slight decline in use per customer caused by more efficient equipment, a projected increase in multifamily housing, and energy efficiency, is expected to be 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 2.1 percent per year over the next 20 years, reaching approximately 1.1 million by 2029.

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 2.8 percent.

Residential accounts are expected to increase at a rate of just over 2.1 percent per year over the next 20 years, and to represent 92.8 percent of our total customer base in 2029, up 1.3 percent from 91.5 percent in 2009.

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 1.9 percent per year during the next two decades, and to account for roughly 7.0 percent of the overall customer base in 2029.

3. Peak day firm gas requirements are expected to increase at an average rate of 1.9 percent per year over the next 20 years, from 9.3 million therms in 2009 to 13.5 million therms in 2029.

Gas peak day growth rates are slightly higher than those for total load because faster 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 70 percent of the peak daily requirement; the commercial and industrial sectors account for 28 percent and 2 percent, respectively. Large-volume commercial and industrial customers are included in this forecast.

Compared to the gas peak day forecast from the 2009 IRP, this forecast is lower during the 20-year forecast. This reduction is caused by a lower residential billed sales forecast, the primary driver of the peak day forecast, which is slightly lower due to a reduced customer growth forecast, as well as slightly lower use per customer due to weaker economic conditions and a slightly higher retail rate.

The tables below summarize gas demand forecast results.

Figure H-12

Gas Sendout Forecast Scenarios

(in 1,000 Therms)	2010	2011	2012	2017	2022	2027	2029	AARG
Scenario								
2010 Baseline	1,093,884	1,107,154	1,133,382	1,232,994	1,325,897	1,426,027	1,465,196	1.6%
2010 "Cyclical" Alternate Low	1,091,416	1,094,866	1,104,059	1,217,850	1,311,987	1,411,341	1,450,258	1.5%
2010 "Cyclical" Alternate High	1,095,541	1,113,410	1,144,079	1,240,649	1,334,061	1,434,913	1,474,361	1.6%
2010 "Structural" Alternate Low	1,093,884	1,103,197	1,124,539	1,196,356	1,257,430	1,320,987	1,344,306	1.1%
2010 "Structural" Alternate High	1,093,884	1,110,951	1,142,047	1,270,592	1,398,806	1,542,217	1,601,009	2.0%
2009 IRP	1,124,345	1,129,982	1,145,530	1,248,410	1,363,660	1,486,884	NA	1.7%

Figure H-13

Gas Sendout Forecast by Class (2010 Base Case)

(in 1,000 Therms)	2010	2011	2012	2017	2022	2027	2029	AARG
2010 Base Scenario								
Total	1,093,884	1,107,154	1,133,382	1,232,994	1,325,897	1,426,027	1,465,196	1.6%
Residential	556,123	565,367	580,645	647,522	713,823	782,901	809,757	2.0%
Commercial	249,477	253,240	260,313	295,505	327,997	364,576	379,122	2.2%
Industrial	31,698	32,249	32,965	31,618	30,225	28,916	28,398	-0.6%
Interruptible	53,664	52,700	53,465	55,103	54,636	54,292	54,072	0.0%
Transportation	202,923	203,598	205,994	203,246	199,215	195,343	193,848	-0.2%

Figure H-14

Annual Average Gas Customer Count Forecasts by Class (2010 Base Case)

	2010	2011	2012	2017	2022	2027	2029	AARG
2010 Base Scenario								
Total	752,143	762,590	777,625	875,176	975,401	1,080,067	1,123,064	2.1%
Residential	695,007	704,577	718,375	809,276	903,445	1,001,598	1,041,853	2.2%
Commercial	54,106	55,011	56,273	63,041	69,203	75,811	78,588	2.0%
Industrial	2,493	2,476	2,462	2,389	2,316	2,245	2,217	-0.6%
Interruptible	387	377	366	320	288	263	255	-2.2%
Transportation	150	150	150	150	150	150	150	0.0%

Figure H-15

Firm Gas Peak Day Forecast by Class (2010 Base Case)

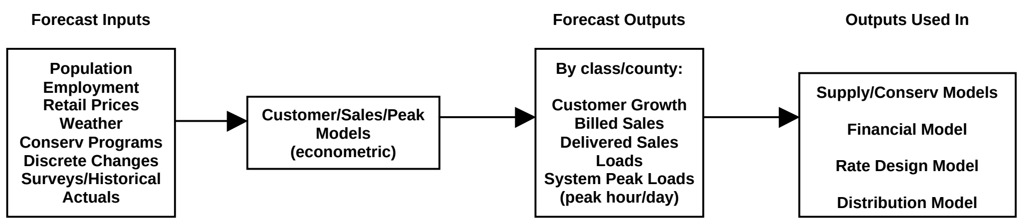
(in Therms)	2010	2011	2012	2017	2022	2027	2029	AARG
2010 Base Scenario								
Total	9,124,134	9,279,897	9,504,391	10,701,876	11,820,710	13,019,355	13,489,001	2.1%
Residential	6,300,341	6,409,224	6,560,566	7,376,794	8,160,947	8,981,746	9,300,773	2.1%
Commercial	2,480,041	2,521,199	2,586,143	2,967,120	3,304,528	3,685,120	3,836,516	2.3%
Industrial	270,759	275,235	281,647	272,347	261,091	250,431	246,195	-0.5%
Losses	72,993	74,239	76,035	85,615	94,566	104,155	107,912	2.1%
2009 IRP	9,449,453	9,655,477	9,894,575	11,140,841	12,453,514	13,867,904	NA	2.3%

4. Load Forecasting Models

This section 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 2010 load forecast used in this IRP, the company updated our key forecast driver assumptions and re-estimated the main equations. The diagram below shows the overall structure of the analysis.

Figure H-16
Econometric Model for Forecasts of Energy Sales, Customer Counts,



and Peak Loads

A. 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 December 2009, 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.

B. Peak Load Forecasting

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 three 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 30 years. The winter peaks are set at the highest Normal peak which is currently the December peak of 23 degrees Fahrenheit.

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 degrees Fahrenheit for January and February, 17 degrees Fahrenheit for November, and 13 degrees Fahrenheit for December. Finally, the “Extreme” peak design temperatures are estimated at 13 degrees Fahrenheit 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 2009.

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 Fahrenheit
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 (seven coefficients). The difference between α_m and $\vec{\alpha}_m$ is that all values in α_m are constant, whereas $\vec{\alpha}_m$ 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.

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 2009 to represent peak day firm requirements:

$$PkDThm_t = \vec{\alpha}_{1,m}Fr_t + \vec{\alpha}_{2,m}\Delta T_g \cdot Fr_t + \alpha_{3,m}EN + \alpha_{4,m}Win + \alpha_{5,m}Smr + \alpha_{6,m}Csnp$$

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 degrees Fahrenheit average temperature for the day), based on the costs and benefits of meeting a higher or lower design day temperature. In the 2003 LCP, PSE changed the gas supply peak-day planning standard from 55 heating degree days (HDD), which is equivalent to 10 degrees Fahrenheit or a coldest day on record standard, to 51 HDD, which is equivalent to 14 degrees Fahrenheit 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 Appendix I of the 2005 LCP, 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 degrees Fahrenheit) to 52 HDD (13 degrees Fahrenheit). PSE’s gas planning standard relies on the value our natural gas customers attribute to reliability and covers 98 percent 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.

C. 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.

Data

PSE developed a representative distribution of hourly temperatures based on data from Jan. 1, 1950 to Dec. 31, 2009. Actual hourly delivered electric loads between Jan. 1, 1994 and Dec. 16, 2009 were used to develop the statistical relationship between temperatures and loads for estimating hourly electric demand based on a representative distribution of hourly temperatures.

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 60 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 PSE 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.

Methodology for Hourly Distribution of Load

For the time period Jan. 1, 1994 to Dec. 31, 2009, PSE 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 one 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 Analysis

Contents

This appendix presents details of the methods and models employed in PSE's electric resource analysis, and the data produced by that analysis.

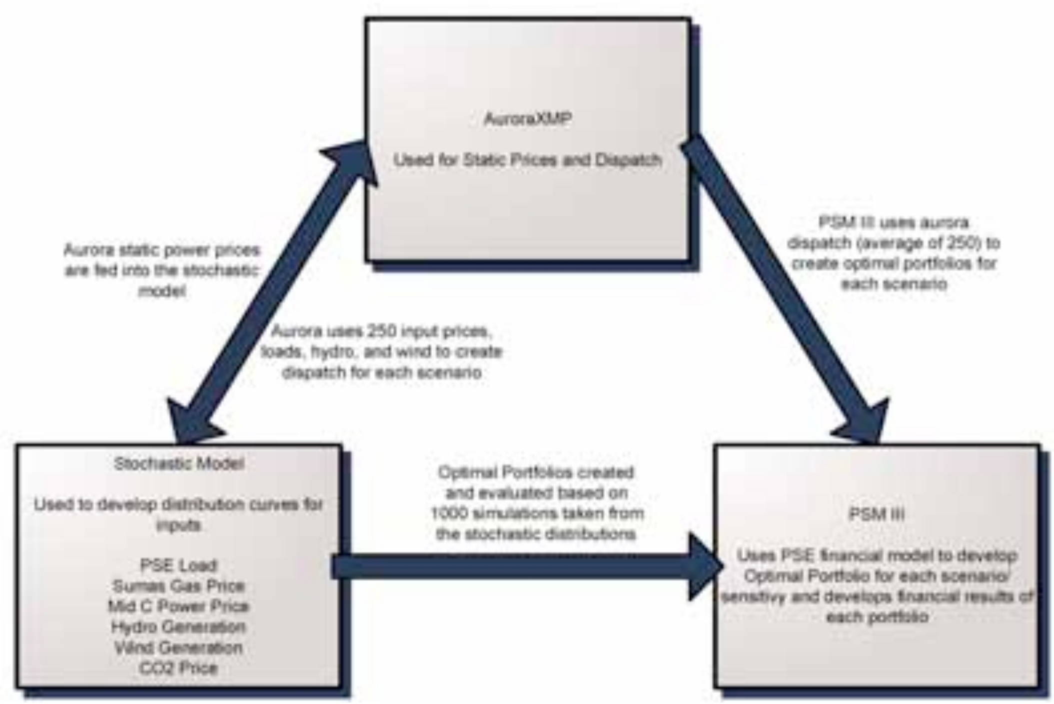
1. Methods and Models

I. Methods

A. Diagram of Process for 2011 IRP

PSE uses three models for electric integrated resource planning: AURORAxmp, a Stochastic Model, and the Portfolio Screening Model III (PSM III). AURORA analyzes the western power market to produce hourly electricity price forecasts of potential future market conditions and resource dispatch, as described later in this appendix. The stochastic model is used to create draws and distributions for various variables. PSM III creates optimal portfolios and 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.

Figure I-1
Electric Analysis Methodology



B. Risk Analysis

i. Scenarios

A description of the scenarios and sensitivities can be found in Chapter 4. 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 4. 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.

iii. Probabilistic Analysis of Risk Factors

In addition to using scenarios to assess risk, this 2011 IRP continues to assess portfolio uncertainty through probabilistic Monte Carlo modeling in PSM III. It relies on Monte Carlo simulations of six uncertainty factors: natural gas prices, power prices, CO2 prices, weather and economic-demographic 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 Stochastic model. This model and its assumptions are further described later in this appendix.

iv. Risk Measures

The results of the risk simulation allow PSE to calculate portfolio risk. Risk is calculated as the average value of the worst 10 percent of outcomes (called TailVar90). This risk measure is the same as the risk measure used by the Northwest Power Planning and Conservation Council (NWPCC) in its power plans. Additionally, PSE looked at annual volatility by measuring year-to-year changes in revenue requirements. Then we 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 our 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, to drive the electric energy market using the logic of a production costing model. 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 percent. PSE tested capacity pool reserve margins at 0 percent, 5 percent, and 15 percent. A pool reserve margin of 15 percent best mitigated summer price spreads without increasing average prices unreasonably. Many U.S. regions plan for at least a 15 percent 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.

B. Stochastic Model

i. Overview

The goal of the stochastic modeling process is to understand the risks of alternative portfolios in terms of costs and revenue requirements. This requires developing stochastic inputs for the Portfolio Screening Model for risk simulation analysis, which then allows for the development of risk metrics to evaluate alternative portfolios. The stochastic modeling process used in this IRP consists of developing stochastic inputs using Monte Carlo analysis, using the Monte Carlo draws to generate a distribution of resource outputs (dispatched to prices and must take), costs and revenues from AuroraXMP, and utilizing these distributions to perform risk simulations in the PSMIII model for any given portfolio. The stochastic inputs considered in this IRP are MidC

[1] *EPIS, Inc., "Long-Term Studies Using Reserve Margins," from AURORAxmp electronic documentation, December 2005.*

power price, Sumas gas price, CO2 price (once it is introduced), PSE load, hydropower and wind generation. This section describes how PSE developed these stochastic inputs.

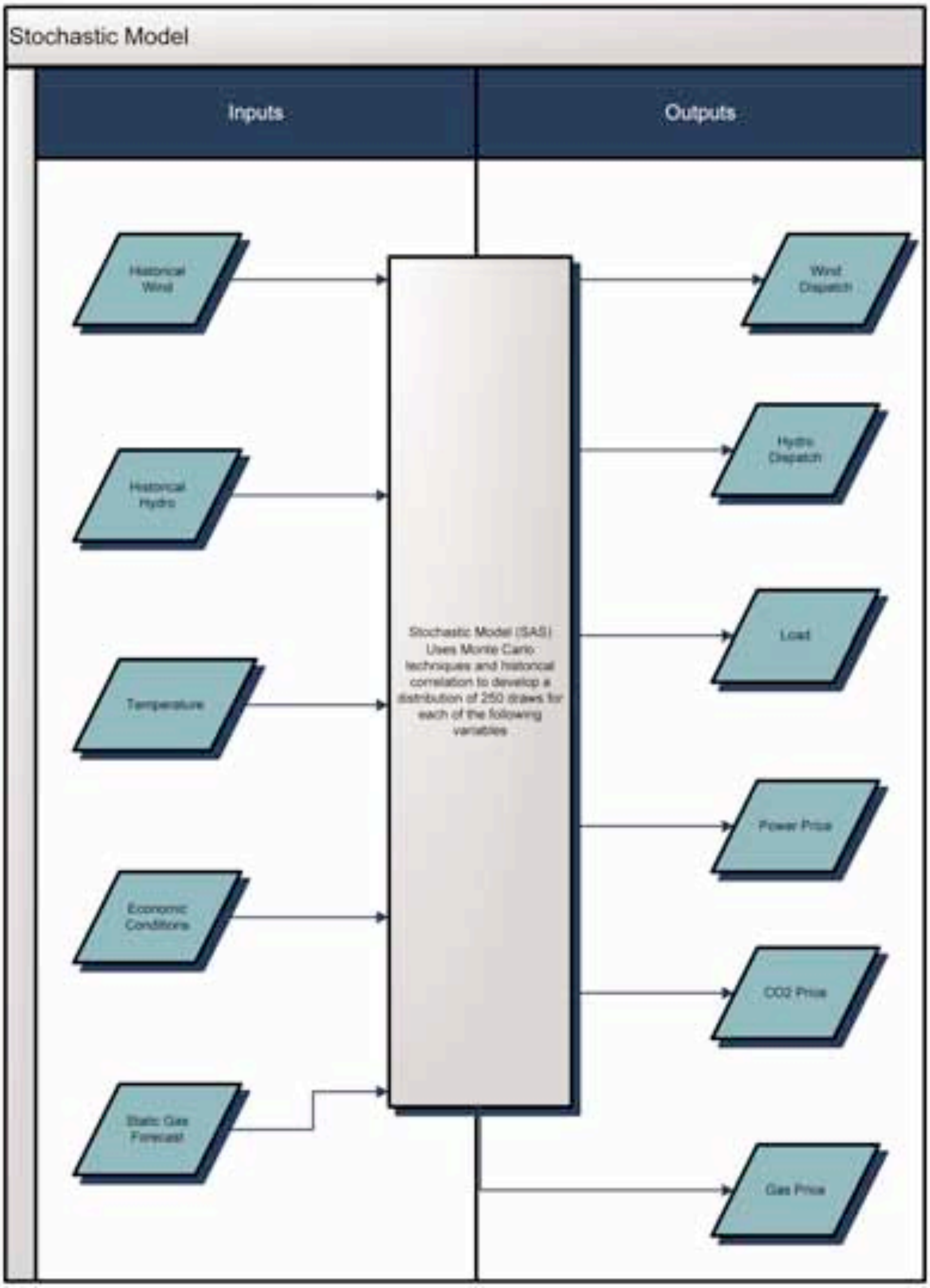
ii. Development of Monte Carlo Draws for the Stochastic Variables

One important aspect in the development of the stochastic variables is the imposition of consistency across draws and key scenarios. This required ensuring, for example, that the same temperature conditions prevail for a load draw and for a power price draw. Figure I-2 shows the key drivers in developing these stochastic inputs. In essence, weather variables and long-term economic conditions determine the variability in the stochastic inputs. Furthermore, two distinct approaches were used to develop the 250 Monte Carlo draws for the inputs: a) loads and prices were developed using econometric analysis given their connection to weather variables (temperature and water conditions) and key economic assumptions, and b) hydro and wind variability were based directly on historical information.

The econometric equations estimated using regression analysis provide the best fit between the individual explanatory values and maximize the predictive value of each explanatory variable to the dependent variable. However, there exist several components of uncertainty in each equation, including: i) uncertainty in the coefficient estimate, ii) uncertainty in the residual error term, iii) the covariate relationship between the uncertainty in the coefficients and the residual error, and iv) uncertainty in the relationship between equations that are simultaneously estimated. Monte Carlo draws utilizing these econometric equations capture these elements of uncertainty.

By preserving the covariate relationships between the coefficients and the residual error, we are 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.

Figure I-2
Stochastic Model Diagram



PSE's Load Forecast

PSE developed a set of 250 Monte Carlo load forecast draws by allowing two sets of variable inputs to vary for each draw: 1) weather, and 2) economic-demographic conditions. The load forecast draws were created in three steps. First, PSE created 250 unique annual temperature profiles to use in the place of "normal" weather. Second, we created three separate long-term economic-demographic scenarios to use as the drivers of long-term growth. In the final step, for each of the 250 load forecast draws, a load scenario was created by selecting a unique weather pattern from the first step, plus an economic-demographic scenario selected probabilistically from the second step.

The 250 unique annual temperature profiles were created synthetically. For each temperature profile, an annual hourly temperature shape was selected randomly from the 60 years worth of hourly shapes at Sea-Tac Airport: 1950 to 2010. Each annual hourly temperature shape was adjusted in an additive process to fit an annual average temperature selected according to a probabilistic distribution of historical annual average temperatures, also from Sea-Tac: 1950-2010. By this process, PSE is able to create an infinite amount of unique temperature profiles to test possible load outcomes. For the current IRP, 250 annual temperature profiles were generated.

The three economic-demographic scenarios used in the analysis are the ones underlying the following load forecast scenarios: "2010 Base Case," "2010 Structural Alternate Low," and "2010 Structural Alternate High." Information about the economic-demographic conditions forecast for these three scenarios is detailed in Appendix H. For the Monte Carlo draws, the following probabilities were assigned to the selection of economic scenarios: 80 percent Base Case, 10 percent Structural Low, 10 percent Structural High.

For each of the 250 Monte Carlo load forecast draws, a temperature profile was selected sequentially from the 250 pre-created weather scenarios detailed above, ensuring that each profile was used once and not repeated. For each draw, an economic scenario was selected according to the probabilities listed above. In each draw, the selected weather and economic inputs were used in the econometric load models to forecast a unique load scenario. For more details on the econometric load forecast models, see Appendix H.

Gas and Power Prices

The econometric relationship between prices and their explanatory variables is shown in the two equations below:

Sumas Gas Price = f(US Gas Storage Deviation fr. 5 Yr Avg, Oil Price, Lagged Oil Price, Time Trend)

MidC Power Price = f(Sumas Gas Price, Regional Temperature Deviation from Normal, MidC Hydro Generation, Day of Week, Holidays)

A semi-log functional form is used for each equation. The two equations are estimated simultaneously with one period autocorrelation using historical daily data from January 2003 to August 2010.

Monte Carlo draws were obtained based on the error distributions of the estimated equations, oil price draws, temperature draws, and hydro condition draws. The temperature draws are consistent with those drawn for the load forecast, while the hydro draws are consistent with those drawn directly from the 70-year historical hydro data as described below. Gas price draws were further adjusted so that the 5th percentile, 10th percentile, 90th percentile and 95th percentiles correspond to the very low, low, high and very high gas price scenarios, respectively, based on the rank levelized price of each draw. The price draws were calibrated to ensure that the means of adjusted distributions are equal to the base case prices. Hourly power prices were then obtained using the hourly shape for the base case from AuroraXMP.

Figures I-3 and I-4 show the monthly distribution of gas and power prices for January 2016. As expected, the distribution is skewed positively or right-skewed, implying that there is a higher probability of realizing high prices relative to the mean compared to low prices. The correlation coefficient between gas and power prices for the draws in January 2016 is .75.

Figure I-3
Monthly Sumas Gas Price Distribution – Jan. 2016

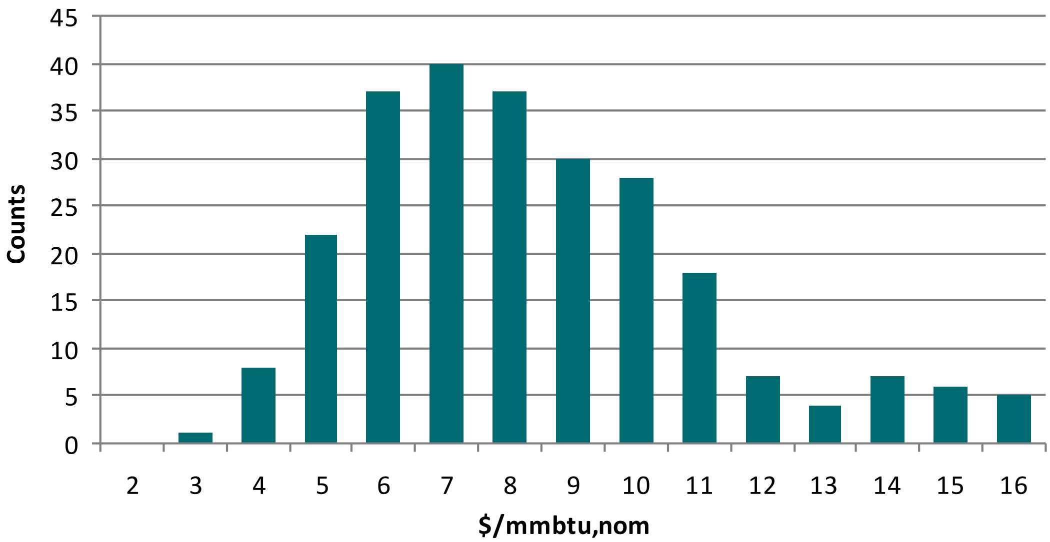
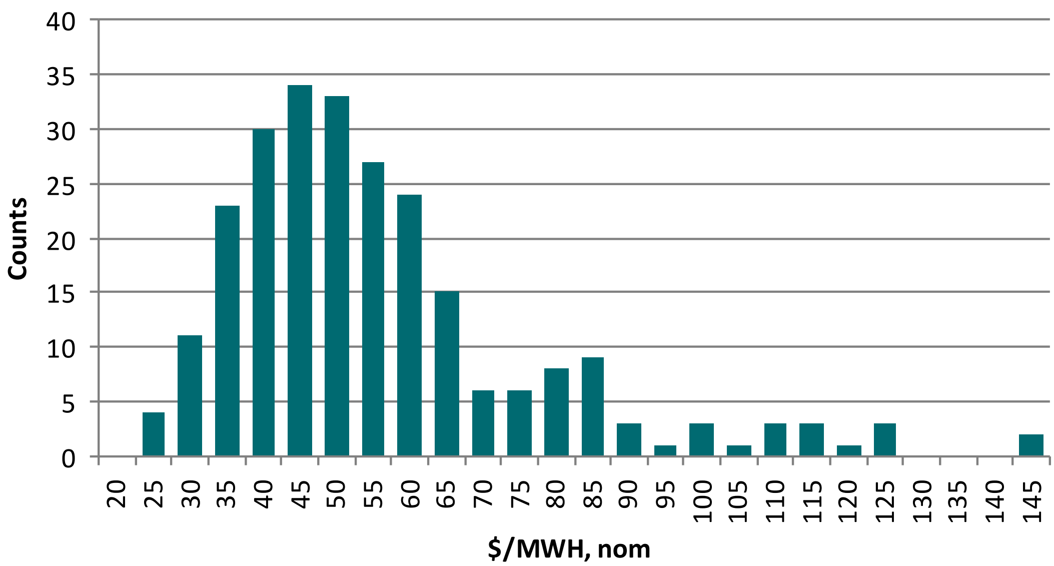


Figure I-4
Monthly Mid-C Power Price Distribution – Jan. 2016



The annual Sumas gas price and MidC power price draws are shown in Figures I-5 and I-6, respectively.

Figure I-5
Annual Sumas Price Draws

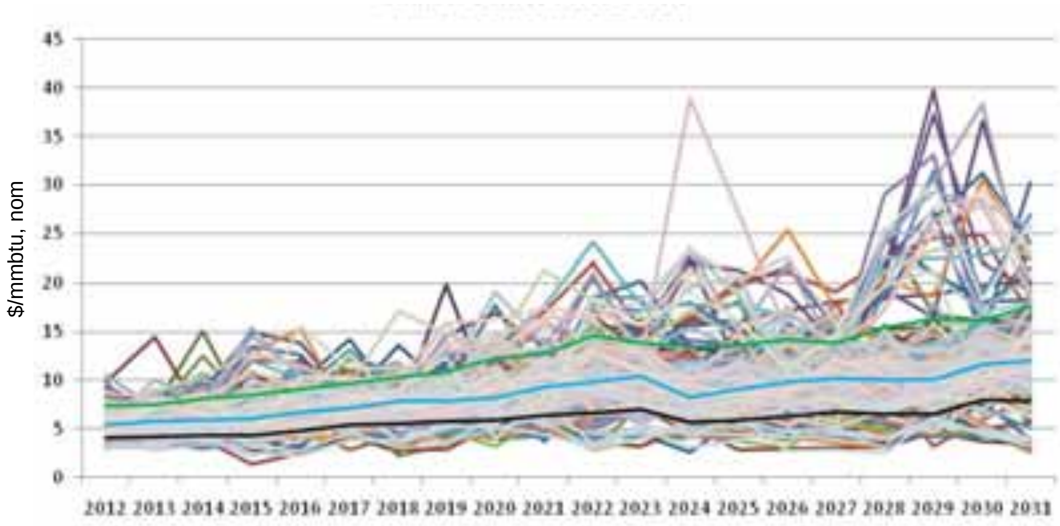
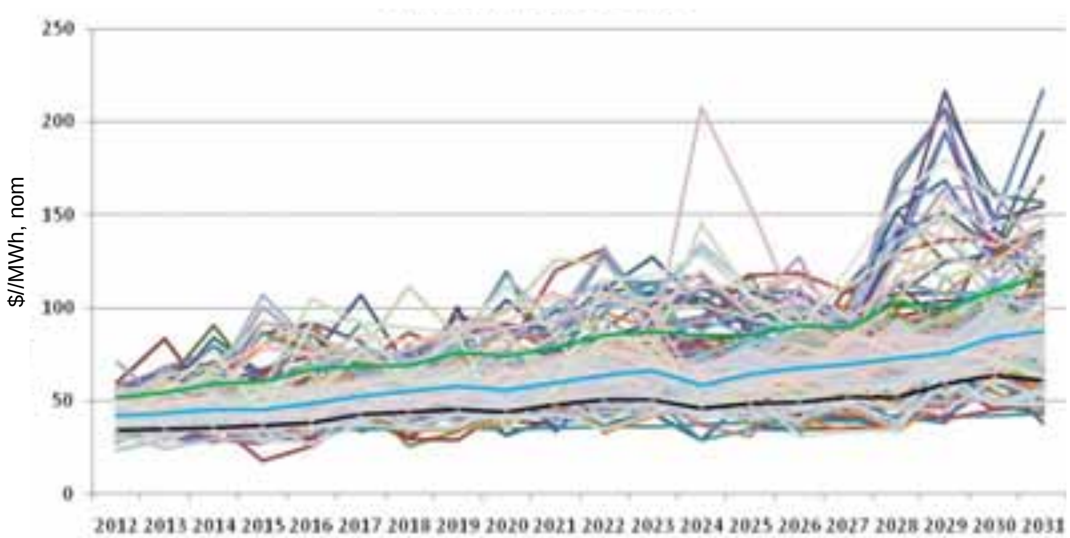


Figure I-6
Annual Mid-C Price Draws

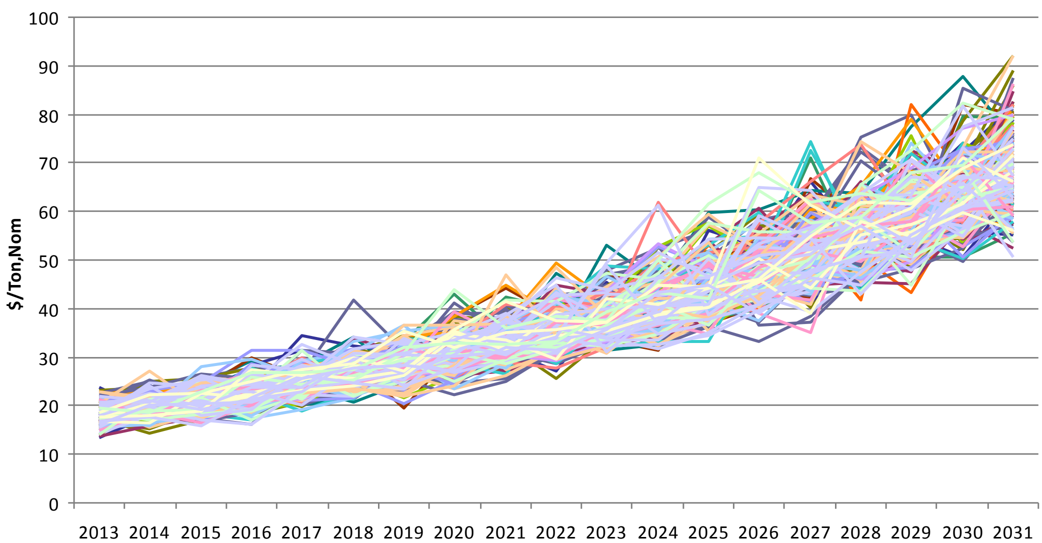


CO2 Prices

Annual CO2 prices in nominal dollars per ton are assumed to follow the EPA study as described in Chapter 4. This implies that the annual price variation will be determined more by how much allowances are put out by the government and the overall macroeconomic conditions. However, given these average annual prices, monthly variations around the annual averages are assumed to vary with the market heat rate based on the gas and power price draws. When gas prices are low, there is less demand for allowances since generators will shift more from coal to gas fuels, and vice versa. Figure I-7 shows the annual CO2 price draws.

Figure I-7

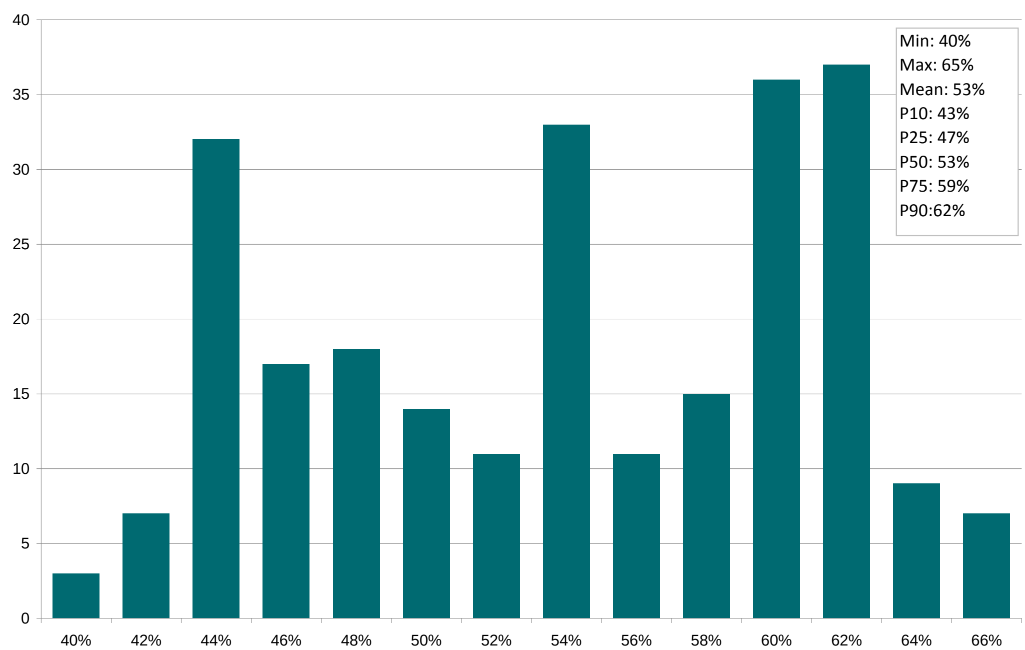
Annual CO2 Price Draws



Hydro Generation

Monte Carlo draws for each of PSE's hydro projects were obtained using the 70-year historical Pacific Northwest Coordination Agreement Hydro Regulation data published in 2010. Each hydro year is assumed to have an equal probability of being drawn in any given calendar year in the planning horizon. Capacity factors and monthly allocations are drawn as a set for each of the 250 draws. This set of 250 hydro draws is applied for each year in the planning horizon. Figure I-8 shows the frequency distribution of capacity factors for Wells based on the 250 draws.

Figure I-8
Frequency of Annual Hydro Capacity Factor for Wells

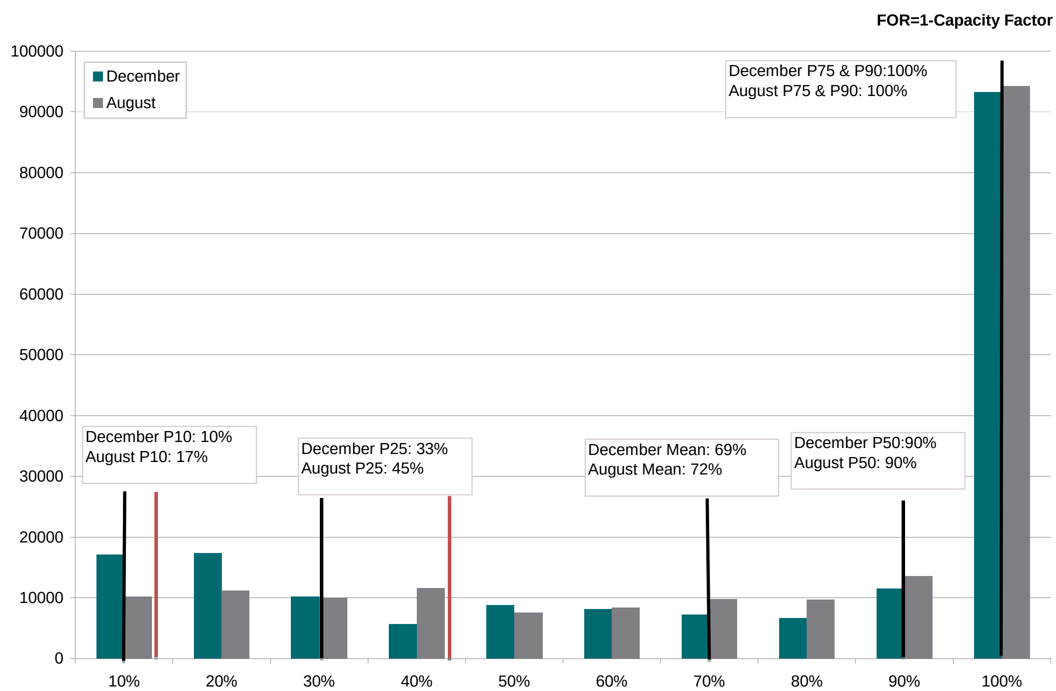


Wind Generation

Since wind is an intermittent resource, one of the goals in developing the generation profile for each wind project considered in this IRP is to ensure that this intermittency is preserved. The other goals are to ensure that there could be correlations across wind farms and the seasonality of wind generation. The wind distributions were derived from 3.5 years of historical data from Hopkins Ridge and Wild Horse. Given the limited historical data that is available to generate the 250 hourly wind profiles, draws of daily 24-hour wind profiles are made each month with each day having an equal probability of being chosen until all days in the month are populated. Since draws for each month are based only on daily profiles within each month, the seasonality of wind generation is also preserved. Finally, draws across wind farms are synchronized on a daily basis to preserve any correlations that may exist between Hopkins Ridge and Wild Horse. The Lower Snake River wind farm, which has not been built yet, is assumed to have the same wind profile as Hopkins Ridge, with a lag since it is located near Hopkins Ridge, and scaled to its nameplate capacity and pro-forma capacity factor. Finally, the generic wind farm is assumed to have a wind profile distribution similar to that of Hopkins Ridge, scaled to a 100 MW capacity. Again, the same set of 250 draws is used for each of the calendar years in the planning horizon. Figure I-9 below shows the frequency distribution of hourly forced outage rate for the generic wind farm for August and December.

Figure I-9

Frequency of Hourly Forced Outage Rate for Generic Wind Farm



iii. Aurora Risk Modeling of PSE Portfolios

The advanced risk modeling capabilities of AuroraXMP are utilized to generate the variable costs, outputs and revenues of any given portfolio. The main advantage of using AuroraXMP 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 250 draws for all of the risk variables (power prices, gas prices, CO2 prices, PSE loads, hydro generation and wind generation) are fed into the AuroraXMP model. Given each of these input draws, AuroraXMP then dispatches PSE's existing portfolio and all generic resources to market price. The results are then saved and passed on to the PSMIII model where expected dispatch energy, expected costs, and revenues are utilized to obtain the optimal set of generic portfolio builds. Revenue requirements based on the expected energy outputs, costs, and revenues can then be computed for each set of portfolio generated by PSMIII.

iv. Risk Simulation in PSM III

In order to perform risk simulation of any given portfolio in PSMIII, the distribution of the stochastic variables must be incorporated into the model. The base case 250 draws of dispatched outputs, costs and revenues for PSE's existing and generic resources were fed into PSMIII from AuroraXMP and the Stochastic Model as described above. Note that these AuroraXMP outputs have already incorporated the variability in gas and power prices, CO2 price, PSE's loads, hydro and wind generation from the Stochastic Model. Frontline System's Risk Solver Platform Excel Add-On allows for the automatic creation of distributions of energy outputs, costs, and revenues based on the 250 draws that PSMII can utilize for the simulation analysis. In addition, peak load distribution, consistent with the energy load distribution, was incorporated into the PSMII. Given these distributions, the risk simulation function in the Risk Solver Platform allowed for drawing 1,000 trials to obtain the expected present value of revenue requirements, TailVar90, and the volatility index for any given portfolio. In addition to computing the risk metrics for the present value of revenue requirements, risk metrics are also computed for annual revenue requirements and power costs. The results of the risk simulation are presented in Chapter 5.

C. Portfolio Screening Model III

i. Overview

The risk model used for this IRP combines the strengths of the stochastic model 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 stochastic model, the Aurora model generates the variable costs of dispatched generation from existing/new resources and market purchases/sales for all 250 trials. These outputs are then averaged and the expected is 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. 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 250 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 average of the 250 draws is then computed, and the expected results are saved and passed on to the portfolio screening model, where the model is optimized to find a portfolio based on a minimized expected revenue requirement. Expected costs and risk metrics can then be computed for each set of portfolio generated by the optimization.

iii. Portfolio Screening Model

The Portfolio Screening Model (PSM3 for version 3) is a spreadsheet-based capacity expansion model that the company developed to evaluate incremental costs and risks of a wide variety of resource alternatives and portfolio strategies. The model produces the optimal mix of resources that minimizes the present value of revenue requirements subject to planning margin and renewable portfolio standard constraints. 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 resource dispatched outputs are deficient or surplus to meet PSE's need.

The primary input assumptions to the PSM are:

a) PSE's peak and energy demand forecasts,
b) PSE's existing and generic resources, their capacities and outage rates,
c) expected dispatched energy (MWh), variable cost ($000) and revenue ($000) from AURORAxmp for existing contracts, existing and generic resources,
d) capital and fixed-cost assumptions of generic resources,
e) financial assumptions such as cost of capital and escalation rates,
f) capacity contributions and planning margin constraints,
g) renewable portfolio targets.

Mathematical representation of PSM III

The purpose of the programming model is to create an optimal mix of new generic resources that minimizes the 20-year net present value of the revenue requirement plus end effects (or total costs) given that the portfolio meets the planning reserve margin (PRM) and the renewable portfolio standard (RPS), and subject to other various non-negativity constraints for the decision variables. The decision variables are the annual integer number of units to add for each type of generic resources being considered in the model. We may add one or two more constraints later on. The revenue requirement is the incremental portfolio cost for the 20-year forecast.

Let:

gn, gr – index for generic non-renewable and renewable resource at time t, respectively;
xn, xr – index for existing non-renewable and renewable resource at time t, respectively;
d(gn) – index for decision variable for generic non-renewable resource at time t;
d(gr) - index for decision variable for generic renewable resource at time t;

AnnCapCost = annual capital costs at time t for each type of resource (the components are defined more fully in the excel model);
VarCost = annual variable costs at time t for each type of resource (the components are defined more fully in the excel model);
EndEff = end effects at T, end of planning horizon, for each type of generic resource only (the components are defined more fully in the excel model);
ContractCost = annual cost of known power contracts;
DSRCost = annual costs of a given demand side resources;
NetMktCost = Market Purchases less market sales of power at time t;
RECSales = Sales of excess over RPS required renewable energy at time t
Cap = capacities of generic and existing resources;
PM = planning margin to be met each t;
MWH = energy production from any resource type gn,gx,xn,xr at time t;
RPS = percent RPS requirement at time t;
PkLd = expected peak load forecast for PSE at time t;
EnLd = forecasted Energy Load for PSE at generator without conservation at time t;
LnLs = line loss associated with transmission to meet load at meter;
DSR = demand side resource energy savings at time t;
r = discount rate.

Annual revenue requirement (for any time t) is defined as:

$$RR_t = \sum_{gn} d(gn)*[AnnCapCost(gn) + VarCost(gn)] + \sum_{gr} d(gr)*[AnnCapCost(gr) + VarCost(gr)] + \sum_{xn} VarCost(xn) + \sum_{xr} VarCost(xr) + ContractCost + DSRCost + NetMktCost - RECSales.$$

a) The objective function for the model is the present value of RR to be minimized. This function is non-linear with integer decision variables.

$$PVRR = \sum_{t=1}^{T} RR_t *[1/(1+r)^t]+ [1/(1+r)^{20}]*[\sum_{gn} d(gn)*EndEff(gn) + \sum_{gr} d(gr)*EndEff(gr)].$$

b) The objective function is subject to two constraints

a. The planning margin was found using the loss of load probability (LOLP) approach. Details about the planning margin can be found later in this appendix. In the model, the planning margin of 15.7 percent is used as a lower bound on the constraint. That is, the model must minimize the objective function while maintaining a minimum of 15.7 percent capacity above the load in any given year. Below is the mathematical representation of how the planning margin is used as a constraint for the optimization.

$$\sum_{gn} d(gn)*Cap(gn) + \sum_{gr} d(gr)*Cap(gr) + \sum_{xr} Cap(xr) + \sum_{xn} Cap(xn) \geq PkLd + PM \text{ for all } t;$$

b. PSE is subject to the Washington state renewable target as stated in RCW 19.285. The load input for PSM is the load at generator, so that the company generates enough power to account for line loss and still meet customer needs. The RPS target is set to the average of the previous two years' load at meter less DSR. The model must minimize the objective function while maintaining a minimum of the total RECs need to meet the state RPS. Below is the mathematical representation of how the RPS is used as a constraint for the optimization.

$$\sum_{gr} d(gr)*MWH(gr) + \sum_{xr} MWH(xr) \geq RPS* \frac{\sum_{t-2}^{t-1}(EnLd*(1-LnLs)-DSR)}{2} \quad \text{for all t;}$$

d(gn), d(gr) ≥ 0, and are integer values for all t,

Other restrictions include total build limits. For example, only one biomass plant can be built a year for a total of four plants over the 20-year time horizon. For the generic wind, five plants may be built in a year, for a total of 10 plants over the 20-year time horizon.

The model is solved using Frontline System's Risk Solver Premium, software that provides various linear, quadratic and nonlinear programming solver engines in Excel environment. Frontline System is the developer of the Solver function that comes standard with Excel. The software solves this non-linear objective function typically in less than a minute. It also provides a simulation tool to calculate the expected costs and risk metrics for any given portfolio.

iv. Monte Carlo Draws for the Risk Simulation

PSE utilized the 250 draws from the stochastic model as the basis for the 1,000 simulated risk trials. For each of the 1,000 trials, a draw was chosen at random from the 250 draws and the revenue requirement for the portfolio was calculated using all the outputs associated with that draw (MidC power price, CO2 price, Sumas natural gas price, hydro generation, wind generation, and load).

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, which 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 2011 IRP, load forecasts for Oregon, Washington, Montana, and Idaho were based on the Northwest Power and Conservation Council (NPCC) 6th Power Plan load forecast. 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 2009.02 version produced in October 2009.

Many states in the WECC have passed statutes requiring Renewable Portfolio Standards (RPS) to support the development of renewable resources. Typically, an RPS state has a specific percentage of energy consumed that must come from renewable resources by a certain date (e.g., 10 percent 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 2009 U.S. 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 70 historical years of 1929 to 1998. 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 2010, the PTC was scheduled to expire at the end of 2012. The reference assumption is that PTCs remain at the current rate through 2012. PTCs are still assumed to be given to a project for 10 years after it is placed into service. As of 2013, 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 percent of the capital cost for solar and wind resources, and 10 percent of the capital cost for biomass and geothermal resources. Currently, the ITC is scheduled to expire at the end of 2012. This scenario assumes ITCs remain at the current rate through 2012.

iii. Treasury Grant

The Treasury Grant (Grant) is a third federal subsidy available to qualifying renewable energy projects. This subsidy differs from the previous two in that it is a cash payment, vs. a tax credit, from the federal government. Currently, the Grant amounts to 30 percent of the eligible capital cost for renewable resources; it is scheduled to expire at the end of 2012. Through 2012, this scenario assumes the Grant remains at current levels. It is important to note that this is the financial incentive modeled in the 2011 IRP analysis. This simplifies the modeling, as the grant is not a function of taxable income.

iv. Renewable Portfolio Standard (WECC)

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 percent in 2015, then 15 percent 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.

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.

Figure I-10

RPS Requirements for States in WECC

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 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.	The primary resource for Colorado is wind. The 4% solar requirement is modeled as central power only.

State	Standard (LBNL)	Notes for AURORA Modeling
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.	
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.	

v. Renewable Portfolio Standard (PSE)

The current PSE resources that meet the Washington state RPS include Hopkins Ridge, Wild Horse, Klondike III, Snoqualmie Upgrades, Lower Snake River I, and Lower Baker Upgrades. The Washington state RPS also gives an extra 20 percent credit to renewable resources that use apprenticeship labor. That is, with the adder a resource can contribute 120 percent to RCW 19.285. The PSE resources that can claim the extra 20 percent are Wild Horse Expansion, Lower Snake River I and Lower Baker Upgrades. For modeling purposes, we assume that the generic wind receives the extra 20 percent.

C. Generic Resource Costs and Characteristics

Figure I-11

Generic Resource Costs and Characteristics

2010 $	Units	CCCT	Peaker	Wind	Biomass	Transmission
Winter Capacity	MW	334	213	100	25	500
Capital Cost	$/KW	$1,540	$1,010	$2,151	$4,330	$436
O&M Fixed	$/KW-yr	$22.00	$15.90	$29.90	$190.00	$15.25
O&M Variable	$/MWh	$0.44	$0.67	$3.50	$3.40	
Force Outage Rate	%	3%	3%		6.3%	
Wind Capacity Factor	%			30%		
Capacity Credit	%	93%	93%	1.8%	93%	100%
Heat Rate – GT	Btu/KWh	7,085	10,440		13,420	
Heat Rate – DF	Btu/KWh	9,350				
Fixed Gas Transport	$/KW-yr	$31.80	$0.00			
Variable Gas Transport	$/MWh	$2.00	$5.20			
Fixed Transmission	$/KW-yr	$0.00	$0.00	$34.30	$18.01	
Variable Transmission	$/MWh	$0.00	$0.00	$3.30	$1.71	
Water Consumption	Gallons/MWh	26				
Emissions:						
SO_2	lbs/MMBtu	0.010	0.010			
NO_x	lbs/MMBtu	0.007	0.009			
CO_2	lbs/MMBtu	115.9	115.9			
Location		PSE Control	PSE Control	WA/OR	PSE Control	Mid-C to PSE
First Year Available		2014	2014	2014	2014	2017

The generic Combined Cycle Combustion Turbine (CCCT) is assumed to be a 1x1 facility with a dry air cooled condenser.

D. Financial Assumptions

We used the pre-tax weighted average cost of capital (WACC) from the 2009 General Rate Case of 8.1 percent nominal or 6.89 percent after-tax. The REC price of $8/MWh in 2012 was escalated at 2.5 percent.

E. Wind Capacity Credit

i. Methodology Used

The wind capacity credits for PSE's existing and prospective wind farms were developed by applying the ELCC (equivalent load carrying capability) approach with our LOLP (loss of load probability) model. In essence, the ELCC approach identifies the equivalent capacity of a peaker plant that would yield the same loss of load probability as the capacity of a given wind farm. The ratio of the equivalent peaker capacity to the wind capacity is the ELCC or the capacity credit of the wind farm. Appendix I of the 2009 IRP provides a detailed description of the LOLP model. The basic idea of the LOLP model is to shock the electric system with Monte Carlo draws of hourly loads, forced outages, hydro conditions, and availability of transmission for market purchases to determine the percent of the time that a load is greater than resources over the number of iterations. This might require adding more resources in order to achieve the industry standard of five percent LOLP.

In order to implement the ELCC approach in the LOLP model, the distribution of wind hourly generation for each of the existing and prospective wind farms was developed. These are described in Appendix I, in the Stochastic Model portion of the Methods and Models section, under the Wind Generation subheading. Given these distributions, the wind farms were incrementally added into the LOLP model to determine the reduction in peaker capacity to achieve the 5 percent loss of load probability. The ratio of the change in peaker capacity with and without the incremental wind capacity is that wind farm's capacity credit. The order in which the existing and prospective wind farms were added in the model follows the schedule when these wind farms were acquired or about to be acquired by PSE: Wild Horse, Hopkins Ridge, Lower Snake River, then a generic wind resource expected to be located in southeast Washington close to the Lower Snake River project, or a generic wind resource located in Kittitas County close to the Wild Horse project.

ii. Results

The figure below shows the results of the ELCC study.

Figure I-12
Effective Load Carrying Capability of Wind

Summary All Wind	Wind Capacity	Effective Thermal Capacity	ELCC
Hopkins Ridge	157	23	14.8%
Wild Horse	272	39	14.5%
Lower Snake River	342	33	9.6%
Generic SE WA(w/Added Transmission)	100	2	1.8%
Generic Kittitas(w/Added Transmission)	100	5	4.9%

* Wild Horse is supply only since it displaces existing transmission allocated for short-term market purchase.

These results indicate that wind power's contribution to capacity is not as significant as other resources, such as thermal power. Although the capacity contribution of existing wind facilities is higher than the regional assumption of 5 percent, subsequent wind farms are likely to show lower capacity contribution because of the correlation of wind outputs with pre-existing farms. This result is consistent with those found in earlier studies. While diversity may show different capacity credit, the differences in amounts are not significant. These results are highly dependent on PSE's resource mix, load characteristics, and projected distribution of wind profiles.

F. Planning Standard

The company's planning standard is a 15.7 percent planning margin for capacity plus relevant operating reserves. PSE's planning margin is net of operating reserves. This is so the specific implications of different resource operating reserve requirements can be modeled independently. For example, peakers must carry 7 percent contingency reserves, but demand-side resources have none. Embedding operating reserves in the planning margin would not allow the company to reflect such differences in our analytical framework. This planning standard was adopted in the 2009 IRP. It is consistent 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. PSE values the NW Regional Resource Adequacy Forum's work on resource adequacy. It is the best assessment available in the region and PSE actively participates on both the steering committee and technical committee.

The following summarizes how the company derived the 15.7 percent planning margin standard:

The primary objective of PSE's capacity planning standard analysis was to determine the appropriate level of planning margin for the utility. Planning 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 margin is measured as:

Planning Margin = (Generation Capacity – Normal Peak Loads)/Normal Peak Loads

The appropriate level of planning 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 LOLP 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 degree Fahrenheit, 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:

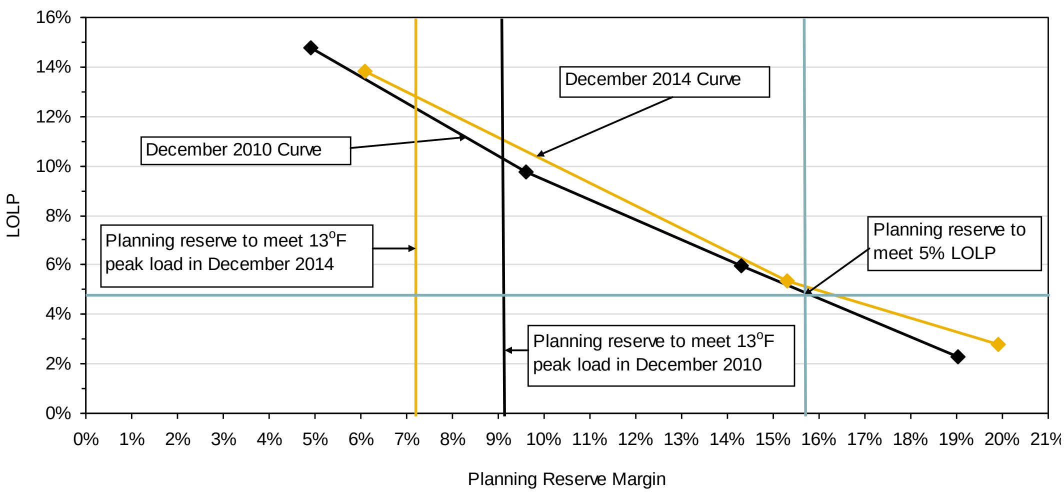
1. Forced Outage Rate for Thermal Units - modeled as a combination of an outage event and duration of an outage event (skewed beta distribution with fixed endpoints), subject to minimum up and down time conditions and total outage rate equal to GRC reported outage rate;
2. Hourly System Loads – modeled 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 percent from hydropower with same variability as Mid Columbia resources; 50 percent 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 percent for 60 percent of the trials, with a range of +/-3.5 percent.

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 I-13. The figure illustrates that the planning reserve margin implied by a 5 percent LOLP is around 15.7 percent for both years. The figure also demonstrates that the LOLP implied by meeting the 13 degrees Fahrenheit peak loads from the B2 Energy Planning Standard is much higher (10 percent for December 2010 and 13 percent for December 2014) if no additional resources are added. The 5 percent 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 percent LOLP in December, we will have resources sufficient to meet that reliability threshold during the rest of the year.

Figure I-13
Planning Margin and LOLP



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.

Figure I-14
Monthly Flat Mid-C Prices
(Nominal $/MWH)

Base

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	44.76	47.59	40.87	35.77	31.49	32.60	40.71	43.06	45.59	44.68	52.64	50.30	42.51
2013	47.30	50.48	43.39	39.00	32.32	32.83	42.07	45.01	48.56	46.03	52.87	52.20	44.34
2014	49.14	52.01	44.41	39.32	32.62	33.74	44.01	47.04	51.13	48.66	57.18	56.55	46.32
2015	49.97	53.45	45.78	40.87	34.13	36.56	46.13	48.59	52.50	49.76	58.18	57.34	47.77
2016	53.65	56.98	49.10	44.15	35.68	38.67	49.18	52.51	55.69	51.51	62.25	59.26	50.72
2017	58.06	60.26	49.71	44.74	36.03	39.64	52.88	57.01	60.10	57.52	68.33	65.55	54.15
2018	61.94	65.31	52.74	46.38	35.81	38.37	55.71	61.46	64.83	59.54	68.74	68.16	56.58
2019	63.96	67.89	55.89	51.50	39.35	40.75	58.82	63.58	66.98	61.65	71.63	70.90	59.41
2020	65.80	65.64	51.37	44.88	31.03	36.65	58.57	64.70	69.60	64.52	74.88	73.29	58.41
2021	69.80	69.77	54.58	47.17	32.47	39.56	64.57	70.24	74.13	64.48	80.28	77.19	62.02
2022	74.11	75.24	61.54	56.06	38.04	45.27	68.13	75.93	78.65	69.03	85.79	81.19	67.42
2023	75.46	75.02	57.75	48.70	34.58	42.00	69.48	78.45	82.12	76.57	90.53	84.73	67.95
2024	70.32	72.37	55.53	48.85	35.71	37.30	65.62	71.73	75.64	67.31	78.33	77.05	62.98
2025	73.05	74.97	60.27	55.60	39.58	42.59	67.85	73.75	78.18	68.59	80.95	80.93	66.36
2026	76.89	78.25	60.28	51.89	36.49	42.91	71.85	78.43	84.30	76.69	89.39	87.71	69.59
2027	78.36	81.21	62.04	52.20	37.37	45.12	73.84	80.09	83.76	72.55	90.78	89.16	70.54
2028	82.68	86.50	69.16	61.11	45.68	53.52	77.94	84.55	86.80	77.55	97.40	93.60	76.37
2029	89.35	93.43	69.50	57.92	44.22	47.37	82.14	92.93	98.68	88.65	102.76	101.27	80.68
2030	97.01	99.74	73.16	62.22	48.08	50.68	89.97	97.70	103.22	88.97	107.90	107.80	85.54
2031	98.78	103.57	79.91	73.09	54.86	60.14	92.16	98.37	106.15	91.09	111.71	112.22	90.17

Base + CO_2

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	43.22	46.30	41.14	35.71	31.40	32.60	40.52	42.68	45.34	44.55	52.31	48.80	42.05
2013	54.07	58.12	51.90	47.86	44.50	46.00	51.30	54.16	57.13	54.48	61.58	60.07	53.43
2014	56.48	60.65	54.29	50.10	46.77	47.99	53.71	56.85	60.49	57.01	66.40	63.78	56.21
2015	58.28	63.57	57.99	53.24	48.47	51.07	56.93	59.55	63.07	60.27	68.68	66.41	58.96
2016	62.10	67.26	60.27	55.14	51.39	53.52	59.63	63.01	66.26	63.82	73.71	71.28	62.28
2017	66.66	71.86	64.24	58.04	54.11	56.66	63.99	68.00	71.51	68.74	80.02	77.06	66.74
2018	71.39	77.50	68.89	62.08	55.82	58.29	68.20	73.02	76.75	73.47	82.56	81.13	70.76
2019	74.45	80.48	71.93	65.81	59.01	60.73	71.82	75.91	80.28	76.32	85.94	84.20	73.91
2020	77.28	81.75	72.55	65.74	57.11	59.90	74.30	78.45	83.37	78.84	90.80	87.94	75.67
2021	83.54	87.01	77.57	70.86	60.39	63.79	80.07	84.74	88.63	83.23	96.53	92.03	80.70
2022	89.06	91.33	84.00	78.46	63.44	67.52	84.75	91.31	93.97	87.79	101.64	95.34	85.72
2023	91.63	92.78	83.33	75.33	62.52	64.72	87.12	94.40	96.96	92.53	106.61	99.99	87.33
2024	89.50	94.70	84.04	75.63	61.24	61.21	86.84	93.01	96.30	90.63	100.18	97.68	85.91
2025	93.96	99.34	89.62	81.89	63.53	66.23	91.31	96.74	101.09	94.79	105.33	103.54	90.61
2026	99.01	105.05	91.96	81.99	65.77	68.66	96.14	103.07	108.46	101.86	114.47	111.57	95.67
2027	103.34	109.81	95.93	86.62	67.69	73.07	99.82	107.24	111.03	104.45	118.32	115.27	99.38
2028	109.28	115.94	103.72	93.58	75.31	83.07	105.32	112.73	114.86	110.55	125.41	120.75	105.88
2029	115.52	123.04	106.97	90.31	73.21	77.05	111.79	121.26	125.63	118.14	131.92	129.81	110.39
2030	123.64	130.68	111.97	97.82	77.49	82.35	120.42	127.17	131.26	123.26	138.28	136.58	116.74
2031	129.19	139.96	120.49	108.15	82.25	91.18	127.67	132.55	138.03	129.57	145.95	145.64	124.22

Load Growth

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	33.58	36.59	32.95	29.21	27.17	28.44	32.34	33.98	36.09	35.24	41.58	39.58	33.90
2013	35.89	38.27	34.31	31.09	27.69	28.13	33.36	35.34	37.81	36.21	41.90	40.79	35.07
2014	38.42	40.67	35.84	32.14	28.42	29.43	35.72	37.76	41.02	38.66	45.43	44.26	37.31
2015	40.45	43.49	38.14	34.27	30.19	32.03	38.14	40.05	43.25	41.56	48.41	46.35	39.69
2016	41.50	44.66	39.33	35.63	29.46	31.69	38.73	41.11	44.15	42.20	49.82	46.87	40.43
2017	43.04	45.28	39.46	35.34	29.29	31.72	40.14	42.86	46.01	44.13	52.84	49.63	41.65
2018	44.22	47.31	40.52	35.97	29.11	29.47	40.88	44.09	47.42	43.98	51.64	49.12	41.98
2019	45.29	48.26	41.89	38.17	30.11	30.70	41.85	44.63	48.29	44.92	52.42	50.22	43.06
2020	45.05	46.05	39.27	34.48	25.28	26.97	40.97	44.37	48.24	44.68	53.12	50.50	41.58
2021	45.66	46.88	40.08	34.63	25.07	27.27	41.71	45.08	48.12	43.84	53.28	50.03	41.80
2022	45.55	47.05	42.52	38.31	27.21	29.40	42.06	46.37	49.64	45.04	55.00	49.72	43.16
2023	46.73	47.03	40.38	34.76	24.71	26.47	42.41	47.68	50.62	47.57	57.29	52.21	43.16
2024	48.33	49.57	42.00	36.93	24.72	24.52	43.60	48.93	52.89	48.10	55.25	51.78	43.89
2025	49.68	50.80	44.58	40.34	25.25	27.08	44.31	49.39	53.85	48.70	56.31	53.27	45.30
2026	51.12	52.29	42.56	37.67	21.80	26.66	45.02	51.36	56.82	52.20	60.15	56.93	46.22
2027	52.27	53.60	43.67	37.92	21.23	27.04	45.37	52.36	56.88	51.15	60.69	57.07	46.60
2028	53.03	55.06	46.92	40.77	24.62	29.48	46.06	53.66	57.57	52.19	62.66	57.80	48.32
2029	54.88	56.64	46.27	38.61	21.99	25.12	46.76	55.67	61.63	56.45	63.82	60.78	49.05
2030	58.81	59.79	46.22	39.48	22.39	25.25	49.13	57.32	62.03	56.66	65.84	63.52	50.54
2031	58.14	61.49	53.33	48.60	27.33	33.17	51.66	59.36	65.12	59.69	69.18	64.22	54.27

High Growth

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	50.77	52.32	45.51	39.11	33.39	34.69	45.24	48.16	51.13	49.95	58.24	55.61	47.01
2013	56.91	58.88	51.36	44.90	36.71	36.50	50.11	53.65	58.07	54.69	62.20	61.65	52.14
2014	61.68	63.92	52.81	46.95	36.76	38.16	54.53	58.43	64.10	60.14	69.55	69.58	56.38
2015	68.70	71.84	58.66	52.41	40.39	43.11	61.03	65.31	70.52	66.12	76.93	76.61	62.64
2016	75.62	79.73	66.12	58.91	44.70	48.56	66.83	72.78	77.48	72.22	85.89	85.01	69.49
2017	75.05	77.52	61.09	54.29	42.17	46.64	66.65	72.83	77.89	73.53	86.49	85.30	68.29
2018	74.41	78.17	61.11	53.03	40.62	42.20	65.98	72.85	77.80	70.69	82.16	82.49	66.79
2019	80.14	83.66	66.77	61.23	45.55	46.60	72.39	78.52	83.62	74.74	88.06	88.27	72.46
2020	83.06	82.90	61.34	53.61	34.61	42.35	74.25	82.15	89.40	79.08	94.48	94.12	72.61
2021	84.45	83.95	63.45	53.70	33.83	43.68	76.04	83.62	88.77	74.40	94.71	94.25	72.90
2022	85.62	87.95	68.94	61.55	39.93	49.57	77.14	86.41	91.04	77.39	99.02	97.21	76.81
2023	95.97	92.98	69.12	57.47	38.14	48.52	85.64	97.00	104.05	93.87	114.53	110.11	83.95
2024	96.87	97.89	69.73	59.29	39.26	44.96	86.15	96.46	102.90	85.75	104.52	107.09	82.57
2025	97.57	98.98	74.71	66.33	43.02	51.14	87.44	95.63	103.96	85.31	107.36	109.11	85.05
2026	104.13	103.61	73.41	60.51	38.54	53.22	92.56	102.29	114.51	100.18	122.14	120.86	90.50
2027	109.69	110.19	78.34	63.96	42.11	57.90	97.49	107.05	116.13	94.81	126.31	125.17	94.10
2028	112.63	116.03	88.25	76.94	56.73	67.32	100.70	111.26	118.13	100.42	133.19	129.59	100.93
2029	117.04	119.61	84.55	68.90	52.37	59.14	104.06	118.87	128.99	114.51	136.69	136.19	103.41
2030	123.11	124.78	86.89	70.74	55.59	62.27	110.67	120.85	130.90	109.24	138.51	138.80	106.03
2031	131.91	139.52	108.65	97.19	76.12	81.24	117.34	128.53	138.20	121.49	146.00	149.45	119.64

Green World

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	49.41	51.03	44.78	38.61	32.93	34.39	44.92	47.43	50.32	48.98	57.09	54.65	46.21
2013	73.38	77.50	71.95	66.33	62.29	62.98	70.63	73.84	77.58	74.15	81.07	79.66	72.61
2014	77.35	82.59	76.28	70.49	65.79	67.07	75.19	78.37	83.01	78.87	88.09	86.01	77.43
2015	85.47	89.85	83.66	77.12	72.01	74.31	82.84	85.92	90.16	87.20	95.82	93.57	84.83
2016	90.41	95.61	88.32	82.43	76.99	80.39	87.73	91.93	95.71	92.45	104.57	100.30	90.57
2017	92.80	96.97	89.71	82.97	77.37	81.65	89.41	94.03	97.96	94.80	106.81	103.08	92.30
2018	94.60	101.44	93.76	85.85	75.60	80.03	92.02	96.52	100.91	97.13	105.50	103.22	93.88
2019	100.68	107.48	99.52	92.54	82.47	85.55	97.87	102.50	107.25	103.14	112.57	109.77	100.11
2020	106.86	111.36	102.82	92.90	73.62	77.06	101.34	106.77	113.14	108.14	120.43	115.98	102.53
2021	112.17	117.61	107.50	94.00	72.62	79.21	106.31	111.88	118.04	113.93	125.59	120.39	106.60
2022	118.11	123.45	115.56	105.86	79.70	85.91	111.73	118.29	124.24	119.84	132.06	126.03	113.40
2023	129.34	132.70	120.05	104.55	80.43	82.88	121.30	128.05	135.87	131.12	146.13	138.89	120.94
2024	133.71	138.71	124.67	109.10	80.40	74.02	123.08	132.28	140.64	134.36	145.42	141.25	123.14
2025	140.79	146.02	134.43	119.72	80.04	82.54	127.17	137.19	147.34	140.42	152.56	148.76	129.75
2026	148.54	154.30	129.74	100.98	69.09	75.76	134.45	145.06	156.69	150.12	163.43	159.66	132.32
2027	157.89	163.68	134.37	114.76	69.24	78.69	141.81	153.71	164.36	155.60	173.40	168.67	139.68
2028	165.66	170.88	147.76	129.40	84.09	87.71	145.37	158.91	168.39	162.53	179.58	174.05	147.86
2029	170.10	178.93	137.96	100.35	61.22	67.12	146.97	168.24	178.46	168.37	185.38	182.08	145.43
2030	178.60	184.42	135.59	106.77	62.83	67.61	153.98	174.94	184.64	171.53	192.06	191.29	150.36
2031	185.90	196.61	172.13	152.46	82.09	87.25	165.25	182.46	193.54	182.61	203.75	201.20	167.10

Very High Gas

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	49.89	51.79	45.45	39.14	33.92	34.95	45.27	48.03	50.67	49.09	57.61	54.55	46.70
2013	57.19	59.73	51.61	46.67	37.21	37.13	50.91	54.96	58.47	55.35	62.65	61.86	52.81
2014	63.85	66.33	55.30	49.17	37.95	39.79	57.16	61.71	66.39	62.21	71.71	71.44	58.58
2015	74.16	76.83	62.37	55.31	41.71	45.57	65.56	70.96	74.99	70.68	81.28	80.95	66.70
2016	82.25	84.72	70.33	61.10	47.34	51.47	72.56	79.35	82.75	77.59	91.24	89.88	74.22
2017	82.29	83.68	63.71	56.83	42.88	48.71	73.24	80.34	84.46	80.13	93.97	91.72	73.50
2018	82.88	85.07	65.30	56.94	41.19	45.00	73.32	81.21	85.54	77.68	90.43	90.66	72.94
2019	89.31	92.04	71.86	65.97	47.95	49.66	79.32	86.46	91.34	82.41	96.16	96.62	79.09
2020	90.93	85.49	64.44	53.50	33.69	44.14	78.66	88.29	96.15	87.96	102.52	100.61	77.20
2021	95.15	90.14	66.74	54.86	36.20	46.37	82.19	90.49	96.42	82.15	104.11	103.06	78.99
2022	95.37	95.46	75.74	67.23	41.99	52.83	84.33	94.48	99.17	84.74	109.29	105.52	83.85
2023	108.45	100.21	73.63	57.86	40.30	51.41	93.81	107.71	114.92	106.90	127.51	120.22	91.91
2024	109.32	104.36	75.17	61.92	40.81	45.90	95.77	107.23	113.85	95.35	116.85	115.70	90.19
2025	109.44	107.30	82.35	73.45	46.67	55.40	97.49	107.95	116.11	97.14	119.95	120.91	94.51
2026	117.38	111.35	79.00	63.07	39.77	55.30	106.37	119.40	130.91	117.19	138.98	134.95	101.14
2027	118.19	113.37	81.08	62.37	38.69	57.88	109.38	120.82	128.54	104.06	138.44	132.96	100.48
2028	121.72	121.26	94.17	79.39	50.79	67.95	113.15	124.18	128.47	108.51	143.83	135.96	107.45
2029	124.79	123.84	83.57	64.68	41.58	52.76	114.61	131.89	142.63	124.95	146.41	142.68	107.87
2030	129.73	126.83	84.49	67.62	43.62	54.98	121.21	132.12	140.81	114.57	143.52	142.54	108.50
2031	134.85	134.50	99.71	87.12	53.50	69.51	125.44	135.85	147.66	119.62	149.90	151.26	117.41

Very Low Gas

	1	2	3	4	5	6	7	8	9	10	11	12	Ave
2012	34.51	36.52	32.79	29.15	27.31	28.47	32.37	34.11	36.19	35.17	41.73	39.35	33.97
2013	34.65	37.07	33.25	30.32	27.52	27.88	32.47	34.50	36.90	35.27	40.45	39.15	34.12
2014	34.74	37.35	33.34	29.94	27.34	28.06	32.79	34.88	37.72	35.59	42.02	40.46	34.52
2015	35.69	38.78	34.69	30.84	28.08	29.38	33.68	35.64	38.18	36.85	41.97	40.79	35.38
2016	34.36	37.14	33.43	30.29	27.39	28.53	32.67	34.74	37.28	35.65	41.84	39.63	34.41
2017	34.99	38.38	33.72	29.88	27.17	28.70	33.02	35.43	37.62	36.70	44.03	41.51	35.10
2018	35.39	39.31	34.38	30.31	26.94	27.35	33.22	35.88	38.22	36.91	42.38	41.12	35.12
2019	35.46	39.68	34.34	30.47	27.12	27.26	33.55	35.91	38.79	37.16	43.17	41.53	35.37
2020	34.94	38.81	33.60	29.36	24.83	25.67	33.10	35.18	39.02	36.85	44.02	42.04	34.79
2021	35.61	39.85	34.10	29.86	25.07	26.45	33.66	35.80	39.45	37.27	44.46	42.21	35.32
2022	35.71	40.23	34.75	30.31	26.57	27.11	33.66	36.42	39.64	38.01	45.25	42.29	35.83
2023	36.70	40.94	34.95	29.95	25.49	26.51	34.36	37.16	40.60	39.57	46.99	43.99	36.43
2024	38.45	43.24	36.45	31.06	25.94	25.04	35.21	38.07	41.71	40.00	46.43	44.45	37.17
2025	38.78	44.05	37.40	31.44	26.89	26.65	35.71	38.26	42.32	40.37	47.41	45.94	37.94
2026	39.76	44.76	37.33	30.92	25.49	26.14	36.49	39.21	43.44	41.29	49.28	47.80	38.49
2027	41.18	47.02	38.29	31.36	26.04	27.49	37.38	40.39	44.33	41.80	50.90	48.88	39.59
2028	42.25	47.69	39.11	32.36	27.89	29.18	37.84	41.59	44.88	42.94	51.99	49.65	40.61
2029	43.54	49.55	40.21	32.06	27.32	27.08	38.56	43.66	47.25	44.02	52.58	51.50	41.44
2030	44.70	50.29	40.46	32.75	27.55	27.18	39.43	43.88	47.69	44.13	52.48	51.54	41.84
2031	45.84	51.43	41.85	34.39	28.47	29.32	40.43	44.44	49.02	45.08	53.51	53.02	43.07

B. Electric Demand-Side Screening Results

The results in the following tables were part of the bundles provided by Cadmus Group. See Appendix K for a discussion of Cadmus' methodology and analysis.

Figure I-15

Annual Energy Savings (aMW)

Bundles A through H includes Energy Efficiency, Fuel Conversion, Distributed Generation, and Distribution Efficiency

	Bundle									
	A	B	C	D	E	F	G	H	DE	EISA
2012	27.5	32.5	36.4	38.0	39.0	40.8	41.6	50.1	1.1	4.1
2013	56.1	67.0	74.9	78.1	80.3	83.9	85.5	102.9	2.2	11.9
2014	82.7	100.1	112.2	117.1	120.6	126.1	128.5	155.1	3.4	22.6
2015	107.8	132.7	149.0	155.7	160.8	168.2	171.5	207.6	4.5	31.7
2016	132.2	165.5	186.1	194.6	201.9	211.3	215.4	261.4	5.7	39.6
2017	155.2	197.4	222.3	232.6	242.5	253.8	258.8	314.6	7.2	46.1
2018	178.9	230.6	260.1	272.2	284.7	298.0	303.9	369.8	8.8	51.8
2019	203.1	266.0	300.8	315.0	330.1	345.5	352.3	428.6	10.3	56.5
2020	227.8	298.3	338.6	354.9	372.8	390.3	398.0	485.4	12.0	77.6
2021	251.3	328.5	374.1	392.4	412.9	432.5	441.1	539.1	13.6	95.3
2022	258.5	339.0	386.3	405.3	427.5	447.5	456.2	557.7	15.7	111.1
2023	265.9	349.7	398.7	418.4	442.3	462.7	471.6	576.8	17.9	125.1
2024	274.2	361.8	412.8	433.4	459.1	480.1	489.1	598.2	20.1	137.6
2025	280.7	371.4	424.1	445.4	472.7	494.0	503.2	616.0	22.3	147.3
2026	288.3	382.4	437.0	459.0	488.2	509.9	519.2	636.6	24.6	155.7
2027	295.7	393.2	449.7	472.4	503.1	525.3	534.8	656.6	27.0	162.7
2028	304.1	405.1	463.5	487.0	519.1	541.9	551.5	678.1	29.6	169.6
2029	311.1	415.2	475.5	499.7	532.7	555.9	565.7	696.3	31.9	174.9
2030	319.1	426.8	489.0	514.1	548.0	571.7	581.6	716.9	34.4	180.3
2031	327.0	438.2	502.3	528.2	563.0	587.2	597.3	737.2	36.8	185.5

Figure I-16

Total December Peak Reduction (MW)

Bundles A through H includes Energy Efficiency, Fuel Conversion, Distributed Generation, Distribution Efficiency, and Demand Response

	Bundle										
	A	B	C	D	E	F	G	H	DE	EISA	DR
2012	37	49	56	59	61	63	64	77	2	5	10
2013	75	99	115	120	124	128	130	157	4	16	20
2014	110	149	172	180	186	192	195	237	5	30	30
2015	144	197	228	240	248	256	260	317	7	42	49
2016	176	246	286	300	312	322	327	400	9	52	50
2017	206	294	342	359	375	387	392	482	11	61	51
2018	237	342	398	419	437	451	458	564	14	68	75
2019	268	392	457	482	504	520	527	649	16	74	90
2020	300	439	514	542	567	586	594	734	19	102	127
2021	319	467	549	578	607	626	635	787	21	121	144
2022	342	501	589	621	652	673	683	847	25	146	162
2023	350	513	604	637	670	692	701	872	28	165	165
2024	358	525	617	651	685	708	717	894	32	181	169
2025	367	539	634	668	705	727	737	921	35	194	172
2026	377	554	652	688	726	749	759	952	39	205	175
2027	388	570	672	709	749	773	783	986	43	215	179
2028	397	584	688	726	767	792	802	1013	46	223	182
2029	405	597	704	742	785	810	820	1039	50	231	185
2030	414	610	720	759	803	829	839	1065	55	238	189
2031	424	626	738	779	823	850	860	1096	58	245	193

The DSR December peak reduction is based on the average of the very heavy load hours (VHLH). The VHLH method takes the average of the five-hour morning peak from hour ending 7 a.m. to hour ending 11 a.m. and the five-hour evening peak from hour ending 6 p.m. to hour ending 10 p.m. Monday through Friday.

Figure I-17

Annual Costs (Thousands $)

Bundles A through E includes Energy Efficiency, Fuel Conversion, Distributed Generation, Distribution Efficiency, and Demand Response

	Bundle										
	A	B	C	D	E	F	G	H	DE	EISA	DR
2012	$29,160	$58,001	$85,232	$100,108	$110,522	$130,716	$140,619	$612,534	$1,184	$0	$8,839
2013	$30,105	$62,458	$90,733	$106,239	$116,837	$137,504	$147,585	$640,565	$1,184	$0	$9,680
2014	$30,862	$66,407	$95,589	$111,582	$122,339	$143,429	$153,652	$664,289	$1,184	$0	$10,078
2015	$31,268	$70,914	$100,770	$117,167	$128,088	$149,599	$159,941	$686,937	$1,184	$0	$17,698
2016	$31,813	$76,031	$106,677	$123,416	$134,511	$156,456	$166,898	$709,821	$1,184	$0	$4,301
2017	$32,306	$79,869	$111,280	$128,286	$139,563	$161,942	$172,466	$731,104	$2,002	$0	$4,376
2018	$32,754	$82,686	$114,798	$132,004	$143,464	$166,272	$176,851	$750,660	$2,002	$0	$30,166
2019	$33,657	$94,223	$132,473	$151,449	$163,334	$187,145	$198,361	$795,614	$2,002	$0	$11,651
2020	$34,186	$73,849	$113,370	$132,735	$144,891	$169,237	$180,610	$793,174	$2,002	$0	$42,737
2021	$34,449	$73,202	$112,554	$132,044	$144,407	$168,841	$180,192	$806,499	$2,002	$0	$16,283
2022	$9,940	$29,082	$43,407	$49,621	$52,157	$57,244	$59,308	$279,141	$2,537	$0	$18,112
2023	$10,200	$29,183	$43,824	$50,086	$52,843	$58,079	$60,182	$292,652	$2,537	$0	$14,714
2024	$10,486	$29,412	$44,391	$50,747	$53,732	$59,134	$61,279	$307,334	$2,537	$0	$14,953
2025	$10,714	$29,635	$44,895	$51,382	$54,480	$60,015	$62,194	$318,708	$2,537	$0	$15,192
2026	$10,966	$29,946	$45,486	$52,146	$55,351	$61,031	$63,243	$330,688	$2,537	$0	$15,434
2027	$11,240	$30,358	$46,162	$53,037	$56,341	$62,178	$64,422	$342,605	$2,678	$0	$15,679
2028	$11,468	$30,896	$46,937	$54,064	$57,455	$63,446	$65,714	$352,867	$2,678	$0	$15,923
2029	$11,736	$31,631	$47,923	$55,357	$58,840	$65,032	$67,335	$364,341	$2,678	$0	$16,194
2030	$12,002	$32,627	$49,111	$56,875	$60,431	$66,813	$69,139	$375,724	$2,678	$0	$16,459
2031	$12,278	$33,502	$50,112	$58,245	$61,863	$68,444	$70,788	$387,273	$2,678	$0	$16,730

C. Electric Integrated Portfolio Results

This chart summarizes the expected costs of the different portfolios.

Figure I-18

Revenue Requirements with Expected Inputs for the Scenario

Scenario	20-yr NPV Expected Cost ($Millions)						Expected Portfolio Cost $/MWh
	Expected Portfolio Cost	Net Purchases/ (Sales)	DSR Rev. Req.	Generic Rev. Req.	Variable Cost of Existing	REC Revenue	
Base	$13,365	$5,207	$1,262	$3,913	$3,035	($52)	$46.72
Base + CO2	$15,928	$5,210	$1,262	$4,647	$4,861	($51)	$55.68
Low Growth	$9,826	$2,283	$1,262	$3,282	$3,057	($56)	$36.17
High Growth	$18,582	$7,435	$1,262	$5,900	$4,057	($71)	$61.66
Very Low Gas	$10,870	$2,016	$767	$5,076	$3,061	($50)	$37.70
Very High Gas	$16,455	$6,749	$1,262	$4,605	$3,917	($78)	$57.51
Green World	$21,065	$6,847	$1,513	$5,412	$7,534	($242)	$77.54
PTC Sensitivity							
Base + PTC/ITC Extension 2013	$13,331	$5,025	$1,262	$4,102	$3,035	($94)	$46.60
Base + PTC/ITC Extension 2016	$13,271	$5,044	$1,262	$4,018	$3,035	($88)	$46.39
Base + PTC/ITC Extension 2020	$13,241	$5,120	$1,262	$3,896	$3,035	($72)	$46.29
Base + PTC/ITC Extension 2031	$13,236	$5,175	$1,262	$3,823	$3,035	($59)	$46.27
Risk Sensitivity							
Base + Fixed Gas Transport	$14,103	$5,195	$1,262	$4,664	$3,035	($53)	$49.30
Base + No Peakers	$14,539	$2,796	$1,262	$7,507	$3,035	($60)	$50.83
Base + Thermal Mix	$14,259	$3,130	$1,262	$6,702	$3,035	($50)	$49.85
Base + No DSR	$16,071	$6,842	$0	$6,239	$3,035	($45)	$56.18

Figure I-19

Revenue Requirement with Input Simulations – 1000 Trials

20-yr NPV Portfolio Cost ($Millions)	Risk Simulation - 1000 Trials			
	Base	Base + Thermal Mix	Base + No Peaker	Base + No DSR
Expected	$13,365	$14,259	$14,539	$16,071
Minimum	$9,235	$9,699	$9,993	$10,592
1st Quartile (P25)	$12,402	$13,218	$13,428	$14,987
Mean	$13,349	$14,209	$14,448	$16,045
Median	$13,122	$14,062	$14,346	$15,794
3rd Quartile (P75)	$13,712	$14,746	$15,021	$16,474
TVar90	$17,902	$18,411	$18,525	$21,433
Maximum	$20,508	$21,168	$21,348	$24,237
Standard Deviation	$1,850	$1,801	$1,787	$2,182
Annual Volatility	18.1%	17.4%	17.1%	18.5%

Figure I-20

Base

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	300	25	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	100	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	213	-	25	-	29	4
2030	-	213	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	400	50	500	1126	193

Figure I-21

Base + CO_2

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	300	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	100	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	100	-	-	29	4
2030	-	-	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	500	0	500	1126	193

Figure I-22

Low Growth

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	852	-	-	-	78	10
2015	-	-	-	25	-	76	19
2016	-	-	-	25	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	-	200	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	-	-	-	-	35	3
2025	-	-	100	-	-	36	3
2026	-	213	-	-	-	36	3
2027	-	-	-	-	-	36	3
2028	-	213	-	-	-	30	3
2029	-	-	-	-	-	29	4
2030	-	-	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	1491	300	50	500	1126	193

Figure I-23

High Growth

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	25	-	78	10
2015	-	213	-	25	-	76	19
2016	-	-	-	25	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	25	-	75	16
2020	-	213	200	-	-	94	36
2021	-	213	-	-	-	66	17
2022	-	-	200	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	213	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	-	-	-	29	4
2030	-	213	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	3195	400	100	500	1126	193

Figure I-24

Green World

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	70	10
2013	-	-	-	-	-	77	10
2014	-	852	-	-	-	80	10
2015	-	-	500	-	-	78	19
2016	-	-	500	-	-	78	1
2017	-	-	-	-	500	76	1
2018	-	-	-	-	-	75	23
2019	-	-	-	-	-	77	16
2020	-	-	-	-	-	96	36
2021	-	-	-	-	-	67	17
2022	-	-	-	-	-	71	18
2023	-	213	-	-	-	40	3
2024	-	-	-	-	-	36	3
2025	-	-	-	-	-	37	3
2026	-	213	-	-	-	37	3
2027	-	-	-	-	-	36	3
2028	-	-	-	-	-	31	3
2029	-	213	-	-	-	30	4
2030	-	-	-	-	-	30	4
2031	-	-	-	-	-	32	4
Total	0	1491	1000	0	500	1153	193

Figure I-25

Very Low Gas

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	56	10
2013	-	-	-	-	-	63	10
2014	-	1,065	-	-	-	65	10
2015	-	-	-	-	-	62	19
2016	-	213	-	-	-	61	1
2017	-	-	-	-	500	59	1
2018	-	-	-	-	-	58	23
2019	-	-	-	-	-	59	16
2020	-	213	300	-	-	77	36
2021	-	-	100	-	-	54	17
2022	-	-	-	-	-	58	18
2023	-	213	-	-	-	35	3
2024	-	213	-	-	-	31	3
2025	-	-	-	-	-	31	3
2026	-	-	-	-	-	30	3
2027	-	213	100	-	-	29	3
2028	-	-	-	-	-	25	3
2029	-	426	-	-	-	25	4
2030	-	-	100	-	-	25	4
2031	-	-	-	-	-	26	4
Total	0	2556	600	0	500	929	193

Figure I-26

Very High Gas

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	25	-	78	10
2015	-	-	-	25	-	76	19
2016	-	-	-	25	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	25	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	100	-	-	94	36
2021	-	-	200	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	-	-	-	-	35	3
2025	-	213	-	-	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	213	-	-	-	29	4
2030	-	213	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	300	100	500	1126	193

Figure I-27

Base + Fixed Gas Transport

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	300	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	25	-	40	3
2024	-	-	-	25	-	35	3
2025	-	213	-	25	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	100	-	-	29	4
2030	-	-	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	400	75	500	1126	193

Figure I-28

Base + No Peaker

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	71	10
2013	-	-	-	-	-	78	10
2014	1,002	-	-	-	-	81	10
2015	-	-	-	25	-	79	19
2016	-	-	-	25	-	79	1
2017	-	-	-	-	500	77	1
2018	-	-	-	-	-	76	23
2019	-	-	-	-	-	78	16
2020	334	-	300	-	-	97	36
2021	-	-	-	-	-	68	17
2022	-	-	-	-	-	71	18
2023	334	-	-	-	-	40	3
2024	-	-	-	-	-	36	3
2025	-	-	-	-	-	37	3
2026	334	-	-	-	-	37	3
2027	-	-	100	-	-	36	3
2028	-	-	-	-	-	31	3
2029	334	-	-	-	-	30	4
2030	-	-	-	-	-	30	4
2031	-	-	-	-	-	32	4
Total	2338	0	400	50	500	1163	193

Figure I-29
Base + Thermal Mix

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	668	426	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	334	213	-	-	-	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	300	-	-	94	36
2021	-	-	-	-	-	66	17
2022	334	-	-	-	-	69	18
2023	-	-	-	-	-	40	3
2024	-	-	-	-	-	35	3
2025	-	-	-	25	-	36	3
2026	-	213	-	-	-	36	3
2027	-	-	100	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	-	-	25	500	29	4
2030	-	-	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	1336	1065	400	50	500	1126	193

Figure I-30
Base + PTC/ITC Extension 2013

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	300	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	-	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	100	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	100	-	-	29	4
2030	-	-	-	25	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	500	25	500	1126	193

Figure I-31

Base + PTC/ITC Extension 2016

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	400	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	-	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	-	25	-	29	4
2030	-	-	-	-	-	29	4
2031	-	-	100	-	-	31	4
Total	0	2343	500	25	500	1126	193

Figure I-32

Base + PTC/ITC Extension 2020

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	500	-	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	-	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	426	-	-	-	29	4
2030	-	-	-	25	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	500	25	500	1126	193

Figure I-33

Base + PTC/ITC Extension 2031

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	68	10
2013	-	-	-	-	-	75	10
2014	-	1,065	-	-	-	78	10
2015	-	-	-	-	-	76	19
2016	-	-	-	-	-	76	1
2017	-	-	-	-	500	74	1
2018	-	-	-	-	-	73	23
2019	-	-	-	-	-	75	16
2020	-	213	300	25	-	94	36
2021	-	-	-	-	-	66	17
2022	-	-	100	-	-	69	18
2023	-	213	-	-	-	40	3
2024	-	213	-	-	-	35	3
2025	-	-	-	-	-	36	3
2026	-	-	-	-	-	36	3
2027	-	213	-	-	-	36	3
2028	-	-	-	-	-	30	3
2029	-	213	-	25	-	29	4
2030	-	213	-	-	-	29	4
2031	-	-	-	-	-	31	4
Total	0	2343	400	50	500	1126	193

Figure I-34

Base + No DSR

	CCGT	Peaker	Wind	Biomass	Transmission	DSR	DR
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	1,278	-	-	-	-	-
2015	-	213	-	-	-	-	-
2016	-	-	-	-	-	-	-
2017	-	-	-	-	500	-	-
2018	-	213	-	-	-	-	-
2019	-	213	-	-	-	-	-
2020	-	213	400	25	-	-	-
2021	-	213	-	25	-	-	-
2022	-	-	-	25	-	-	-
2023	-	213	-	-	-	-	-
2024	-	213	100	-	-	-	-
2025	-	-	-	-	-	-	-
2026	-	213	-	-	-	-	-
2027	-	213	100	-	-	-	-
2028	-	-	-	-	-	-	-
2029	-	426	100	-	-	-	-
2030	-	-	-	-	-	-	-
2031	-	213	-	-	-	-	-
Total	0	3834	700	75	500	0	0

D. Incremental Cost of Renewable Resources to meet RCW 19.285 Incremental Cost Alternative Compliance

1. Overview

According to RCW 19.285, certain electric utilities in Washington must meet 15 percent of their retail electric load with eligible renewable resources by the calendar year 2020. The annual target for the calendar year 2012 is 3 percent of retail electric load. However, if the incremental cost of those renewable resources compared to an equivalent non-renewable is greater than 4 percent of its revenue requirement, then a utility will be considered in compliance with the annual renewable energy target in RCW 19.285. "The incremental cost of an eligible renewable resource is calculated as the difference between the levelized delivered cost of the eligible renewable resource, regardless of ownership, compared to the levelized delivered cost of an equivalent amount of reasonably available substitute resource that do not qualify as eligible renewable resources"[3] (equivalent non-renewable).

2. Analytic Framework

This analysis compares the revenue requirement cost of each renewable resource with the projected market value and capacity value at the time of the renewable acquisition. This, "contemporaneous" with the decision-making aspect of PSE's approach, is important. Utilities should be able to assess whether they will exceed the cost cap before an acquisition, without having to worry about ex-post adjustments that could change compliance status. The analytical framework here reflects a close approximation of the portfolio analysis used by PSE in resource planning, as well as in the evaluation of bids received in response to the company's Request for Proposals (RFP).

[3] *RCW 19.285.050 (1) (a) (b)*

3. Resources that meet RCW 19.285 definition of Eligible Renewable Resource

Figure I-35

Resources that meet RCW 19.285 definition of Eligible Renewable Resource

	Nameplate (MW)	Annual Energy (aMW)	Commercial Online Date	Market Price/ Peaker Assumptions	Capacity Credit Assumption
Hopkins Ridge	149.4	53.3	Dec 2005	2004 RFP	20%
Wild Horse	228.6	73.4	Dec 2006	2006 RFP	17.2%
Klondike III	50	18.0	Dec 2007	2006 RFP	15.6%
Hopkins Infill	7.2	2.4	Dec 2007	2007 IRP	20%
Wild Horse Expansion	44	10.5	Dec 2009	2007 IRP	15%
Lower Snake River I	342.7	102.5	Apr 2012	2010 Trends	5%
Snoqualmie Upgrades	6.1	3.9	Mar 2013	2009 Trends	95%
Lower Baker Upgrades	30	12.5	May 2013	2011 IRP Base	95%
Generic Wind 2020	300	89.7	Jan 2020	2011 IRP Base	1.8%
Generic Wind 2027	100	29.9	Jan 2027	2011 IRP Base	1.8%
Generic Biomass 2020	25	21.25	Jan 2020	2011 IRP Base	93%
Generic Biomass 2029	25	21.25	Jan 2029	2011 IRP Base	93%

4. Equivalent Non-Renewable

The incremental cost of a renewable resource is defined as the difference between the levelized cost of the renewable resource compared to an equivalent non-renewable resource. An equivalent non-renewable is an energy resource that does not meet the definition of a renewable resource in RCW 19.285, but is equal to a renewable resource on an energy and capacity basis. For the purpose of this analysis, the cost of an equivalent non-renewable resource has three components:

1. Capacity Cost: There are two parts of capacity cost: First is the capacity in MW. This would be nameplate for a firm resource like biomass, or the assumed capacity of a wind plant. Second is the $/kW cost, which we assumed to be equal to the cost of a peaker.
2. Energy Cost: This was calculated by taking the hourly generation shape of the resource, multiplied by the market price in each hour. This is the equivalent cost of purchasing the equivalent energy on the market.

3. Imputed Debt: The law states the non-renewable must be an "equivalent amount," which includes a time dimension. If PSE entered into a long-term contract for energy, there would be an element of imputed debt. Therefore, it is included in this analysis as a cost for the non-renewable equivalent.

For example, Hopkins Ridge produces 466,900 MWh annually. The equivalent non renewable is to purchase 466,900 MWh from the Mid-C market and then build a 30 MW (149.4*20 percent = 30) peaker plant for capacity only. With the example, the cost comparison includes the hourly Mid-C price plus the cost of building a peaker, plus the cost of the imputed debt. The total revenue requirement (fixed and variable costs) of the non-renewable is the cost stream—including end-effects—discounted back to the first year. That net present value is then levelized over the life of the comparison renewable resource.

5. Cost of Renewable Resource

Levelized cost of the renewable resource is more direct. It is based on the preforma financial analysis performed at the time of the acquisition. The stream of revenue requirement (all fixed and variable costs, including integration costs) are discounted back to the first year—again, including end effects. That net present value is then levelized out over the life of the resource/contract. The levelized cost of the renewable resource is then compared with the levelized cost of the equivalent non-renewable resource to calculate the incremental cost.

6. Example

The following is a detailed example of how PSE calculated the incremental cost of Wild Horse. It is important to note that PSE's approach uses information contemporaneous with the decision making process, so this analysis will not reflect updated assumptions for capacity, capital cost, or integration costs, etc.

Eligible Renewable: Wild Horse Wind Facility
Capacity Contribution Assumption: 228.6 * 17.2% = 39 MW

1. Calculate Wild Horse Revenue Requirement

Figure I-36 is a sample of the annual revenue requirement calculations for the first few years of Wild Horse, along with the NPV of revenue requirement.

Figure I-36
Calculation of Wild Horse Revenue Requirement

($ Millions)	20-yr NPV	2007	2008	…	2025
Gross Plant		384	384	…	384
Accumulative depreciation (Avg.)		(10)	(29)	…	(355)
Accumulative deferred tax (EOP)		(20)	(56)	…	(7)
Rate base		354	299	…	22
After tax WACC		7.01%	7.01%	…	7.01%
After tax return		25	21	…	2
Grossed up return		38	32	…	2
PTC grossed up		(20)	(20)	…	-
Expenses		16	16	…	22
Book depreciation		19	19	…	19
Revenue required	370.9	53	48	…	44
End effects	4.6				
Total revenue requirement	375				

2. Calculate Revenue Requirement for Equivalent non-renewable: Peaker Capacity

Capacity = 39 MW

Capital Cost of Capacity: $462/KW

Figure I-37

Calculation of Peaker Revenue Requirement

($ Millions)	20-yr NPV	2007	2008	…	2025
Gross Plant		18	18	…	18
Accumulative depreciation (Avg.)		(0)	(1)	…	(10)
Accumulative deferred tax (EOP)		(0)	(0)	…	(3)
Rate base		18	17	…	5
After tax WACC		7.01%	7.01%	…	7.01%
After tax return		1	1	…	0
Grossed up return		2	2	…	0
Expenses		1	1	…	2
Book depreciation		1	1	…	1
Revenue required	32	4	4	…	3
End effects	2				
Total revenue requirement	34				

3. Calculate Revenue Requirement for Equivalent non-renewable: Energy

Energy: 642,814 MWh

For the Market purchase, we used the hourly power prices from the 2006 RFP plus a transmission adder of $1.65/MWh in 2007 and escalated at 2.5 percent.

Mont h	Day	Hour	20-yr NPV	2007	…	2025
1	1	1		49 MW * $59/MW = $2891	…	49 MW * $61/MW = $2989
1	1	2		92 MW * $60/MW = $5520	…	92 MW * $63/MW = $5796
…	….	…		…	…	…
12	31	24		13 MW * $59/MW = $767	…	13 MW * $65/MW = $845
($Millions)						
Cost of Market				36	…	41
Imputed Debt				1	…	0
Total Revenue Requirement			285	37	…	41

Figure I-38

Calculation of Energy Revenue Requirement

4. Incremental Cost

The table below is the total cost of Wild Horse less the cost of the peaker and less the cost of the market purchases for the total 20-year incremental cost difference of the renewable to an equivalent non-renewable.

Figure I-39

20-yr Incremental Cost of Wild Horse

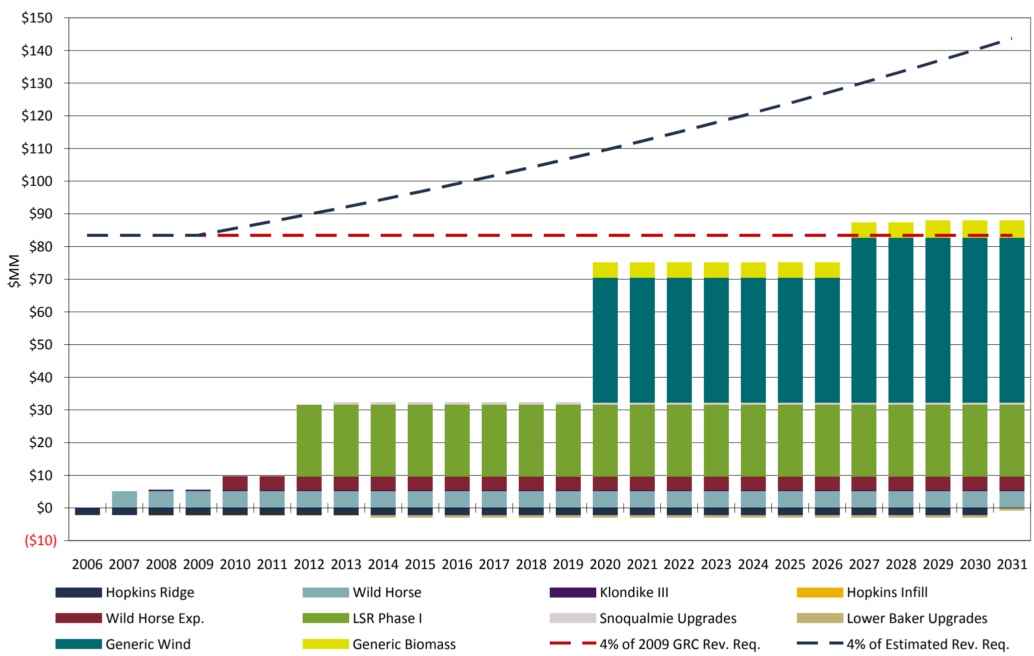
($ Millions)	20-yr NPV
Wild Horse	375
Peaker	34
Market	285
20-yr Incremental Cost of Wild Horse	56

We chose to spread the incremental cost over 25 years since that is the depreciable life of a wind project used by PSE. The payment of $56 Million over 25 years comes to $5.2 Million/Year using the 7.01 percent discount rate.

7. Summary Results

Each renewable resource that counts towards meeting the renewable energy target was compared to an equivalent non-renewable resource starting in the same year and levelized over the book life of the plant: 25 years for wind power, and 40 years for hydroelectric power. Figure I-40 presents results of this analysis for existing resources and projected resources. This demonstrates PSE expects to meet the physical targets under RCW 19.285 without being constrained by the cost cap. The negative cost difference means that the renewable was lower-cost than the equivalent non-renewable, while a positive cost means that the renewable was a higher cost.

Figure I-40
Equivalent Non-renewable 20-year Levelized Cost Difference Compared to 4 Percent of 2009 GRC Revenue Requirement



As the chart reveals, even if the company's revenue requirement were to stay the same for the next 10 years, PSE would still not hit the 4 percent requirement. The estimated revenue requirement uses a 2.5 percent assumed escalation from the 2009 General Rate Case revenue requirement.

Gas Analysis

Contents

1. 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. The current version of SENDOUT used by PSE (Version 12.5.5) incorporates a Monte Carlo capability allowing analysis of uncertainty about future prices and weather driven loads. 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, transportation, and Demand Side Resources (DSR) 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.

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 HDD 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 percent. 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 percent or greater on nine 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 percent. If the jump occurred, the magnitude was calculated as follows: When the spread between daily prices exceeded average daily prices by 40 percent or more, the average percentage increase was used. For Sumas, this was a jump multiplier of 1.53.

2. Analytical Results

Seven planning scenarios were analyzed for the gas sales portfolio using the Sendout Model. As discussed in Chapter 4, the planning scenarios are:

1. Base
2. Base + CO2
3. Low Growth
4. High Growth
5. Green World
6. Very Low Gas Prices
7. Very High Gas Prices

Three sensitivity cases were analyzed for the combined gas sales and gas for power portfolio. The focus of these analyses is to determine the lowest cost mix of resources to meet the combined needs of the gas sales and gas for power loads. The three cases are:

1. Base gas sales combined with Base gas for power
2. Base gas sales combined with the Base + Thermal Mix gas for power
3. Base gas sales combined with the Base + No Peakers gas for power

The resource need for the three gas sales load forecasts, the three gas for power scenarios, and the three combined need cases are shown in Figures J-1 thru J-3, respectively.

The optimal portfolios of supply and energy efficiency resources for each of the scenarios and sensitivity cases were identified using SENDOUT. The results of the analyses are shown in Figures J-4 thru J-13. The specific resource additions for each of these scenarios are described in Chapter 6, Section 3.

Figure J-1

Gas Sales Resource Need (MDth/day)

	2016-17	2020-21	2025-26	2030-31
Base Load Forecast	26	115	234	353
Low Load Forecast		62	146	225
High Load Forecast	56	172	330	498

Figure J-2

Gas for Power Resource Need (MDth/day)

	2016-17	2020-21	2025-26	2030-31
Base				
Thermal Mix	169	169	225	188
No Peakers	169	226	338	357

Figure J-3

Combined Gas Resource Need (MDth/day)

	2016-17	2020-21	2025-26	2030-31
Base + Base	20	109	228	310
Base + Thermal Mix	194	284	459	541
Base + No Peakers	195	342	572	709

Figure J-4

Base Optimal Portfolio – Gas Sales

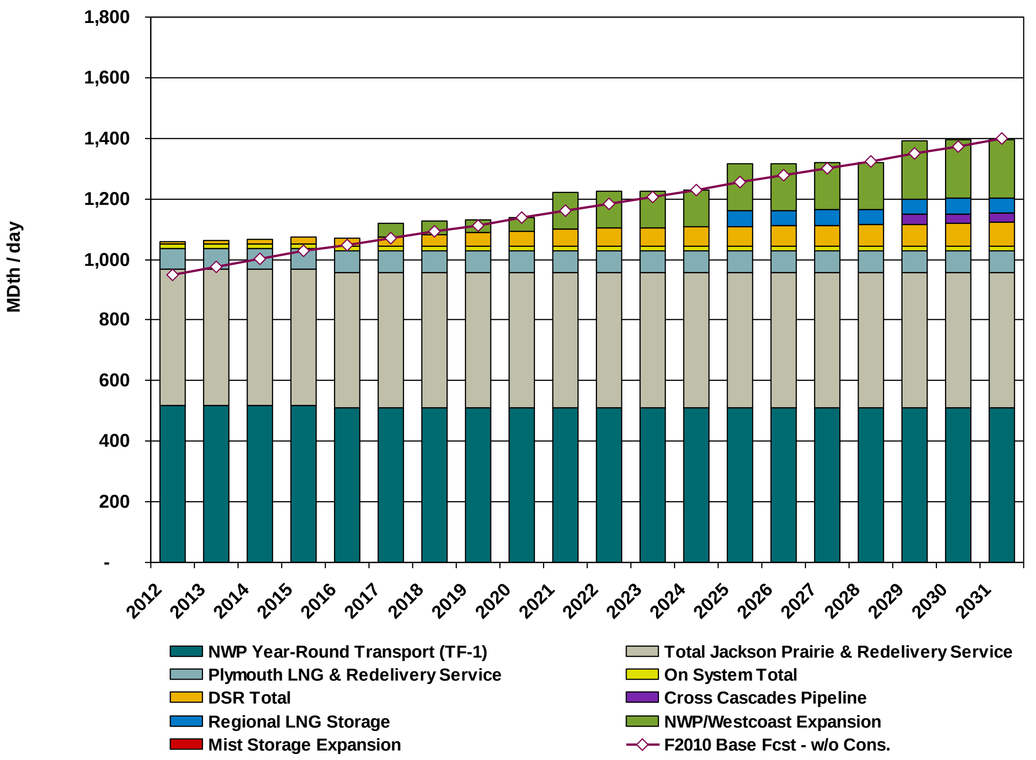


Figure J-5

Base + CO2 Optimal Portfolio – Gas Sales

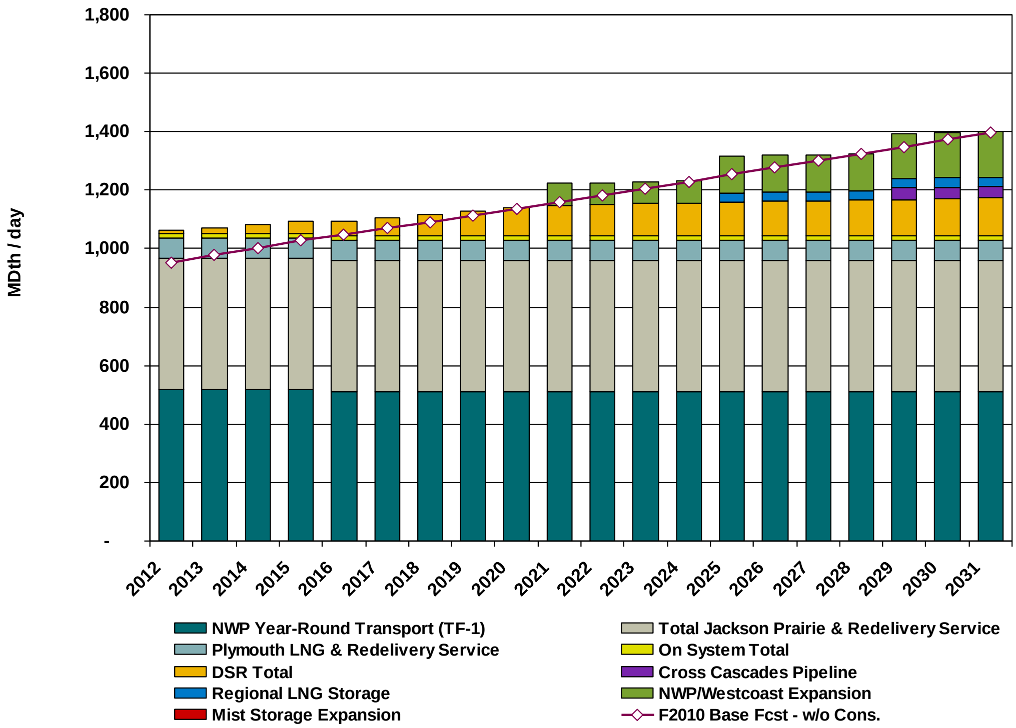


Figure J-6

Low Growth Optimal Portfolio – Gas Sales

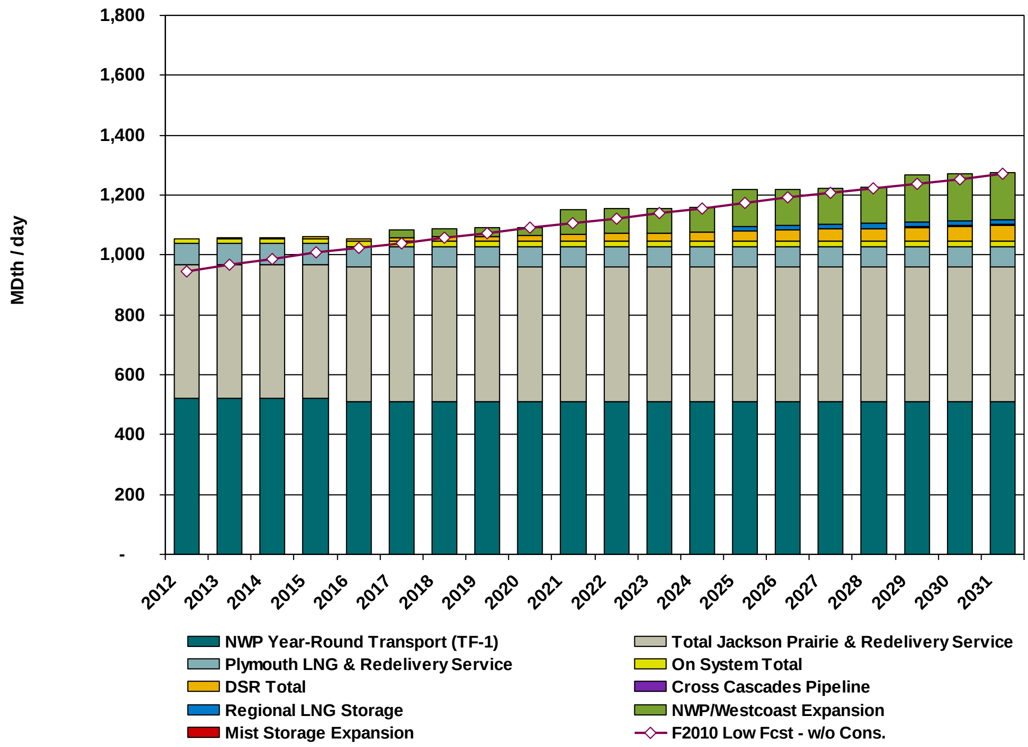


Figure J-7

High Growth Optimal Portfolio – Gas Sales

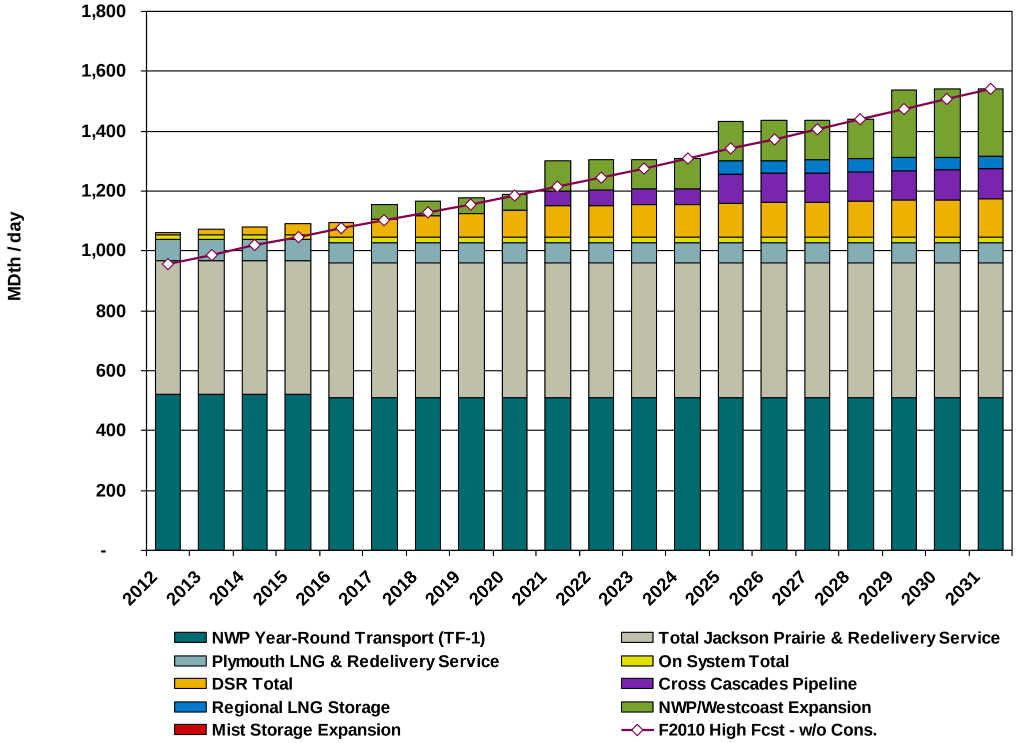


Figure J-8

Green World Optimal Portfolio – Gas Sales

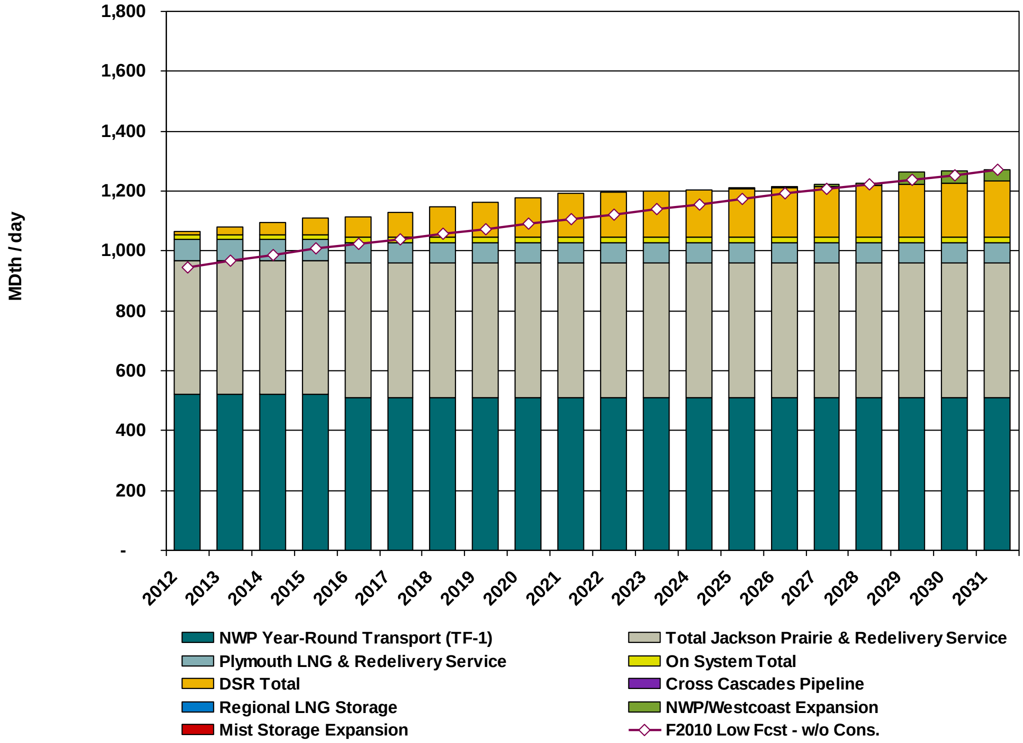


Figure J-9

Very Low Gas Prices Optimal Portfolio – Gas Sales

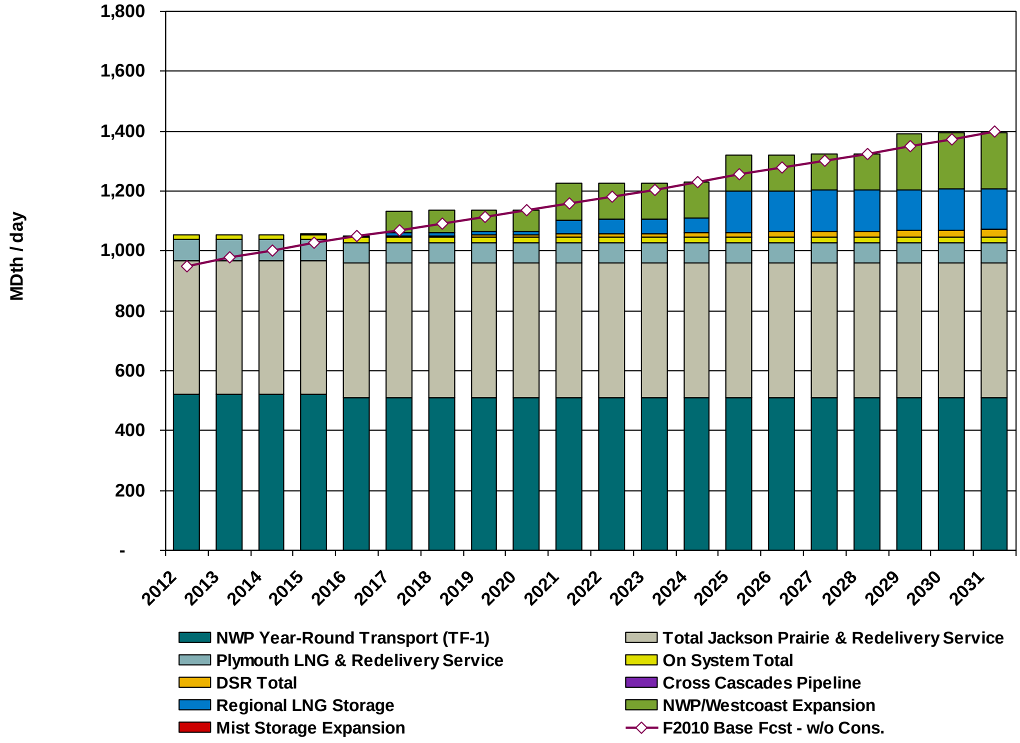


Figure J-10

Very High Gas Prices Optimal Portfolio – Gas Sales

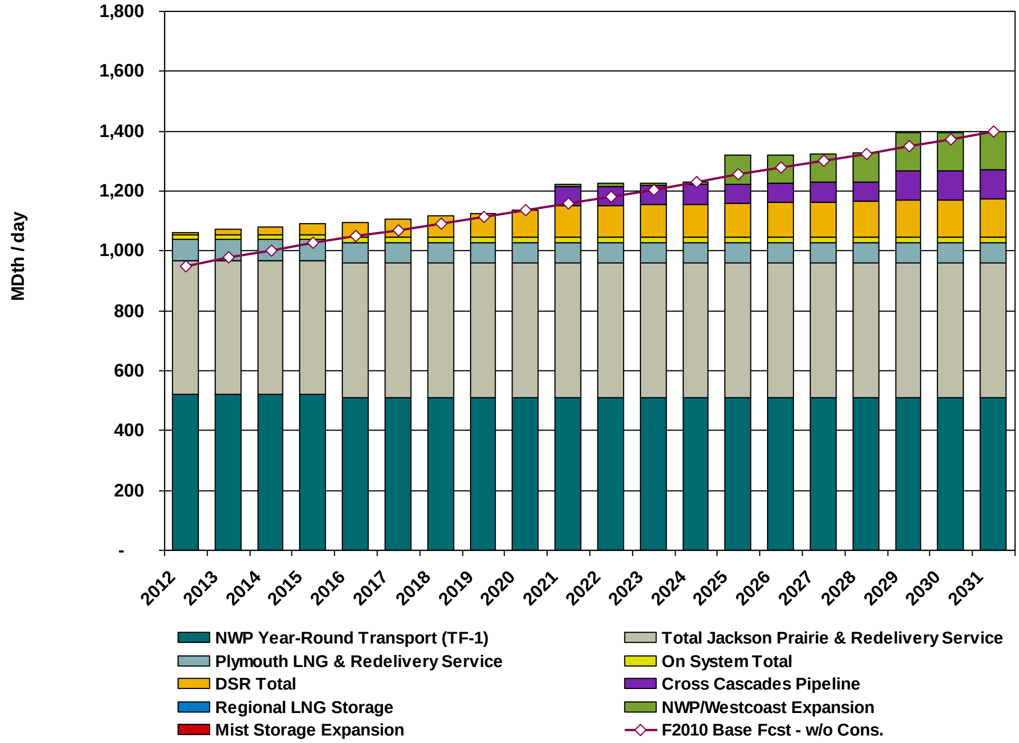


Figure J-11

Base Optimal Portfolio – Combined

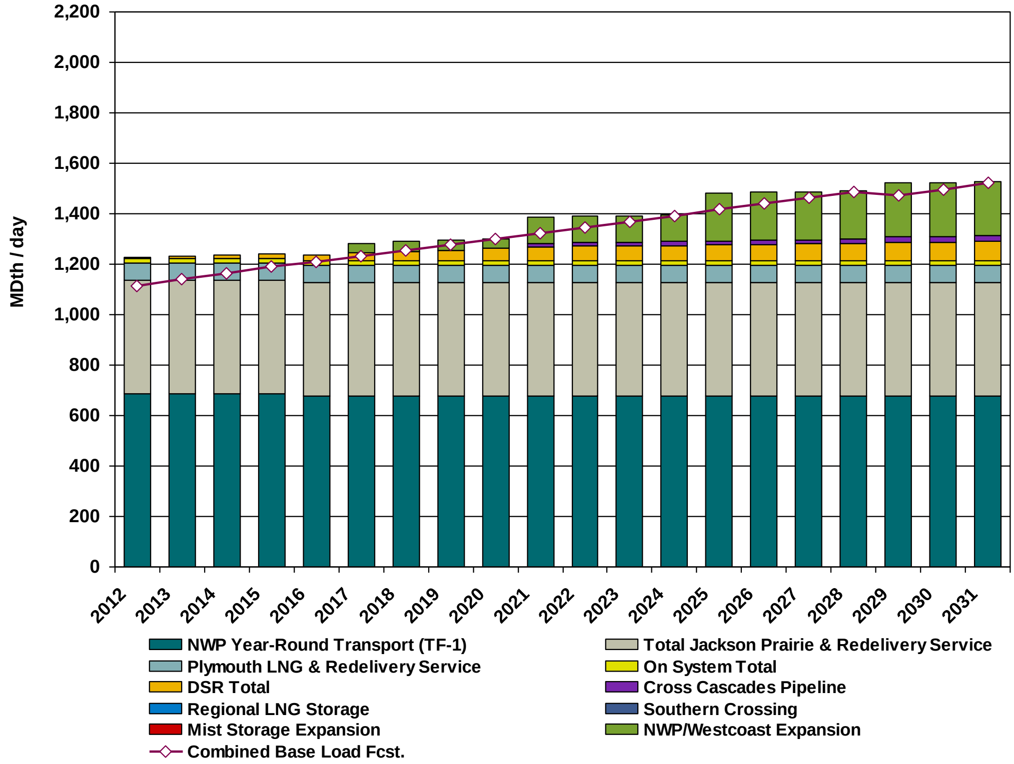


Figure J-12

Base + Thermal Mix Optimal Portfolio – Combined

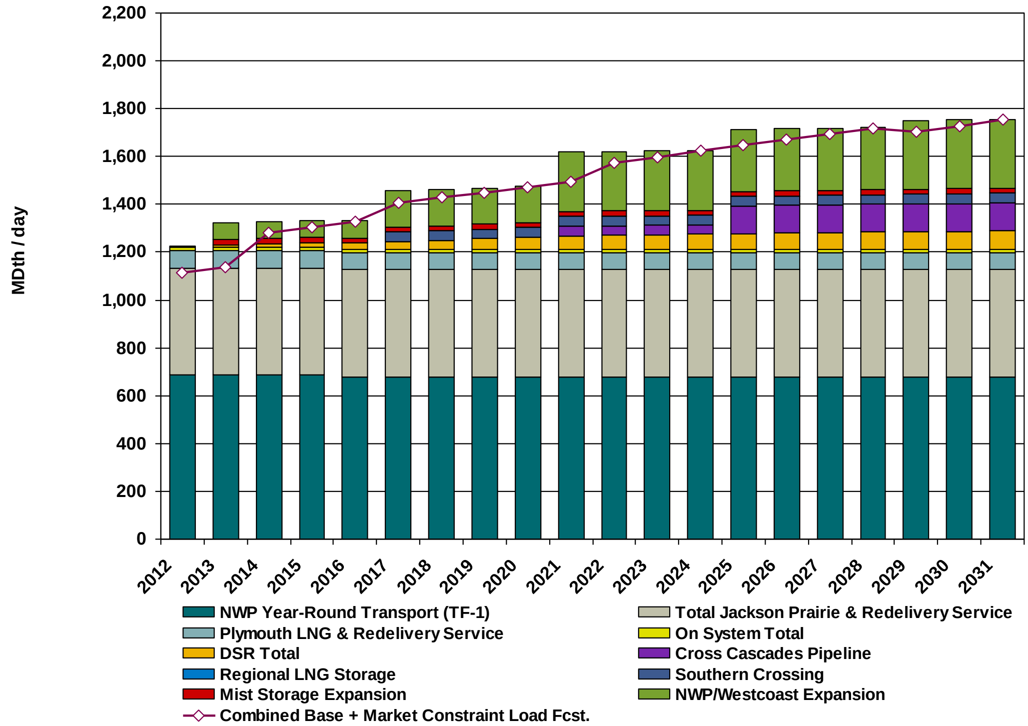
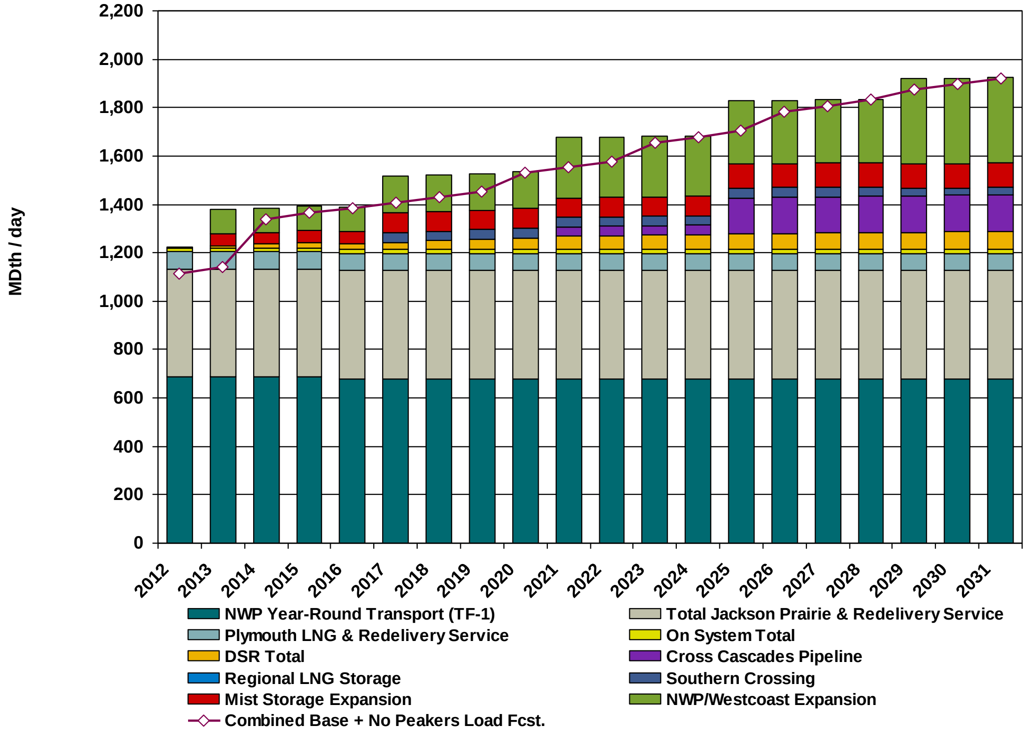


Figure J-13

Base + No Peakers Optimal Portfolio – Combined



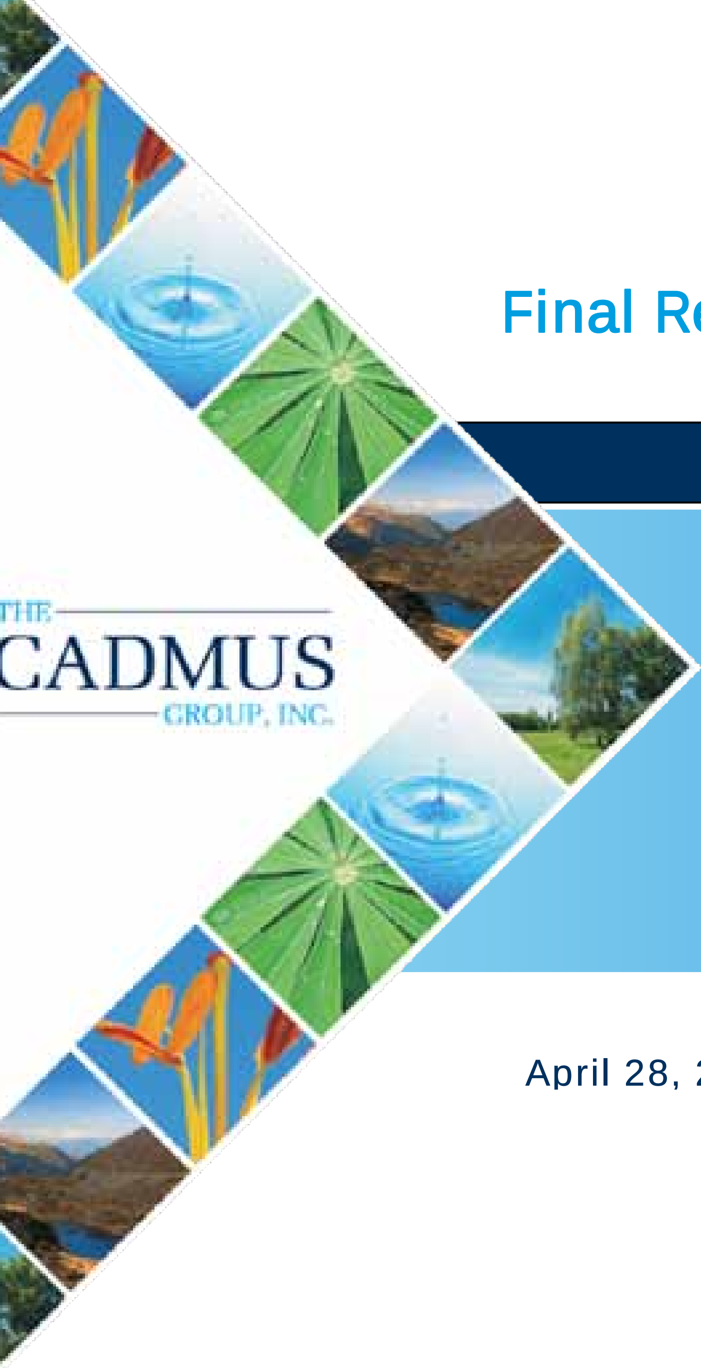
3. Portfolio Delivered Gas Costs – Avoided Costs

The average delivered portfolio cost for the gas sales scenarios are shown graphically in Chapter 6. They are presented below in tabular form in Figure J-14. These costs represent the avoided portfolio gas costs. Note however, these costs represent the avoided cost of gas delivered to PSE's system. They do not include the avoided gas distribution system costs.

Figure J-14

Avoided Portfolio Gas Costs ($/Dth)

Year	Base	Base + CO2	Low Growth	High Growth	Green World	Very Low Gas Prices	Very High Gas Prices
2010	7.17	7.71	5.77	8.46	11.27	5.68	8.48
2011	7.67	9.04	6.00	9.22	12.20	5.66	9.52
2012	7.85	9.30	6.27	9.89	13.16	5.64	10.42
2013	8.24	9.85	6.63	10.67	14.21	5.62	11.73
2014	8.62	10.33	6.84	11.44	14.90	5.69	12.54
2015	9.04	10.82	7.20	11.41	15.28	5.77	12.82
2016	9.45	11.48	7.37	11.49	15.84	5.75	13.19
2017	10.11	11.99	7.58	12.03	16.47	5.74	13.80
2018	10.60	12.80	7.72	12.47	17.11	5.82	14.31
2019	11.46	13.81	8.00	13.36	18.26	5.93	15.34
2020	11.77	13.74	8.14	13.52	18.35	5.90	15.68
2021	12.07	14.35	8.29	14.10	18.93	5.88	16.19
2022	11.05	13.57	8.50	14.65	20.23	6.04	16.97
2023	11.72	14.35	8.69	15.21	20.84	6.04	17.70
2024	11.88	14.65	8.92	15.86	22.18	6.09	18.46
2025	12.42	15.72	9.09	16.69	23.02	6.07	19.52
2026	12.82	16.03	9.28	17.05	24.00	6.08	20.06
2027	13.78	17.18	9.56	17.48	25.51	6.21	20.64
2028	14.10	17.65	9.72	17.93	26.22	6.19	21.22
2029	14.44	18.50	9.91	18.46	26.69	6.17	21.97



Final Report

Comprehensive Assessment of Demand-Side Resource Potentials (2012-2031)

April 28, 2011

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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 resources (DSR) in Puget Sound Energy's (PSE's) service territory from 2012 to 2031. The study was commissioned by PSE as part of its biennial integrated resource planning (IRP) process.

The study, which builds upon previous efforts, incorporates updated baseline and DSR data informed by primary and secondary data collection. The study is also informed by 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 potential and achievable technical potential 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 Results

The potentials identified in this study are summarized in Table 1. As shown, electric demand-side resources account for 667 aMW and 1,208 winter peak MW of achievable technical potential by 2031. These potentials represent 19% of retail energy sales and 21% of winter peak demand[1]. Similarly, achievable technical natural gas potential accounts for 20% of forecasted 2031 retail sales. High-level potentials by resource are presented below, with more detailed results in the sections of this report that follow.

Table 1. Summary of Energy and Capacity Saving Potentials, Cumulative in 2031

	Energy (aMW / million therms)		Winter Coincident Peak Capacity (MW)	
Resource	Technical Potential	Achievable Technical Potential	Technical Potential	Achievable Technical Potential
Electric Resources				
Energy Efficiency	961	645	1,497	985
Fuel Conversion	55	22	75	30
Demand Response	N/A	N/A	1,995	193
Electric Resources Total	1,016	667	3,567	1,208
Natural Gas Resources				
Energy Efficiency	427	268	N/A	N/A

Energy Efficiency

Table 2 shows 2031 forecasted baseline electric sales and potential by sector. As shown, the results of this study indicate 961 aMW of technically feasible electric energy-efficiency potential will be available by 2031, the end of the 20-year planning horizon. Once market constraints are

[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.

taken into account, this translates to an achievable technical potential of 645 aMW. Were all of this potential cost-effective and realizable, it would amount to an 18 percent reduction in 2031 forecasted retail sales and a reduction in forecasted load growth of roughly 50 percent. This study, consistent with the Council, assumes that 85 percent of electric resources will be achievable over time. However, due timing of lost opportunity resource acquisition, the achievable technical potential amounts to less than 85 percent of the technical potential, as described in greater detail in Section 1.

Table 2. Electric Energy-Efficiency Potential by Sector, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
Sector	Baseline Sales	aMW	Percent of Baseline Sales	aMW	Percent of Baseline Sales
Residential	1,620	566	35%	336	21%
Commercial	1,823	373	20%	291	16%
Industrial	111	22	20%	18	17%
Total	3,554	961	27%	645	18%

Table 3 shows 2031 forecasted baseline natural gas sales and potential by sector. As shown, the results of this study indicate roughly 427 million therms of technically feasible natural gas energy-efficiency potential by 2031. This translates to an achievable technical potential of 268 million therms. If all of this potential was cost-effective and realizable, it would amount to a 20 percent reduction in 2031 forecasted retail sales and a 68% reduction in forecasted load growth from 2012 to 2031.

Table 3. Natural Gas Energy-Efficiency Potential by Sector, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
Sector	Baseline Sales	Million Therms	Percent of Baseline Sales	Million Therms	Percent of Baseline Sales
Residential	846	303	36%	183	22%
Commercial	445	117	26%	80	18%
Industrial	31	7	21%	5	16%
Total	1,322	427	32%	268	20%

Comparison to 2009 IRP

The assessment of energy efficiency potential is largely an update of the analysis conducted for PSE's 2009 IRP. However, there are a number of differences between the two studies that have led to differences in technical, and thus, achievable technical potential, namely:

- Updated commercial baseline data from the Northwest Energy Efficiency Alliance's (NEEA's) Commercial Building Stock Assessment (CBSA)
- Utilization of PSE's most recent energy and sales forecasts
- Incorporation of assumptions, data, and new measures from the Council's 6th Northwest Power Plan
- Adjustments to remaining potential based on PSE's actual 2008-2009 and projected 2010-2011 energy efficiency program accomplishments
- Updated data on measure costs, savings, lifetime, and applicability
- Incorporation of new codes and standards, as described in Section 1 of this report.

A comparison of electric and natural gas technical potentials from the two studies, by sector, is presented in Table 4. As shown, the results of the two studies are similar, with the exception of electric potential in the residential sector, where potential has increased by approximately 65 percent, as compared to the 2009 IRP. This increase is driven largely by increased savings from measures included in the Council's 6th Plan, such as heat pump water heaters and consumer electronics. Additionally, the impact of upcoming residential lighting standards is being treated differently in this study, as described in Section 1, which has increased the remaining lighting potential.

Table 4. Comparison of Energy Efficiency Technical Potential, 2009 IRP to 2011 IRP

	Electric (aMW)		Natural Gas (million therms)	
Sector	2009 IRP	2011 IRP	2009 IRP	2011 IRP
Residential	343	566	263	303
Commercial	378	373	132	117
Industrial	17	22	12	7
Total	739	961	407	427

Fuel Conversion

The fuel conversion analysis estimates available potential from converting electric equipment to natural gas for two main customer types: customers in PSE's natural gas service territory who do not currently have natural gas service, and those who do, but still have electric equipment (i.e. water heaters or appliances) that could be converted to natural gas. Table 5 shows the available technical and achievable technical potential in 2031 for each type of customer.

Table 5. Summary of Fuel Conversion Potentials, Cumulative in 2031

	Technical Potential		Achievable Technical Potential	
Customer Type	Electric Savings (aMW)	Additional Gas Usage (million therms)	Electric Savings (aMW)	Additional Gas Usage (million therms)
Electric-Only	23.5	16.0	10.6	7.3
Existing Gas Customer	31.4	18.6	11.5	7.5
Total	54.9	34.6	22.1	14.8

Comparison to 2009 IRP

As for energy efficiency, this analysis is largely an update to the 2009 IRP. The analysis builds upon the same updated data mentioned above, including baseline data, PSE's sales and customer forecasts, and measure assumptions. Table 6 presents a comparison of the estimated technical and achievable technical potential, as compared to the 2009 IRP. Whereas the 2009 IRP included customers in Cascade Natural Gas service territory, this study addresses conversion only for customers in PSE's natural gas service territory. Additionally, this study incorporated expected participation rates based on PSE pilot program experience, leading to substantially lower potential for electric customers.

Table 6. Comparison of Fuel Conversion Potential, 2009 IRP to 2011 IRP

	Technical Potential (aMW)		Achievable Technical Potential (aMW)	
Customer Type	2009 IRP	2011 IRP	2009 IRP	2011 IRP
Electric-Only	136	24	50	11
Existing Gas Customer	38	31	15	12
Total	174	55	65	22

Demand Response

Table 7 presents estimated winter and summer resource potentials for all demand response resources for the residential, commercial, and industrial sectors. As shown, demand response achievable technical potential represents reductions of approximately 3 percent of forecasted 2031 winter and summer peaks.

Table 7. Demand Response Technical and Achievable Technical Potential, MW in 2031

	Winter			Summer		
Sector	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak
Residential	1,184	110	1.95%	402	32	0.72%
Commercial	767	79	1.40%	783	82	1.85%
Industrial	44	4	0.08%	54	5	0.12%
Total	1,995	193	3.43%	1,239	119	2.68%

*System peak is based on PSE's average load in the top 20 hours for each season.

Comparison to 2009 IRP

This study relies on the same methodologies used in the 2009 IRP analysis; however, the program strategies included differed. The 2011 IRP assessed one incentive-based and one pricing-based program strategy in each sector, whereas the 2009 IRP included multiple options. This decision reflected the structure of PSE's current demand response pilot programs, and to minimize the interactive effects between similar program options. A comparison of estimated achievable technical potential during peak periods, by sector, is presented in Table 8.

Table 8. Comparison of Demand Response Achievable Technical Potential, 2009 IRP to 2011 IRP

	Winter MW		Summer MW	
Sector	2009 IRP	2011 IRP	2009 IRP	2011 IRP
Residential	170	110	48	32
Commercial	14	79	14	82
Industrial	5	4	5	5
Total	189	193	68	119

*System peak is based on PSE's average load in the top 20 hours for each season.

The largest difference in results between the two studies is in the commercial sector, where potentials have increased considerably. The results of the 2011 IRP are based on the structure of PSE's nonresidential pilot program and informed by its success. Residential potential has decreased due to removal of multifamily customers from the program concept.

Distributed Generation

Distributed generation potentials were not estimated as part of this study. PSE incorporated the results of the 2009 IRP analysis into its 2011 IRP. For detailed potentials from the 2009 IRP analysis, see the 2008 Cadmus' report.[2]

Comparison to the Council's 6th Plan

This study employs methodologies consistent with the Council's 6th Plan to estimate available energy-efficiency potential (See Appendix A for a detailed comparison of methodologies). Additionally, Cadmus conducted a thorough review of baseline and measure assumptions used by the Council, including costs, savings, applicability, and current saturation. Although this study relies on data specific to PSE's service territory whenever possible, Council assumptions were incorporated where appropriate.

By applying PSE's share of regional sales, by sector, to the Council's regional potential, one can estimate the 6th Plan's share of potential in PSE's service territory. However, there are a number of factors that must be considered in comparing that allocated potential to the results of this study:

- The Council, by necessity, relies on average regional data; whereas this study utilizes primary data from PSE's service territory. Therefore, an allocation of regional potential based on sales may not account for PSE's unique service territory characteristics, such as customer mix, use per customer, end use saturations, fuel shares, and current measure saturation. Similarly, some industries included in the 6th Plan may not exist in PSE's service territory.
- PSE and the Council rely on unique baseline energy forecasts, each of which is a major driver in the respective estimates of potential.
- Both studies assess potential over a 20-year period; however, the 6th Plan begins in 2010, while estimation of potential in this study begins in 2012.
- Due to the timing of the release of the 6th Plan, not all upcoming codes and standards were removed from the potential (most notably, new standards relating to commercial lighting and residential water heating, as described in Section 1 of this report).

These caveats aside, Table 9 provides a comparison of the 2-, 10-, and 20-year achievable technical potentials estimated in this study, as compared to the 6th Plan. The 6th Plan numbers are derived by applying PSE's share of regional sales, by sector, to the 6th Plan estimates[3] of regional potential.[4]

- In the residential sector, while the 6th Plan allocation of 10- and 20-year potentials are substantially higher, the two-year 2011 IRP savings is higher due to accelerated ramping.
- In the commercial sector, short- and long-term potentials from the 2011 IRP are substantially higher.

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2 http://www.pse.com/SiteCollectionDocuments/2009IRP/AppL1_IRP09.pdf

3 Bus bar savings from the 6th Plan have been adjusted to savings at the customer meter using the Council's line loss factors.

4 Report 6th Plan potentials by sector and end use are based on summarization of measure-specific Council workbooks available here: http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

- In the industrial sector, 2- and 10-year potentials are very close, although the 6th Plan's 20-year potential is substantially higher.

Details on sector-level differences are provided below.

Table 9. Comparison of 2011 IRP and 6th Plan Achievable Technical Potential (aMW)

	2-Year Achievable Technical Potential		10-Year Achievable Technical Potential		20-Year Achievable Technical Potential	
Sector	2011 IRP	PSE Share of Regional Potential	2011 IRP	PSE Share of Regional Potential	2011 IRP	PSE Share of Regional Potential
Residential*	47	40	229	263	336	584
Commercial	43	14	230	115	284	227
Industrial	4	2	18	17	18	35
Total	93	56	478	394	638	845
* Solar photovoltaic potential has been removed from 6th Plan potential to allow for direct comparison between studies						

Residential Sector

As shown in Table 9, the residential sector accounts for the largest differences in estimates of long-term achievable technical potential. Because of differences in end-use definitions, it is difficult to compare the two studies at a detailed end-use level; however, Table 10 shows the distribution of 20-year potential by major end-use group for each study. Differences in assumptions by end use are described below:

- ***Appliances and water heating*** are combined for this comparison because a large portion of appliance potential is water heating savings from clothes washers and dishwashers. A key difference in the modeling approaches is the incorporation of new residential water heating standards in the 2011 IRP, as described in Section 1 of this report. It is assumed that new equipment installed after 2014 would need to meet the new minimum efficiency requirements, reducing the potential for high-efficiency water heating equipment. Additionally, there is a substantial difference in the assumed percentage of water heaters using electricity (42 percent in PSE's service territory versus 64 percent for the region).
- The category of ***consumer electronics and other plug loads*** contains a variety of end uses, including televisions, computers, and other household electronics. While the base-year saturations of the various types of equipment are similar between the two studies, the assumptions differ regarding how saturations may change over time, leading to a difference in long-term potential.[5] Additionally, the 6th Plan includes commercial computers and monitors as part of the residential potential, while the study performed by Cadmus includes only units in residences.
- ***HVAC*** encompasses heating, cooling, and ventilation savings, which are combined due to differences in model structures. The main drivers of this difference are assumed saturation of central cooling (15 percent in PSE's service territory versus 53 percent for the region) and the share of electric heating (15 percent for PSE's service territory versus 35 percent for the region).

5 The 2011 IRP assumes annual increases in saturations by technology ranging from 0.3% to 1.0% based on the EIA's 2010 Annual Energy Outlook. Council escalation assumptions vary by technology with an average annual increase of around two percent.

- ***Lighting*** savings in the 2011 IRP assumes a technology that meets the minimum requirements of the Energy Independence and Security Act of 2007 (EISA) will be available and that savings from CFL installations will still be available.

Table 10. Comparison of 20-Year Residential Achievable Technical Potential by End Use

	20-Year Achievable Technical Potential	
End Use Group	2011 IRP	PSE Share of Regional Forecast
Appliances and Water Heating	89	213
Consumer Electronics and Other Plug Loads	61	125
HVAC	125	202
Lighting	56	43
Total	366	584

Commercial Sector

Although in the commercial sector, this study estimates higher 2-, 10-, and 20-year achievable technical potential than does the 6th Plan, this difference is largely a function of differing load forecasts. Both studies estimate that approximately 16 percent of year-20 commercial sales could be saved; however, PSE forecasts its load to be approximately 20 percent higher than its allocation of the regional commercial sales forecast. Higher potential in the early years of this study is due to the 10-year acceleration of all discretionary potential.

Industrial Sector

Because the two assessments rely on the same measure assumptions, differences in potential are driven by the mix of industries present. For example, in the Northwest region on the whole, pulp and paper industries account for the largest portion of both baseline sales and achievable technical potential (roughly 30 percent and 40 percent, respectively). However, in PSE's service territory, these facilities account for less than 1 percent of baseline consumption. Additionally, PSE's forecasted industrial sales are approximately 30-percent lower than its allocated share of the regional forecast.

Incorporation of Demand Side Resources into PSE's IRP

The achievable technical potential shows above were grouped by levelized cost of conserved energy for inclusion in PSE's IRP model. Note, levelized costs are calculated over a measure's life, even if that life extends past the end of the planning horizon. Bundling resources into a number of distinct cost groups allows the model to select the optimal amount of DSR annually based on expected load growth, energy prices, and other factors.

Figure 1 shows the annual cumulative combined potential for energy efficiency, fuel conversion, and distributed generation by each of the cost bundles considered in PSE's 2011 IRP. Figure 2 shows the annual DSR bundles for natural gas energy efficiency.

Figure 1. Annual Electric DSR Bundles by Cost Group

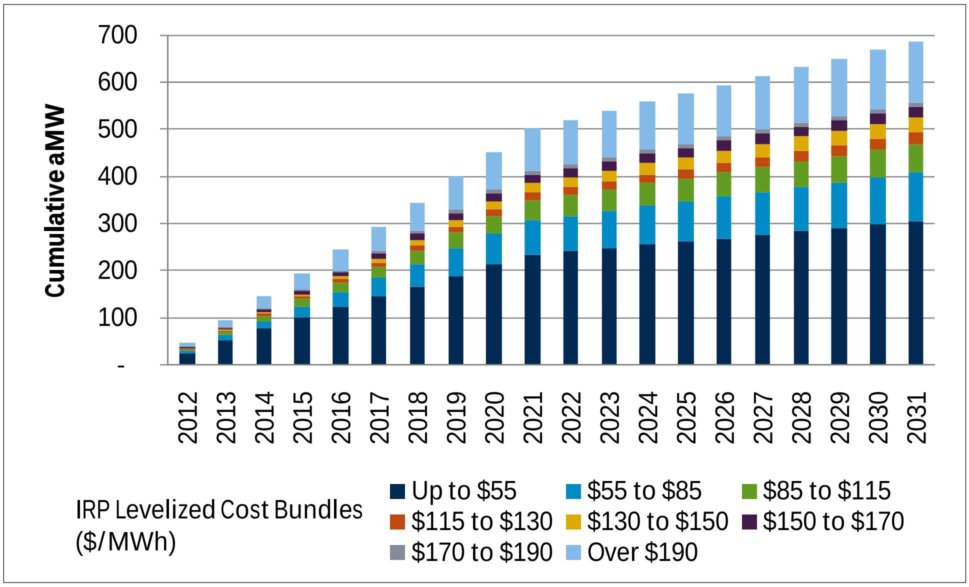
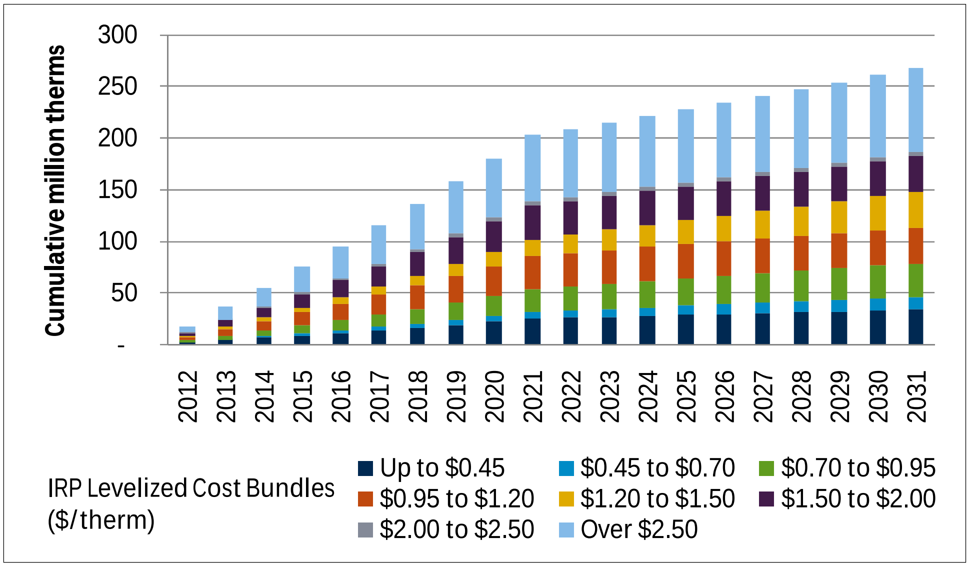


Figure 2. Annual Natural Gas DSR Bundles by Cost Group



In addition to the energy efficiency, fuel conversion, and distributed generation bundles displayed above, PSE included three other resource bundles in its IRP:

1. The expected effects on residential lighting due to EISA (shows graphically in Figure 3),
2. Capacity-only impacts of demand response, and
3. Savings associated with distribution efficiency improvements (outside the scope of this study).

Organization of the Report

The remainder of this report is organized in four sections. The first outlines the general methodology for assessment of potential for each resource type, while the remaining three sections present the key assumptions and results for each resource. Additional technical information and descriptions of data and their sources are presented in the appendices to this document.

1. General Approach and Methodology

This report describes the technologies, data inputs, data sources, data collection processes, and all assumptions used in the calculation of technical and achievable technical long-term potentials.

General Approach

The demand-side resources (DSR) 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 aim to arrive at estimates of two distinct types of potential: technical and achievable technical.

Technical potential assumes that all technically feasible resource opportunities may be captured, regardless of their costs or other market barriers. It is important to note that the notion of technical potentials is less relevant to resources (such as demand response) since nearly all end-use loads may be subject to interruption or displacement by on-site generation from a strictly technical point of view.

Achievable technical potential is defined as that portion of technical potential that might be assumed to be achievable in the course of the planning horizon, regardless of the acquisition mechanism. (For example, savings may be acquired through utility programs, improved codes and standards, or market transformation.) The identified potential is then grouped by levelized cost, allowing PSE's IRP model to pick the optimal amount of DSR, given various assumptions around future resource requirements and costs. In addition to the up-front capital cost and annual energy savings, the levelized cost calculation incorporates several other factors, consistent with the Council's methodology:

- ***Incremental operations and maintenance (O&M) costs or benefits*** are considered annually over the life of the measure. The present value is used to adjust the levelized cost- upward for measures with costs above baseline technologies and downward for measures that decrease O&M costs.
- ***Non-energy benefits*** are treated as a reduction in levelized costs for measures that save resources in addition to the primary fuel being considered. This includes secondary fuel benefits (e.g. natural gas savings for electric measures) as well as reductions in consumption of water, detergent, or other applicable resources.
- ***The regional ten percent conservation credit, capacity benefits during PSE's system peak, and transmission and distribution (T&D) deferrals*** are similarly treated as reductions in levelized cost for electric measures.

In addition to the quantity of available potential, the timing of resource availability is a key consideration. For this analysis, resources are split into two distinct categories:

- ***Discretionary resources*** are retrofit opportunities in existing facilities that, theoretically, are available at any point over the course of the study period.
- ***Lost opportunity resources*** are those with pre-determined availability, such as replacement after equipment failure and opportunities in new construction.

Data Sources

The full assessment of resource potential required the compilation of a large set of measure-specific technical, economic, and market data obtained from secondary sources and through primary research. The main sources of data used in this study included:

- ***PSE Internal Data.*** This encompasses historical and forecasted sales and customers, hourly load profiles, and historic DSR accomplishments
- ***Primary Data.*** This study relies on several sources of data specific to PSE's service territory and customers. These sources include the 2008 Residential End Use Survey, 2008 Fuel Conversion Survey, 2007 CFL Saturation Study, and NEEA's 2009 Commercial Building Stock Assessment (CBSA).
- ***Secondary Pacific Northwest Sources.*** Several Northwest entities provided data critical to this study, including the Council, the Regional Technical Forum (RTF), and the Northwest Energy Efficiency Alliance (NEEA). This included technical information on measure savings, costs, and lives, hourly end-use load shapes (to supplement building simulations described above), and commercial building and energy characteristics.
- ***Additional Secondary Sources.*** The study relied on a number of secondary sources to characterize measures, assess baseline conditions, and benchmark results against other utilities' experiences. These sources include the California Energy Commission's Database of Energy Efficiency Resources (DEER), ENERGY STAR, the Energy Information Administration, and various utilities' annual and evaluation reports on energy efficiency and demand response programs.

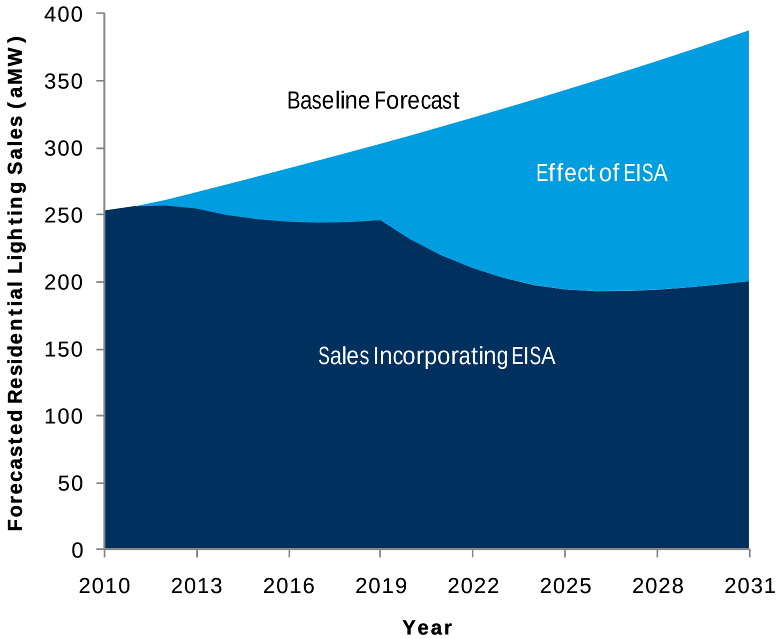
Incorporation of Upcoming Codes and Standards

While Cadmus' analysis does not attempt to predict how energy codes and standards may change, it does capture legislation that has been enacted, even if it will not go into effect for several years. The most notable, recent efficiency regulation is the Energy Independence and Security Act of 2007 (EISA), which set new standards for general service lighting, motors, and other end use equipment. It is particularly important to capture the effects of this legislation because residential lighting has played a large role in PSE's energy efficiency programs over the past several years.

EISA requires that general service lighting becomes roughly 30 percent more efficient than current incandescent technology, with standards phased in by wattage from 2012 to 2014. In addition to the 2012 phase-in, EISA contains a backstop provision that requires still higher efficacy beginning in 2020.

To ensure an accurate assessment of remaining lighting potential, Cadmus created a new forecast netting out EISA's effect on residential lighting (Figure 3). This was based on a strict interpretation of the legislation, assuming that affected bulbs would be replaced with technologies meeting EISA minimum standards, meaning savings from CFL and LED technologies would still exist. Note that PSE's 2009 IRP assumed CFLs would become the *de facto* baseline after the codes took effect, thus eliminating the potential for CFLs.

Figure 3: Residential Lighting Forecasts Before and After EISA Adjustment



While the new residential lighting standards have the largest effect on potential, several other codes and standards were explicitly accounted for in this study. Specifically, these:

- Current Washington state energy code (as of 2010)
- Residential water heating standards established on April 16, 2010, and taking effect in 2015, setting new requirement for Efficiency Factor (EF)[6]: The analysis assumes that, beginning in 2015, all new equipment installed will meet these minimum efficiency requirements.

Table 11. 2015 Residential Water Heater EF Requirements

Equipment Type	55 Gallons and Below	56 Gallons and Above
Electric Storage	EF = 0.960 - (0.0003 × Rated Storage Volume in gallons)	EF = 2.057 - (0.00113 × Rated Storage Volume in gallons)
Gas-fired Storage	EF = 0.675 - (0.0015 × Rated Storage Volume in gallons)	EF = 0.8012 - (0.00078 × Rated Storage Volume in gallons
Gas-fired Instantaneous	EF = 0.82	

- Two commercial lighting standards are phased in over the study horizon. First, as of July 2010, Department of Energy standards mandate that magnetic ballasts be phased out and replaced with electronic ballasts. In addition, standards require that all T-12 lamps be phased-out beginning in July 2012.[7] These standards are modeled as a percentage reduction to the lighting end use intensity (EUI), phased in upon ballast replacement. The EUI reduction is based on two factors:

6 http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/htgp_finalrule_fedreg.pdf

7 http://www1.eere.energy.gov/buildings/appliance_standards/residential/fluorescent_lamp_ballasts.html

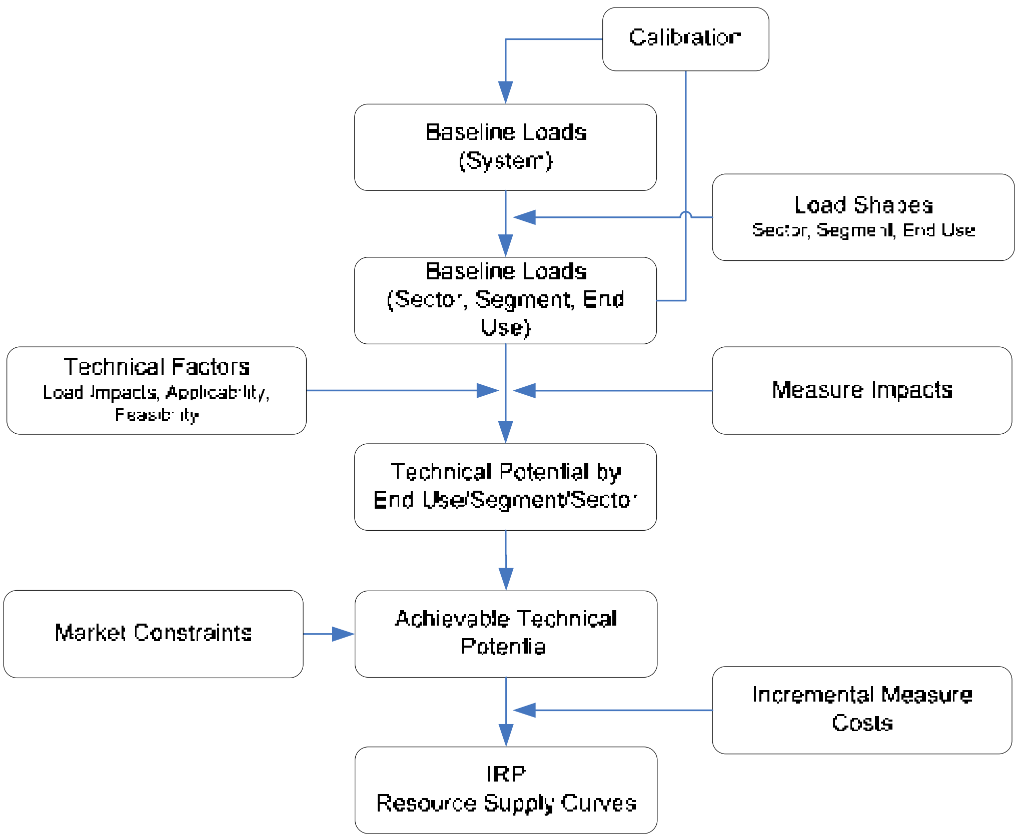
1. The difference in wattage between a T-12 lamp with a magnetic ballast and a T-8 lamp with an electronic ballast, and,
2. The percentage of floor space lit by T-12 lamps, as estimated by the 2009 CBSA.

The remainder of this section outlines the specific methodologies used for each resource.

Energy Efficiency

The methodology used for estimating the technical and achievable technical energy-efficiency potential is based on standard industry practices. This methodology is consistent with that of the Council in its assessments of conservation potentials for the 6th Northwest Regional Power Plan (6th Plan). The general approach, shown in Figure 4, illustrates how baseline and efficiency data are combined to develop estimates of potential for use in PSE's IRP process.

Figure 4. General Methodology for Assessment of Energy Efficiency Potentials



Developing Baseline Forecasts

As shown, the first step entails creating a baseline (no-DSR) forecast. In the residential and commercial sectors, the analysis relies on a bottom-up forecasting approach, beginning with annual consumption estimates by segment, end use, and efficiency level of equipment. Average base-year use per customer is then calculated from the saturations of equipment, fuel, and efficient equipment. These estimates are validated by comparison to PSE's historical use per customer, and a forecast of future energy sales is then created based on expected new construction and equipment turnover rate.

In the industrial sector, as is standard practice, PSE's industrial forecast is disaggregated to end uses based on data available from the EIA's Manufacturing Energy Consumption Survey.

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. Cadmus conducted the analyses for the following customer segments:

- 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),
- 17 industrial segments (17 facility types, treated only as an existing construction vintage)

Estimating Technical Potential

To estimate technical potential, a comprehensive list of measures was developed for all sectors, segments, and end uses. For the residential and commercial sectors, the study begins with a review of a broad range of energy-efficiency measures. These measures are then screened to include only those measures that are: (1) commonly available, (2) based on well-understood technology, and (3) applicable to PSE's buildings and end uses.

The industrial sector measures were based on the Council's 6th Plan and other general categories of process improvements.[8]

The study encompasses 309 *unique* electric energy-efficiency measures and 106 unique gas energy-efficiency measures (Table 12). When expanded across segment, end use, and construction vintage, this amounts to over 6,000 measures. (A comprehensive list of measures included in the analysis is provided in Appendix B.2, with inputs and outputs provided in Appendix B.3.)

Table 12. Energy-Efficiency Measure Counts by Fuel

Sector	Electric Measure Counts	Gas Measure Counts
Residential	89 unique, 922 permutations across segments	48 unique, 409 permutations across segments
Commercial	138 unique, 2,503 permutations across segments	50 unique, 908 permutations across segments
Industrial	82 unique, 1,145 permutations across segments	8 unique process improvements, 124 permutations across segments

For every measure permutation contained in the study, a number of key inputs—varying by segment and end use—were compiled, specifically, these:

8 Industrial improvements are derived from a variety of practices and specific measures defined in DOE's Industrial Assessment Centers Database, http://www.iac.rutgers.edu/database/.

- ***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, the Regional Technical Forum (RTF), the Council's 6th Plan, and secondary sources such as Energy Star and DEER.
- ***Measure costs.*** The per-unit cost (either full or incremental, depending on the application) associated with installation of the measure. Sources include the Council's 6th Plan, DEER, RS Means, and merchant Websites.
- ***Measure life.*** The expected useful life (EUL) of the measure. Sources include the Council's 6th Plan, DEER, and demand-side management (DSM) program evaluations.
- ***Measure applicability.*** A general term encompassing a number of factors, such as the technical feasibility of installation, the current saturation of the measure, measure interaction, and competition. Where possible, applicability factors are based on PSE survey data.

An alternate sales forecasts was created, incorporating the effects of all technically feasible measures, and the difference between this forecast and the baseline forecast represents the technical potential. This method allows for long-term estimates of technical potential by measure, while accounting for changes in baseline conditions inherent in the baseline forecast.

Achievable Technical Potential

"Achievable technical potential" is defined as that portion of technical potential expected to be reasonably achievable over the course of the planning horizon. This estimate accounts for likely rates of acquisition and market barriers to customer adoption, but it does not address cost-effectiveness or acquisition mechanism (utility programs, codes and standards, market transformation, etc.). Thus, the amount of savings a utility can expect to acquire cost-effectively may be substantially lower than this estimate.

This study, consistent with the Council's 6th Plan, assumes an achievability factor for electric energy efficiency of 85 percent. For lost opportunity measures, this number (which is applied directly to the total technical potential for discretionary measures) is ramped in at a rate determined by the technology. Because of this ramp-up, less than 85 percent of the lost opportunity potential will be acquired over the planning horizon, consistent with the Council's methodology[9].

Due to higher up-front cost of equipment for gas resources, it is assumed that 75 percent of the technical potential could be achieved over the planning horizon.

As discussed previously, lost opportunity measures have an inherent technical ramping based on new construction and equipment turnover rates. In contrast, discretionary opportunities can be acquired at any point. For this study, it is assumed that all achievable electric and gas discretionary measures can be acquired in 10 years. This 10-year accelerated ramp-in for discretionary measures is considered by PSE to be a reasonable representation of the overall rate

[9] This is consistent with the Council's assumption that 65 percent of lost opportunity resources can be acquired, as discussed in: *A Retrospective Look at the Northwest Power and Conservation Council's Conservation Planning Assumptions,* April 2007 - http://www.nwcouncil.org/library/2007/2007-13.htm

of energy savings acquisition for resource planning analyses. It should be noted that actual market ramp rates will vary for specific measures.

Fuel Conversion

In the context of this study, “fuel conversion” refers to electric savings opportunities involving substitution of natural gas for electricity through replacement of space heating systems, water heating equipment, and appliances. Fuel conversion is only considered for existing single-family homes, new multifamily buildings, and both existing and new commercial facilities. These segments are considered the most likely and able to convert.

Cadmus’ analysis is an extension of the energy-efficiency analysis described above, identifying applicable equipment and customers based on the following criteria:

- Customers must be within PSE’s combined service territory. That is, areas where PSE provides both electricity and natural gas.
- Customers must be either existing gas customers or on a gas main.
- For existing construction, customers must have a ducted system for space heating conversion.
- New natural gas equipment must meet energy-efficiency program criteria (90 percent AFUE furnace, ENERGY STAR water heater, etc.).

Once eligible populations for each equipment type are identified, measure costs and savings are compiled, consistent with the energy-efficiency analysis. Cadmus also accounts for additional up-front costs required due to the natural gas conversion (line extensions, piping, etc.). The cost of natural gas consumed over the life of the measure, calculated based on forecasted avoided costs, is treated as an O&M cost and is included in the calculation of the cost of conserved electricity.

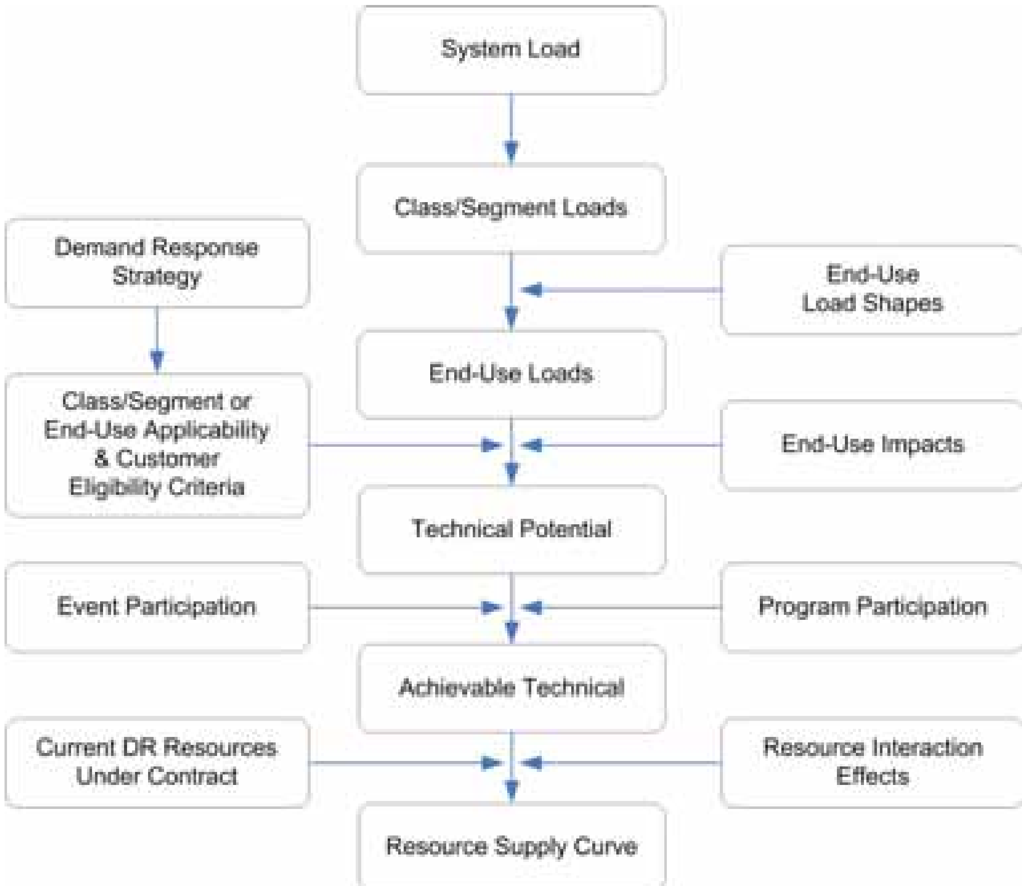
As with energy efficiency, the technical potential assumes all eligible pieces of equipment are converted to natural gas. Achievability is based on the results of PSE’s 2008 fuel conversion survey, which asked customers about their likelihood of participating at various incentive levels. Based on this survey, this analysis assumes 63 percent achievability, the value associated with PSE covering the entire incremental cost of conversion. Available potential is assumed to be acquired in equal amounts annually over the planning horizon.

Demand Response

The methodology for estimating demand response potential is illustrated in Figure 5. The approach begins with utility system loads, which are disaggregated by sector, segment, and applicable end use. For each program strategy, technical potential impacts are calculated for all applicable end uses.

Note that technical potential for demand response resources is not particularly useful for planning, as it tends to be much higher than what can actually be attained. For example, nearly every central air conditioner could, in theory, be controlled. However, in practice, program and event participation rates are likely to be much lower than 100 percent, depending on the program strategy. To estimate achievable technical potential, these expected rates are applied by program strategy to inform the IRP process.

Figure 5. Schematic Overview of Demand Response Assessment Methodology



Identify Eligible Loads

Estimation of both technical and achievable technical demand-response potential requires an understanding of available loads in peak periods by sector, segment, and end use. These loads are identified through the following steps:

1. ***Estimate the hourly demand by sector, segment, and end use.*** This task begins with the baseline forecast by sector, segment, and end use. Annual energy consumption for each combination is spread over hourly end-use loadshapes to estimate the demand in every hour of the year. To ensure the appropriateness of the loadshapes, hourly end-use demand is aggregated to the sector and system levels and compared to PSE's actual hourly loads.

2. ***Develop a list of program strategies for inclusion in analysis.*** The list of strategies was designed to include both price- and incentive-based options for all major customer segments and end uses in PSE's service territory. The list is informed by the 2009 IRP, PSE's demand response pilot program experience, and programs offered by other utilities.

3. ***Define the applicable sectors, segments and end uses for each program strategy.*** Not all loads analyzed in Step 1 will be candidates for any given demand response program strategy. Therefore, for each program strategy, applicable sectors, segments, and end uses are identified, establishing the peak demand that the given program can target.

Estimating Technical Potential

Technical potential (TP) for each demand response program is assumed to be a function of:

- customer eligibility in each class,
- affected end uses in that class, and
- the expected strategy impact on the targeted end uses.

Analytically, technical potential for each demand-response program strategy *(p)* is calculated as the sum of impacts at the end-use level (*e*) generated in customer segment (*s*) by the strategy:

$$TP_{pes} = LE_{ps} \times LI_{pes}$$

and

$$TP_p = \sum TP_{pes}$$

where,

LE_{ps} (load eligibility) represents the percent of customer segment (*s*) loads applicable for program strategy (*p*), referenced as "Eligible Load" in the program assumptions; and

LI_{pes} (load impact) is the percentage reduction in end-use load (*e*) for each segment (*s*) resulting from the program (*p*), referenced as "Technical Potential as a percent of Load Basis" in the program assumptions.

Estimating Achievable Technical Potential

Achievable technical potential is a subset of technical potential that accounts for the customers' ability and willingness to participate in capacity-focused programs subject to their unique business priorities, operating requirements, and economic (price) considerations.

For each program strategy, achievable technical potential is calculated by adjusting the technical potential by two factors:

- expected rates of program participation (percent of eligible load that would sign up for the program)
- event participation (percent of signed-up load that would participate in a given event)

Estimates of each factor were informed by PSE's program experience and/or secondary research. Assumptions for each program strategy are detailed in Section 4.

Demand-response programs vary significantly with respect to both the type and magnitude of costs. Applicable resource acquisition costs for demand-response strategies generally fall into two categories: (1) fixed direct expenses, such as infrastructure, administration, and data acquisition; and (2) variable costs, such as incentive payments to participants. Annual costs and impacts over the 20-year horizon are calculated based on available potential, assumed rate of acquisition, and participant attrition, allowing for a calculation of the levelized cost ($/kW-year) of each program strategy and allowing for comparison to supply-side alternatives. Estimates of achievable technical potential are combined with per-unit resource costs to produce resource supply curves.

Distributed Generation

Distributed generation potentials were not estimated as part of this study. PSE incorporated the results of the 2009 IRP analysis into its 2011 IRP. For detailed potentials from the 2009 IRP analysis, see the 2008 Cadmus' report.[10]

[10] http://www.pse.com/SiteCollectionDocuments/2009IRP/AppL1_IRP09.pdf

2. Energy-Efficiency Potentials

Scope of Analysis

The primary objective for 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 potential 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. The remainder of this section is divided into two parts: (1) a summary of resource potentials by fuel, and (2) detailed results by fuel and sector.

Summary of Resource Potentials – Electric

Table 13 shows 2031 forecasted baseline electric sales and potential by sector.[11] As shown, the results of this study indicate 961 aMW of technically feasible electric energy-efficiency potential will be available by 2031, the end of the 20-year planning horizon. This translates to an achievable technical potential of 645 aMW. Were all of this potential cost-effective and realizable, it would amount to an 18 percent reduction in 2031 forecasted retail sales and a reduction in projected load growth of roughly 50 percent.

Table 13. Electric Energy-Efficiency Potential by Sector, Cumulative in 2031

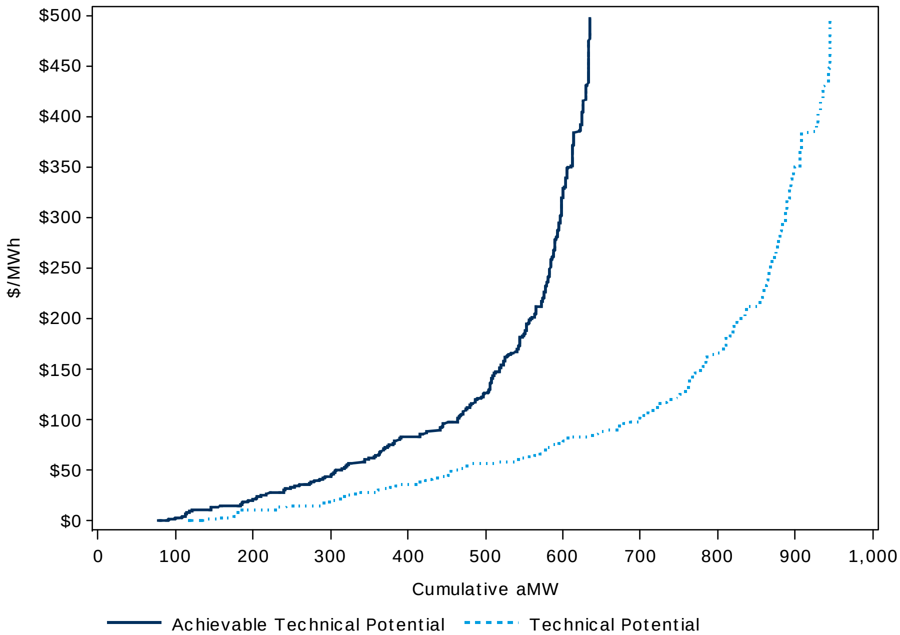
		Technical Potential		Achievable Technical Potential	
Sector	Baseline Sales	aMW	Percent of Baseline Sales	aMW	Percent of Baseline Sales
Residential	1,620	566	35%	336	21%
Commercial	1,823	373	20%	291	16%
Industrial	111	22	20%	18	17%
Total	3,554	961	27%	645	18%

Figure 6 illustrates the relationship between identified technical potential and achievable technical potential and the corresponding cost of conserved electricity.[12] As an example, there is approximately 500 aMW of achievable potential available at a cost of less than $120 per MWh.

[11] 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.

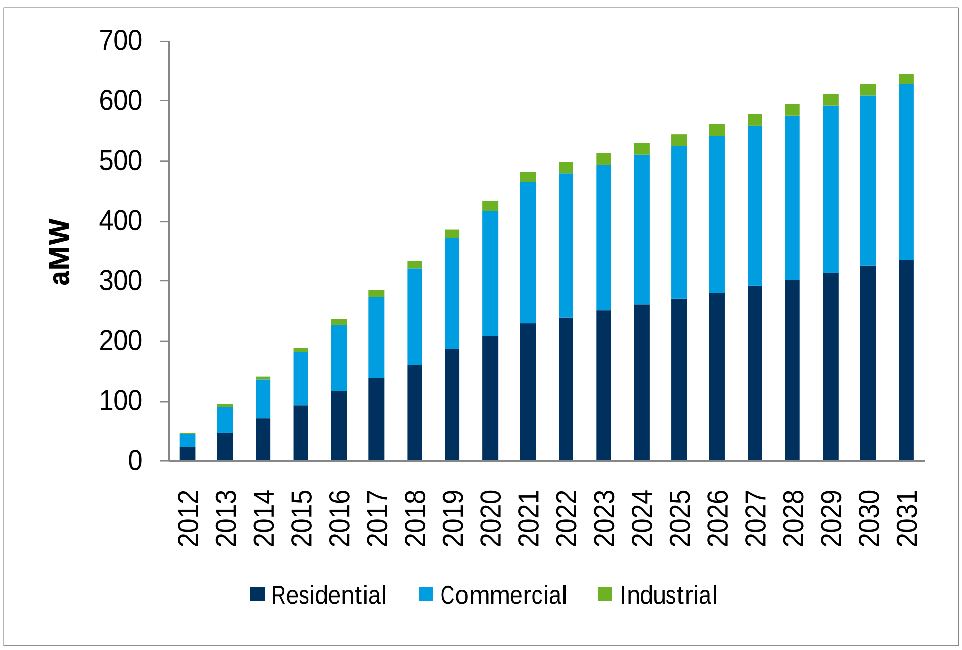
[12] In the calculation of levelized cost of conserved energy, non-energy benefits are treated as a negative cost. This leads to some measures having a negative cost of conserved energy, although there would be an incremental up-front cost.

Figure 6. Electric DSR Supply Curves – Cumulative in 2031



The cumulative potential available in each sector annually is presented in Figure 7. The 10-year acceleration of discretionary resources leads to the change in slope after 2021.

Figure 7. Electric Energy Efficiency Acquisition Schedule by Sector



Summary of Resource Potentials – Natural Gas

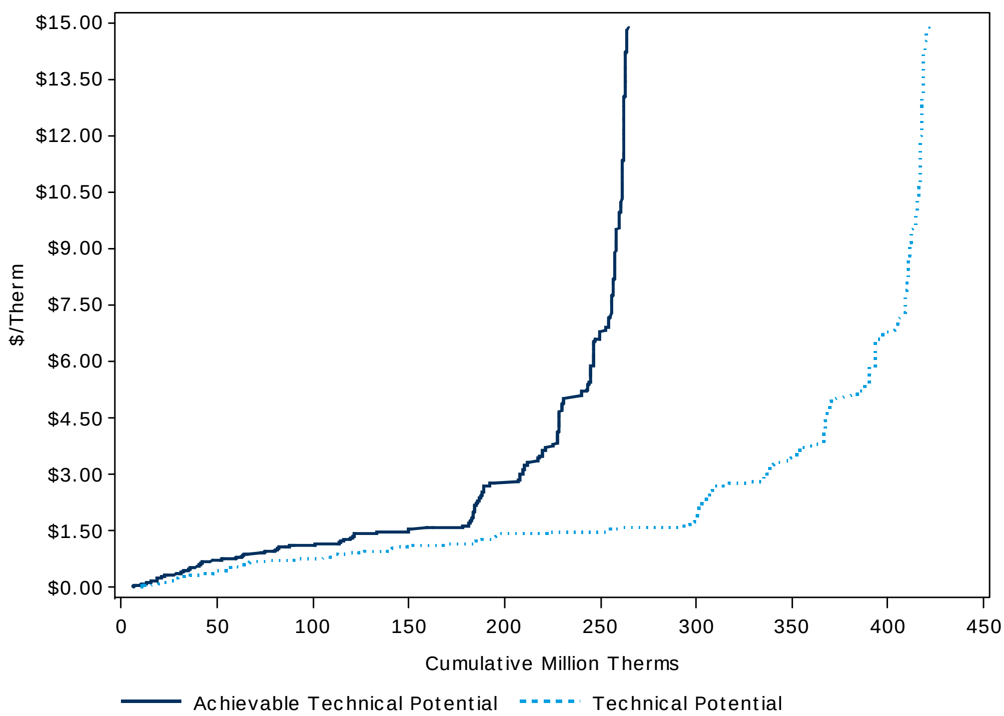
Table 14 illustrates the 2031 forecasted baseline natural gas sales and potential by sector. As shown, the results of this study indicate roughly 427 million therms of technically feasible energy-efficiency potential by 2031, the end of the 20-year planning horizon. This translates to an achievable technical potential of 268 million therms. If all of this potential was cost-effective and realizable, it would amount to a 20-percent reduction in 2031 forecasted retail sales, offsetting approximately 68 percent of forecasted load growth from 2012 to 2031.

Table 14. Natural Gas Energy-Efficiency Potential by Sector, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
Sector	Baseline Sales	Million Therms	Percent of Baseline Sales	Million Therms	Percent of Baseline Sales
Residential	846	303	36%	183	22%
Commercial	445	117	26%	80	18%
Industrial	31	7	21%	5	16%
Total	1,322	427	32%	268	20%

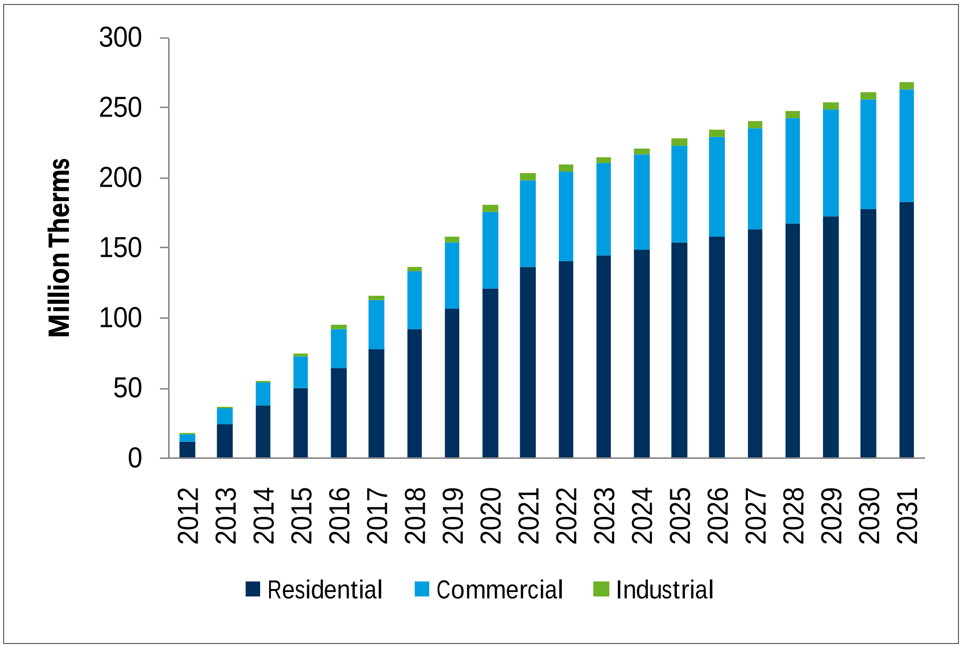
Figure 8 illustrates the relationship between identified technical potential and achievable technical potential and the corresponding cost of conserved energy. As an example, there are roughly 120 million therms of achievable potential available at a cost of less than $1 per therm.

Figure 8. Natural Gas DSR Potential Supply Curves, Cumulative in 2031



The cumulative potential available in each sector annually is presented in Figure 9. As with electric potential, the study assumes all achievable discretionary opportunities will be acquired over ten years.

Figure 9. Natural Gas Energy Efficiency Acquisition Schedule by Sector



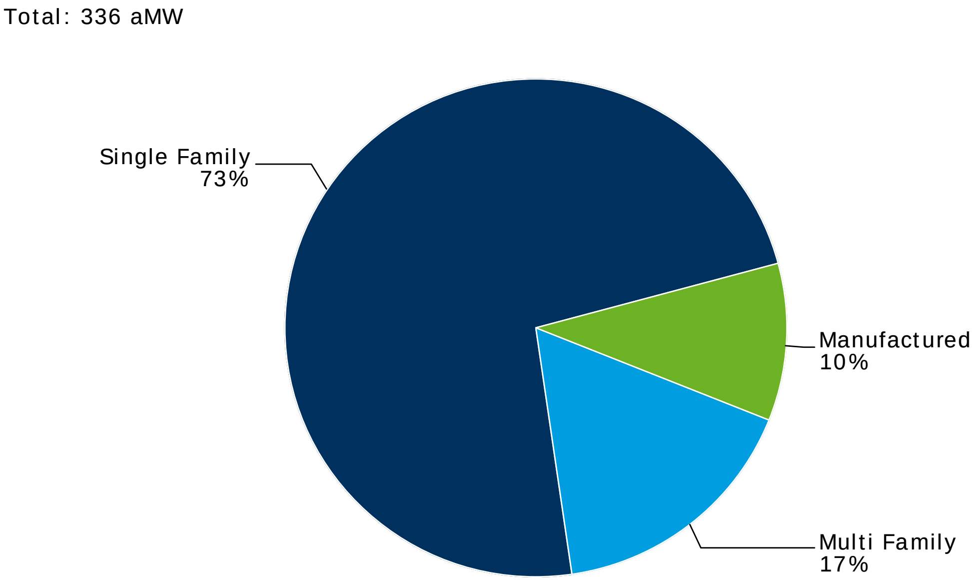
Detailed Resource Potentials

Residential Sector – Electric

Residential customers in PSE's service territory are expected to account for almost one-half of baseline electric retail sales by 2031. 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 and LED light bulbs). As described in Section 1, the expected impacts of new lighting standards established through EISA have been removed from the potential presented in this section.

As shown in Figure 10, single-family homes represent 73 percent of the total achievable technical residential electric potential, followed by multifamily (16 percent) and manufactured homes (9 percent). The main driver of these results is each home type's proportion of baseline sales, but other factors play an important role in determining potential, such as heating fuel sources,. For example, a higher percentage of manufactured homes are heated electrically than other home types, which increases their relative share of the potential. However, manufactured homes are typically smaller than detached single-family homes, ***and*** per-customer energy use is lower, so the same measure may save less in a manufactured home than in a single-family home. Volume II, Appendix B.3 provides a comprehensive list of the factors that impact segment-level energy-efficiency potential.

Figure 10. Residential Electric Achievable Technical Potential by Segment, Cumulative in 2031



Heating end uses represent the largest portion (27 percent) of achievable technical potential. Water heating, lighting, and consumer electronics also represent over 10 percent of the total identified potential. Because the analysis assumes an EISA-minimum lighting baseline, a considerable amount of energy-efficiency potential remains in the lighting end use, even after EISA effects have been removed from the baseline forecast. Figure 11 shows the total achievable technical potential by end-use group. Detailed potentials by end use are presented in Table 15.

Figure 11. Residential Electric Achievable Technical Potential by End Use, Cumulative in 2031

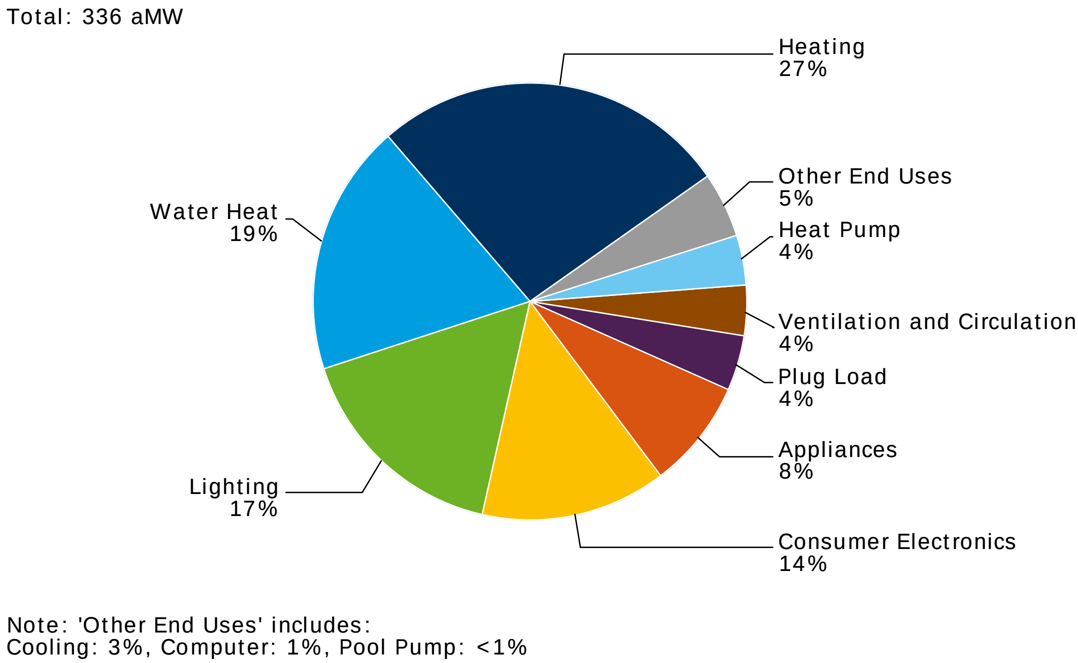


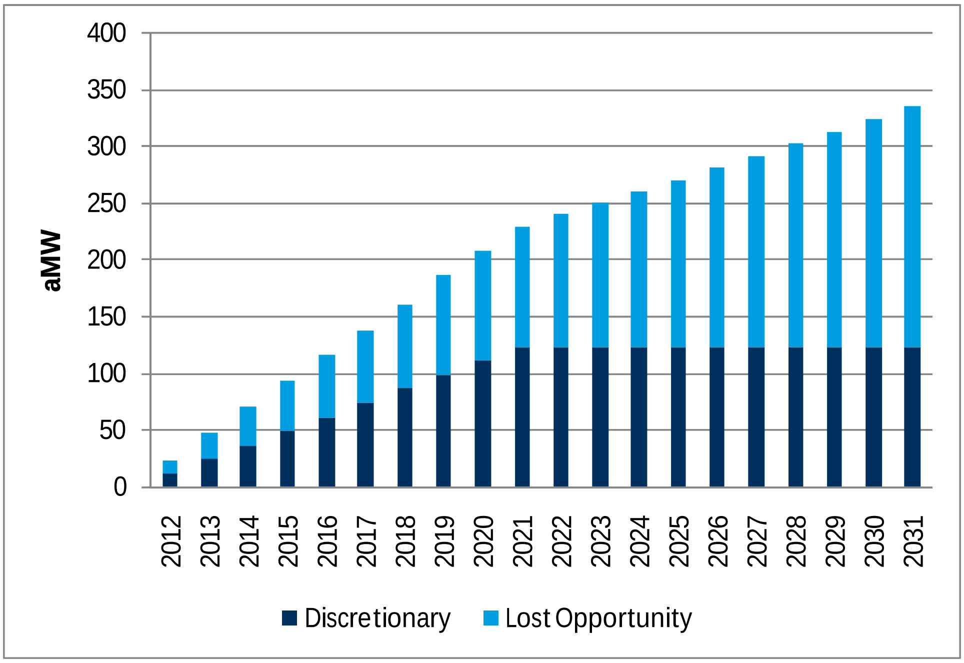
Table 15. Residential Electric Potential by End Use, Cumulative in 2031

End Use	Baseline Sales (aMW)	Technical Potential		Achievable Technical Potential	
		aMW	Percent of Baseline Sales	aMW	Percent of Baseline Sales
Appliances	288	42	14%	27	9%
Computer	37	10	27%	5	13%
Consumer Electronics	222	86	39%	46	21%
Cooling	27	14	52%	10	38%
Heat Pump	43	17	40%	12	29%
Heating	298	143	48%	90	30%
Lighting	198	121	61%	56	28%
Other Plug Loads	163	18	11%	14	9%
Pool Pump	6	2	42%	1	23%
Ventilation and Circulation	81	29	35%	13	15%
Water Heat	257	84	33%	62	24%
Total	1,620	566	35%	336	21%

Additional details regarding the savings associated with specific measures assessed within each end use are provided in Volume II, Appendix B.3.

Figure 12 shows annual cumulative achievable technical potential by resource type for the sector. Discretionary measures are acquired in equal increments over a ten-year period and account for 37 percent of cumulative achievable technical potential in 2031.

Figure 12. Residential Electric Annual Cumulative Achievable Technical Potential by Resource Type

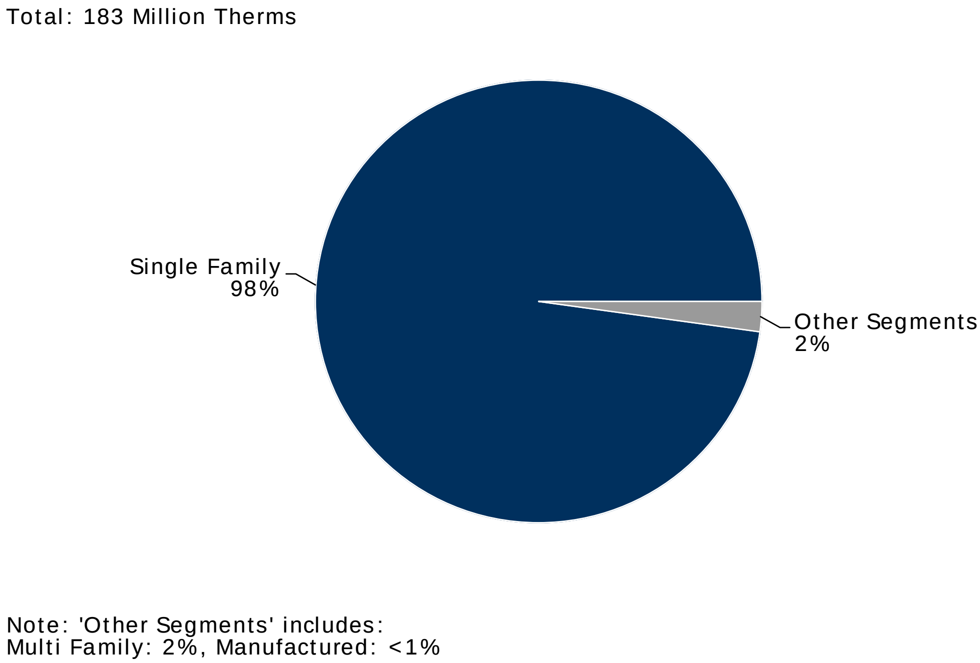


Residential Sector – Natural Gas

By 2031, residential customers are expected to account for over 55 percent of PSE's natural gas sales. Unlike residential electricity consumption, relatively few natural gas-fired end uses exist (primarily, space heating, water heating, and appliances); however, significant energy savings opportunities remain available. Based on resources used in this assessment, the achievable technical potential in the residential sector is expected to be about 183 million therms over 20 years, corresponding to a 19-percent reduction of forecasted 2031 sales.

Single-family homes account for 98 percent of the identified achievable technical potential, as shown in Figure 13. Due to lack of gas connections, only two percent of total achievable technical potential is in multifamily and manufactured residences.

Figure 13. Residential Natural Gas Achievable Technical Potential by Segment, Cumulative in 2031



The space heating and water heating end uses account for over 99 percent of the identified achievable technical potential (Figure 14). This potential is a combination of high-efficiency equipment (such as condensing furnaces and water heaters) and retrofits (such as shell measures, duct and pipe insulation, and low-flow showerheads). Detailed potentials by end use are presented in Table 16.

Figure 14. Residential Natural Gas Achievable Technical Potential by End Use, Cumulative in 2031

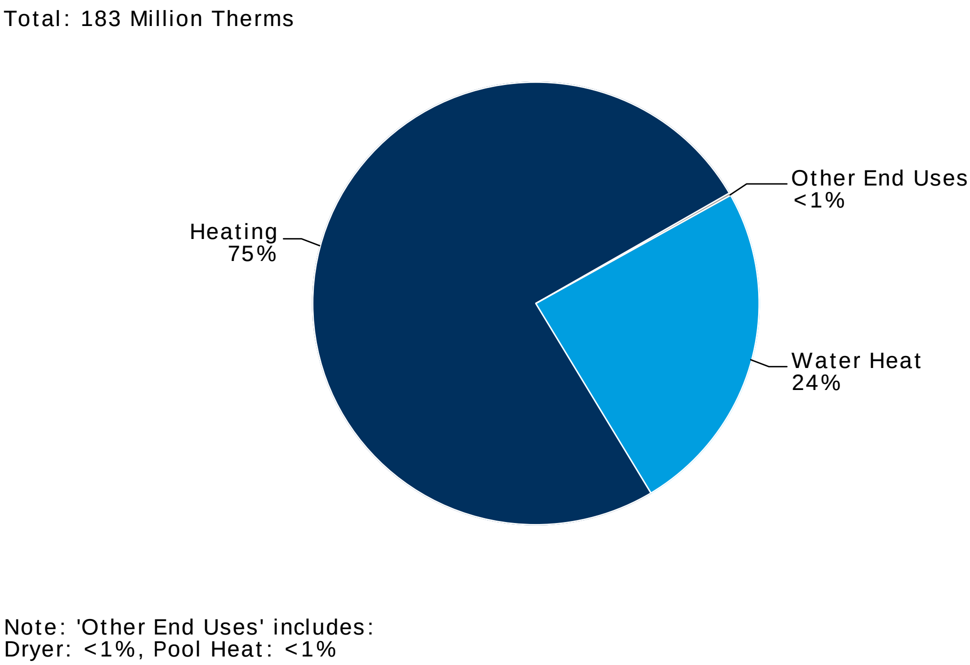
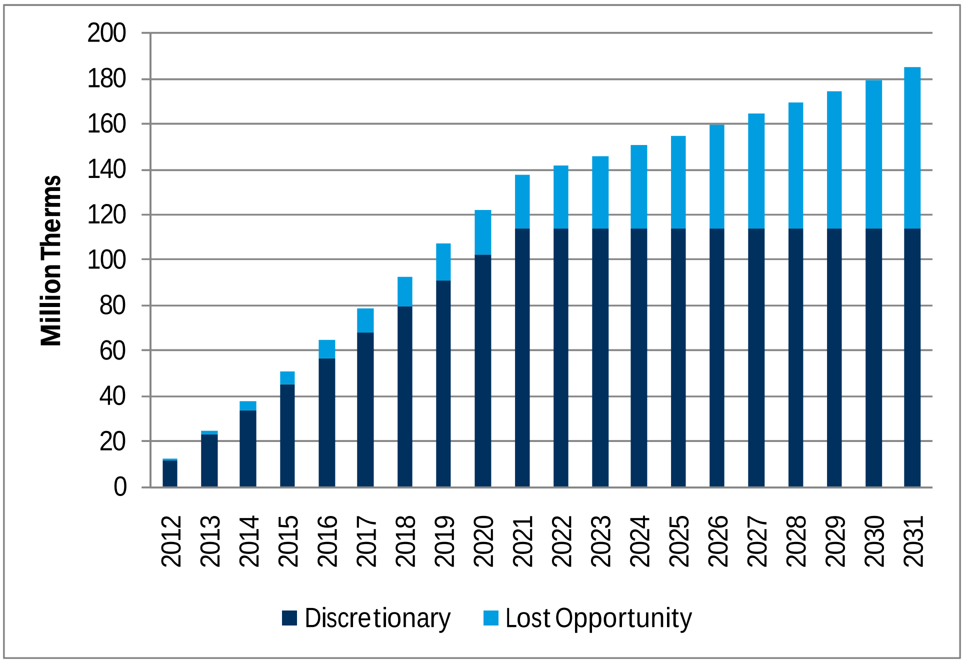


Table 16. Residential Natural Gas Potential by End Use, Cumulative in 2031

End Use	Baseline Sales (Million Therms)	Technical Potential		Achievable Technical Potential	
		Million Therms	Percent of Baseline Sales	Million Therms	Percent of Baseline Sales
Cooking	16	0	0%	0	0%
Dryer	8	1	7%	0	3%
Heating	554	219	40%	138	25%
Miscellaneous End Uses	23	0	0%	0	0%
Pool Heat	5	0	5%	0	3%
Water Heat	240	83	35%	45	19%
Total	830	303	37%	183	22%

Figure 15 shows residential natural gas annual cumulative achievable technical potential by resource type. Discretionary measures are acquired in equal increments over a ten-year period and account for 61 percent of cumulative achievable technical potential in 2031.

Figure 15. Residential Natural Gas Annual Cumulative Achievable Technical Potential by Resource Type

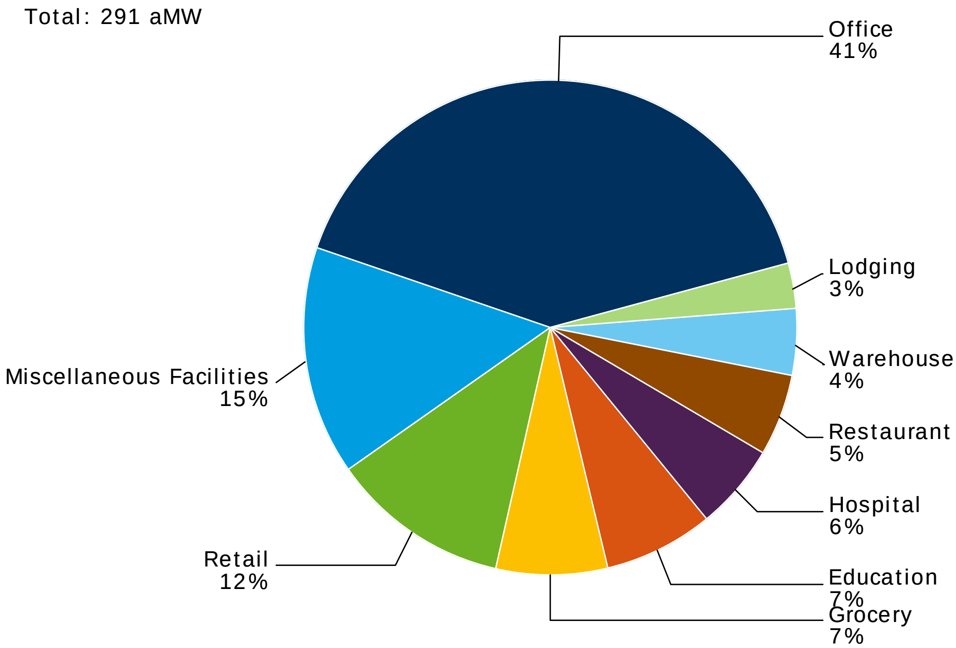


Commercial Sector – Electric

Based on resources included in this assessment, electric achievable technical potential in the commercial sector is expected to be 291 aMW over 20 years, a 17 percent reduction in forecasted 2031 commercial sales.

As shown in Figure 16, offices represent almost half of the available potential (41 percent). Miscellaneous facilities (15 percent) also represent a large portion of available potential. The miscellaneous segment consists of customers who do not fit into any of the other categories and customers for whom there is not enough information to be classified.

Figure 16. Commercial Electric Achievable Technical Potential by Segment, Cumulative in 2031



Lighting efficiency improvements represent by far the largest portion of achievable technical potential in the commercial sector (37 percent), followed by cooling (13 percent), space heating (10 percent), and HVAC auxiliary (10 percent), as shown in Figure 17. The large lighting potential entails bringing existing buildings to code and exceeding code in new and existing structures. Table 17 shows how baseline sales and savings are distributed across end uses.

Figure 17. Commercial Electric Achievable Technical Potential by End Use, Cumulative in 2031

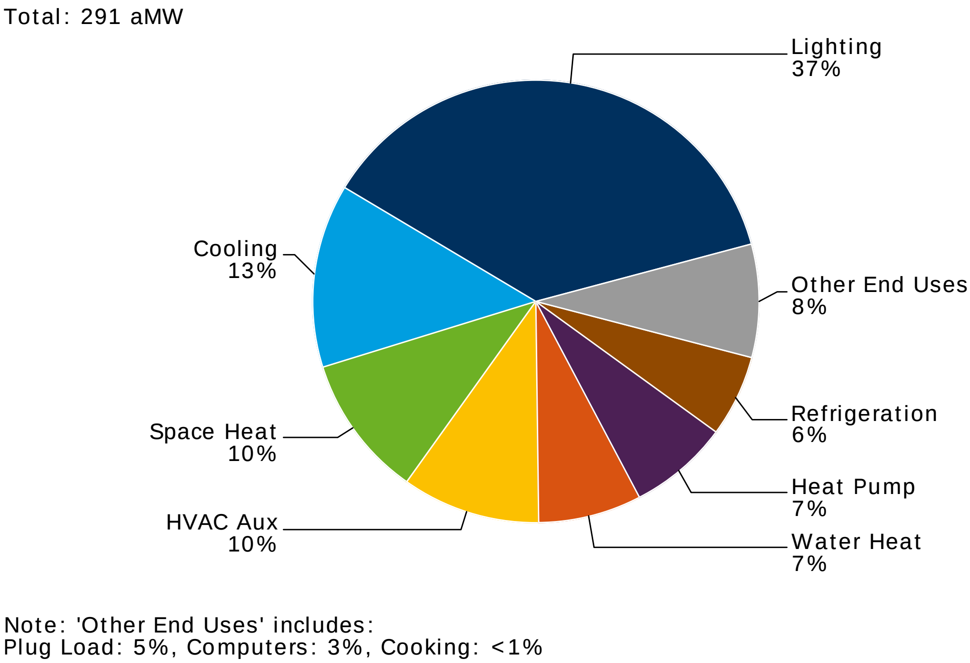
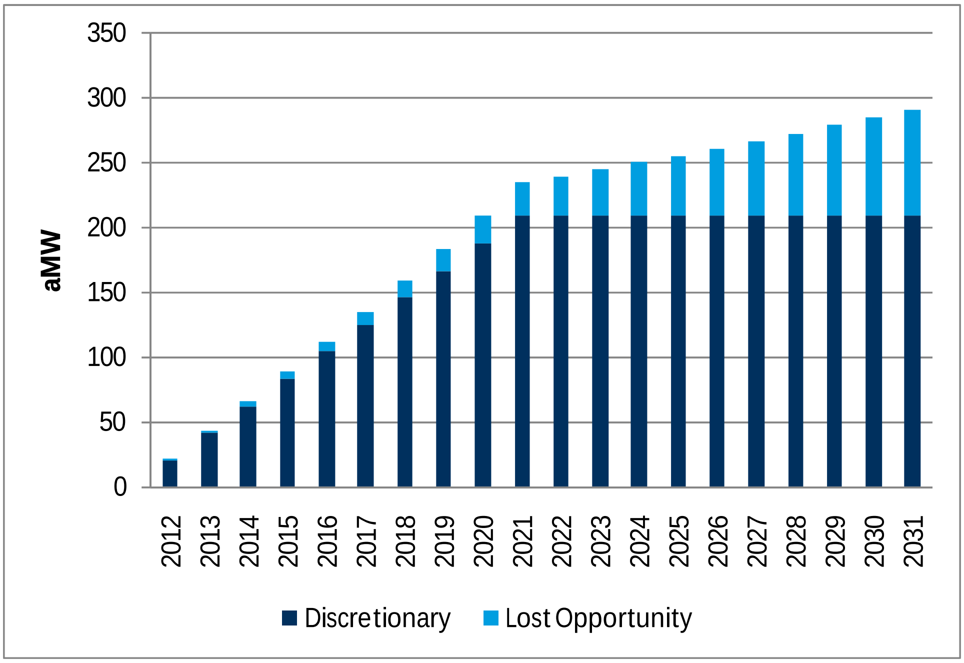


Table 17. Commercial Electric Potential by End Use, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
End Use	Baseline Sales (aMW)	aMW	Percent of Baseline Sales	aMW	Percent of Baseline Sales
Computers	64	18	28%	9	15%
Cooking	24	1	4%	1	3%
Cooling	111	49	44%	39	35%
HVAC Auxiliary	299	38	13%	29	10%
Heat Pump	78	28	36%	21	27%
Lighting	757	134	18%	108	14%
Other Plug Loads	208	17	8%	14	7%
Refrigeration	105	22	21%	17	16%
Space Heat	102	36	36%	30	30%
Water Heat	74	29	39%	22	29%
Total	1,823	373	20%	291	16%

Figure 18 shows commercial electric annual cumulative achievable technical potential by resource type. Discretionary measures are acquired in equal increments over a ten-year period and account for 72 percent of cumulative achievable technical potential in 2031.

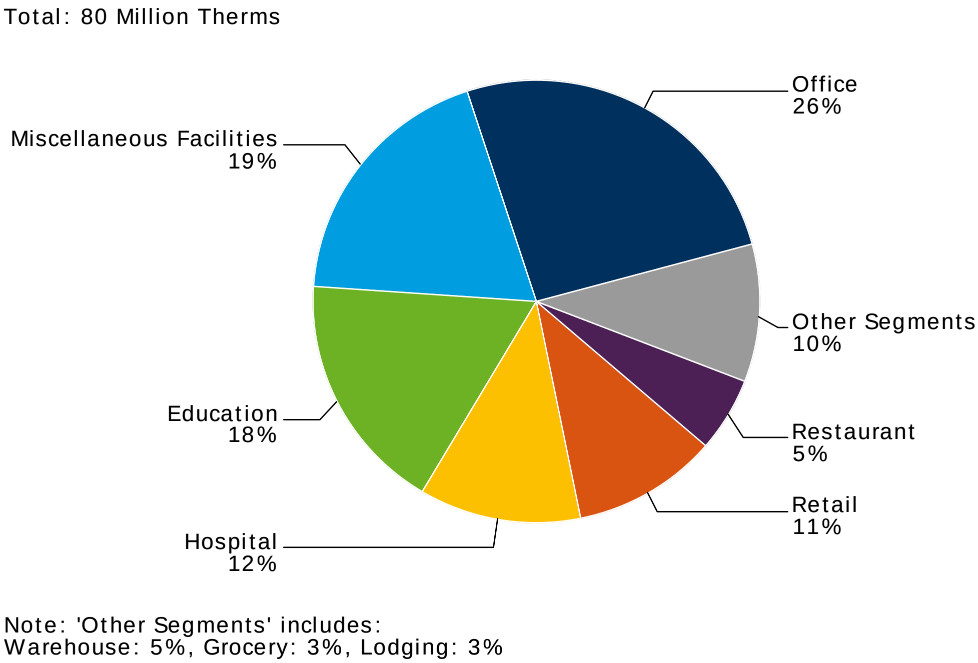
Figure 18. Commercial Electric Annual Cumulative Achievable Technical Potential by Resource Type



Commercial Sector – Natural Gas

Based on resources included in this assessment, natural gas achievable technical potential in the commercial sector is expected to be 80 million therms over 20 years, an 18 percent reduction in forecasted 2031 commercial sales. Achievable technical natural gas potential in the commercial sector represents about one-third of the total identified potential across all sectors. For electric customers, office buildings represent the largest portion of potential (26 percent, Figure 19). Significant amounts of achievable technical potential are also available in miscellaneous facilities (19 percent) and education buildings (18 percent).

Figure 19. Commercial Natural Gas Achievable Technical Potential by Segment, Cumulative in 2031



As in the residential sector, there are far fewer gas-fired end uses than electric end uses. Space heating accounts for 76 percent of the identified potential, and the remaining potential is mostly in water heating (21 percent), with small amounts in cooking and pool heating (Figure 20 and Table 18).

Figure 20. Commercial Natural Gas Achievable Technical Potential by End Use, Cumulative in 2031

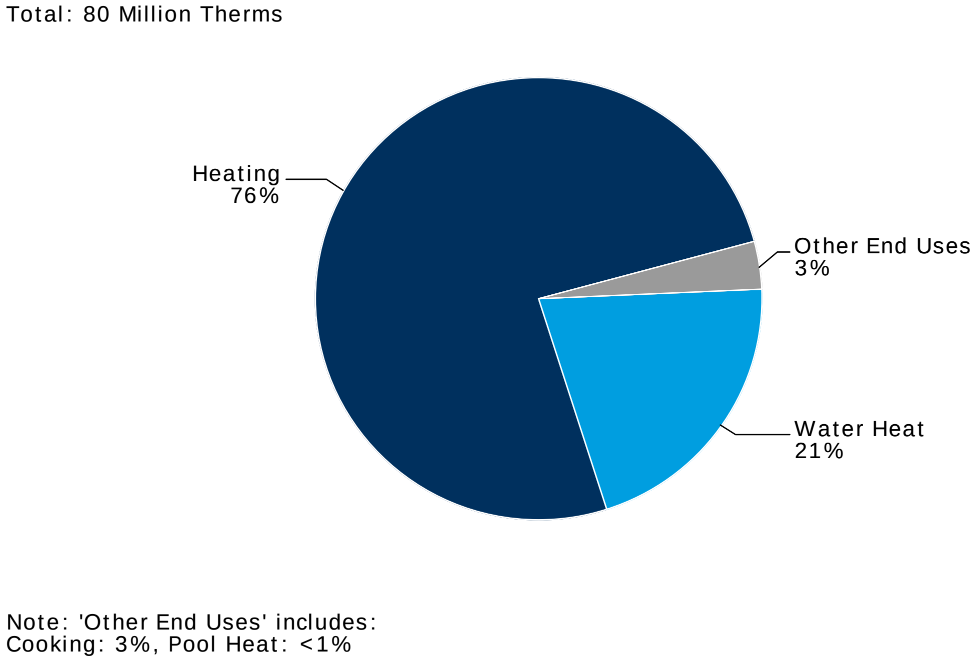
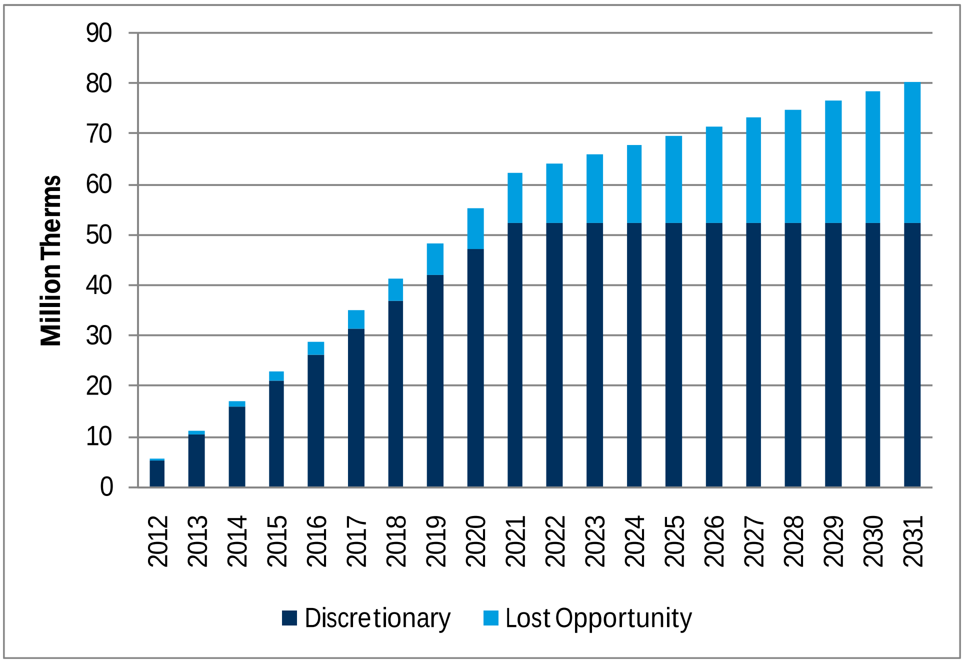


Table 18. Commercial Natural Gas Potential by End Use, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
End Use	Baseline Sales (Million Therms)	Million Therms	Percent of Baseline Sales	Million Therms	Percent of Baseline Sales
Cooking	62	3	5%	2	3%
Heating	293	88	30%	60	21%
Pool Heat	6	1	18%	1	13%
Water Heat	84	25	30%	17	20%
Total	445	117	26%	80	18%

Figure 21 shows commercial natural gas annual cumulative achievable technical potential by resource type. Discretionary measures are acquired in equal increments across a ten year period and account for 65 percent of cumulative achievable technical potential in 2031.

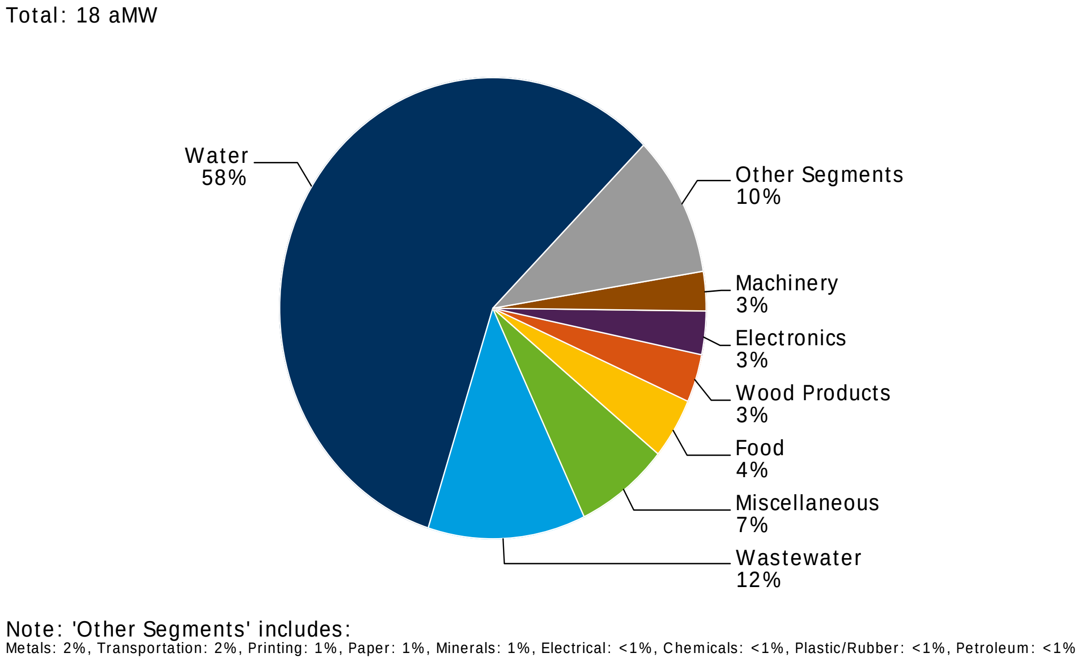
Figure 21. Commercial Natural Gas Annual Cumulative Achievable Technical Potential by Resource Type



Industrial Sector – Electric

Technical and achievable technical energy-efficiency potential 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 B.1.) Across all industries, achievable technical potential totals approximately 18 aMW over the 20-year planning horizon, corresponding to an 18 percent reduction of forecasted 2031 industrial consumption.

Figure 22. Industrial Sector Electric Achievable Technical Potential by Segment



The majority of electric achievable technical potentials in the industrial sector (50 percent) are in pumps, shown in Figure 23. Process improvement measures (16 percent) and fans (12 percent) also comprise significant portions of available technical potential. A small amount of additional potential exists for lighting and other facility improvements. Detailed potentials by end use are presented in Table 19. All industrial measures are considered discretionary with savings acquired over a ten-year timeframe.

Figure 23. Industrial Electric Achievable Technical Potential by End Use, Cumulative in 2031

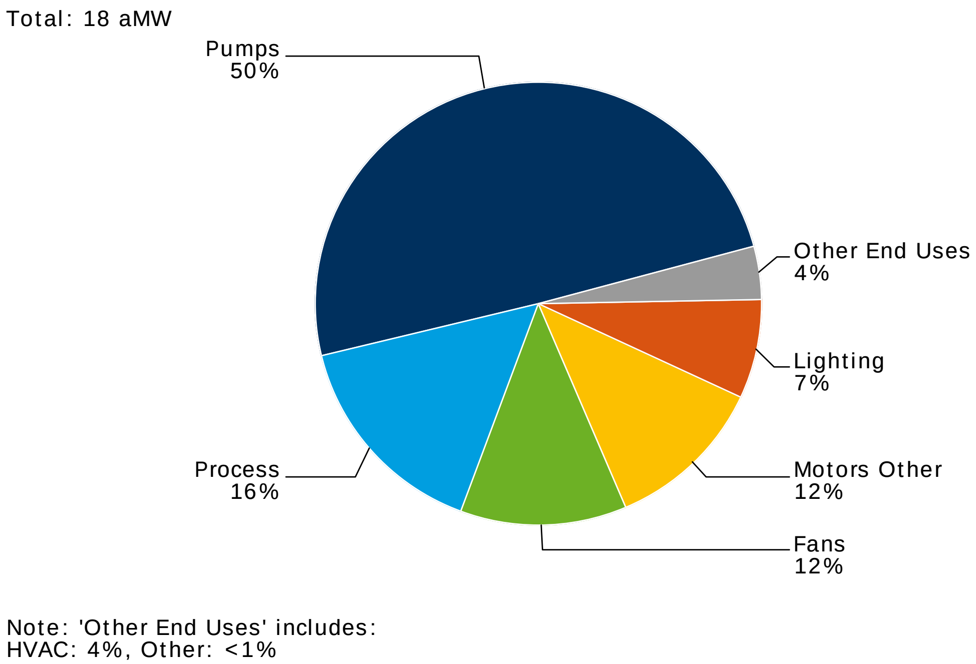


Table 19. Industrial Electric Potential by End Use, Cumulative in 2031

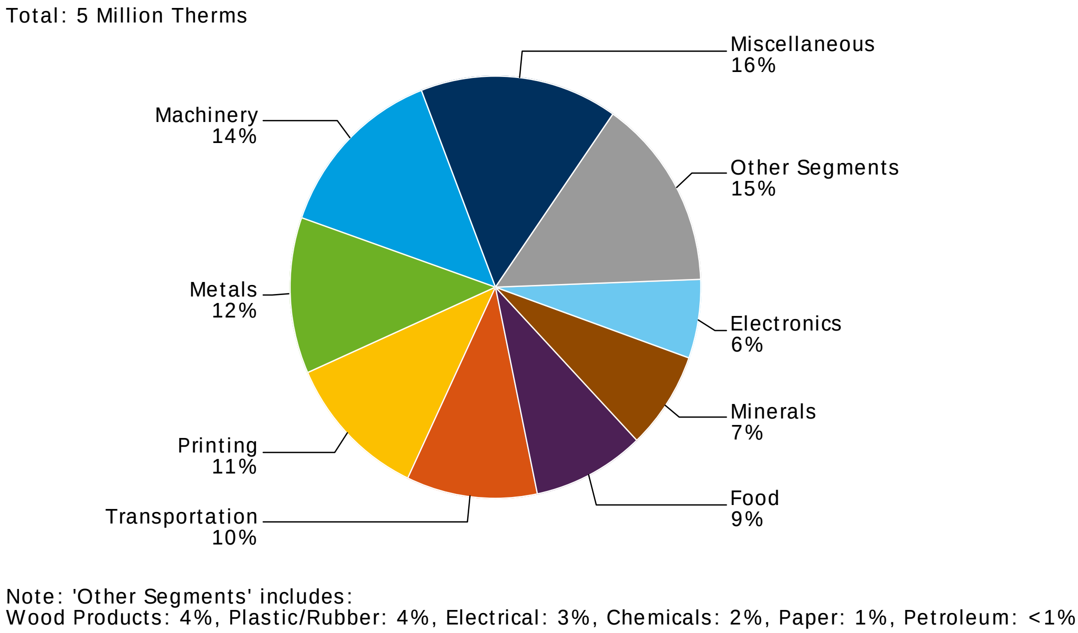
		Technical Potential		Achievable Technical Potential	
End Use	Baseline Sales (aMW)	aMW	Percent of Baseline Sales	aMW	Percent of Baseline Sales
Fans	8	3	33%	2	28%
HVAC	10	1	8%	1	7%
Indirect Boiler	1	0	0%	0	0%
Lighting	8	2	20%	1	17%
Motors Other	15	3	17%	2	14%
Other	10	0	0%	0	0%
Process	23	3	14%	3	12%
Pumps	36	11	30%	9	26%
Total	**111**	**22**	20%	**18**	17%

Industrial Sector – Natural Gas

Most industrial processes and end uses are powered by electricity and, thus, the industrial sector represents a small portion of natural gas baseline sales and potential.

Across all industries, achievable technical potential totals approximately 5 million therms over 20 years. Although this represents 16 percent of forecasted 2031 industrial sales, it accounts for only 2 percent of the achievable technical potential across the three sectors. As shown in Figure 24, substantial achievable technical potential lies in miscellaneous manufacturing (16 percent), machinery (14 percent), metals (12 percent), and paper (11 percent).

Figure 24. Industrial Natural Gas Achievable Technical Potential by Segment, Cumulative in 2031



Half of the achievable technical potential comes from process heating improvements. The remaining potentials are in HVAC and boiler improvements (Figure 25 and Table 20). All industrial measures are considered discretionary with savings acquired over a ten-year timeframe.

Figure 25. Industrial Natural Gas Achievable Technical Potential by End Use

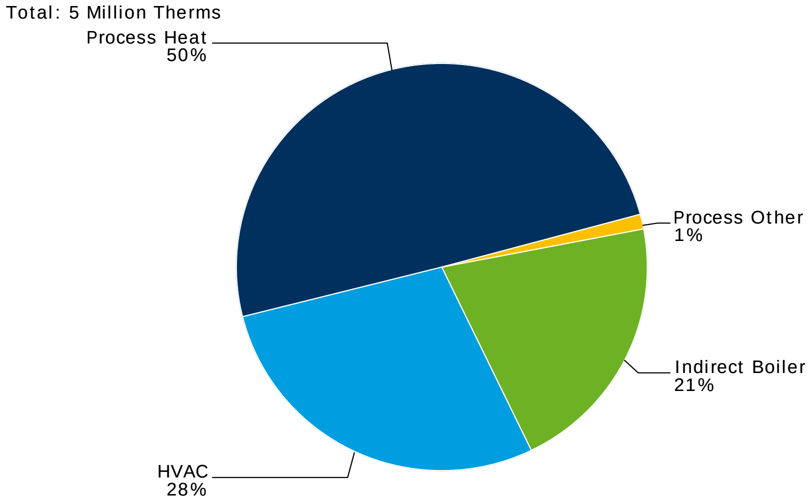


Table 20. Industrial Natural Gas Potential by End Use, Cumulative in 2031

		Technical Potential		Achievable Technical Potential	
End Use	Baseline Sales (Million Therms)	Million Therms	Percent of Baseline Sales	Million Therms	Percent of Baseline Sales
HVAC	9	2	21%	1	15%
Indirect Boiler	9	1	16%	1	12%
Other	0	0	0%	0	0%
Process Heat	12	3	27%	2	20%
Process Other	1	0	9%	0	6%
Total	31	7	21%	5	16%

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.

In the area where PSE provides both gas and electric service, fuel conversion potentials were examined for existing residential single-family homes, existing and new commercial buildings, and new multifamily structures. Three end uses were included in the analysis for single and multifamily homes: space heating, water heating, and appliances (clothes dryers and cooking ranges). For new multifamily homes, the potential from conversion of electric baseboard heating to natural gas furnaces was also included in Cadmus' analysis. For commercial buildings, only space and water heating end uses were analyzed.

Summary of Resource Potentials

Fuel conversion technical potentials were calculated by assuming all applicable customers and end uses would be converted. As part of the 2009 IRP, 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. Based on this survey, approximately 63 percent of respondents indicated they would either be likely or highly likely to convert from electric to gas space heating if the utility were to pay 100 percent of the cost. As such, the achievable technical potential is assumed to be 63 percent of the technical potential. In the absence of comparable primary data, the same percentage was used for the commercial sector.

Based on the results of the survey and previous PSE experience, it is assumed that of the new residential-sector gas customers who convert a space heater, 70 percent will also convert a water heater, and 5 percent will convert a range and/or dryer. For existing gas customers, all will convert a water heater, and 5 percent will convert a range and/or dryer. Similar percentages are assumed for the water heating conversions in the commercial sector.

The cumulative electric technical potential from fuel conversion by 2031 is estimated at 55 aMW. Acquisition of the indicated electricity savings would, however, result in increased gas consumption of about 35 million therms by 2031. After making the adjustments for achievability described above, the total achievable technical electric savings potential of fuel conversion in 2031 is estimated at just over 22 aMW. This achievable technical potential corresponds to increased gas consumption of about 15 million therms.

Technical and achievable technical potential by customer type and market segment are shown in Table 21 and Table 22, respectively

Table 21. Fuel Conversion Potentials by Customer Type, Cumulative in 2031

Customer Type	Technical Potential: Electric Savings (aMW)	Technical Potential: Additional Gas Usage (million therms)	Achievable Technical Potential: Electric Savings (aMW)	Achievable Technical Potential: Additional Gas Usage (million therms)
Electric-Only	23.5	16.0	10.6	7.3
Existing Gas Customer	31.4	18.6	11.5	7.5
Total	54.9	34.6	22.1	14.8

Table 22. Fuel Conversion Potentials by Market Segment, Cumulative in 2031

Market Segment	Technical Potential: Electric Savings (aMW)	Technical Potential: Additional Gas Usage (million therms)	Achievable Technical Potential: Electric Savings (aMW)	Achievable Technical Potential: Additional Gas Usage (million therms)
Single Family	30.6	15.8	9.4	5.0
Multifamily	1.6	1.3	0.5	0.4
Commercial	22.7	17.5	12.3	9.4
Total	54.9	34.6	22.1	14.8

Detailed Resource Potentials

Residential Sector

The fuel conversion potential for single-family homes 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, so those customers are not considered for water heater conversion. In addition, the potential market size for new construction excludes the percentage of customers who have historically included gas systems.

Measures Considered

Cadmus' analysis of fuel conversion considered opportunities for three major end uses in residential dwellings: central heating, water heating, and appliances (clothes dryer and oven).

- For new multifamily buildings, conversion of room (or zonal) heating systems to natural gas furnaces was examined.
- For existing single-family buildings, the cost of converting an existing baseboard system to a central system was not considered, given the high cost of installing the necessary ductwork.

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 measure can result in a 15-percent decrease in energy usage over a standard dryer due to reduced run-time.[13]

Similarly, there are minor differences in the efficiency level of ovens, and an energy savings of 20 percent can be achieved by using a convection oven.[14] Applicable measures and their assumed technical specifications are shown in Table 23. These measures are equivalent to those used for the energy-efficiency analysis, and detailed descriptions can be found in Volume II, Appendix B.

Table 23. End Uses and Measures Assessed

End Use	Gas Measure	Electric Baseline
Space heating	90-percent AFUE condensing furnace	Electric furnace Electric baseboard (new MF only)
Water heating	EF=0.67 storage water heater	Electric water heater
	EF=0.82 tankless water heater	
Appliances	Gas dryer w/ moisture sensor	Electric dryer w/ moisture sensor
	Convection gas range	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. A major factor in determining the cost of new gas service is whether an electric-only customer is on a gas main. For existing single-family customers, data from several sources (including PSE's 2008 REUS) were used to determine availability. In addition, consideration was given to the size range of single family homes, given that larger homes are likely to use more energy for space heating. Homes of 2,000 or fewer square feet were excluded as not meeting the programmatic requirements of sufficient electric usage..

PSE currently provides gas to approximately 49 percent of single-family homes in its electric service area. Customers who currently receive gas service from PSE are considered candidates only for *additional* gas-using equipment, without imposing additional line extension costs. The REUS was used to estimate the total number of gas-heated single-family homes with electric water heater and other appliances. This resulted in an estimate of nearly 24,000 existing gas homes eligible for conversion.

Of the electric customers without PSE gas service, approximately one-third reside in PSE's gas service territory. However, based on the latest data available from PSE, approximately 25 percent of these customers are on a gas main and would be candidates for conversion of all applicable end uses. Off-main customers were excluded from the analysis, as too economically and technically impractical.

For the multifamily segment, a previous residential survey (2004 Residential Energy Study) was used to determine the distribution of market share, as the REUS had only a small sample of multifamily homes. For new electric multifamily customers, approximately 14 percent are in

[13] http://www.consumerenergycenter.org/home/appliances/dryers.html
[14] 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.

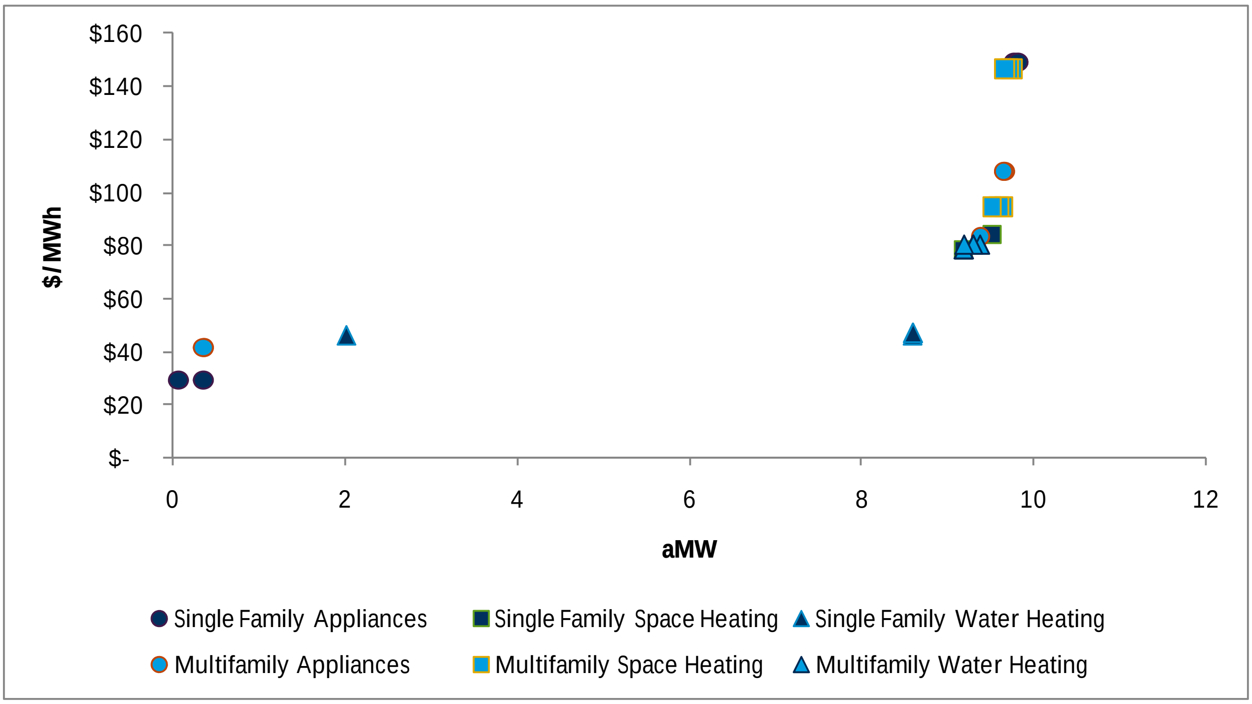
PSE combination territory, a quarter of which are on a main. Of those, approximately 1,200 customers are expected to install a furnace, and another 1,000 customers will install baseboard heating systems.

Conversion Costs and Savings

The total resource cost (TRC) perspective was used to assess conversion costs. This considers the assumed installed cost of the gas measure, less the cost of the equivalent electric measure, and includes gas line extension costs. For electric-only customers, connecting a house to the gas main is assumed to require a service line extension of $3,600. 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 (estimated at $200 per piece of equipment, as determined through interviews with local HVAC contractors on PSE's Contract Referral Service List).

Figure 26 shows how cumulative electric savings categorized by home type and end use are distributed by levelized cost. Conversion savings were estimated based on the same assumed levels of unit energy consumption (UEC) used in the energy-efficiency analysis described in Section 2. Increased gas usage was counted as an ongoing annual O&M cost, and is included in the calculation of levelized cost. For baseline values, electric UECs (kWh/yr) and gas UECs (therms/year) from the baseline forecast for existing single-family and new multifamily homes were used.

Figure 26. Residential Fuel Conversion Supply Curve, Cumulative in 2031



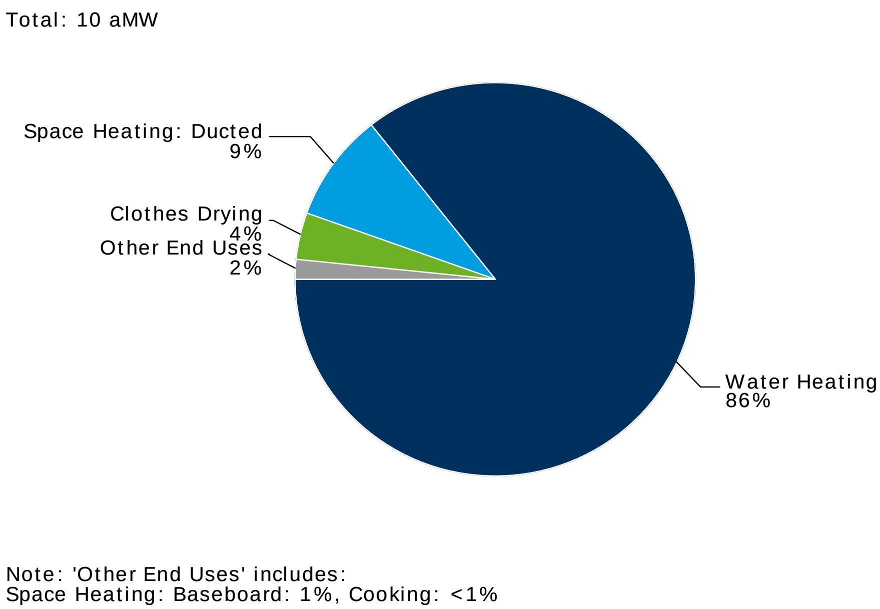
Potential

The technical and achievable technical conversion potential in 2031 for the residential sector by end use are given in Table 24 and Figure 27.

Table 24. Residential Fuel Conversion Potential by End Use, Cumulative aMW in 2031

End Use	Technical Potential	Achievable Technical Potential
Clothes Drying	11.9	0.4
Cooking	2.0	0.1
Space Heating: Baseboard	0.3	0.1
Space Heating: Ducted	2.8	0.9
Water Heating	15.3	8.4
Total	32.3	9.8

Figure 27. Residential Fuel Conversion Achievable Technical Potential by End Use, Cumulative in 2031



Commercial Sector

Conversion of equipment in existing buildings and new facilities was included in the fuel conversion potential for the commercial sector.

Measures Considered

For existing facilities in the commercial sector, the measures considered were 90 percent AFUE furnaces and high-efficiency water heaters (≥0.67 EF storage and tankless). For the new construction segment, the same measures are included, as well as conversion from electric to gas warm-up heaters. Note that it is only the smaller buildings (less than approximately 7,500 square feet) that are likely to utilize a furnace.

Gas Availability

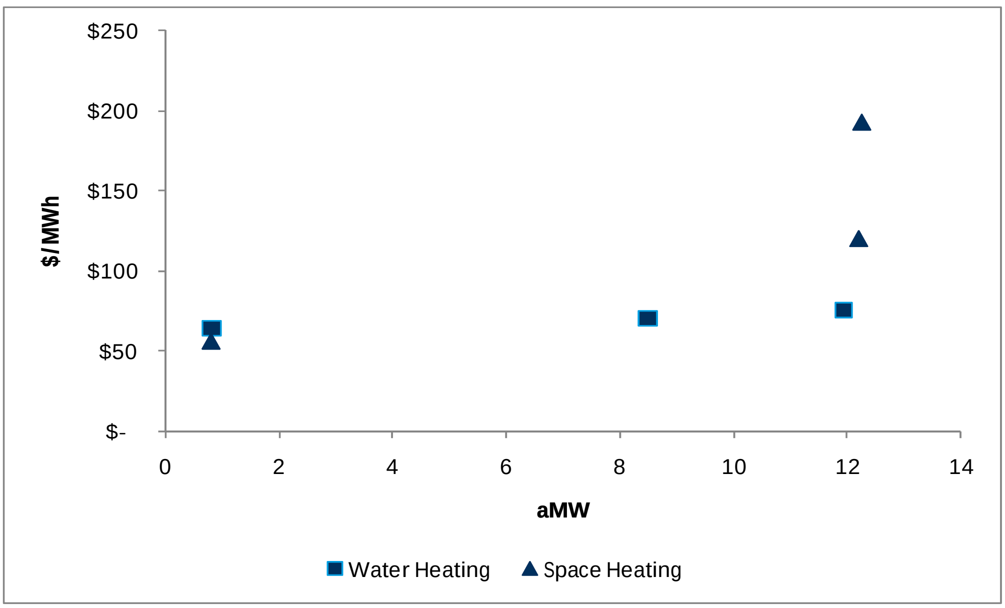
Data from the 2008 Commercial Building Stock Assessment (CBSA), coupled with PSE's nonresidential customer database, provided the market shares by territory and end use. Of existing electric-only customers, approximately 60 percent are in PSE gas territory, and a quarter of those are on a main line. For new customers, approximately 32 percent are expected to be in the combination service territory, a quarter of whom will be on a gas main. By applying this percentage to PSE's commercial new customer forecast and accounting for saturation of furnaces, Cadmus estimates about 400 customers would be eligible over the 20-year study to install a furnace. This number excludes customers who are expected to install a gas line anyway. Additional potential exists for current gas customers who do not already have gas water heaters (approximately 6,500 customers).

Conversion Costs and Benefits

Conversion savings were estimated based on the assumed levels of UEC, consistent with those used in the energy-efficiency analysis described in Section 2. Increased gas usage is counted as an ongoing annual O&M cost, and is counted in the calculation of levelized cost. For baseline values, electric UECs (kWh/yr) and gas UECs (therms/year) from the baseline forecast were used.

Figure 28 shows how cumulative electric savings by end use are distributed by levelized cost. Similar to the residential sector, service-line connection cost is added only to existing customers for the furnace cost. For simplicity, commercial buildings were modeled assuming an energy consumption that was the weighted average of all segments, based on likelihood of equipment being used in the given facility.

Figure 28. Commercial Fuel Conversion Supply Curve, Cumulative in 2031



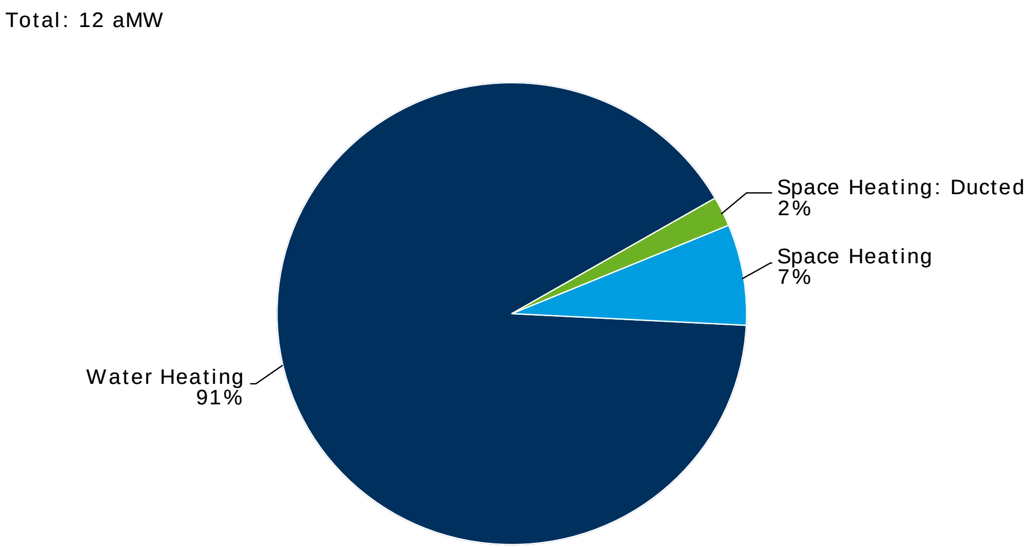
Potential

Table 25 and Figure 29 show the technical and achievable technical conversion potential in 2031 by end use. The end-use "Space Heating: Ducted" represents conversion for electric furnaces in existing buildings, while the "Space Heating" end use represents both furnace and gas warm-up heat conversion in new construction.

Table 25. Commercial Fuel Conversion Potential by End Use, Cumulative aMW in 2031

End Use	Technical Potential	Achievable Technical Potential
Space Heating	1.4	0.9
Space Heating: Ducted	0.4	0.3
Water Heating	21.0	11.1
Total	22.8	12.3

Figure 29. Commercial Fuel Conversion Achievable Technical Potential by End Use, Cumulative in 2031



4. Demand Response Potentials

Scope of Analysis

Focused on reducing a utility's capacity needs, demand-response programs rely on flexible 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 and promote improved system reliability. In some instances, these programs may defer investments in delivery and generation infrastructure.

Demand-response objectives may be met through a broad range of strategies, both price-based (such as time-varying rates or interruptible tariffs) and incentive-based (such as direct load control) strategies. The following demand response strategies are used in this assessment:

1. ***Direct Load Control*** (DLC) programs allow a utility to interrupt or cycle electrical equipment and appliances remotely at a customer's facility. In this study, the assessment of DLC program potential is analyzed for two programs in the residential sector:
    - a combination program of central electric heating (including heat pumps) and electric water heating
    - a combination program of room heating and electric water heating
2. ***Load Curtailment*** programs refer to contractual arrangements between the utility and a third-party aggregator that works with utility customers. The third-party aggregator typically guarantees a specific level of curtailment during an event period, achieving load reduction by working with utility customers who agree to curtail or interrupt their loads in whole or in part when requested. In most cases, participation is required once the customer enrolls in the program and incentives are paid per curtailed kW. Cadmus' analysis of these programs assumes they target nonresidential customers with average monthly loads greater than 100 kW. Customers may use backup generation to meet displaced loads.
3. ***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 time-of-use (TOU) program, with the distinction of more extreme pricing signals during critical events. CPP options are explored for both the residential and commercial sectors in this assessment.

As this study is an update to the 2009 IRP, the program options listed above are based largely on that assessment, with revisions based on input from PSE. After Cadmus completed a review of new demand response literature on the selected programs and on PSE's pilot programs, updates were made to each program. Design specifications and assumptions underlying the analysis for each program strategy are described in detail in this chapter.

Summary of Resource Potentials

Table 26 represents estimated resource potentials for all demand-response strategies for the residential, commercial, and industrial sectors during summer and winter. Achievable technical potential is highest in the residential sector due to the direct load control programs. Note that this analysis does not account for program interactions and overlap; thus, the total technical potential and achievable technical potential estimates may not be fully attainable if all program strategies are implemented.

Table 26. Demand Response Technical and Achievable Technical Potential, MW in 2031

	Winter			Summer		
Sector	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak
Residential	1,184	110	1.95%	402	32	0.72%
Commercial	767	79	1.40%	783	82	1.85%
Industrial	44	4	0.08%	54	5	0.12%
Total	1,995	193	3.43%	1,239	119	2.68%

*System peak is based on PSE's average load in the top 20 hours for each season.

Resource Costs and Supply Curves

Applicable resource acquisition costs generally fall into two categories: (1) fixed program expenses such as infrastructure, administration, maintenance, and data acquisition; and (2) variable costs. Variable costs have two categories: those that vary by the number of customers (e.g., hardware costs) and those that vary by kW reduction (primarily incentives).

Where possible, cost estimates were developed for each program option based on comparable programs offered by other utilities. In certain cases, costs at this level of detail were difficult to determine. Many utilities do not report specific program costs, and among those that do there are a wide range of costs.

Development of a new demand-response program can be a significant cost for a utility, requiring enrollment, call centers, program management, load research, development of evaluation protocols, changes to billing systems, and program marketing. Based on the experiences of utilities, this analysis assumed $400,000 as a typical first cost for program development for residential and nonresidential programs.

Marketing costs can vary greatly by utility and program, from about $25 per customer to more than $5,000 per customer, based on interviews with program managers. Cadmus' analysis assumed $25 for each new residential participant and $200 for each commercial or industrial participant.

To develop supply curves, Cadmus calculated streams of projected annual program costs and impacts. These annual figures account for program assumptions such as eligible loads, program participation, participant attrition, and ramp-up time. The levelized cost of each program was then calculated as the ratio of the present value of costs to winter demand savings for comparison with supply-side alternatives. Note that some programs would have additional summer demand savings potential, but these impacts have not been factored into these levelized cost calculations.

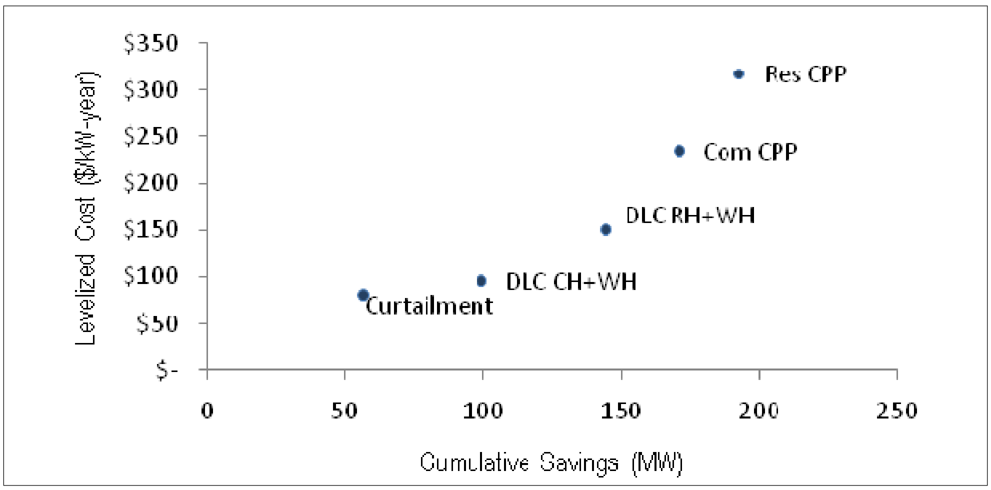
Table 27 displays the per-unit ($/kW per year) costs by program for the estimated achievable technical potential. It is important to note that all programs have higher $/kW costs in the early years due to program start-up costs. The curtailable load program for large nonresidential customers is estimated to be the least-expensive option, having a levelized cost of $81.25/kW per year, while residential CPP was the most costly with a levelized cost of $317/kW per year.

Table 27. Demand Response Achievable Technical Potential and Levelized Costs, Winter MW in 2031

Program Strategy	Achievable Potential	Levelized Cost ($ / Winter kW)
Residential Direct Load Control - Space and Water Heat	43	$95.31
Residential Direct Load Control - Room and Water Heat	45	$150.36
Residential Critical Peak Pricing	22	$316.90
Commercial Critical Peak Pricing	27	$234.48
Commercial Curtailment	56	$81.25

Supply curves were constructed from quantities of estimated achievable technical potential and per-unit costs of each program option. Figure 30 shows the quantity of achievable technical demand-response potential available during winter peak hours in 2031 as a function of levelized cost.

Figure 30. Demand Response Supply Curve, Winter MW in 2031



Resource Acquisition Schedule

Cadmus assumed each program will require an ample start-up period before achieving full participation. Therefore, each program option has an associated ramp rate, as described below:[15]

- The curtailment program is assumed to be the first to begin, achieving approximately 10 MW per year until reaching maximum participation in 2015.

15 Once programs reach full participation, impacts continue to grow due to forecasted load growth.

- Residential DLC programs start in 2015 as three-year pilot program. In 2018, the programs will slowly begin to grow to full participation by 2022.
- The CPP programs are assumed to start as a three-year pilot 2015 to account for the time required to create a new tariff and put necessary infrastructure in place. In 2018, the programs will begin to ramp up, growing to full deployment by 2020.

Figure 31 and Figure 32 shows the acquisition schedule for achievable potential for winter and summer impacts, respectively.

Figure 31. Demand Response Annual Achievable Technical Potential by Strategy - Winter

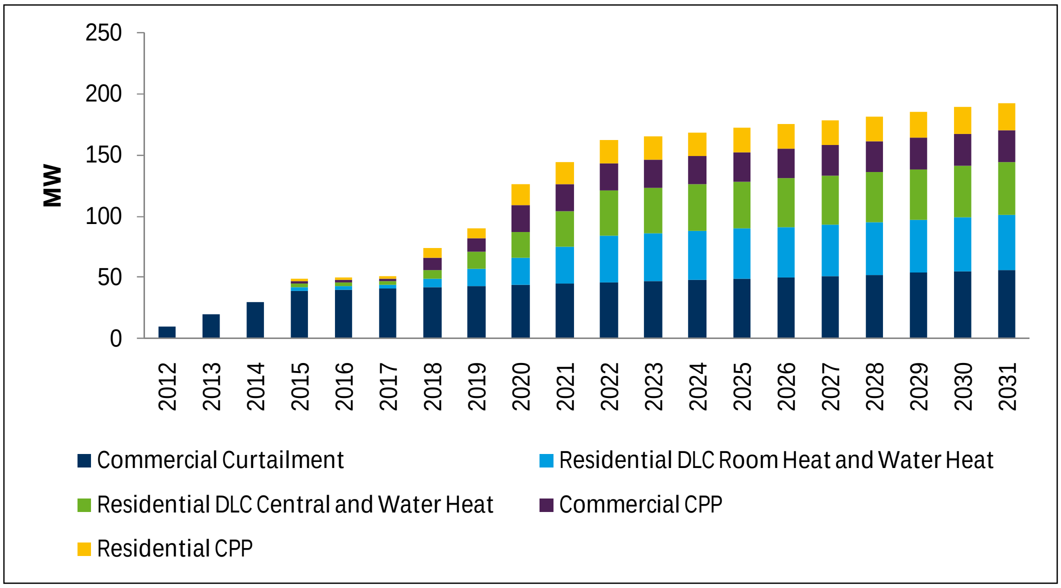
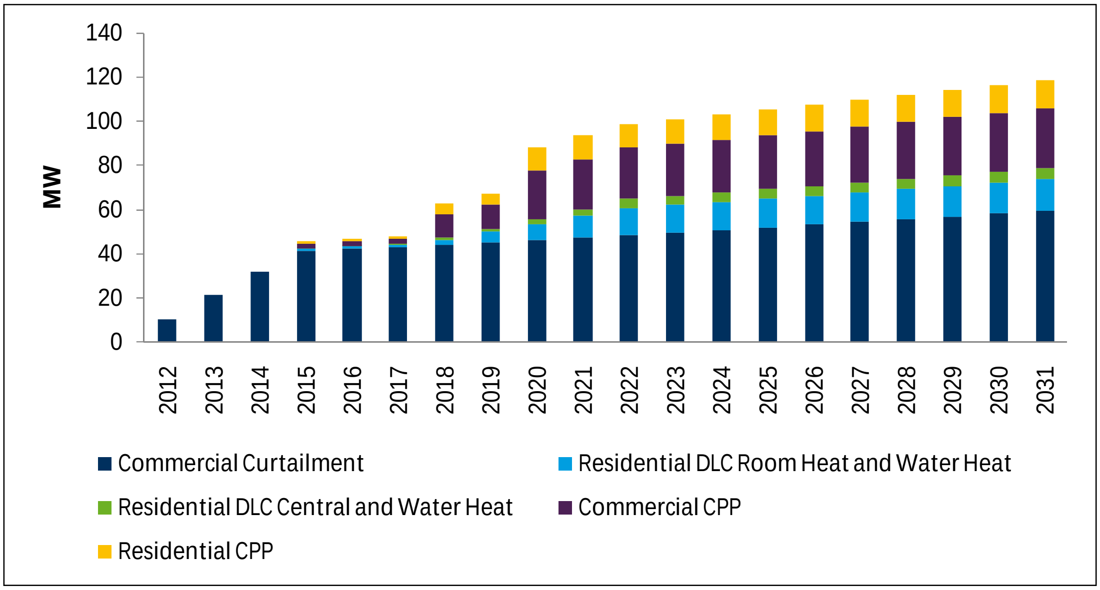


Figure 32. Demand Response Annual Achievable Technical Potential by Strategy – Summer



Detailed Resource Potentials by Program Strategy

Residential Direct Load Control (DLC)

DLC programs are designed to interrupt specific end-use loads at customer facilities through utility-directed control. When deemed necessary, the utility, through a third-party contractor, 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 they typically receive incentives paid through monthly credits on their utility bills.

For this type of program, receiver systems are installed on 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.[16]

Because PSE's system peak occurs in the winter, this assessment focuses on two DLC programs that focus on controlling heating loads. Although residential DLC for air conditioning has been one of the most well-established programs in the nation (utilized by PacifiCorp, MidAmerican Energy, Alliant Energy, Florida Power and Light, Xcel Energy, et al.), the central and room heating DLC programs are a relatively new idea with minimal data available through secondary research.

PSE is currently implementing a space-and-water-heating DLC pilot for 700 homes, with approximately one MW available to be curtailed during each event. Since minimal data are available for these types of programs, some summer DLC program assumptions have been adapted to supplement PSE's pilot data for this assessment.

Central Heating and Water Heating

Table 28 shows the technical and achievable technical potential results by end use by season. Although this is program is primarily focused on reducing the winter peak, water heaters would be available for control in the summer.

Table 28. Residential DLC Central Heat and Water Heat: Technical and Achievable Technical Potential, MW in 2031

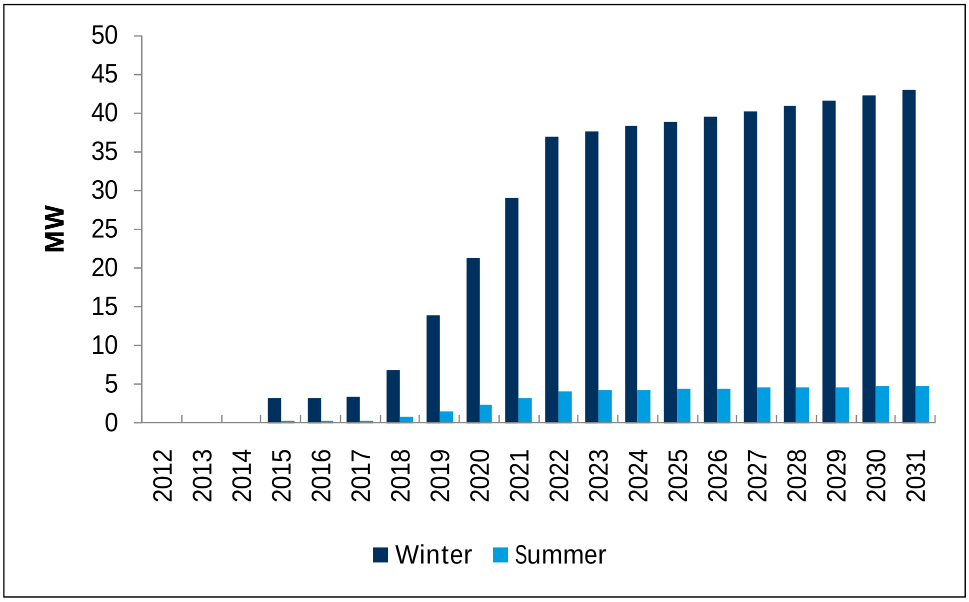
	Winter			Summer		
End Use	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak
Central Heat	251	38	0.67%	0	0	0.00%
Water Heat	46	5	0.10%	42	5	0.11%
Total	297	43	0.77%	42	5	0.11%

*System peak is based on PSE's average load in the top 20 hours for each season.

[16] Typically, penalties are associated with non-compliance or opt-outs.

Figure 33 shows the achievable potential for the central heat DLC program, based on an acquisition schedule with a three-year pilot program starting in 2015 and ramping up to full participation in 2022.

Figure 33. Residential DLC Central Heat and Water Heat Acquisition Schedule



Utility incentives for residential DLC programs can vary greatly, from a free programmable thermostat, to a set incentive amount per month, to a 15 percent discount on customers' summer electricity bills (which may amount to from $50 to $60 annually for many participants). Incentives for this analysis are set at $32/year for central heat cycling, with an additional $8 for water heating control. Additional costs are assessed for this program, including the following:

- $25 of marketing; per new customer
- $7 for communications per existing customer
- a third-party vendor administrative cost

Detailed assumptions are provided in Table 29 and Table 30.

Table 29. Residential DLC Central Heat and Water Heat: Program Basics

Program Concept	Assumptions
Customer Sectors Eligible	Residential customers in single-family and manufactured homes
End Uses Eligible for Program	Electric central heating (including air-source heat pumps) and electric water heaters
Customer Size Requirements, if any	N/A
Winter Load Basis	Top 20 hours
Summer Load Basis	Top 20 hours

Table 30. Residential DLC Central Heat and Water Heat: Inputs and Sources

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Studies found 7% (composed of 5% change-of-service and 2% removals) from utilities, including PacifiCorp, Xcel Energy, Eon US, Sacramento Municipal Utility District,, Florida Power and Light (removals range from 1% to 3%). Removals are accounted for in event participation.
Per Customer Impacts (kW)	1.0 Central Heating 0.6 Water Heating	Based on PSE's central and water heating pilot.
Annual Administrative Costs (percent of annual costs)	5%	An additional utility administrative cost is added to the vendor program cost.
Annual Vendor Administrative Costs (percent of annual costs)	15%	Based on research of vendor bids and informal communication with vendors. Includes maintenance, administrative labor, and dispatch software.
Technology Cost	$160 per switch plus $100 for installation labor	Based on PSE's experience. Assumes the water heater will be controlled by the same switch, consistent with PSE's central heating and water heating pilot program.
Marketing Cost	$25	Assumes 1/2 hour of staff time valued at $50/hour (fully loaded). Based on research of vendor bids and informal communication with vendors.
Incentive (annual costs)	Central Heating $32 Water Heating $8	Incentives range from $30 to $35 for most utilities for one piece of equipment and $8 for additional equipment. Currently PSE's pilot program offers $50 for both central and water heating.
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a one-way transmission system.
Eligible Load (%)	100%	Assumes all electric central heating customers and associated loads are eligible for the program.
Technical Potential (as percent of Gross)	Central Heating 50% Water Heating 100%	Assumes all central heating units and heat pumps can be retrofit and that the program employs a 50% cycling strategy. Due to the tank, water heaters can be shut off for the entire event (100% reduction).
Program Participation (%)	Single Family and Manufactured Central Heating 20% Multifamily Central Heating 0% Water Heating Single Family: 2%; Multifamily 0%; Manufactured: 5%	Assumes 20% of single-family and manufactured homes with electric central heating will participate. Minimal data for DLC heating programs exist; therefore, this assumption is based on the average participation rate for national programs for DLC cooling programs (between 15% and 20% of all residential customers, which translates to 20% to 30% of eligible customers). This is consistent with the 2009 FERC study[17] estimate of 25% program participation for DLC cooling programs. Due to difficulty in reaching the multifamily segment, these customers have been removed from the potential.. As customers with electric central heating will also include water heating, the water heating participation rates reflect the portion of electric water heaters in homes with electric central heating.
Event Participation (%)	Central Heating 94% Water Heating 94%	Based on utility experience with DLC cooling programs, accounting for homeowners removing units and operational breakdowns (from 2.5% to 5.8%). Because one switch controls both devices, the event participation is the same for both end-uses.

Room Heating and Water Heating

Similar to a central heating DLC program, a room heating DLC program is a relatively new idea with little or no data available through secondary research. Table 31 shows the technical and achievable technical potential results by end use for winter and summer. As with the central heating, there is greater potential in the winter since all the heating load occurs in the winter. The summer portion of the program would only target the water heating load.

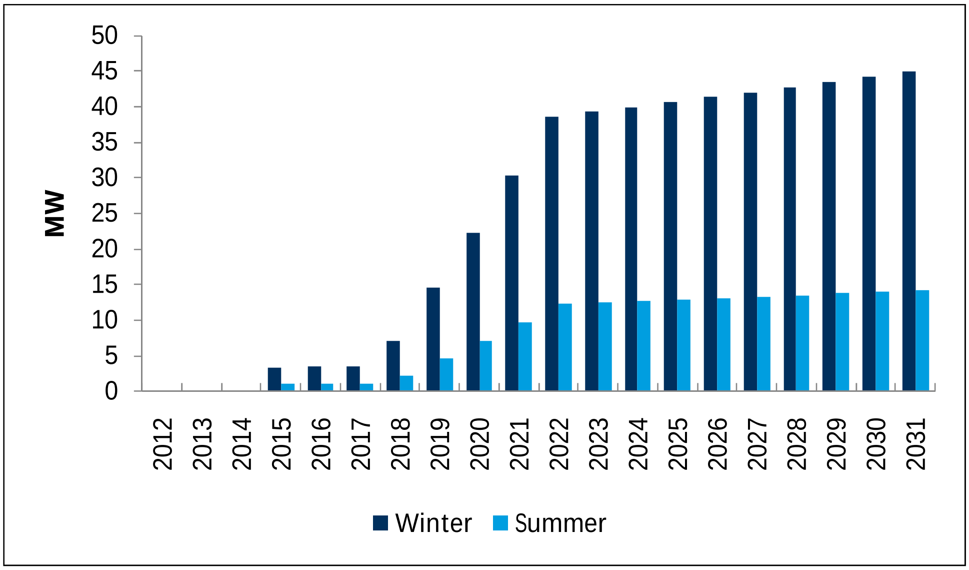
[17] Federal Energy Regulatory Commission. "A National Assessment of Demand Response Potential." June 2009.

Table 31. Residential DLC Room Heat and Water Heat: Technical and Achievable Technical Potential, MW in 2031

	Winter			Summer		
End Use	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As Percent of System Peak
Room Heat	325	29	0.52%	0	0	0.00%
Water Heat	103	16	0.28%	93	14	0.32%
Total	428	45	0.80%	93	14	0.32%
*System peak is based on PSE's average load in the top 20 hours for each season.						

Figure 34 shows the achievable potential for the central heat DLC program based on an acquisition schedule starting in 2015, with a three-year pilot program, ramping up to full participation in 2022.

Figure 34. Residential DLC Room Heat and Water Heat Acquisition Schedule



All cost assumptions, except for technology costs, are consistent with the central heating program. Detailed assumptions are provided in Table 32 and Table 33.

Table 32. Residential DLC Room Heat and Water Heat: Program Basics

Program Concept	Assumptions
Customer Sectors Eligible	All residential
End Uses Eligible for Program	Electric room heating (baseboard)
Customer Size Requirements, if any	N/A
Winter Load Basis	Top 20 hours
Summer Load Basis	Top 20 hours

Table 33. Residential DLC Room Heat and Water Heat: Inputs and Sources

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Studies have found 7% (composed of 5 % change-of-service and 2% removals) from utilities, including PacifiCorp, Xcel Energy, Eon US, Sacramento Municipal Utility District,, Florida Power and Light (removals range from 1 to 3%). Removals are accounted for in event participation.
Per Customer Impacts (kW)	0.75 Room Heating 0.6 Water Heating	Assumes approximately 25% lower demand savings than the central heating program, based on engineering estimate. Water heating savings are based on PSE's pilot program.
Annual Administrative Costs (percent of annual costs)	5%	An additional utility administrative cost is added to the vendor program cost.
Annual Vendor Administrative Costs (percent of annual costs)	15%	Based on research of vendor bids and informal communication with vendors. Includes maintenance, administrative labor, and dispatch software.
Technology Cost	$160 per switch plus $250 for installation labor	Assumes one switch will control all room heaters and the water heater. Switch costs are based on PSE's experience. Installation cost is $250 (assumes 25 percent labor cost savings per heater).
Marketing Cost	$25	Marketing costs are based on 1/2 hour of staff time valued at $50/hour (fully loaded).
Incentive (annual costs)	Room Heating $32 Water Heating $8	Incentives range from $30 to $35 for most utilities for one piece of equipment and $8 for additional equipment. Currently PSE's pilot program offers $50 for both space and water heating.
Technical Potential (as percent of Gross)	Room Heating 50% Water Heating 100%	Assumes all room units can be retrofit and that the program employs a 50 percent cycling strategy. Due to the tank, water heating can be shut off for the entire event (100 percent reduction).
Program Participation (%)	Single Family and Manufactured Room Heating 15% Multifamily Room Heating 0% Water Heating Single Family: 5%; Multifamily 11%; Manufactured: 3%	Assumes 15% of customers with electric room heating will participate. Minimal data for DLC heating programs exists; therefore, the assumption is based on the average participation rate for national programs for DLC AC programs (between 15% and 20% of all residential customers, which translates to 20% to 30% of eligible customers). Due to the difficulty of reaching the multifamily segment, it is assumed that multifamily customers will only participate in the water heating portion of this program. All customers with electric room heating will also include water heating in the program, so participation rates have been adjusted to account for the percent of electric heating customer with electric water heat.
Event Participation (%)	Room Heating 94% Water Heating 94%	Based on PacifiCorp's Cool Keeper historic event participation, which accounts for homeowners removing units and operational breakdowns (2.5% to 5.8%). Because one switch controls both devices, the event participation is the same for both end-uses.
Annual Attrition (%)	5%	Based on utility experience with DLC cooling programs, accounting for homeowners removing units and operational breakdowns (2.5% to 5.8%). Because one switch controls both devices, the event participation is the same for both end-uses.

Nonresidential Load Curtailment

Load curtailment programs utilize contractual arrangements between the utility, a third-party aggregator that implements the program, and utility 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 each contract.

Customers are generally not paid for individual events, but are compensated in the form of a fixed monthly amount per kW of pledged curtailable load or in the form of a rate discount. Typically, contracts require customers to curtail their connected load by either a set percentage (typically, from 15 percent to 20 percent) or a predetermined level (e.g., 100 kW). These types of 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.

For this study, Cadmus assumed nonresidential customers with a monthly demand of at least 100 kW would be eligible for such a program. One key aspect to the potential savings associated with the curtailment 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, and these customers are included in this assessment.

Table 34 shows the estimated technical and achievable technical potential by sector for winter and summer. These potentials are inclusive of the approximate five MW PSE has under control through its curtailment pilot program.

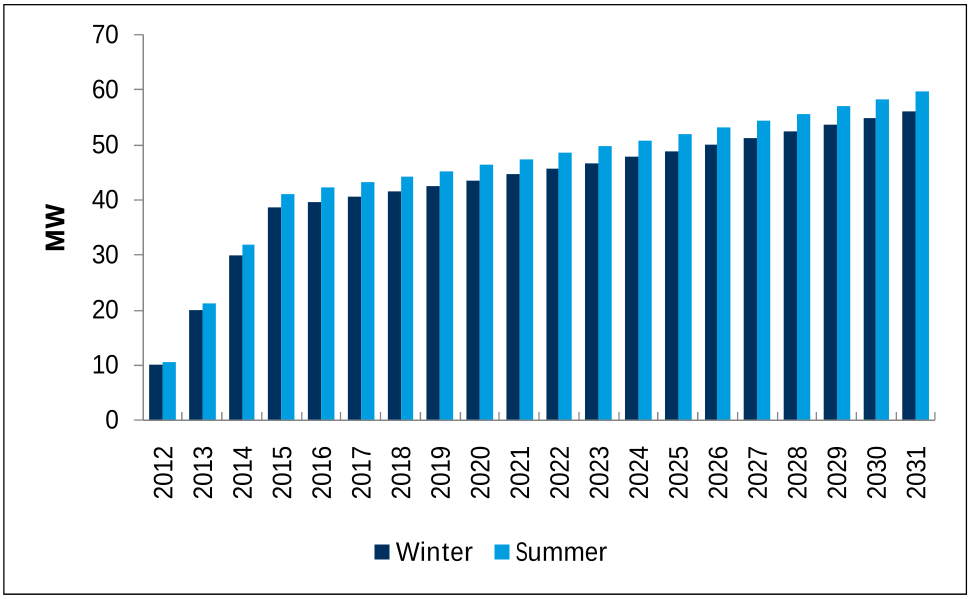
Table 34. Load Curtailment Technical and Achievable Technical Potential, MW in 2031

	Winter			Summer		
Sector	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak
Commercial	383	55	0.98%	391	58	1.31%
Industrial	22	1	0.02%	27	2	0.03%
Total	406	56	1.00%	418	60	1.35%

*System peak is based on PSE's average load in the top 20 hours for each season.

Figure 35 shows the achievable potential for the curtailment program based on an acquisition schedule that begins in 2012, achieving approximately 10 winter MW per year until full potential is reached in 2015.

Figure 35. Load Curtailment Acquisition Schedule



Curtailment programs are typically run through third-party aggregators that charge a set $/kW cost. For this assessment, the technology costs and marketing costs were excluded from the bid when calculating the total $/kW cost of the program. Detailed assumptions providing values and sources that derived potential and levelized costs are shown in Table 35 and Table 36.

Table 35. Load Curtailment Program Basics

Program Concept	Assumptions
Customer Sectors Eligible	All industrial and commercial market segments
End Uses Eligible for Program	Total load of all end uses
Customer Size Requirements, if any	Customers >100kW
Winter Load Basis	Top 20 hours
Summer Load Basis	Top 20 hours

Table 36. Load Curtailment Inputs Consistent Across Market Segments

Inputs	Value	Sources or Assumptions
Annual Administrative Costs (%)	5%	Administrative costs are rolled into the $/kW cost
Technology Cost (per new participant)	$1,400	Technology costs include communications, connectivity and meters, if necessary, based on California spending of $32m for 23,000 large C&I hardware after energy crisis
Marketing Cost (per new participant)	$200	Assumes 4 hours of utility labor at $50/hour (fully loaded)
Incentives (annual costs per participating kW)	N/A	Included in third-party aggregator bid
Overhead: First Costs	N/A	Included in third-party aggregator bid
Vendor Costs	$80	Based on third-party aggregator bid (exclusive of technology and marketing costs)
Technical Potential	Varies by Sector	Based on detailed engineering audits of demand response potential of commercial and industrial 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 (%)	Varies by Sector	Based on survey of PacifiCorp nonresidential customers. See Table 37 for details.
Event Participation (%)	95%	Based on informal conversations with a third-party aggregator.

Table 37. Load Curtailment Inputs and Sources Varying by Segment

Market Segment	End Use	Technical Potential as percent of Load Basis	Program Participation
Grocery	Segment Total	5%	13%
Hospital	Segment Total	12%	0%
Office	Segment Total	16%	21%
Dry Goods Retail	Segment Total	16%	8%
Hotel-Motel	Segment Total	17%	0%
Other	Segment Total	16%	13%
Restaurant	Segment Total	17%	25%
School	Segment Total	17%	23%
University	Segment Total	17%	23%
Warehouse	Segment Total	16%	13%
Industrial	Segment Total	17%	6%

Critical Peak Pricing (CPP)

Under a CPP program, customers receive a discount on their retail rates during non-critical 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 the 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-, off-, and mid-peak prices by season). During CPP events, the normal peak price under a TOU rate structure is replaced with a much higher price, generally set to reflect the utility's avoided cost of supply during peak periods.

CPP rates only take effect a limited number of times during the year. 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 shed or shift load. Most CPP programs provide advanced notice in addition to event criteria (such as a threshold for forecasted weather temperatures) to help customers plan their operations. One attractive feature of the CPP program is the absence of a mandatory curtailment requirement.

The benefit of a CPP rate over a standard TOU rate is that an extreme price signal can be sent to customers for a limited number of events. Utilities have found that demand reductions during these events are typically greater than during TOU peak periods for several reasons:

- Customers under CPP rates are often equipped with automated controls triggered by a signal from the utility
- The higher CPP rate serves as an incentive for customers to shift load away during the CPP event period
- 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, this 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 vary widely by utility and by program, with some utilities reserving the right to call an event at any time while others must provide notice one day before the event. This analysis assumes that approximately 10 four-hour events will be called during the summer and winter for a total of 40 event hours.

Currently, peak pricing is 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 in Eastern states.

Table 38 shows the estimated technical and achievable technical potential by sector for winter and summer.

Table 38. CPP Technical and Achievable Technical Potential, MW in 2031

	Winter			Summer		
Sector	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak	Technical Potential	Achievable Technical Potential	Achievable Technical As percent of System Peak
Residential	458	22	0.39%	267	13	0.29%
Commercial	383	24	0.42%	391	24	0.54%
Industrial	22	3	0.05%	27	4	0.08%
Total	863	48	0.86%	685	40	0.90%

*System peak is based on PSE's average load in the top 20 hours for each season.

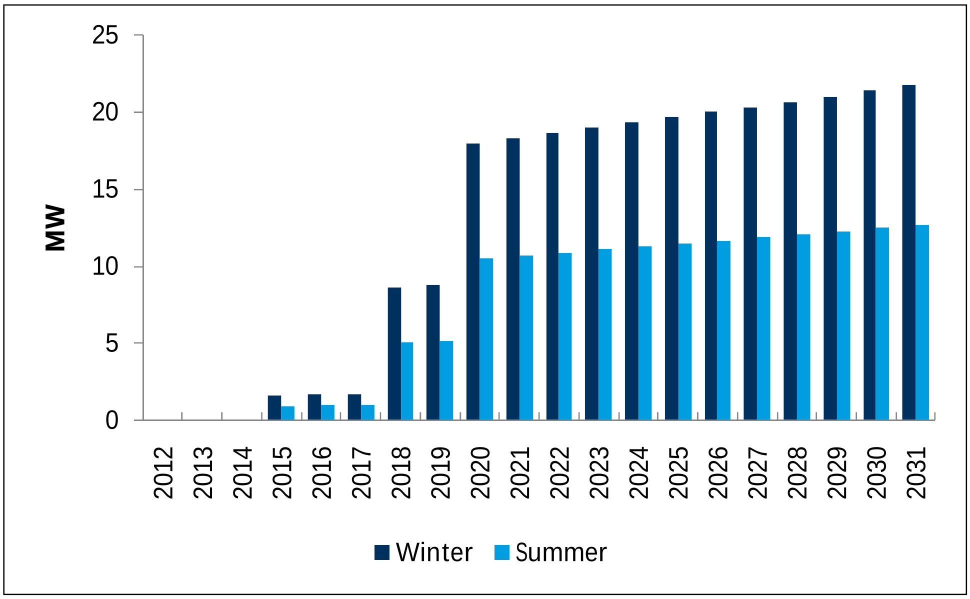
Residential CPP

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 (such as critical peak, on-peak, or off-peak). This combination of pricing and technology has shown to be an effective means of improving per-customer load impacts.

Technically, national studies have shown that 13 percent to 40 percent[18] of peak demand can be reduced for participating customers. Cadmus' study assumes a 15-percent reduction based on the California pricing pilot and PSE's experience with the nonresidential curtailable load pilot. Five percent is consistent with the 2009 FERC study, and event participation is estimated to be 95 percent, based on almost all participants shifting consumption during a CPP event.

Figure 36 shows the achievable technical potential for the nonresidential CPP program, based on an acquisition schedule that begins with a three-year pilot program in 2015 to account for the time necessary to create a new tariff and put infrastructure in place. This is expected to be followed by two years of increased participation, reaching full participation in 2020.

Figure 36. Residential CPP Acquisition Schedule



The residential CPP program has a start-up cost of $400,000, since a new rate structure will be put in place. Additionally, the program will require the installation of a smart thermostat and meter and ongoing communication, priced at $515 and $7 per participant, respectively.

[18] 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.

Marketing costs are consistent with other program assumptions, and no incentives are given because the program is rate-based. Detailed assumptions of values and sources that derived the potential and levelized costs are shown in Tables 39 and 40.

Table 39. Residential CPP Program Basics

Program Concept	Assumptions
Customer Sectors Eligible	All residential customers
End Uses Eligible for Program	Total load of all end uses
Customer Size Requirements, if any	N/A
Winter Load Basis	Top 20 hours
Summer Load Basis	Top 20 hours

Table 40. Residential CPP Inputs and Sources

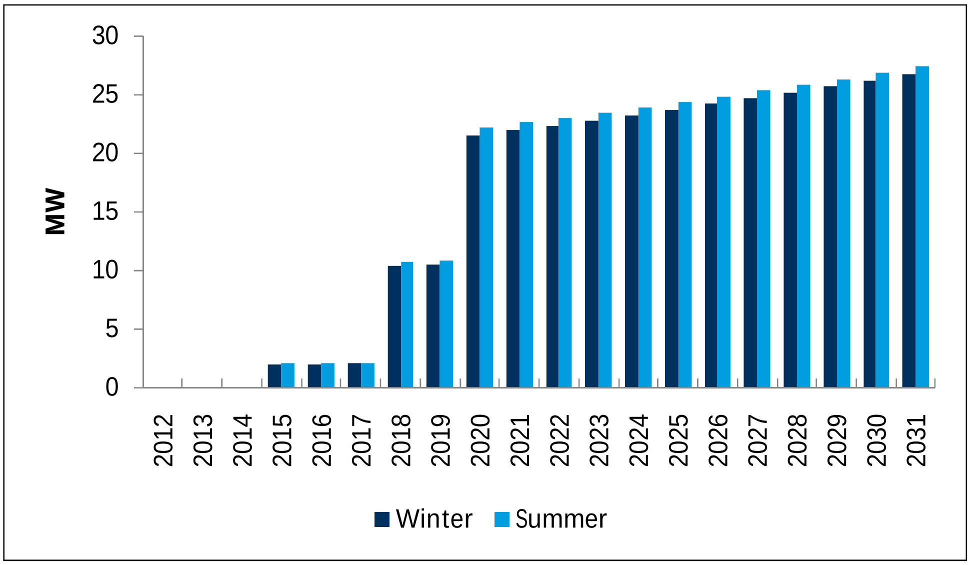
Inputs	Value	Sources or Assumptions
Annual Attrition	5%	Accounts for 5%change of service.
Annual Administrative Costs (%)	15%	Assumes administrative adder of 15%
Technology Cost (per new participant)	$515	Smart Thermostat: $200 installation and $315 for the meter, based on $150 for the installed cost of radio frequency devices (CEC 2004 report) plus an additional $150 to upgrade to AMI and $15/customer communication charge.
Marketing Cost (per new participant)	$25	Marketing costs are based on one-half hour of staff time valued at $50/hour (fully-loaded).
Incentives (annual costs per participant)	N/A	There are no customer incentives, but customers may have a lower bill than they would have on a standard rate.
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	Standard program development assumption, including necessary internal labor, research, and IT/billing system changes
Eligible Load (%)	100%	All residential customers are eligible.
Technical Potential	15%	An average statewide reduction of 27% was found for the California residential pilot CPP programs implemented in the summer (Charles River Associates, 2005). PSE's experience with a C&I pilot shows that winter events save about 50% less than summer events and, therefore, event participation was reduced to 15%.
Program Participation (%)	5%	Gulf Power 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.) Gulf Power expects 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.) 2009 FERC study reports a 5% maximum participation rate.
Event Participation (%)	95%	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: Comverge). With two-way communications (through AMI or Zigbee gateway for example) utilities can identify and replace malfunctioning thermostats, so event participation is much higher than in old one-way, switch-based DLC programs.

Nonresidential CPP

Cadmus has identified very few nonresidential CPP programs for medium-to-large customers; therefore, this analysis relies on engineering audit assumptions for technical potential estimates, which are consistent with CPP studies showing an average of 8 percent savings.[19] Event participation of 56 percent is based on the 2006 California C&I Pilot,[20] and it accounts for the higher rate of opt-outs expected for commercial customers.

Figure 37 shows the achievable technical potential for the nonresidential CPP program based on an acquisition schedule that begins with a three-year pilot program in 2015, accounting for the time needed to create a new tariff and put infrastructure in place. This is expected to be followed by two years of increased participation, reaching full participation in 2020.

Figure 37. Nonresidential CPP Acquisition Schedule



The nonresidential CPP program will also have a start-up cost of $400,000, since a new rate structure will be put in place. Additionally, the program will require the installation of metering and communication equipment (priced at $1,400) and ongoing communication costs of $7 per participant, respectively. Marketing costs are consistent with other program assumptions, and no incentives are given because the program is rate-based. Detailed assumptions for the nonresidential CPP program are shown in Tables 41 and 43.

19 LBNL Fully Automated CPP study, 2006.

20 Hopper, Nicole and Charles Goldman. The Summer of 2006: A Milestone in the Ongoing Maturation of Demand Response. 2007.

Table 41. Nonresidential CPP Program Basics

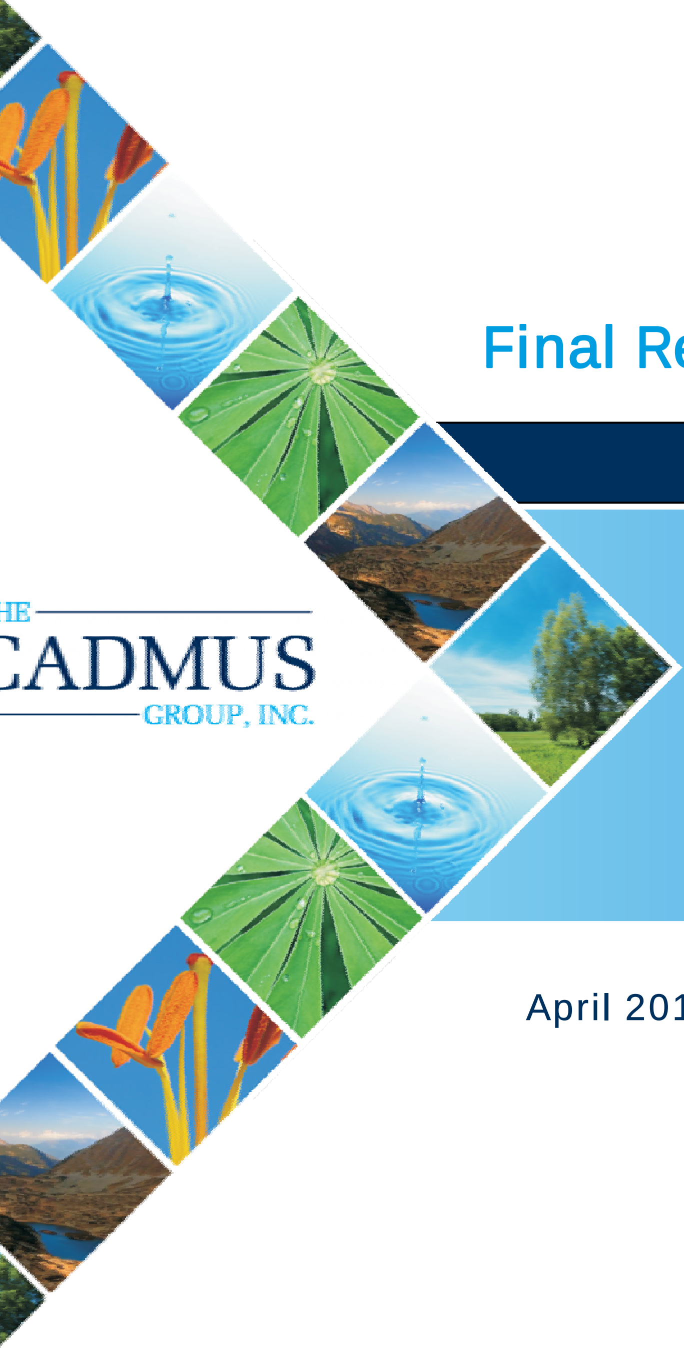
Program Concept	Assumptions
Customer Sectors Eligible	All nonresidential market segments
End Uses Eligible for Program	Total load of all end uses
Customer Size Requirements, if any	Nonresidential customers with monthly load greater than 100 kW
Winter Load Basis	Top 20 hours
Summer Load Basis	Top 20 hours

Table 42. Nonresidential CPP Inputs and Sources not Varying by Sector or Segment

Inputs	Value	Sources or Assumptions
Annual Administrative Costs (%)	15%	Assumes administrative adder of 15%
Technology Cost (per new participant)	$1,400	Technology costs include communications, connectivity and meters, if necessary, based on California spending of $32 million for hardware for 23,000 large C&I after energy crisis
Marketing Cost (per new participant)	$200	Assumes 4 hours of utility labor at $50/hour (fully-loaded) for account representatives.
Marketing Cost (first year)	$150,000	Assumes an additional one time FTE cost to implement the program.
Communication Costs (per Customer Per Year)	$7	This value accounts for annual per-customer communication of a one-way transmission system.
Incentives (annual costs per participant)	N/A	There are no customer incentives, but customers may have a lower bill than they would have on a standard rate.
Overhead: First Costs	$400,000	Standard program development assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as percent of Load Basis	Varies by Sector	Based on detailed engineering audits of demand response potential for commercial and industrial customers throughout California, with third-party verification of results. Studies of CPP results show that 8% was saved on average (LBNL Fully Automated CPP study, 2006), which is comparable to taking this technical potential and the event participation combined.
Program Participation (%)	Varies by Sector	Based on survey of PacifiCorp nonresidential customers. See Table 37 for details.
Event Participation (%)	56%	Based on 2006 California C&I results for CPP Pilot

Table 43. Nonresidential CPP Inputs and Sources Varying by Sector or Segment

Market Segment	End Use	Technical Potential as percent of Load Basis	Program Participation
Grocery	Segment Total	5%	12%
Hospital	Segment Total	12%	0%
Office	Segment Total	16%	8%
Dry Goods Retail	Segment Total	16%	16%
Hotel-Motel	Segment Total	17%	0%
Other	Segment Total	16%	12%
Restaurant	Segment Total	17%	25%
School	Segment Total	17%	18%
University	Segment Total	17%	18%
Warehouse	Segment Total	16%	12%
Chemical Manufacturing	Segment Total	17%	24%
Computer Electronic Manufacturing	Segment Total	17%	24%
Electrical Equipment Manufacturing	Segment Total	17%	24%
Fabricated Metal Products	Segment Total	17%	24%
Food Manufacturing	Segment Total	18%	24%
Industrial Machinery	Segment Total	17%	24%
Miscellaneous Manufacturing	Segment Total	17%	24%
Nonmetallic Mineral Products	Segment Total	17%	24%
Paper Manufacturing	Segment Total	17%	24%
Petroleum Refining	Segment Total	17%	0%
Plastic Rubber Products	Segment Total	17%	24%
Primary Metal Manufacturing	Segment Total	17%	24%
Printed Related Support	Segment Total	17%	24%
Transportation Equipment Manufacturing	Segment Total	17%	24%
Wastewater	Segment Total	17%	24%
Water	Segment Total	17%	24%



Final Report

Comprehensive Assessment of Demand-Side Resource Potential (2012-2031): Appendices

Volume II

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Appendix A. Methodological Consistency with the 6th Northwest Power Plan

To facilitate a comparison with the 6th Power Plan, the Council has prepared an overview of the methodology used in the development of conservation potential estimates in the 6th Power Plan.[1] This appendix compares the methodology used in PSE's 2011 IRP to those benchmarks established by the Council.

Descriptions of methodology used in this study are in italics below.

Technical Resource Potential Assessment

Review a wide array of energy-efficiency technologies and practices across all sectors and major end uses.

> *The study considered measures from a variety of sources, including the 6th Plan, RTF, ENERGY STAR, and DEER. Descriptions of all measures analyzed are provided in Appendix B.2.*

Methodology

- Technically feasibility savings = Number of applicable units * incremental savings/applicable unit
- "Applicable" Units accounts for:
    - Fuel saturations (e.g. electric vs. gas DHW)

      Fuel saturations were based on data specific to PSE's service territory whenever possible. PSE's 2008 Residential End Use Survey (REUS) and NEEA's 2008 Commercial Building Stock Assessment (CBSA) were the primary sources of this information.
    - Building characteristics (single family vs. mobile homes, basement/non-basement, etc.)

      Data came from PSE billing information and the REUS and CBSA studies.

[1] http://www.nwcouncil.org/energy/powerplan/6/supplycurves/I937/CouncilMethodology_outline%20_2_.pdf

- System saturations, (e.g., heat pump vs. zonal, central AC vs. window AC)

  System saturations were based on data specific to PSE's service territory whenever possible. PSE's 2008 Residential End Use Survey (REUS) and NEEA's 2008 Commercial Building Stock Assessment (CBSA) were the primary sources of this information.

- Current measure saturations

  Current saturations were incorporated into the applicability based on information from the REUS and CBSA, the 6th Plan, and the experience of PSE conservation staff.

- New and existing units

  Existing and new units are calculated based on current and forecasted customers, respectively.

- Measure life (stock turnover cycle)

  Measure decay rates are applied to lost opportunity measures, based on measure life. Discretionary measures are assumed to be reinstalled at the end of their useful life.

- Measure substitutions (e.g., duct sealing of homes with forced-air resistance furnaces vs. conversion of homes to heat pumps with sealed ducts)

  Competition between measures is accounted for in the measure share applicability factor to avoid double-counting.

- "Incremental" Savings/applicable unit accounts for:
  - Expected kW and kWh savings shaped by time-of-day, day of week and month of year

    Energy and demand savings are either based on deemed values or calculated as a percent reduction in baseline end use consumption. Hourly impacts are provided to PSE's IRP model.

  - Savings over baseline efficiency
    - Baseline set by codes/standards or current practices

      Baselines are set based on current codes, standards, or current practices. Standards that have been passed but not yet implemented become the baseline at the time mandated in the new standard.

    - Not always equivalent to savings over "current use" (e.g., new refrigerator savings are measured as "increment above current federal standards, not the refrigerator being replaced)

      Savings from equipment upgrades on burnout are calculated based on the minimum efficiency level available.

- Climate—heating, cooling degree days and solar availability

  Savings are based on typical climate in PSE's service territory.

- Measure interactions (e.g. lighting and HVAC, duct sealing and heat pump performance, heat pump conversion and weatherization savings)

  These interactive effects are treated as a reduction in measure savings (e.g., commercial lighting measures may save less due to increased heating requirements).

Economic Potential: Ranking Based on Resource Valuation

- Total Resource Cost (TRC) is the criterion for economic screening - TRC includes all cost and benefits of measure, regardless of who pays for or receives them.
  - TRC B/C Ratio > = 1.0

    Benefit-to-cost ratios were not calculated. The analysis used the levelized cost of conserved energy, as described below.

  - Levelized cost of conserved energy (CCE) < levelized avoided cost for the load shape of the savings may substitute for TRC if "CCE" is adjusted to account for "non-kWh" benefits, including deferred T&D, non-energy benefits, environmental benefits and Act's 10% conservation credit

    Levelized costs, on a TRC basis, were calculated for each measure for comparison with supply-side resources in the IRP. The levelized cost calculation incorporated deferred T&D (for electric resources), non-energy benefits, and Act's 10-percnet conservation credit (for electric resources).

Methodology

Valuation of energy and capacity savings was conducted in PSE's Integrated Resource Planning (IRP) model and is not included as part of this study.

  - Energy and capacity value (i.e., benefit) of savings based on avoided cost of future wholesale market purchases (forward price curves).
  - Energy and capacity value accounts for shape of savings (i.e., uses time and seasonally differentiated avoided costs and measure savings).
  - Uncertainties in future market prices are accounted for by performing valuation under wide range of future market price scenario during Integrated Resource Planning process

- Costs Inputs (Resource Cost Elements):

  All of the costs listed below were included in the per-unit measure costs, where appropriate.

  - Full incremental measure costs (material and labor)
  - Applicable on-going O&M expenses (plus or minus)
  - Applicable periodic O&M expenses (plus or minus)
  - Utility administrative costs (program planning, marketing, delivery, on-going administration, evaluation)

- Benefit Inputs (Resource Value Elements):

  All of the benefits listed below were assessed in the calculation of levelized cost of conserved energy, where appropriate.

  - Direct energy savings
  - Direct capacity savings
  - Avoided T&D losses
  - Deferral value of transmission and distribution system expansion (if applicable)
  - Non-energy benefits (e.g. water savings)
  - Environmental externalities

- Discounted Presented Value Inputs:
  - Rate = After-tax average cost of capital weighted for project participants (real or nominal)

    The analysis used PSE's weighted average cost of capital of 8.1 percent, nominal.

  - Term = Project life, generally equivalent to life of resources added during planning period

    Costs were levelized over each measure's expected useful life.

  - Money is discounted, not energy savings

    This is the method used in the IRP analysis.

Achievable Potential

- Annual acquisition targets established through Integrated Resource Acquisition Planning (IRP) process (i.e., portfolio modeling)

  The results of the potentials assessment, bundled by levelized costs of conserved energy, were incorporated in the IRP model. Based on the value of the savings, the IRP model selected the appropriate amount of conservation.

- Conservation competes against all other resource options in portfolio analysis.
  - Conservation resource supply curves separated into:
    - Discretionary (non-lost opportunity)

      Defined as retrofit opportunities in existing facilities

    - Lost-opportunity

      Includes equipment replacement in existing facilities and all new construction measures

- Annual achievable potential constrained by historic "ramp rates" for discretionary and lost-opportunity resources:
    - Maximum ramp up/ramp down rate for discretionary is 3x prior year for discretionary, with upper limit of 85 percent over 20 year planning period

      Analysis assumed that 85 percent of discretionary resources could be acquired in a 10-year timeframe.

    - Ramp rate for lost-opportunity is 15 percent in first year, growing to 85 percent in twelfth year

      Lost opportunity ramp rates varied by measure, based on the assumptions used in the 6th Plan.

    - Achievable potentials may vary by type of measure, customer sector, and program design (e.g., measures subject to federal standards can have 100-percent "achievable" potential).

      While the analysis removed savings from known standards, it did not attempt to predict which savings would be acquired from future codes or standards.

- Revise Technical, Economic and Achievable Potential based on changes in market conditions (e.g., revised codes or standards), program accomplishments, evaluations and experience

  Changes taking effect after the finalization of the 2011 IRP will be reflected in the 2013 IRP.

  - All programs should incorporate Measurement and Verification (M&V) plans that at a minimum track administrative and measure costs and savings.
  - Use International Performance Measurement and Verification Protocols (IPMVP) as a guide.

Appendix B.1: Detailed Results

The following graphs show baseline electric and gas forecasts by sector and segment. The following tables show assumptions of gas and electric equipment saturations, fuel shares, annual per unit energy consumption for residential end uses, and annual per square foot energy consumption for commercial end uses.

Figure B.1.1. Residential Electric Baseline Forecast 2009 - 2031

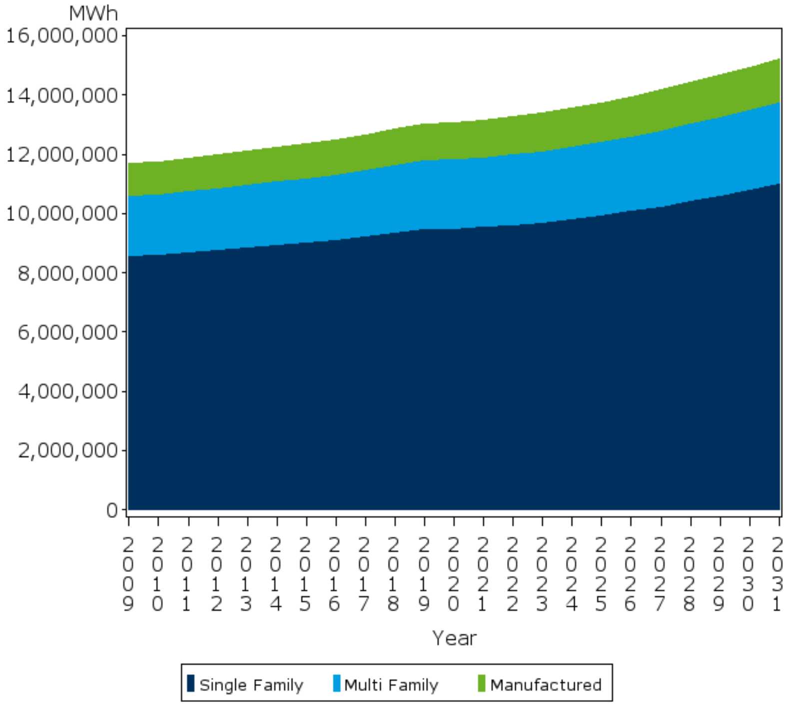


Figure B.1.2. Commercial Electric Baseline Forecast 2009 - 2031

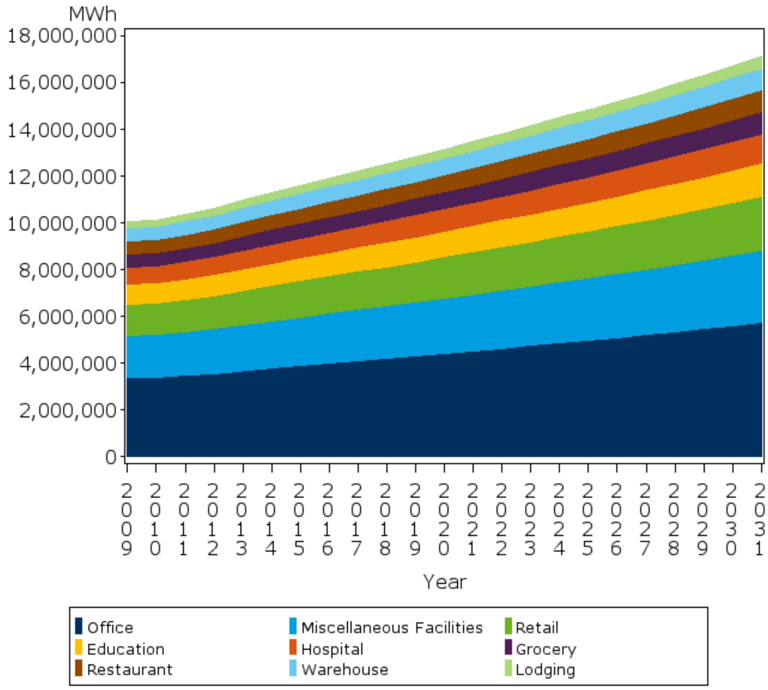
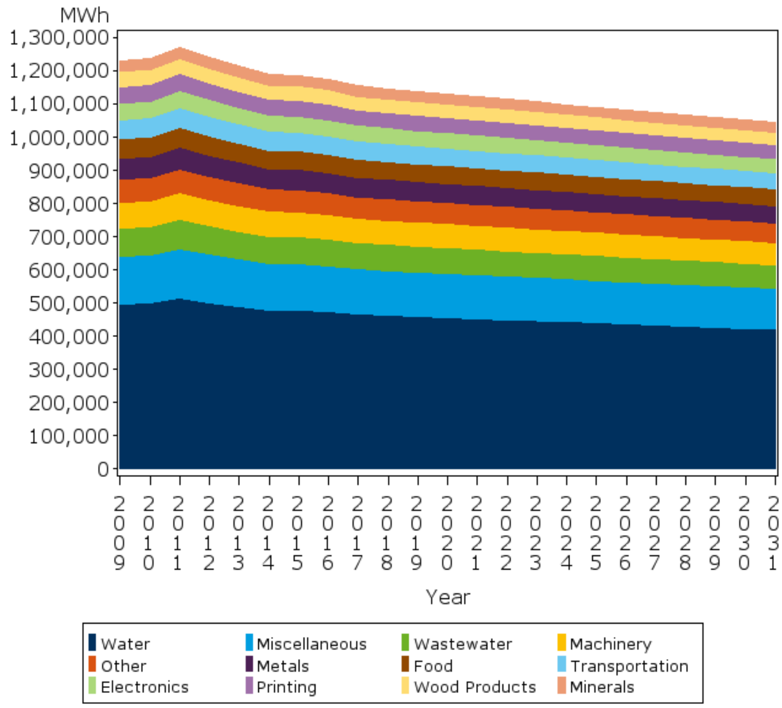


Figure B.1.3. Industrial Electric Baseline Forecast 2009 - 2031



*Note: “Other” includes Petroleum, Plastics/Rubber, Paper, Electrical Equipment Mfg, and Chemicals.

Figure B.1.4. Residential Gas Baseline Forecast 2009 – 2031

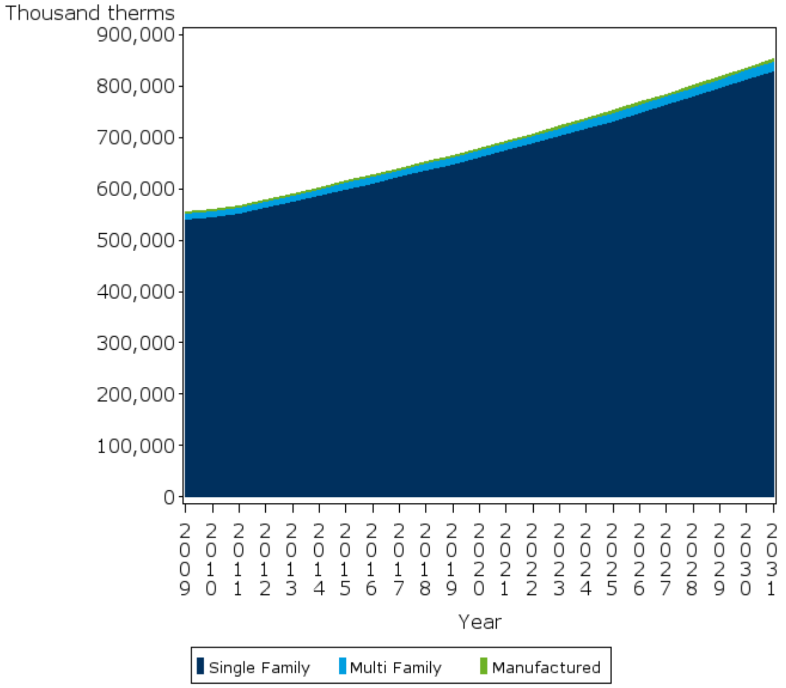


Figure B.1.5. Commercial Gas Baseline Forecast 2009 - 2031

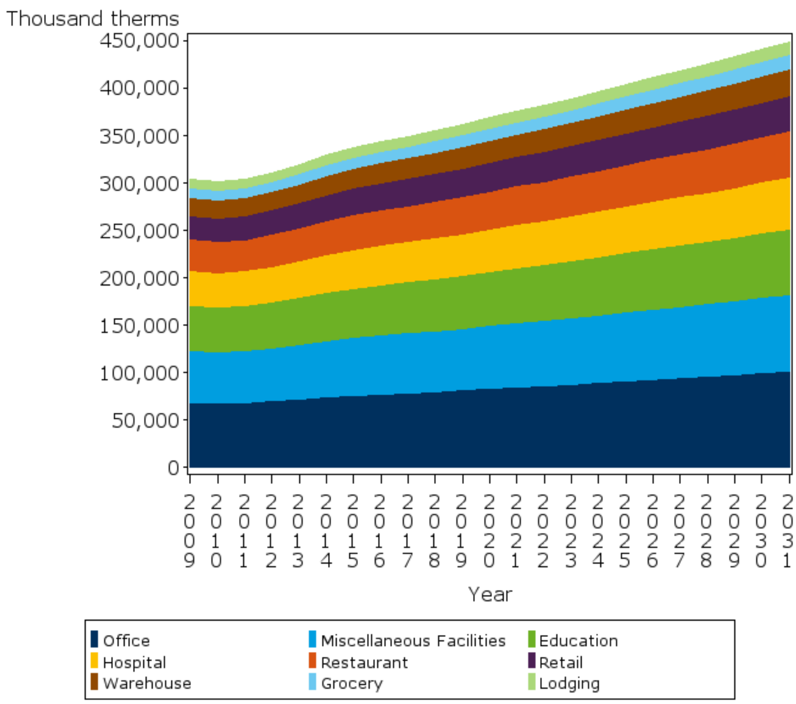
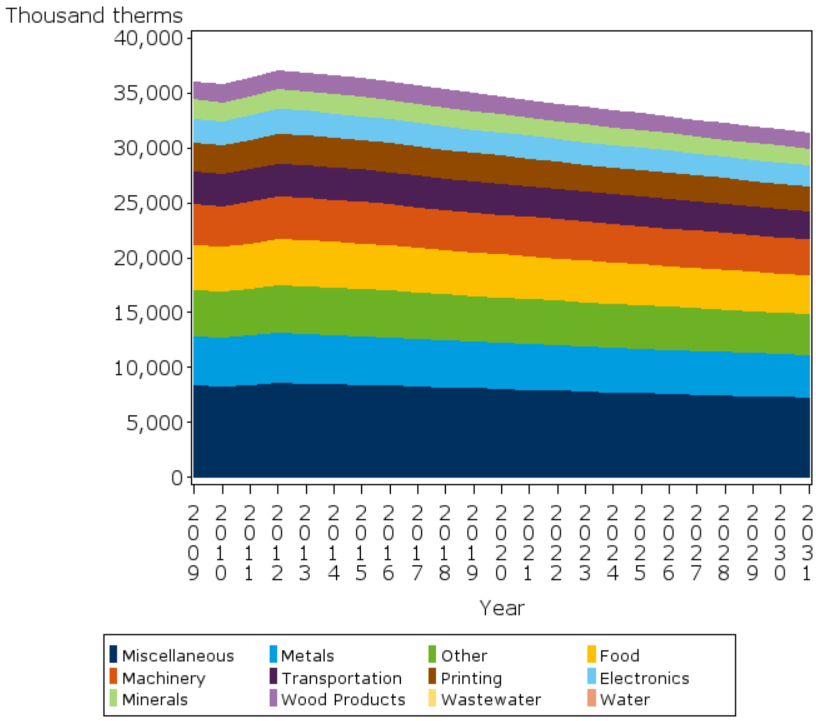


Figure B.1.6. Industrial Gas Baseline Forecast 2009 - 2031



*Note: "Other" includes Petroleum, Plastics/Rubber, Paper, Electrical Equipment Mfg, and Chemicals.

Table B.1.7. Residential Electric Saturations, Fuel Shares, and UECs

Segment	End Use	Saturation	Electric Fuel Share	Weighted Average UEC - Existing	Weighted Average UEC - New
Manufactured	Computer	93%	100%	156.68	156.68
Manufactured	Cooking Oven	103%	97%	153.62	153.62
Manufactured	Cooking Range	103%	93%	128.20	128.20
Manufactured	Cool Central	18%	100%	870.50	626.82
Manufactured	Cool Room	24%	100%	460.98	359.47
Manufactured	Dehumidifier	0%	100%	710.13	710.13
Manufactured	Dryer	98%	96%	607.38	577.25
Manufactured	DVD	145%	100%	101.20	101.20
Manufactured	Freezer	71%	100%	696.60	533.80
Manufactured	Heat Central	69%	58%	6,635.00	4,688.00
Manufactured	Heat Pump	16%	100%	5,622.38	3,478.19
Manufactured	Heat Room	16%	100%	5,109.00	3,610.00
Manufactured	Home Audio System	75%	100%	61.89	61.89
Manufactured	Lighting Exterior	100%	100%	156.70	210.65
Manufactured	Lighting Interior Specialty	100%	100%	231.43	311.10
Manufactured	Lighting Interior Standard	100%	100%	935.96	1,258.18
Manufactured	Microwave	100%	100%	148.18	148.18
Manufactured	Monitor	113%	100%	76.41	76.41
Manufactured	Plug Load Other	100%	100%	715.74	715.74
Manufactured	Refrigerator	109%	100%	626.85	561.98
Manufactured	Set Top Box	117%	100%	262.84	262.84
Manufactured	TV	145%	100%	195.88	195.88
Manufactured	TV Bigscreen	27%	100%	417.02	417.02
Manufactured	Ventilation And Circulation	100%	100%	653.25	399.75
Manufactured	Water Heat	100%	85%	3,333.85	2,791.91
Multi Family	Computer	100%	100%	155.89	155.89
Multi Family	Cooking Oven	106%	96%	153.62	153.62
Multi Family	Cooking Range	95%	90%	128.20	128.20
Multi Family	Cool Central	3%	100%	708.82	539.03
Multi Family	Cool Room	0%	100%	374.64	309.68
Multi Family	Dehumidifier	1%	100%	710.13	710.13
Multi Family	Dryer	64%	98%	607.38	577.25
Multi Family	DVD	176%	100%	101.20	101.20
Multi Family	Freezer	5%	100%	696.60	533.80
Multi Family	Heat Central	22%	25%	5,354.00	3,361.00
Multi Family	Heat Pump	0%	100%	4,278.89	2,876.02
Multi Family	Heat Room	64%	100%	4,123.00	2,588.00
Multi Family	Home Audio System	63%	100%	61.89	61.89
Multi Family	Lighting Exterior	57%	100%	148.13	206.69
Multi Family	Lighting Interior Specialty	100%	100%	190.75	266.16
Multi Family	Lighting Interior Standard	100%	100%	883.77	1,233.17
Multi Family	Microwave	91%	100%	148.18	148.18
Multi Family	Monitor	84%	100%	76.41	76.41
Multi Family	Plug Load Other	100%	100%	319.33	319.33
Multi Family	Refrigerator	103%	100%	634.73	566.34
Multi Family	Set Top Box	109%	100%	262.84	262.84
Multi Family	TV	160%	100%	195.88	195.88
Multi Family	TV Bigscreen	16%	100%	417.02	417.02
Multi Family	Ventilation And Circulation	100%	100%	429.98	335.40
Multi Family	Water Heat	100%	73%	1,973.43	1,692.31

Segment	End Use	Saturation	Electric Fuel Share	Weighted Average UEC - Existing	Weighted Average UEC - New
Single Family	Computer	163%	100%	148.35	148.35
Single Family	Cooking Oven	117%	83%	153.62	153.62
Single Family	Cooking Range	97%	68%	128.20	128.20
Single Family	Cool Central	14%	100%	996.51	871.38
Single Family	Cool Room	6%	100%	527.24	499.87
Single Family	Dehumidifier	2%	100%	710.13	710.13
Single Family	Dryer	99%	82%	709.92	577.25
Single Family	DVD	194%	100%	101.20	101.20
Single Family	Freezer	64%	100%	696.60	533.80
Single Family	Heat Central	73%	10%	9,000.00	5,561.00
Single Family	Heat Pump	5%	100%	7,218.50	5,496.39
Single Family	Heat Room	15%	94%	6,930.00	4,282.00
Single Family	Home Audio System	101%	100%	61.89	61.89
Single Family	Lighting Exterior	100%	100%	310.09	362.66
Single Family	Lighting Interior Specialty	100%	100%	419.28	490.36
Single Family	Lighting Interior Standard	100%	100%	1,850.80	2,164.58
Single Family	Microwave	99%	100%	148.18	148.18
Single Family	Monitor	134%	100%	76.41	76.41
Single Family	Plug Load Other	100%	100%	760.12	760.12
Single Family	Pool Pump	3%	100%	1,470.00	1,470.00
Single Family	Refrigerator	136%	100%	623.38	560.06
Single Family	Set Top Box	137%	100%	262.84	262.84
Single Family	TV	203%	100%	195.88	195.88
Single Family	TV Bigscreen	44%	100%	417.02	417.02
Single Family	Ventilation And Circulation	100%	100%	543.08	470.93
Single Family	Water Heat	100%	42%	3,447.11	2,893.68

Table B.1.8. Residential Gas Saturations, Fuel Shares, and UECs

Segment	End Use	Saturation	Gas Fuel Share	Weighted Average UEC - Existing	Weighted Average UEC - New
Manufactured	Cooking Oven	100%	20%	19.39	19.39
Manufactured	Cooking Range	100%	42%	23.62	23.62
Manufactured	Dryer	100%	21%	38.28	36.55
Manufactured	Heat Central Boiler	3%	100%	614.97	567.35
Manufactured	Heat Central Furnace	93%	100%	467.69	422.49
Manufactured	Water Heat	100%	82%	154.26	190.15
Multi Family	Cooking Oven	105%	31%	19.39	19.39
Multi Family	Cooking Range	91%	39%	23.62	23.62
Multi Family	Dryer	74%	7%	38.28	36.55
Multi Family	Heat Central Boiler	5%	100%	444.47	378.60
Multi Family	Heat Central Furnace	51%	100%	353.66	316.71
Multi Family	Water Heat	100%	82%	136.79	168.81
Single Family	Cooking Oven	115%	20%	19.39	19.39
Single Family	Cooking Range	98%	42%	23.62	23.62
Single Family	Dryer	99%	21%	38.28	36.55
Single Family	Heat Central Boiler	3%	100%	758.82	601.57
Single Family	Heat Central Furnace	93%	96%	616.03	459.91
Single Family	Pool Heat	3%	77%	257.41	257.41
Single Family	Water Heat	100%	85%	234.78	291.05

Table B.1.9. Commercial Electric Saturations, Fuel Shares, and EUIs

Segment	End Use	Saturation	Electric Fuel Share	Weighted Average EUI - Existing	Weighted Average EUI - New
Dry Goods Retail	Computers	100%	100%	0.03	0.03
Dry Goods Retail	Cooling Dx	48%	100%	2.04	1.06
Dry Goods Retail	Heat Pump	10%	100%	3.04	1.55
Dry Goods Retail	HVAC Aux	88%	100%	2.71	2.21
Dry Goods Retail	Lighting Exterior	100%	100%	1.11	1.11
Dry Goods Retail	Lighting Interior	100%	100%	5.33	4.18
Dry Goods Retail	Other Office Equipment	100%	100%	0.04	0.04
Dry Goods Retail	Other Plug Load	100%	100%	0.80	0.80
Dry Goods Retail	Space Heat	78%	24%	2.02	0.45
Dry Goods Retail	Water Heat	100%	68%	0.28	0.28
Grocery	Computers	100%	100%	0.16	0.16
Grocery	Cooking	100%	56%	2.67	2.67
Grocery	Cooling Dx	59%	100%	1.74	1.48
Grocery	Heat Pump	13%	100%	4.75	1.76
Grocery	HVAC Aux	87%	100%	2.14	2.57
Grocery	Lighting Exterior	100%	100%	1.05	1.05
Grocery	Lighting Interior	100%	100%	8.10	6.46
Grocery	Other Office Equipment	100%	100%	0.12	0.12
Grocery	Other Plug Load	100%	100%	1.02	1.02
Grocery	Refrigeration	100%	100%	20.39	20.39
Grocery	Space Heat	73%	11%	2.14	0.19
Grocery	Water Heat	100%	32%	0.30	0.30
Hospital	Computers	100%	100%	0.96	0.96
Hospital	Cooking	100%	32%	0.54	0.54
Hospital	Cooling Chillers	23%	100%	1.75	0.46
Hospital	Cooling Dx	49%	100%	1.91	0.50
Hospital	Heat Pump	7%	100%	3.74	1.64

Segment	End Use	Saturation	Electric Fuel Share	Weighted Average EUI - Existing	Weighted Average EUI - New
Hospital	HVAC Aux	93%	100%	5.37	4.19
Hospital	Lighting Exterior	100%	100%	0.58	0.58
Hospital	Lighting Interior	100%	100%	4.55	2.85
Hospital	Other Office Equipment	100%	100%	0.87	0.87
Hospital	Other Plug Load	100%	100%	2.54	2.54
Hospital	Refrigeration	100%	100%	0.50	0.50
Hospital	Space Heat	87%	48%	1.26	0.69
Hospital	Water Heat	100%	48%	1.36	1.37
Hotel Motel	Computers	100%	100%	0.10	0.10
Hotel Motel	Cooking	100%	8%	0.65	0.65
Hotel Motel	Cooling Chillers	27%	100%	1.59	0.50
Hotel Motel	Cooling Dx	16%	100%	1.74	0.54
Hotel Motel	Heat Pump	27%	100%	4.00	2.10
Hotel Motel	HVAC Aux	90%	100%	3.24	2.02
Hotel Motel	Lighting Exterior	100%	100%	0.66	0.66
Hotel Motel	Lighting Interior	100%	100%	2.87	1.90
Hotel Motel	Other Office Equipment	100%	100%	0.08	0.08
Hotel Motel	Other Plug Load	100%	100%	1.12	1.12
Hotel Motel	Space Heat	57%	53%	4.01	2.55
Hotel Motel	Water Heat	100%	39%	1.70	1.72
Office	Computers	100%	100%	0.52	0.52
Office	Cooling Chillers	23%	100%	1.53	0.57
Office	Cooling Dx	39%	100%	1.67	0.62
Office	Heat Pump	28%	100%	3.22	1.39
Office	HVAC Aux	85%	100%	1.53	1.29
Office	Lighting Exterior	100%	100%	0.51	0.51
Office	Lighting Interior	100%	100%	3.80	2.34
Office	Other Office Equipment	100%	100%	0.41	0.41
Office	Other Plug Load	100%	100%	0.65	0.65
Office	Space Heat	56%	61%	3.21	0.66
Office	Water Heat	100%	82%	0.46	0.46
Other	Computers	100%	100%	0.20	0.20
Other	Cooking	100%	53%	0.39	0.39
Other	Cooling Chillers	7%	100%	1.70	0.77
Other	Cooling Dx	29%	100%	1.85	0.84
Other	Heat Pump	9%	100%	3.13	1.47
Other	HVAC Aux	83%	100%	2.12	1.75
Other	Lighting Exterior	100%	100%	1.23	1.23
Other	Lighting Interior	100%	100%	2.75	1.95
Other	Other Office Equipment	100%	100%	0.22	0.22
Other	Other Plug Load	100%	100%	1.08	1.08
Other	Refrigeration	100%	100%	0.20	0.20
Other	Space Heat	73%	44%	2.62	0.55
Other	Water Heat	100%	60%	0.37	0.37
Restaurant	Computers	100%	100%	0.13	0.13
Restaurant	Cooking	100%	18%	9.42	9.42
Restaurant	Cooling Dx	51%	100%	4.16	1.58
Restaurant	Heat Pump	14%	100%	5.07	2.20
Restaurant	HVAC Aux	89%	100%	3.57	2.84
Restaurant	Lighting Exterior	100%	100%	2.36	2.36
Restaurant	Lighting Interior	100%	100%	5.71	3.23
Restaurant	Other Office Equipment	100%	100%	0.23	0.23
Restaurant	Other Plug Load	100%	100%	1.39	1.39
Restaurant	Refrigeration	100%	100%	5.50	5.50

Segment	End Use	Saturation	Electric Fuel Share	Weighted Average EUI - Existing	Weighted Average EUI - New
Restaurant	Space Heat	76%	12%	1.35	0.31
Restaurant	Water Heat	100%	38%	8.63	8.53
School	Computers	100%	100%	0.47	0.47
School	Cooking	100%	55%	0.22	0.22
School	Cooling Chillers	25%	100%	0.33	0.15
School	Cooling Dx	21%	100%	0.36	0.17
School	Heat Pump	25%	100%	2.82	1.22
School	HVAC Aux	99%	100%	1.32	0.89
School	Lighting Exterior	100%	100%	0.76	0.76
School	Lighting Interior	100%	100%	2.73	1.96
School	Other Office Equipment	100%	100%	0.25	0.25
School	Other Plug Load	100%	100%	0.26	0.26
School	Refrigeration	100%	100%	0.50	0.50
School	Space Heat	74%	9%	5.67	1.84
School	Water Heat	100%	34%	1.42	1.42
University	Computers	100%	100%	0.47	0.47
University	Cooking	100%	55%	0.42	0.42
University	Cooling Chillers	4%	100%	0.33	0.15
University	Cooling Dx	5%	100%	0.36	0.17
University	Heat Pump	1%	100%	2.82	1.22
University	HVAC Aux	96%	100%	1.32	0.89
University	Lighting Exterior	100%	100%	0.76	0.76
University	Lighting Interior	100%	100%	3.79	2.72
University	Other Office Equipment	100%	100%	0.25	0.25
University	Other Plug Load	100%	100%	0.26	0.26
University	Refrigeration	100%	100%	0.50	0.50
University	Space Heat	95%	9%	5.67	1.84
University	Water Heat	100%	34%	1.42	1.42
Warehouse	Computers	100%	100%	0.06	0.06
Warehouse	Cooling Chillers	4%	100%	0.17	0.21
Warehouse	Cooling Dx	14%	100%	0.19	0.23
Warehouse	Heat Pump	6%	100%	0.76	0.56
Warehouse	HVAC Aux	52%	100%	0.58	0.56
Warehouse	Lighting Exterior	100%	100%	0.28	0.28
Warehouse	Lighting Interior	100%	100%	2.50	1.67
Warehouse	Other Office Equipment	100%	100%	0.05	0.05
Warehouse	Other Plug Load	100%	100%	0.41	0.41
Warehouse	Refrigeration	100%	100%	0.05	0.05
Warehouse	Space Heat	48%	26%	1.13	0.37
Warehouse	Water Heat	100%	82%	0.19	0.19

Table B.1.10. Commercial Gas Saturations, Fuel Shares, and EUIs

Segment	End Use	Saturation	Gas Fuel Share	Weighted Average EUI - Existing	Weighted Average EUI - New
Dry Goods Retail	Other	100%	100%	0.00	0.00
Dry Goods Retail	Space Heat Boiler	9%	100%	0.07	0.04
Dry Goods Retail	Space Heat Furnace	83%	81%	0.10	0.06
Dry Goods Retail	Water Heat	100%	40%	0.03	0.03
Grocery	Cooking	100%	54%	0.19	0.19
Grocery	Other	100%	100%	0.00	0.00
Grocery	Space Heat Boiler	1%	100%	0.24	0.05
Grocery	Space Heat Furnace	96%	88%	0.34	0.07
Grocery	Water Heat	100%	80%	0.12	0.13
Hospital	Cooking	100%	67%	0.04	0.04
Hospital	Other	100%	100%	0.00	0.00
Hospital	Pool Heat	100%	3%	0.03	0.02
Hospital	Space Heat Boiler	35%	85%	0.33	0.32
Hospital	Space Heat Furnace	56%	78%	0.48	0.46
Hospital	Water Heat	100%	64%	0.41	0.42
Hotel Motel	Cooking	100%	98%	0.08	0.08
Hotel Motel	Other	100%	100%	0.00	0.00
Hotel Motel	Pool Heat	100%	44%	0.11	0.06
Hotel Motel	Space Heat Boiler	57%	69%	0.17	0.13
Hotel Motel	Space Heat Furnace	31%	44%	0.25	0.18
Hotel Motel	Water Heat	100%	77%	0.31	0.31
Office	Other	100%	100%	0.00	0.00
Office	Space Heat Boiler	28%	66%	0.22	0.11
Office	Space Heat Furnace	57%	41%	0.32	0.16
Office	Water Heat	100%	34%	0.03	0.04
Other	Cooking	100%	49%	0.04	0.04
Other	Other	100%	100%	0.00	0.00
Other	Space Heat Boiler	25%	100%	0.15	0.08
Other	Space Heat Furnace	68%	73%	0.21	0.11
Other	Water Heat	100%	58%	0.03	0.03
Restaurant	Cooking	100%	82%	1.61	1.61
Restaurant	Other	100%	100%	0.00	0.00
Restaurant	Space Heat Boiler	0%	100%	0.04	0.03
Restaurant	Space Heat Furnace	92%	96%	0.06	0.05
Restaurant	Water Heat	100%	67%	0.43	0.44
School	Cooking	100%	46%	0.02	0.02
School	Other	100%	100%	0.00	0.00
School	Pool Heat	100%	13%	0.17	0.03
School	Space Heat Boiler	75%	98%	0.12	0.10
School	Space Heat Furnace	23%	83%	0.17	0.14
School	Water Heat	100%	79%	0.06	0.06
University	Cooking	100%	46%	0.05	0.05
University	Other	100%	100%	0.00	0.00
University	Pool Heat	100%	13%	0.14	0.05
University	Space Heat Boiler	75%	98%	0.23	0.20
University	Space Heat Furnace	23%	83%	0.34	0.29
University	Water Heat	100%	79%	0.10	0.10
Warehouse	Other	100%	100%	0.00	0.00
Warehouse	Space Heat Boiler	1%	100%	0.09	0.05
Warehouse	Space Heat Furnace	65%	84%	0.13	0.07
Warehouse	Water Heat	100%	20%	0.02	0.02

Table B.1.11. Industrial Electric End Use Percents by Segment

End Use	Chemical Mfg	Computer Electronic Mfg	Electrical Equipment Mfg	Fabricated Metal Products	Food Mfg	Industrial Machinery	Misc. Mfg	Nonmetallic Mineral Products	Paper Mfg	Petroleum Coal Products	Plastics Rubber Products	Primary Metal Mfg	Printing Related Support	Transport. Equipment Mfg	Waste-water	Water	Wood Product Mfg
Fans	7%	4%	5%	7%	3%	6%	5%	8%	15%	12%	7%	4%	7%	4%	0%	10%	10%
HVAC	7%	28%	15%	10%	8%	23%	25%	6%	5%	3%	11%	3%	19%	19%	0%	0%	5%
Indirect Boiler	2%	1%	0%	0%	2%	0%	2%	0%	4%	1%	1%	0%	1%	1%	0%	0%	1%
Lighting	4%	12%	12%	9%	7%	15%	17%	5%	4%	2%	9%	3%	12%	15%	2%	2%	7%
Motors Other	16%	8%	10%	19%	17%	18%	20%	22%	30%	34%	20%	18%	20%	10%	0%	10%	29%
Other	3%	8%	4%	3%	4%	4%	6%	3%	2%	1%	4%	1%	6%	5%	14%	14%	4%
Process Aircomp	17%	1%	11%	8%	3%	7%	5%	9%	4%	14%	8%	4%	8%	10%	66%	0%	12%
Process Cool	9%	11%	5%	4%	27%	3%	6%	3%	2%	6%	9%	1%	6%	6%	0%	0%	1%
Process Electro Chemical	10%	1%	0%	2%	0%	0%	0%	0%	1%	0%	0%	32%	0%	1%	0%	0%	1%
Process Heat	5%	11%	23%	20%	6%	7%	10%	22%	3%	0%	16%	29%	3%	13%	0%	0%	7%
Process Other	1%	8%	3%	3%	1%	2%	1%	3%	1%	0%	0%	1%	0%	3%	0%	0%	0%
Process Refrig	5%	1%	3%	3%	13%	3%	0%	4%	4%	6%	3%	0%	4%	3%	0%	0%	5%
Pumps	16%	7%	10%	12%	7%	11%	3%	14%	24%	21%	13%	3%	13%	10%	18%	64%	18%

Table B.1.12. Industrial Gas End Use Percents by Segment

End Use	Chemical Mfg	Computer Electronic Mfg	Electrical Equipment Mfg	Fabricated Metal Products	Food Mfg	Industrial Machinery	Misc. Mfg	Nonmetallic Mineral Products	Paper Mfg	Petroleum Coal Products	Plastics Rubber Products	Primary Metal Mfg	Printing Related Support	Transport. Equipment Mfg	Waste-water	Water	Wood Product Mfg
HVAC	2%	40%	21%	15%	5%	40%	55%	4%	3%	1%	20%	6%	17%	41%	0%	0%	8%
Indirect Boiler	60%	47%	18%	16%	58%	27%	18%	5%	62%	34%	47%	9%	12%	20%	0%	0%	30%
Other	1%	3%	2%	2%	0%	1%	0%	2%	3%	0%	3%	11%	8%	0%	100%	100%	0%
Process Heat	28%	7%	57%	67%	34%	32%	23%	87%	28%	61%	26%	71%	62%	36%	0%	0%	58%
Process Other	9%	2%	3%	0%	4%	0%	5%	2%	4%	5%	5%	3%	0%	2%	0%	0%	4%

Appendix B.2: Measure Descriptions

This section contains a brief description of each measure used in the energy-efficiency potential.

Appendix B.2: Measure Descriptions

1. Residential Electric Retrofit Measure Descriptions

Heating and Cooling

Air-to-Air Heat Exchanger. This measure mechanically ventilates homes in cold climates. During the winter, it transfers heat from the air being exhausted to outside air entering the home. Between 50 and 80 percent of the heat normally lost in exhausted air is returned to the house. Air-to-air heat exchangers can be installed as part of a central heating and cooling system or in walls or windows. Wall- and window-mounted units resemble air conditioners and ventilate one room or area.[1]

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 around lighting fixtures.

Ceiling Fan. ENERGY STAR®-qualified ceiling fans have improved motor and blade designs that allow the user to increase the thermostat set point by a few degrees, which decreases the AC cooling runtime yet still feels at least 5° cooler. The fans do not create cooler temperatures. This measure does not include light fixtures; all savings are associated with installating an ENERGY STAR® ceiling fan where no prior fan was present.

Ceiling Insulation. This measure represents an increase in R-value. Added ceiling insulation increases the building's thermal performance and brings the resistance value up to and past code, depending on the building vintage. Table B-2.1 summarizes the different resistance values compared in the measure.

Table B-2.1. Ceiling R-Value Comparison

Measure Insulation	Baseline Insulation
R-49	R-0
R-49	R-10
R-60	R-49

Check Me! O&M Tune-up. Performing a system tune-up and regular maintenance ensures that the refrigerant charge and airflow through the evaporator coil (two factors that affect system efficiency) are properly tested and correctly adjusted. Maintenance includes changing filters and cleaning the coils to maintain the overall performance and efficiency of the unit.

Construction, ICF. Building a concrete home with insulating concrete forms (ICFs) saves energy. Greater insulation, tighter construction, and the temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Construction, SIP. A structural insulated panel (SIP) uses continuous foam insulation throughout the panel, which provides excellent energy efficiency and low levels of air infiltration. The baseline is standard wood framing.

1 http://cipco.apogee.net/res/reevhex.asp

Cool Roofs. ENERGY STAR®-qualified cool roofs have reflective coating and can decrease roof surface temperatures by up to 100º F, thereby decreasing the amount of heat transferred into a building. Cool roofs can reduce the amount of air conditioning needed in buildings and can reduce peak cooling demand by 10 percent to 15 percent.[2] This could be considered a passive measure.

Dehumidifier, Whole House. A high capacity whole house dehumidifier can stand alone in a basement or be ducted into an existing central air conditioning system. These units remove moisture content from the air and prevent mold, mildew, and damp conditions.

Doors. Composite or steel doors with a foam core increase overall insulation, slowing heat loss. This measure includes adding a thermal door with a resistance value of R-5 or R-11 to houses without a thermal or storm door (R-2.5).

Doors, Weatherization. Mounting weather stripping to the bottom of an exterior door minimizes infiltration door sweep. This type of weatherization consists of an extruded aluminum strip holding a flexible vinyl strip that blocks the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Fittings, Leak-Proof. 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.

Duct Insulation Upgrade. The addition of insulation around ducts in a heating system reduces heat loss to unconditioned spaces. This measure improves existing duct insulation from R-4 to R-8.

Duct Location. Locating ducts in conditioned spaces reduces wasted heat loss.[3] Many homes have ducts that run through unconditioned areas (such as attics, garages, crawlspaces, and basements) for convenience and practical reasons. Ducts in unconditioned areas lose energy because of the temperature difference between conditioned air in the ducts and the surrounding space.

Duct 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 (such as smoking vs. non-smoking, bio-aerosols, and localized indoor air pollutants).

Duct Sealing, Aerosol-Based. This aerosol technology seals duct holes up to 1/4-inch in diameter by spraying atomized latex aerosol into the inside of a pressurized duct system. A significant amount of energy use in residential buildings is associated with duct losses due to leakage.

Fan, Whole House. A whole house fan is a simple and inexpensive method of cooling a house when outdoor temperatures are lower than indoor temperatures. The fan draws cool outdoor air inside the home through open windows and exhausts hot indoor air through the attic to the outside.

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2 http://www.aceee.org/consumer/cooling

3 http://www.toolbase.org/pdf/techinv/ductsinconditionedspace_techspec.pdf

Floor Insulation. The addition of floor insulation increases the overall resistance value of a home and slows heat transfer from the basement to the upper levels. Table B-2.2 summarizes the different resistance values compared in the measure.

Table B-2.2. Floor R-Value Comparison

Measure Insulation	Baseline Insulation
R-30	R-0
R-38	R-30

Green Roof. The added mass and thermal resistance of green roofs reduces the heating and cooling loads of the building. These roofs reduce the ambient temperature of the roof surface and slow the transfer of heat into the building, which reduces cooling costs. They also add insulation to the roof structure, reducing heating requirements in the winter.[4] Additionally, they reduce the ambient temperature around the roof, which decreases the building's urban heat island effect.

HVAC Unit, Proper Sizing. Correctly-sized HVAC systems operate for longer periods of time (instead of cycling on and off frequently), which results in optimum equipment operating efficiency and better control.[5]

Infiltration Control (Caulk, Weather Strip, etc*.) ***Blower Door Test. Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls prevents drafts and reduces overall heating and cooling losses.

Radiant Barrier, Ceiling. A radiant barrier generally consists of a thin piece of aluminum installed in a ceiling that reduces the solar heat gain from the sun during the summer and traps heat in during the winter. These barriers reduce heat transfer between the air space of the roof deck and the attic floor.

Smart Siting. This measure, which applies only to new construction, entails optimizing the building orientation to minimize the heating and cooling load on the HVAC system.

Solar Attic Fan. This measure provides forced attic fan ventilation, which reduces residential heat gains from the ceiling. Because this fan is solar-powered, it runs conveniently when the sun is shining. The baseline uses passive ventilation without a fan.

Thermal Shell, Infiltration at 0.2 ACH w/ HRV. Heat recovery ventilation (HRV) provides fresh air and improved climate control, while also saving energy by reducing the heating (or cooling) requirements of a building. Combining this feature with better infiltration control (0.2 air changes per hour) minimizes the energy needed to maintain a healthy level of fresh air and reduces heat loss due to air leakage.

Thermostat, Multi-Zone. A multi-zone programmable thermostat automatically controls the set point temperatures for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours. The baseline for this measure is a programmable thermostat with central control only.

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4 http://www.toolbase.org/Technology-Inventory/Roofs/green-roofs

5 http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice

Wall Insulation, 2x4 and 2x6. The presence of wall insulation slows the transfer of heat and reduces the heating and cooling loads in a house. Table B-2.3 compares the different insulation levels for 2x4 and 2x6 framing.

Table B-2.3. Wall Insulation Measures

Construction Type	Measure Insulation	Baseline Insulation
2x4	R-13	R-0
2x6	R-21	R-0
	R-21 + R-5 Sheathing	R-21

Windows. This measure provides increased building performance by reducing the U-value in existing and new construction windows, as shown in Table B-2.4.

Table B-2.4. High Efficiency Window Measures

Measure U-Value	Baseline U-Value
0.30	Single Pane
0.30	Double Pane
0.25	0.30
0.22	0.30

Window Overhang. A window overhang shades windows, which reduces solar heat gains and decreases the overall cooling load on the home.

Lighting

Daylighting Controls (Photocell), Indoor/Outdoor. Photocells adjust lighting levels according to the level of daylight the room is receiving. The baseline is no daylighting controls.

Occupancy Sensor. An occupancy sensor turns off the lights after a space is unoccupied for a designated amount of time. The lights turn on again when the sensor detects a person in the space.

Time Clock, Exterior Lighting. This technology allows users to program times for lights outside the residence to be turned on and off automatically. Programmed exterior lighting saves energy by ensuring that lights are not left on during the daytime.

Water Heat

Clothes Washer, ENERGY STAR®. This clothes washer uses less energy and water than regular washers.[6] We compared three levels of efficiency—in units of the corresponding Modified Energy Factor (MEF) —for this measure, as shown in Table B-2.5. The baseline MEF represents the average MEF of non-ENERGY STAR®-qualified models.

6 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

Table B-2.5. Clothes Washer Modified Energy Factor Comparisons

Measure Level	Measure MEF	Baseline MEF
ENERGY STAR	2.0-2.19	1.66
CEE Tier 2	2.2-2.45	1.66
CEE Tier 3	2.46 +	1.66

Dishwasher, ENERGY STAR®. This dishwasher uses advanced technology to clean dishes with less water and energy. The efficient model uses less than 307 kWh/year (including standby consumption) and less than 5 gallons of water per cycle. The baseline model consumes 340 kWh/year.

Drain Water Heat Recovery. Also called gravity film heat exchanges, this device recovers heat energy from domestic drain water, which is then used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the temperature of the water entering the system.

Hot Water Pipe Insulation. The addition of R-4 insulation around pipes decreases heat loss. The baseline is a hot water pipe without 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. This measure reduces a showerhead's flow rate from 2.5 gallons per minute to 2.0 gallons per minute.

Water Heater Tank Blanket. The installation of R-5 insulation on older models of water heaters helps reduce standby losses.

Water Heater Thermostat Setback. This measure generates savings by reducing the thermostat set point temperature from 135° to 120°F. The set point temperature on hot water systems is often set higher than necessary.

Appliances

Refrigerator/Freezer, Removal of Secondary. This refers to environmentally friendly disposal of unneeded or inefficient appliances such as secondary refrigerators or stand-alone freezers.

Stand-Alone Freezer, Removal. The removal of stand-alone freezers is beneficial because of the inefficient use of energy by these appliances. Proper disposal is required due to their use of hazardous materials such as Freon and CFCs.

Plug Load

1-Watt Standby Power. Standby power is the electricity used by small electrical equipment or appliances when they are switched off or are not performing their main function. Minimizing this loss to one watt or less can reduce this standby energy consumption by more than 50 percent.

Battery Charger, ENERGY STAR®. On average, these battery chargers use 35 percent less energy than conventional battery chargers, which draw as much as five to 20 times more energy than is actually stored in the battery (even when not actively charging a product). Battery charging systems recharge a variety of cordless products, including power tools, small household appliances, and electric shavers. The baseline is a standard battery charger.[7]

Office Copier, ENERGY STAR®. These copy machines are 40 percent more efficient than standard office copy machines.[8]

Office Printer, ENERGY STAR®. These printers are 40 percent more efficient than standard printers.

Smart Strip. Power strips with an occupancy sensor will turn power to all devices plugged into the strip on and off, such as computers, desk lights, and audio equipment, based on occupancy within the work area.

Other (Pool)

Pool Pump Timers. A pool pump with a timer set to run during off-peak times (starting after 8:00 p.m. and cycling off before 10:00 a.m.) reduces energy costs. Cycling the pumps will further reduce monthly costs. The baseline is a continuously running pump.

[7] http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers
[8] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=IEQ

2. Residential Electric Equipment Measure Descriptions

Heating and Cooling

Air or Ground Source Heat Pump (ASHP or GSHP). Electric heat pumps move heat to or from the air or the ground to cool and heat a home. Table B-2.6 displays the different efficiency levels we compared for this measure. The baseline size is the same as the measure size.

Table B-2.6. Heat Pump SEER/HSPF Comparisons

Measure Efficiency	Baseline SEER & HSPF
ASHP 14 SEER, 8.5 HSPF	ASHP 13 SEER, 7.7 HSPF
ASHP 16 SEER, 8.8 HSPF	
GSHP 16.2 EER, 8.8 HSPF	

Central Cooling. This measure consists of several different air conditioner technology/efficiency levels, as summarized in Table B-2.7. The baseline size is the same as the measure size.

Table B-2.7. Central AC SEER Comparison

Measure	Baseline SEER
14 SEER	13 SEER
16 SEER	
18 SEER	

Conversion Baseboard Heating to Ductless Heat Pump (DHP). DHPs move heat to or from the air to cool and heat a home without the need for costly ductwork. This method of heating has a HSPF value of 7.7, consuming less energy than baseboard heating that has a HSPF value of 1.

Conversion Electric Furnace to Air Source Heat Pump (ASHP). ASHPs move heat to or from the air to cool and heat a home. This method of heating has a HSPF value of 7.7, consuming less energy than an electric furnace that has a HSPF value of 1.

Motor, ECM and ECM-VFD. Electronically commutated motors (ECMs) and ECMs with variable frequency drives (VFD) consume less power than the standard motor used in ventilation and circulation systems.

Room Air Conditioner (Room AC), 10,000 BTU/HR. ENERGY STAR®-qualified room ACs use less energy than conventional models through improved energy performance and timers, which allow for better temperature control. ENERGY STAR®-qualified room air conditioners have an efficiency rating of 10.8 EER, compared to standard models, which have an efficiency rating of 9.8 EER.

Room AC Conversion to Ductless Heat Pump (DHP). DHPs use less energy than room AC while also producing less noise and requiring no costly ductwork. DHPs have an efficiency of 13 SEER, replacing a room AC unit with an efficiency rating of 9.8 EER.

Lighting

Compact Fluorescent Lights (CFL), 13, 20, and 25 Watt. Specialty 3-way CFLs use 73 percent to 83 percent less energy and have a longer life than incandescent 3-way, 60, 75, or 150 watt light bulbs.

Compact Fluorescent Lights (CFL), 15 Watt. Standard CFLs use 62 percent less energy than the Energy Independence and Security Act (EISA) 43 watt incandescent bulbs. The baseline for this measure reflects the 2012-2014 changes to accommodate the EISA of 2007, reaching a baseline value of 43 watts.

Compact Fluorescent Lights (CFL), 17 Watt Flood Light. Exterior CFLs use 62 percent less energy than EISA 45 watt incandescent bulbs. The baseline for this measure reflects the 2012-2014 changes to accommodate the EISA of 2007, reaching a baseline value of 45 watts.

Light emitting diodes (LEDs), 7 Watts. LEDs are solid-state devices that convert electricity to light, use 80 percent less energy, and have a long life. The baseline for this measure reflects the 2012-2014 changes to accommodate the EISA of 2007, reaching a baseline value of 43 watts.

Water Heat

Water Heater, Heat Pump. This measure moves heat from a warm reservoir (such as air) into the hot water system.[9] This measure assumes an energy factor (EF) of 2.2, an increase from the standard EF of 0.92.

Water Heater, Storage. A high-efficiency water heater reduces standby loss and is more efficient than a standard electric water heater. This measure assumes an EF of 0.95, an increase from the standard EF of 0.92.

Appliances

Cooking Oven, High Efficiency. A high-efficiency cooking oven uses fans to circulate heat evenly throughout the oven (convection heat), operating at lower temperatures and achieving cook times quicker than a standard oven. The baseline is a standard oven.

Dryer, High Efficiency. A high-efficiency dryer has features (such as moisture sensors) that minimize energy usage while retaining performance. The efficiency levels for this measure are shown in Table B-2.8.

Table B-2.8. Dryer EF Comparison

Measure	Baseline
3.08 EF	
3.19 EF	3.01 EF
3.30 EF	

Freezer, ENERGY STAR. ENERGY STAR® -qualified freezers use 10 percent less energy than standard models due to improvements in insulation and compressors.

9 Description source: U.S. Department of Energy; http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12840

Microwave, High Efficiency. High-efficiency microwaves use more efficient power supplies, fans, magnetron, and reflective surfaces that provide energy savings compared to conventional microwaves.

Refrigerator*, *ENERGY STAR. ENERGY STAR®-qualified refrigerators use 20 percent less energy than standard models, due to improvements in insulation and compressors.

Plug Load

Computer, ENERGY STAR. ENERGY STAR® computers consume less than 2 watts in sleep and off modes, and are more efficient than conventional units in idle mode, resulting in 30 percent to 65 percent energy savings.

Dehumidifier, ENERGY STAR. ENERGY STAR®-qualified models have more efficient refrigeration coils, compressors, and fans than conventional models, and use less energy to remove moisture. Qualified models remove the same amount of moisture as a similarly-sized standard unit, but use 10 percent to 20 percent less energy. The baseline for this measure is a standard dehumidifier.[10]

DVD, ENERGY STAR. ENERGY STAR®-qualified DVD products meeting the new requirements use up to 60 percent less energy than standard models.[11] ENERGY STAR® DVD players use as little as one-fourth of the energy of standard models in the off mode. The baseline for this measure is a standard DVD player.

Home Audio System, ENERGY STAR. According to ENERGY STAR® products, a 6 percent energy savings can be achieved over standard home audio systems.[12]

Monitor, ENERGY STAR. ENERGY STAR® monitors feature: (1) on mode, where the maximum allowed power varies based on the computer monitor's resolution; (2) sleep mode, where computer monitors must consume 2 watts or less; and, (3) off mode, where computer monitors must consume 1 watt or less. The baseline equipment does not include these features.[13]

Set Top Box, ENERGY STAR. Set top boxes that have earned the ENERGY STAR® rating are at least 30 percent more efficient than conventional models.[14] The baseline measure is a standard receiver.

TV, ENERGY STAR. ENERGY STAR®-qualified TVs use roughly 40 percent less energy than standard units.[15] ENERGY STAR® models are required to consume no more than 1 watt while in sleep mode. The baseline is a standard television, which generally consumes more than 3 watts when turned off.

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[10] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DE
[11] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DP
[12] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=HA
[13] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.ShowProductGroup&pgw_code=MO
[14] http://www.energystar.gov/index.cfm?c=settop_boxes.settop_boxes
[15] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TV

Other (Pool)

Pool Pumps, Two Speed Motor. This measure enables a pool pump motor to operate at high and low speeds as opposed to constantly running at full power. The baseline for this measure is a standard one speed motor.

Pool Pumps, VSD. This measure enables a pool pump motor to operate at variable speeds as opposed to constantly running at full power. The baseline for this measure is a standard one speed motor.

3. Residential Gas Retrofit Measure Descriptions

Heating

Air-to-Air Heat Exchanger. An air-to-air heat exchanger mechanically ventilates homes in cold climates. During the winter, it transfers heat from the air being exhausted to the fresh, outside air entering the home. Between 50 and 80 percent of the heat normally lost in exhausted air is returned to the house. Air-to-air heat exchangers can be installed as part of a central heating and cooling system or in walls or windows. Wall- and window-mounted units resemble air conditioners and will ventilate one room or area.[16]

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 around lighting fixtures.

Ceiling Insulation. This measure represents an increase in R-value. Added ceiling insulation increases the building's thermal performance and brings the resistance value up to and past code, depending on the building vintage. Table B-2.9 summarizes the different resistance values compared in the measure.

Table B-2.9. Ceiling R-Value Comparison

Measure Insulation	Baseline Insulation
R-49	R-0
R-49	R-10
R-60	R-49

Construction, ICF. Building a concrete home with insulating concrete forms (ICFs) saves energy. Greater insulation, tighter construction, and the temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Construction, SIP. A structural insulated panel (SIP) uses continuous foam insulation throughout the panel, which provides excellent energy efficiency and low levels of air infiltration. The baseline is standard wood framing.

Doors. Composite or steel doors with a foam core increase overall insulation, slowing heat loss. This measure includes adding a thermal door with a resistance value of R-5 or R-11 to houses without a thermal or storm door (R-2.5).

Doors, Weatherization. Mounting weather stripping to the bottom of an exterior door minimizes infiltration door sweep. This type of weatherization consists of an extruded aluminum strip holding a flexible vinyl strip that blocks the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Fittings, Leak-Proof. 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.

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16 http://cipco.apogee.net/res/reevhex.asp

Duct Insulation Upgrade. The addition of insulation around ducts in a heating system reduces heat loss to unconditioned spaces. This measure improves existing duct insulation from R-4 to R-8.

Duct Location. Locating ducts in conditioned spaces reduces wasted heat loss.[17] Many homes have ducts that run through unconditioned areas (such as attics, garages, crawlspaces, and basements) for convenience and practical reasons. Ducts in unconditioned areas lose energy because of the temperature difference between conditioned air in the ducts and the surrounding space.

Duct 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 (such as smoking vs. non-smoking, bio-aerosols, and localized indoor air pollutants).

Duct Sealing, Aerosol-Based. This aerosol technology seals duct holes up to 1/4-inch in diameter by spraying atomized latex aerosol into the inside of a pressurized duct system. A significant amount of energy use in residential buildings is associated with duct losses due to leakage.

Floor Insulation. The addition of floor insulation increases the overall resistance value of a home and slows heat transfer from the basement to the upper levels. Table B-2.10 summarizes the different resistance values compared in the measure.

Table B-2.10. Floor R-Value Comparison

Measure Insulation	Baseline Insulation
R-30	R-0
R-38	R-30

Green Roof. The added mass and thermal resistance of green roofs reduces the heating and cooling loads of the building. These roofs reduce the ambient temperature of the roof surface and slow the transfer of heat into the building, which reduces cooling costs. They also add insulation to the roof structure, reducing heating requirements in the winter.[18] Additionally, they reduce the ambient temperature around the roof, which decreases the building's urban heat island effect.

HVAC Unit, Proper Sizing. Correctly-sized HVAC systems operate for longer periods of time (instead of cycling on and off frequently), which results in optimum equipment operating efficiency and better control.[19]

Infiltration Control (Caulk, Weather Strip, etc*.) ***Blower Door Test. Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls prevents drafts and reduces overall heating and cooling losses.

Radiant Barrier, Ceiling. A radiant barrier generally consists of a thin piece of aluminum installed in a ceiling that reduces the solar heat gain from the sun during the summer and traps

[17] http://www.toolbase.org/pdf/techinv/ductsinconditionedspace_techspec.pdf
[18] http://www.toolbase.org/Technology-Inventory/Roofs/green-roofs
[19] http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice

heat in during the winter. These barriers reduce heat transfer between the air space of the roof deck and the attic floor.

Smart Siting. This measure, which applies only to new construction, entails optimizing the building orientation to minimize the heating and cooling load on the HVAC system.

Thermal Shell, Infiltration at 0.2 ACH w/ HRV. Heat recovery ventilation (HRV) provides fresh air and improved climate control, while also saving energy by reducing the heating (or cooling) requirements of a building. Combining this feature with better infiltration control (0.2 air changes per hour) minimizes the energy needed to maintain a healthy level of fresh air and reduces heat loss due to air leakage.

Thermostat, Multi-Zone. A multi-zone programmable thermostat automatically controls the set point temperatures for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours. The baseline for this measure is a programmable thermostat with central control only.

Wall Insulation, 2x4 and 2x6. The presence of wall insulation slows the transfer of heat and reduces the heating and cooling loads in a house. Table B-2.11 compares the different insulation levels for 2x4 and 2x6 framing.

Table B-2.11. Wall Insulation Measures

Construction Type	Measure Insulation	Baseline Insulation
2x4	R-13	R-0
2x6	R-21	R-0
	R-21 + R-5 Sheathing	R-21

Windows. This measure provides increased building performance by reducing the U-value in existing and new construction windows, as shown in Table B-2.12.

Table B-2.12. High Efficiency Window Measures

Measure U-Value	Baseline U-Value
0.30	Single Pane
0.30	Double Pane
0.25	0.30
0.22	0.30

Water Heat

Clothes Washer, ENERGY STAR®. This clothes washer uses less energy and water than regular washers.[20] Three levels of efficiency—in units of the corresponding Modified Energy Factor (MEF) —are shown in Table B-2.13. The baseline MEF represents the average MEF of non-ENERGY STAR®-qualified models.

20 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

Table B-2.13. Clothes Washer Modified Energy Factor Comparisons

Measure Level	Measure MEF	Baseline MEF
ENERGY STAR	2.0-2.19	1.66
CEE Tier 2	2.2-2.45	1.66
CEE Tier 3	2.46 +	1.66

***Dishwasher, ENERGY STAR®*.** This dishwasher uses advanced technology to clean dishes with less water and energy. The efficient model uses less than 307 kWh/year (including standby consumption) and less than 5 gallons of water per cycle. The baseline model consumes 340 kWh/year.

Drain Water Heat Recovery. Also called gravity film heat exchanges, this device recovers heat energy from domestic drain water, which is then used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the temperature of the water entering the system.

Hot Water Pipe Insulation. The addition of R-4 insulation around pipes decreases heat loss. The baseline is a hot water pipe without 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. This measure reduces a showerhead's flow rate from 2.5 gallons per minute to 2.0 gallons per minute.

Water Heater Tank Blanket. The installation of R-5 insulation on older models of water heaters helps reduce standby losses.

Water Heater Thermostat Setback. This measure generates savings by reducing the thermostat set point temperature from 135° to 120°F. The set point temperature on hot water systems is often set higher than necessary.

4. Residential Gas Equip Measure Descriptions

Heating

Gas Boiler. Boilers are classified as condensing or non-condensing. Condensing boilers condense the flue gas and water vapor, extracting useful heat and improving the boiler efficiency. 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 energy output divided by the energy input, and is affected by combustion efficiency, standby losses, cycling losses, and heat transfer. Table B-2.14 displays the measure and baseline thermal efficiencies.

Table B-2.14. Gas Boiler Efficiency Comparison

Measure AFUE	Baseline AFUE
90%	82%
94%	

Gas Furnace. Improvements in furnace technology, such as new ignition and heat exchange design, have led to increased furnace efficiency. The AFUE levels considered in this measure are shown in Table B-2.15.

Table B-2.15. Gas Furnace Efficiency Comparison

Measure AFUE	Baseline AFUE
90%	80%
95%	

Water Heat

Water Heater, Storage. A high-efficiency water heater reduces standby loss and is more efficient than a standard electric water heater. The energy factors (EF) considered in this measure are shown in Table B-2.16.

Table B-2.16. Water Heater EF Comparison

Measure EF	Baseline EF
0.67	0.62
0.80	

Water Heater, Tankless. This measure provides hot water at a preset temperature as needed without storage, thereby reducing or eliminating standby losses. Tankless systems have an EF of 0.82, compared to standard water heaters with an EF of 0.62.[21]

21 http://www.toolbase.org/Technology-Inventory/Plumbing/tankless-water-heaters

Appliances

High Efficiency Dryer. High efficiency dryers have features, such as moisture sensors, that minimize energy usage while retaining performance. The efficiency levels for this measure are shown in Table B-2.17.

Table B-2.17. Dryer EF Comparison

Measure	Baseline
2.74 EF	
2.83 EF	2.67 EF
2.93 EF	

Other (Pool)

Energy Efficient Pool Heater. Gas pool heaters use natural gas or propane. The water circulated by the pump passes through a filter and then travels to the heater. Gas burns in the heater combustion chamber, generating heat that warms the water returning to the pool. This measure assumes an efficiency level of 88 percent, compared to a standard 83 percent efficient pool heater.

5. Commercial Electric Retrofit Measure Descriptions

HVAC (and Envelope)

Automated Ventilation Variable Frequency Drive (VFD) Control, Occupancy/CO_2 sensors. This measure is also known as demand-control ventilation (DCV), where the ventilation system automatically adjusts air flow when CO_2 is above a specified level. CO_2 controls maintain a minimum ventilation rate at all times to control non-occupant contaminants, such as off-gassing from furniture, equipment, and building components. The baseline of this measure is a ventilation system that runs constantly.

Chilled Water/Condenser Water Settings, Optimization. Making adjustments to the chilled and condenser water system settings to better match the building load will reduce unnecessary use of the compressor and pumps.

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 speed to vary based on the cooling load, thus reducing pumping energy requirements. The baseline is a constant speed pump with three-way valves.

Chiller Water-Side Economizer. This measure consists of a heat exchanger attached to a condenser water piping loop that operates when outdoor conditions can produce colder condenser water than the mixed air temperature. A water side economizer is used when an outdoor-air economizer is not practical. The baseline measure is no economizer.

Convert Constant Volume Air System to Variable Air Volume (VAV). This measure allows the airflow volume of a HVAC system to vary the heating or cooling load rather than over-conditioning and short-cycling. The baseline is a constant volume system.

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 water leaving the tower and the wet-bulb temperature. This measure assumes a 6 degree delta compared to the baseline of a 10 degree delta.

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 uses less energy than a single, high speed fan. The baseline measure is a single-speed fan motor.

Cooling Tower, Variable Speed Drive (VSD) Fan Control. VSDs modulate the air flow so that heat rejection exactly matches load at the desired set point, which saves energy. The baseline measure is a two-speed fan motor.

Direct Digital Control (DDC) System, Installation. DDC systems allow for both HVAC and lighting to be controlled and monitored. For lighting, the DDC system allows for direct control of lights from a remote location. Entire HVAC systems, including pumps, motors, fans, and set points, can be digitally programmed for tighter control of the system.

Direct Digital Control (DDC) System, Optimization. DDC is also known as an energy management system (EMS), which allows for digital monitoring and control of HVAC and lighting systems. The optimization refers to upgrading a high-efficiency energy management system to a premium efficiency system.

Direct Digital Control (DDS) System, Wireless Performance Monitoring. This second-generation building automation systems allows for wireless optimization and operation of building systems (such as HVAC) through computerized monitoring and control software and interfaces.

Direct Expansion (DX) Package Air-Side Economizer. An air-side economizer mixes return air with outside air to cool indoor spaces, which saves energy as less air needs to be cooled.

Direct Expansion (DX) Tune-Up/Diagnostics. Regular maintenance of DX air-conditioning systems includes checking controls, replacing filters, cleaning coils and blowers, and checking refrigerant levels.

Direct/Indirect Evaporative Cooling, Pre-Cooling. Direct evaporative coolers are low-energy systems that evaporate water into the air stream, thus reducing air temperature and increasing humidity. Indirect evaporative coolers use a secondary air stream that is cooled by water and travels through a heat exchanger with the primary air stream, cooling the air but not affecting the humidity. Direct/indirect systems cool the air stream via the indirect cooler, then cool it further through the direct cooler. Including an evaporative cooler before the DX system reduces the overall cooling load.

Duct Fittings, Leak-Proof. 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.

Duct Repair and Sealing. This maintenance 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. This measure captures heated air exhausted out of a building and transfers it to the incoming air, decreasing the overall heating load.

Exhaust Hood Makeup Air. This measure provides exhaust air at the hood instead of allowing the hood to exhaust conditioned air in the room. The baseline measure is for conditioned air to be expelled through exhaust hoods.

Green Roof. The added mass and thermal resistance of green roofs reduces the heating and cooling loads of the building. These roofs reduce the ambient temperature of the roof surface and slow the transfer of heat into the building, which reduces cooling costs. They also add insulation to the roof structure, reducing heating requirements in the winter.[22] Additionally, they reduce the ambient temperature around the roof, which decreases the building's urban heat island effect.

Hotel Key Card Energy Control System. This measure controls room HVAC and lighting during non-occupied periods. Occupancy is determined by the presence of a key card and/or additional sensors. The central system sets heating and cooling to a minimum and turns off lighting when the key card is removed. Once the key card is inserted, the hotel guest has full control of the room systems.

[22] http://www.toolbase.org/Technology-Inventory/Roofs/green-roofs

Infiltration Reduction (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls decreases overall heating and cooling losses. Baseline and measure values, in units of air changes per hour (ACH), are presented in Table B-2.18.

Table B-2.18. Infiltration Reduction Measures

Measure (ACH)	Baseline (ACH)
0.65	1.00

Insulation, Ceiling. These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.19.

Table B-2.19. Ceiling Insulation Measures

Measure	Baseline
R-38 (State Code)	R-7
R-38 (State Code)	R-8
R-38 (State Code)	R-11
R-49	R-38 (State Code)

Insulation, Duct. Packaged direct expansion and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating these ducts reduces energy loss to the unconditioned plenum space. This measure assumes that R-7 insulation is installed where no insulation previously existed.

Insulation, Floor (Non-Slab). These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. The baseline and measure R-values are presented in Table B-2.20.

Table B-2.20. Floor Insulation Measures

Measure	Baseline
R-30 (State Code)	R-7
R-30 (State Code)	R-8
R-30 (State Code)	R-11
R-30 (State Code)	R-19
R-38	R-30 (State Code)

Insulation, Wall. These measures represent an increase in R-value from existing building conditions to the current state code value of R-13 + 7.5. The baseline value of R-3 represents the average existing insulation level.

Natural Ventilation System. This measure relies on pressure differences to move fresh air through buildings. Natural ventilation, unlike fan-forced ventilation, uses the natural forces of wind and buoyancy to deliver fresh air into buildings. The specific approach and design varies by building type and local climate. The amount of ventilation depends on internal space design and the size and placement of openings in the building. Natural ventilation offsets the energy required to run forced air ventilation systems. [23]

Pipe Insulation. Adding 1.5-inches of insulation to water pipes yields an approximate R-value of R-6, which decreases temperature losses, thereby reducing demand on chilled water systems.

Programmable Thermostat. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

Retro-Commissioning. Commissioning ensures that energy-using systems are operating in an optimal fashion in order to maximize energy efficiency. This 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 them up to the design intentions.[24,25] The baseline measure is no commissioning.

Sensible Heat Recovery Devices. This measure preconditions incoming air by transferring energy between the exhaust air stream and the supply air stream. This raises the temperature of incoming air during the winter and decreases it in the summer. Energy savings results from the reduced need for mechanical heating or cooling.

Total Heat Recovery Devices. This measure, also called enthalpy recovery, transfers sensible and latent heat. Latent heat, which is released or absorbed due to a phase change (such as the condensation of water vapor), significantly raises the outdoor air humidity in the winter and reduces it in the summer.[26]

Window Film. Solar control window films applied to existing windows reduces peak demand during hot months and conserves air conditioning energy. The use of these films also reduces exposure to ultraviolet radiation and glare.[27]

Windows, High Efficiency. This measure increases building performance by reducing the U-value, as shown in Table B-2.21.

Table B-2.21. High-efficiency Window Measures

Measure U-Value	Baseline U-Value
0.40 (State Code)	0.68
0.40 (State Code)	0.67
0.40 (State Code)	0.65
0.40 (State Code)	0.60
0.32	0.40 (State Code)

23 National Renewable Energy Laboratory; http://www.nrel.gov/docs/fy03osti/33698.pdf
24 http://www.green.ca.gov/CommissioningGuidelines/default.htm
25 http://cbs.lbl.gov/BPA/cct.html
26 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf
27 http://www.iwfa.com/iwfa/Consumer_Info/windowfilmbenefits.html

Lighting

Bi-Level Control, Stairwell Lighting. This measure allows an occupancy sensor to reduces the light load in an unoccupied stairwell by 50 percent for a set amount of time. The baseline is continuous operation at full power.

Cold Cathode Lighting. This measure is a tubular light or bulb that passes an electrical current through a gas or vapor, much like neon lighting. A cold cathode light is up to five times brighter than neon, and has one of the longest lives of any lighting fixture at roughly 50,000 hours.[28] Cold cathode lighting uses 5 watts compared to 30 watts for an incandescent bulb.

Covered Parking Lighting. This measure reducing the energy use of covered parking garages by replacing inefficient metal halide lamps with LED and replacing high pressure sodium lamps with LED low bay lighting.

Daylighting Controls, Outdoors (Photocell). Exterior photocells adjust lighting levels according to sunlight levels reaching desired set points. This measure achieves savings over time-clock or manual controls through changes in seasonal and site conditions by improving night time durations.

Dimming, Continuous: Fluorescent Fixtures. A continuous dimming switch allows light level brightness to vary from 0 percent to 100 percent, increasing electricity savings. The baseline measure is fluorescent fixtures operating at full power.

Dimming, Stepped: Fluorescent Fixtures. This measure allows the user to vary the light level by a number of specified tiers to adjust for the amount of outside daylight. The baseline measure is fluorescent fixtures operating at full power.

Exit Sign, Light Emitting Diodes (LED). LED exit signs use only 2 watts of power and last over 50,000 hours, compared to CFL exit signs that use 9 watts of power and have a shorter life.

Exit Sign, Photoluminescent or Tritium. This measure uses no energy and provides lighting suitable for exit signage.

Exterior Building Lighting, Package. This measure decreases lighting power density by 30 percent. The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot.

Light Emitting Diodes (LED) Refrigeration Case Lights. These highly efficient bulbs create 55 percent energy savings over standard 60 watt fluorescent refrigeration case light.

Lighting Reduction Package, High Efficiency. This measure results in a 15 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of the lighting reduction package reduces lighting power density with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Lighting Reduction Package, Premium Efficiency. This measure results in a 20 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of

[28] Conjecture Corporation of wisegeek.com; http://www.wisegeek.com/what-is-a-cold-cathode-light.htm

the lighting reduction package reduces lighting power density with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Lighting Reduction Package, Super Premium Efficiency. This measure results in a 25 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of the lighting reduction package reduces lighting power density (W/sqft) with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Lighting Reduction Package, Super Premium High Bay. Lighting reduction packages, such as T5HO (High Output) for high bay applications in a warehouse or grocery, can reduce the power density by 35 percent. The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot.

Occupancy Sensor, Fluorescent. This measure turns off fluorescent lights after a space is unoccupied for a designated amount of time. The lights turn on again when the sensor detects a person in the space. Occupancy measures can control single or multiple lighting zones. The controlled lighting wattage varies depending on application. The baseline assumes no lighting controls.

Solid State Light Emitting Diode (LED), White Lighting. LEDs are solid-state devices that convert electricity to light, with very high efficiency and long life. Recently, lighting manufacturers have indirectly produced 'cool' white LED lighting using ultraviolet LEDs to excite phosphors that emit a white-appearing light. This measure applies to exterior lighting for landscape, merchandise, signage, and structures. The baseline for this measure is 50 watts, 10 hrs/day, 365 days/yr.

Surface Parking Lighting. Replacing inefficient metal halide lamps that consume between 100-150 watts with LED lighting that consumes 60-111 watts reduces the energy use of surface parking lots. LED lights also last longer than metal halide lamps, reducing the labor of replace lamps.

Time Clock. This technology allows users to program lights and other loads to be turned on and off automatically in response to a time schedule, an occupancy sensor, or a building automation system.

Water Heat

Clothes Washer, Ozonating. This measure disinfects water with ozone-enriched air, which suppresses subsequent biological activity and controls biological growth within the appliance, thus reducing the need for hot water. The baseline measure is a standard commercial clothes washer.[29]

[29] http://www.patentstorm.us/patents/6607672-description.html

Clothes Washer Commercial, ENERGY STAR®. This measure has more capacity than conventional top-load models with an agitator. Some front-loaders can wash over 20 pounds of laundry at once, compared to 10–15 pounds for a standard top-loader.[30]

Demand-Controlled Circulating Systems. This measure circulates hot water only when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwasher, Residential ENERGY STAR®. Residential sized ENERGY STAR® dishwashers are often appropriate for smaller commercial buildings, and are 10 percent more efficient than the federal minimum standard used as the baseline.[31]

Dishwasher, Commercial: High Temperature ENERGY STAR®. This measure has a minimal idle rate, consumes a minimal amount of water per rack of loaded dishes, and is on average 25 percent more efficient than standard high temp commercial dishwashers.[32]

Dishwasher, Commercial: Low Temperature ENERGY STAR®. This measure uses chemicals combined with low temperatures to save energy compared to standard high temperature commercial dishwashers.

Drain Water Heat Recovery, Water Heater. This measure recovers heat energy from drain water and uses it to heat water entering the hot water tank, minimizing the temperature rise required to achieve the water heater set point.[33]

Hot Water (SHW) Pipe Insulation. One inch of extra insulation on hot water pipes yields an approximate R-value of R-4, decreasing temperature losses. This measure is only applicable for existing construction. The baseline measure is no insulation.

Low-Flow Faucet Aerators. This measure mixes water and air, reducing the amount of water that flows through the faucet. It creates a fine water spray through an inserted screen in the faucet head. Flow rate requirements for this measure are presented in Table B-2.22.

Table B-2.22. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.2	3.0
1.5	2.2
* Gallons per minute	

Low-Flow Pre-Rinse Spray Valves. This measure mixes water and air, reducing the amount of water that flows through the spray head. The head creates a fine water spray through an inserted screen, achieving a flow reduction from 1.6 GPM (federal standard) to 0.6 GPM.

30 http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm
31 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW
32 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH
33 www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

Low-Flow Showerheads. This measure mixes water and air, reducing the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen. Flow rate requirements for this measure are presented in Table B-2.23.

Table B-2.23. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.5	4.5
2.0	2.5

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn faucet water on and off when motion is detected at the sink. This eliminates water running continuously while the sink is in use.

Water Cooled Refrigeration with Heat Recovery. Heat recovery gathers and uses thermal energy for the water heater that would normally be rejected to the ambient environment.

Water Heater Temperature Setback. This measure reduces the set point temperature from 130°F to 120°F.

Refrigeration

Anti-Sweat (Humidistat) Controls. This measure 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 controls, heaters generally run continuously.

Case Electronically Commutated Motor (ECM). A case fan is one component of a refrigeration system. ECMs are smaller variable speed motors that operate from a single-phase power source with an electronic controller in or on the motor. The baseline measure is a standard efficiency motor.

Case Replacement, Low and Medium Temperatures. Efficient refrigerated display cases achieve higher performance efficiency and reduce overall energy consumption by incorporating high performance evaporative fans, such as ECMs, energy-efficient double-pane glass doors, anti-sweat controls, high efficiency lighting and ballast, such as T8 or LED lamps, and improved insulation.

Compressor VSD Retrofit. This measure modulates motor speed in response to load changes. When low-load conditions exist, current to the compressor motor is decreased, slowing the compressor motor. Baseline is a constant-speed compressor.

Demand Control Defrost, Hot Gas. Evaporator frost reduces coil capacity by acting as a layer of insulation and reducing the airflow between fins. With hot gas defrost, refrigerant vapor from the compressor discharge or the high pressure receiver is used to warm the evaporator coil and melt the frost.[34]

Evaporative Condenser, High Efficiency. This water cooled measure can cycle a refrigerator with less energy than a standard air-cooled system.

34 Parker Refrigeration Specialists; http://www.parker.com/literature/Refrigerating%20Specialties%20Division/90-11a.pdf

Floating Condenser Head Pressure Controls. This measure adds controls to float head pressure temperature down during periods of low load. The base case is a standard multiplex system with a fixed condensing set point.

Glass Door, ENERGY STAR® Refrigerators/Freezers. Low-E, double-pane thermal glass doors reduce cooling loses in refrigerated reach-in cases.

High Efficiency Compressors. A component of refrigeration systems, this measure operates up to 15 percent more efficiently than standard-efficiency compressors.

Night Covers for Display Cases. This measure eliminates wasted refrigeration cooling by insulating display cases. In addition, it reduces the heating load of buildings by allowing less refrigerated air to escape and need reheated.

Refrigeration Commissioning or Re-Commissioning. Commissioning ensures that refrigeration systems are operating in an optimal fashion in order to maximize energy efficiency. Retro-commissioning checks previously commissioned equipment to ensure that it is continuing to run efficiently. The baseline measure is no commissioning.[35]

Refrigerator eCube. Refrigerators monitor circulating air temperatures to determine when to switch on and off. When the refrigerator door is opened, circulating air temperature increases more rapidly than food temperature, causing the equipment to work harder to maintain the set point. Instead of measuring air temperature, the eCube, a device with similar heat transfer characteristics to food, allows the refrigerator to monitor the more stable food temperature, resulting in less frequent cycling of the compressor.

Solid-Door Refrigerators/Freezers, ENERGY STAR®. This measure is designed with high efficiency components such as an ECM evaporator, condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors, saving energy compared to standard models.[36]

Standalone to Multiplex Compressor. This measure consists of multiple compressors drawing from a common suction header, serving any number of refrigerated display fixtures. The suction group is controlled to satisfy the lowest temperature required by any of the attached display fixtures, and therefore the fixtures served by a given suction group usually have similar temperature requirements. Baseline is a single dedicated compressor system for each refrigeration load.[37, 38]

Strip Curtains on Walk-In Refrigerators. This measure reduces the infiltration of warm air into the refrigerated space by improving the barrier between the refrigerated and the ambient air.

Walk-In Electronically Commutated Motor (ECM). A walk-in fan is one component of refrigeration systems. ECMs typically have small horse power motors (less than 1 HP) that are factory programmed to run at certain speeds. ECMs operate from a single-phase power source

35 http://cbs.lbl.gov/BPA/cct.html
36 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CRF
37 http://www.energysmartgrocer.org/pdfs/PGE/BridgeEquipment%20SpecificationTandCs.pdf
38 http://www.bizlink.com/HPAC_articles/March2007/306.pdf

with an electronic controller in or on the motor. The baseline measure is a standard efficiency motor.[39]

Other

Battery Charger, ENERGY STAR®. On average, these battery chargers use 35 percent less energy than conventional battery chargers, which draw as much as five to 20 times more energy than is actually stored in the battery (even when not actively charging a product). Battery charging systems recharge a variety of cordless products, including power tools, small household appliances, and electric shavers. The baseline is a standard battery charger.[40]

Combination Oven. This measure uses both dry heat and steam, which are injected into the oven when the food being cooked needs it. High efficiency combination ovens with 60 percent efficiency use roughly half the energy of standard combination ovens.[41]

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.

Copier, ENERGY STAR®. This measure delivers the same performance as conventional equipment, powers down when not in use, and averages 40 percent more efficiency. The baseline measure is a non-ENERGY STAR® copier.[42]

Deep Fat Fryer, Consortium for Energy Efficiency (CEE). Commercial, 15 inch CEE rated electric fryers have a heavy load cooking efficiency of 80 percent or better, and use less than 1,000 watts when idle.[43] The baseline is standard electric deep fat fryer.

Fax, ENERGY STAR®. This measure enters sleep mode after inactivity, reducing total power consumption by 40 percent.[44]

Griddle, ENERGY STAR®. This measure is approximately 10 percent more efficient than standard models, and must have a minimum cooking efficiency of 38 percent. They must use less than 0.026 therm/hour/ft^2 when idle. The baseline measure is a standard grill at 32 percent efficiency.[45]

High Efficiency Convection Oven, ENERGY STAR®. This measure must meet the specification requirements of 70 percent cooking energy efficiency and an idle energy rate of 1.6 kW. Standard electric convection ovens have a 65 percent cooking energy efficiency and an idle energy rate of 2 kW.[46]

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39 http://www.fishnick.com/publications/appliancereports/refrigeration/GE_ECM_revised.pdf
40 http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers
41 http://www.energystar.gov/ia/partners/publications/pubdocs/restaurants_guide.pdf
42 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=IEQ
43 http://www.energystar.gov/index.cfm?c=fryers.pr_fryers
44 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf
45 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG
46 http://www.energystar.gov/index.cfm?c=ovens.pr_comm_ovens

High Efficiency Ice Maker. This measure uses high efficiency compressors, fan motors, and thicker insulation to achieve 15 percent more efficiency than the baseline measure, which is a conventional automatic commercial ice maker.[47]

Hot Food Holding Cabinet, ENERGY STAR®. This measure uses a maximum of 40 watts/cubic foot. The baseline measure is a conventional holding cabinet.[48]

Low Pressure Air Distribution Complex HVAC. This under-floor measure introduces air into occupancy zones at relatively low velocities. The decrease in pressure differentials and, therefore in air velocity, results in lower energy consumption by the air handlers. The baseline for this measure is a variable air volume or constant volume HVAC system.

Monitor, ENERGY STAR®. This measure enters sleep mode and consumes less than 2 watts. The sleep mode needs to be enabled.

Motor, Consortium for Energy Efficiency (CEE) Premium-Efficiency Plus. These motors (also known as "super" or "enhanced") are more efficient than standard NEMA premium efficiency motors.[49] This measure specifically relates to HVAC motors ranging from 1 HP to 200 HP.

Motor, Pump and Fan System: Variable Speed Control. This measure allows pump and fan motors to operate at a lower speed while still maintaining set points during partial load conditions. This reduces energy consumption as motor operation can vary with load rather than frequently cycling on and off at constant speed.

Motor Rewind. This measure follows the Green Motors Practices Group™ recommendations of best practices to maintain original efficiency, commonly called a Green Rewind.[50, 51] A failed motor can be rewound to a lower efficiency, rewound to maintain the original efficiency, or replaced.

Motor: Variable Air Volume (VAV) Box High Efficiency Electronically Commutated Motor (ECM). High efficiency fan-powered boxes prevent hot and cold spots by maintaining room air circulation while modulating supply-air temperature to match load. This measure applies to a motor efficiency upgrade. An ECM powers the fan in each VAV box. An ECM is a brushless DC motor with electronically built-in speed and torque controls, which allows the motor speed to adjust for optimal airflow. The baseline assumes a standard VAV with induction motors including silicon controlled rectifier speed control.[52]

Network PC Power Management. This software tool intelligently manages computer powers remotely and automatically across a network overnight, on weekends, and when not in use. This significantly lowers energy consumption without impacting user productivity, desktop maintenance, or upgrades. Workstations operating on a local area network or a wide area

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47 Consortium for Energy Efficiency (CEE); http://www.cee1.org/com/com-kit/com-kit-equip.php3

48 http://www.energystar.gov/index.cfm?c=hfhc.pr_hfhc

49 CEE motor nominal efficiencies are higher than the NEMA federal minimum efficiency levels that became effective in December 2010. On December 19, 2010, the 2007 Energy Independence and Security Act updated the minimum efficiency standards for motors, and the previous NEMA premium efficiency specifications became the federal standard.

50 http://www.bpa.gov/energy/n/industrial/Green_motors/

51 http://www.greenmotors.org/downloads/RTFSubmittalMay_08%20_2_.pdf

52 LEED-qualified Justice Center, reported by DCJ.com and the Minnesota Power Incentive Program.

network can implement PC power-management policies across a network to maximize energy savings .

Optimized Variable Volume Lab Hood Design. This measure allows volumetric flow rate to vary, which causes a constant speed through the duct regardless of sash opening. The baseline measure is a constant volume lab hood.

Power Supply Transformer/Converter. This measure applies to the 80 PLUS performance specification requirements for power in computers and servers. 80 PLUS specifies 80 percent or greater efficiency at 20 percent, 50 percent, and 100 percent of rated load with a true power factor of 0.9 or greater.[53] The baseline assumes an 85 percent efficient power supply (>51 watts).

Printer, ENERGY STAR®. This measure deploys a maximum time delay to sleep depending on the size of the equipment, which reduces power consumption during periods of inactivity.[54]

Residential Refrigerator, ENERGY STAR®.This measure uses at least 20 percent less energy than required by current federal standards.[55]

Residential Refrigerator/Freezer Recycling. This refers to the environmentally-friendly disposal of unneeded appliances such as secondary refrigerators or stand-alone freezers.

Residential-Size Refrigerator/Freezer: Early Replacement, ENERGY STAR®. Replacing equipment before the end of its useful life is advantageous because of significant inefficiencies in older models.

Scanner, ENERGY STAR®. This measure enters a low power sleep mode after inactivity.[56]

Server Virtualization. This measure replaces multiple under-utilized servers with one server. Many data center servers operate at 10 percent capacity or less, allowing their functions to be consolidated onto one virtual server that operates in the range of 85 percent capacity. This measure applies to the plug load end use, although it has a savings effect on the cooling load by reducing power and, therefore, the heat generated by equipment.

Smart Strip. Power strips with an occupancy sensor will turn power to all devices plugged into the strip on and off, such as computers, desk lights, and audio equipment, based on occupancy within the work area.

Steam Cooker, ENERGY STAR®. This measure has a cooking efficiency of 50 percent, with idle energy rates that vary depending upon pan size.[57] The baseline efficiency is a standard commercial steam cooker with 35 percent efficiency.

Vending Machines, High Efficiency ENERGY STAR®. New and rebuilt refrigerated beverage vending machines are 50 percent more energy efficient than the standard model, through more

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53 www.80PLUS.org
54 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf
55 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=RF
56 http://www.energystar.gov.au/products/scanners.html
57 http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers

efficient compressors, fan motors, lighting systems, and low-power mode options during non-use periods.[58]

Vending Miser. This measure senses occupancy and cycles the vending machine cooling off when no occupancy is detected.

Water Cooler, ENERGY STAR®. This measure provides only cold water and consumes less than 0.16 kWh per day. A unit providing hot and cold water consumes less than 1.20 kWh per day. ENERGY STAR®-qualified water coolers consume 45 percent less energy than standard models.[59]

58 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=VMCc
59 http://www.energystar.gov/index.cfm?c=water_coolers.pr_water_coolers

6. Commercial Electric Equipment Measure Descriptions

HVAC

Air or Ground Source Heat Pump (ASHP or GSHP). Electric heat pumps move heat to or from the air or the ground to cool and heat a home. Table B-2.24 displays the different efficiency levels we compared for this measure. The baseline size is the same as the measure size.

Table B-2.24. Heat Pump SEER/HSPF Comparisons

Measure Efficiency	Baseline SEER & HSPF
ASHP 14 SEER, 8.5 HSPF	ASHP 13 SEER, 7.7 HSPF
ASHP 16 SEER, 8.8 HSPF	
GSHP 16.2 EER, 8.8 HSPF	

Centrifugal Chiller. This measure uses the vapor compression cycle to chill water and rejects heat from the chilled water and from the compressor to a second water loop cooled by a cooling tower. The advantage of centrifugal compressors is their high flow rate capability and good efficiency. Table B-2.25compares different efficiencies greater than 300 tons, rated in kW/ton.

Table B-2.25. Centrifugal Chiller kW/ton Comparison

Measure kW / ton	Baseline kW / ton
0.55	0.576 (State Code)
0.52	0.576 (State Code)
0.47	0.576 (State Code)

Direct Expansion (DX) Package. DX systems transfer heat with a refrigerant piping circuit, compressor, and refrigerant coils. All components are in a single package typically installed on the building roof. Commercial-sized units are normally rated by their Energy Efficient Ratio (EER). Table B-2.26 displays the different models compared in this measure.

Table B-2.26. DX AC Unit EER / Advanced Technology Comparisons

kBTU / hr	Measure EER	Baseline EER
65 – 135	11.5	11.2 (State Code)
65 – 135	12.0	11.2 (State Code)
135 – 240	11.5	11.0 (State Code)
135 – 240	12.0	11.0 (State Code)
240 – 760	10.5	10.0 (State Code)
240 – 760	10.8	10.0 (State Code)

Screw Chiller. Screw compressors are positive displacement devices. The refrigerant chamber actively compresses to a smaller volume by the twisting motion of two interlocking, rotating screws. Refrigerant trapped in the space between the two rotating screws is compressed as it travels from the inlet to the outlet of the compressor. A slide valve adjusts 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. Table B-2.27compares different efficiencies, rated in kW/ton.

Table B-2.27. Screw Chiller kW/ton Comparison

Tons	Measure kW / ton	Baseline kW / ton
<150	0.71	0.79 (State Code)
<150	0.63	0.79 (State Code)
<150	0.58	0.79 (State Code)
150-300	0.65	0.68 (State Code)
150-300	0.57	0.68 (State Code)
150-300	0.50	0.68 (State Code)

Water Heating

Water Heater, Heat Pump. This measure moves heat from a warm reservoir (such as air) into the hot water system.[60] Baseline and efficient measure EF values are given in Table B-2.28.

Table B-2.28. Water Heater EF Comparisons

Water Heater Type	Measure EF	Baseline EF
Electric Storage Water Heater	0.95	0.92
Heat Pump Water Heater	2.2	0.92

Other

Computer, ENERGY STAR. This measure consumes less than 2 watts in sleep and off modes, and is more efficient than conventional units in idle mode, resulting in 30 to 65 percent energy savings.

60 Description source: U.S. Department of Energy; http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12840

7. Commercial Gas Retrofit Measure Descriptions

HVAC (and Envelope)

Automated Ventilation Variable Frequency Drive (VFD) Control, Occupancy/CO_2 sensors. This measure is also known as demand-control ventilation (DCV), where the ventilation system automatically adjusts air flow when CO_2 is above a specified level. CO_2 controls maintain a minimum ventilation rate at all times to control non-occupant contaminants, such as off-gassing from furniture, equipment, and building components. The baseline of this measure is a ventilation system that runs constantly.

Boiler Economizer. This measure recovers heat energy that would otherwise be lost out the boiler stack by using a heat exchanger located on the stack to preheat boiler feed water.

Convert Constant Volume Air System to Variable Air Volume (VAV). TThis measure allows the airflow volume of a HVAC system to vary the heating or cooling load rather than over-conditioning and short-cycling. The baseline is a constant volume system.

Direct Digital Control (DDC) System, Installation. DDC systems allow for both HVAC and lighting to be controlled and monitored. For lighting, the DDC system allows for direct control of lights from a remote location. Entire HVAC systems, including pumps, motors, fans, and set points, can be digitally programmed for tighter control of the system.

Direct Digital Control (DDC) System, Optimization. DDC is also known as an energy management system (EMS), which allows for digital monitoring and control of HVAC and lighting systems. The optimization refers to upgrading a high-efficiency energy management system to a premium efficiency system.

Direct Digital Control (DDS) System, Wireless Performance Monitoring. This second-generation building automation systems allows for wireless optimization and operation of building systems (such as HVAC) through computerized monitoring and control software and interfaces.

Duct Fittings, Leak-Proof. 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.

Duct Repair and Sealing. This maintenance 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. This measure captures heated air exhausted out of a building and transfers it to the incoming air, decreasing the overall heating load.

Exhaust Hood Makeup Air. This measure provides exhaust air at the hood instead of allowing the hood to exhaust conditioned air in the room. The baseline measure is for conditioned air to be expelled through exhaust hoods.

Infiltration Reduction (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls decreases overall heating and cooling losses. This measure reduces the number of air changes per hour from 1.00 to 0.65.

Insulation, Ceiling. These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.29.

Table B-2.29. Ceiling Insulation Measures

Measure	Baseline
R-38 (State Code)	R-7
R-38 (State Code)	R-8
R-38 (State Code)	R-11
R-49	R-38 (State Code)

Insulation, Duct. Packaged direct expansion and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating these ducts reduces energy loss to the unconditioned plenum space. This measure assumes that R-7 insulation is installed where no insulation previously existed.

Insulation, Floor (Non-Slab). These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.30.

Table B-2.30. Floor Insulation Measures

Measure	Baseline
R-30 (State Code)	R-7
R-30 (State Code)	R-8
R-30 (State Code)	R-11
R-30 (State Code)	R-19
R-38	R-30 (State Code)

Insulation, Wall. These measures represent an increase in R-value from existing building conditions to the current state code value of R-13 + 7.5. The baseline value of R-3 represents the average existing insulation level.

Programmable Thermostat. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

Retro-Commissioning. Commissioning ensures that energy-using systems are operating in an optimal fashion in order to maximize energy efficiency. This 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 them up to the design intentions.[61,62] The baseline measure is no commissioning.

Sensible Heat Recovery Devices. This measure preconditions incoming air by transferring energy between the exhaust air stream and the supply air stream. This raises the temperature of

[61] http://www.green.ca.gov/CommissioningGuidelines/default.htm
[62] http://cbs.lbl.gov/BPA/cct.html

incoming air during the winter and decreases it in the summer. Energy savings results from the reduced need for mechanical heating or cooling.

Total Heat Recovery Devices. This measure, also called enthalpy recovery, transfers sensible and latent heat. Latent heat, which is released or absorbed due to a phase change (such as the condensation of water vapor), significantly raises the outdoor air humidity in the winter and reduces it in the summer.[63]

Steam Pipe Insulation. R-4 insulation reduces heat loss from a steam pipe. The loss size depends on the pipe diameter and steam temperature.

Steam Trap Maintenance. This measure prevents the dirt created by chemical treatments or pipe scaling from becoming plugged. In most cases, plugging prevents the valve from closing, allowing live steam to escape into the condensate return line or atmosphere, wasting energy.[64]

Windows, High Efficiency. This measure increases building performance by reducing the U-value, as shown in Table B-2.31.

Table B-2.31. High-efficiency Window Measures

Measure U-Value	Baseline U-Value
0.40 (State Code)	0.68
0.40 (State Code)	0.67
0.40 (State Code)	0.65

Water Heat

Clothes Washer, Ozonating. This measure disinfects water with ozone-enriched air, which suppresses subsequent biological activity and controls biological growth within the appliance, thus reducing the need for hot water. The baseline measure is a standard commercial clothes washer.[65]

Demand-Controlled Circulating Systems. This measure circulates hot water only when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwasher, Commercial: High Temperature ENERGY STAR®. This measure has a minimal idle rate, consumes a minimal amount of water per rack of loaded dishes, and is on average 25 percent more efficient than standard high temp commercial dishwashers.[66]

Dishwasher, Commercial: Low Temperature ENERGY STAR®. This measure uses chemicals combined with low temperatures to save energy compared to standard high temperature commercial dishwashers.

63 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf
64 http://www.steamtraptesting.com/
65 http://www.patentstorm.us/patents/6607672-description.html
66 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH

Dishwasher, Residential ENERGY STAR®. Residential sized ENERGY STAR® dishwashers are often appropriate for smaller commercial buildings, and are 10 percent more efficient than the federal minimum standard used as the baseline.[67]

Drain Water Heat Recovery, Water Heater. This measure recovers heat energy from drain water and uses it to heat water entering the hot water tank, minimizing the temperature rise required to achieve the water heater set point.[68]

Hot Water (SHW) Pipe Insulation. One inch of extra insulation on hot water pipes yields an approximate R-value of R-4, decreasing temperature losses. This measure is only applicable for existing construction. The baseline measure is no insulation.

Integrated Space Heating/Water Heating. These systems provide space conditioning and hot water heating in one appliance/energy source. Domestic hot water is heated directly and space is heated by a hot water heat exchanger coil piped to the forced air heating system. This combination space/water heating system provides high efficiency heating for the cost of one high efficiency appliance.

Low-Flow Faucet Aerators. This measure mixes water and air, reducing the amount of water that flows through the faucet. It creates a fine water spray through an inserted screen in the faucet head. Flow rate requirements for this measure are presented in Table B-2.32.

Table B-2.32. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.2	3.0
1.5	2.2
* Gallons per minute	

Low-Flow Pre-Rinse Spray Valves. This measure mixes water and air, reducing the amount of water that flows through the spray head. The head creates a fine water spray through an inserted screen, achieving a flow reduction from 1.6 GPM (federal standard) to 0.6 GPM.

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-2.33.

Table B-2.33. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.5	4.5
2.0	2.5

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn faucet water on and off when motion is detected at the sink. This eliminates water running continuously while the sink is in use.

[67] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW
[68] www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

Water Cooled Refrigeration with Heat Recovery. Heat recovery gathers and uses thermal energy for the water heater that would normally be rejected to the ambient environment.

Water Heater Temperature Setback. This measure reduces the set point temperature from 130°F to 120°F.

Other

Broiler. High efficiency broiler ovens have rigorous start-up, shut down, and turn down schedules for additional energy savings over standard units. Improved efficiency broilers have an efficiency of 34 percent, compared to baseline models at 15 percent.

Convection Oven, High Efficiency ENERGY STAR®. This measure must meet the specification requirements of 70 percent cooking energy efficiency and an idle energy rate of 18,000 Btu/h. Standard electric convection ovens have a 65 percent cooking energy efficiency and an idle energy rate of 13,000 Btu/h.[69]

Fryers, Commercial Gas Cooking ENERGY STAR®. These measures are 50 percent efficient, and when idle use less than 9,000 Btu/hr.[70] The baseline efficiency is 35 percent for a non-ENERGY STAR® commercial fryer.

Griddle, ENERGY STAR®. This measure is approximately 10 percent more efficient than standard models, and must have a minimum cooking efficiency of 38 percent. They must use less than 0.026 therm/hour/ft^2 when idle. The baseline measure is a standard grill at 32 percent efficiency.[71]

Oven, Conveyor. A high efficiency conveyor oven is 23 percent efficient, compared to a standard conveyor oven with 15 percent efficiency.

Oven, Power Burner. A power burner incorporates a larger burner and is often sold on range-oven combination units. This measure mixes a greater percentage of air to the gas to increase the overall combustion efficiency of the burner from 40 to 50 percent efficiency to 60 percent efficiency.

Steam Cooker, ENERGY STAR®. This measure has a cooking efficiency of 50 percent, with idle energy rates that vary depending upon pan size.[72] The baseline efficiency is a standard commercial steam cooker with 35 percent efficiency.

Swimming Pool/Spa Covers. This measure reduces evaporation, which is the largest source of pool/spa energy loss. It takes one British thermal unit (Btu) to raise one pound of water by one degree. Each pound of 80º F water that evaporates takes 1,048 Btus of heat out of the pool.[73] The baseline measure is an uncovered pool or spa.

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69 http://www.energystar.gov/index.cfm?c=ovens.pr_comm_ovens
70 http://www.energystar.gov/index.cfm?c=fryers.pr_fryers
71 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG
72 http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers
73 http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13140

8. Commercial Gas Equipment Measure Descriptions

HVAC

Gas Boiler. Boilers are classified as condensing or non-condensing. Condensing boilers condense the flue gas and water vapor, extracting useful heat and improving the boiler efficiency. 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 energy output divided by the energy input, and is affected by combustion efficiency, standby losses, cycling losses, and heat transfer. Table B-2.34 displays the measure and baseline thermal efficiencies.

Table B-2.34. Gas Boiler Efficiency Comparison

Measure AFUE	Baseline AFUE
90%	82%
94%	

Gas Furnace. Improvements in furnace technology, such as new ignition and heat exchange design, have led to increased furnace efficiency. The AFUE levels considered in this measure are shown in Table B-2.15.

Table B-2.35. Gas Furnace Efficiency Comparison

Measure AFUE	Baseline AFUE
90%	80%
95%	

Water Heat

Water Heater. This measure has a range of thermal efficiencies as shown in Table B-2.36. High efficiency models have better insulation, which reduces standby losses.

Table B-2.36. Commercial Gas Water Heater Comparison

Measure Efficiency	Baseline Efficiency
0.82 EF	0.67 EF
0.90 EF	

9. Industrial Electric Measure Descriptions

Air Compressor Improvements (Demand Reduction, Optimization, Equipment). These measures improve the overall compressed air system by improved system design, leak repair, usage practices, more efficient dryer and storage systems, and compressor upgrades.

Clean Room Improvements (Change Filter Strategy, Chiller Optimize, HVAC). These measures aim to save energy through improved clean room equipment and practices. Savings are attributable to optimization of chiller operating parameters, upgrading to more efficient equipment, and improving filter replacement strategies.

Efficiency Centrifugal Fan. This measure achieves energy savings through improved fan design.

Electric Chip Fab Improvements (Eliminate Exhaust, Exhaust Injector, Reduce Gas Pressure, Solid-state Chiller). These measures are general improvements that increase efficiency in the electric chip fabrication process.

Fan System Optimization. This measure involves the overall optimization of the fan system with improved system design, enhanced flow design, better maintenance practices, and adjustments to system parameters.

Food Manufacturing (Cooling and Storage, Refrigerator Storage Tune-up). These measures maintain and enhance the cooling equipment for each facility type. Tune-ups may include refrigerant charge, equipment cleaning, general maintenance, and improved practices.

General Process Improvements (Paper: Premium Fan, Paper: Large Material Handling, Paper: Material Handling, Paper: Premium Control Large Material, Efficient Pulp Screen, Wood: Replace Pneumatic Conveyor, Metal: New Arc Furnace). These measures include upgrading equipment, replacing hydraulic/pneumatic equipment with electrical equipment, and using optimum size and capacity equipment.

High Efficiency Fans (Fan Equipment Upgrade). This measure involves upgrading motors to higher efficiency. Since NEMA Premium motors are becoming the baseline code requirement in 2010, this measure is based off of super premium motors with efficiency levels at least one efficiency band above NEMA premium.

Lighting Improvements (Efficient Lighting 1, 2, and 3 Shift; HighBay Lighting 1, 2, and 3 Shift; Lighting Controls). Changes to overall illumination levels, use of natural lighting, or technology improvements to more efficient bulbs or ballasts will decrease the overall lighting energy consumption. These measures include upgrades from T12 to T8 systems, T8 to high-performance T8 systems, HID to fluorescent conversions, standard HID to high-efficiency HID systems, and occupancy and day lighting controls.

Material Handling (Material Handling Variable Speed Drive (VFD) 1 and 2, Material Handling 1 and 2). This measure includes equipment upgrades (such as to VSDs) and enhanced system design or practices.

Motor Rewind. This measure follows the Green Motors Practices Group™ recommendations of best practices to maintain original efficiency, commonly called a Green Rewind.[74, 75] A failed motor can be rewound to a lower efficiency, rewound to maintain the original efficiency, or replaced.

Pump Equipment Upgrade. This measure achieves energy savings through improved pump design and sizing.

Pump Improvements (Pump Energy Management, Pump System Optimization). This measure involves optimizing the overall pump system with improved system design, enhanced flow design, better maintenance practices, and adjustments to system parameters.

Synchronous Belts. This measure contains mating, corresponding grooves in the drive sprocket, preventing slip and thus reducing energy losses.

Transformers (New & Retrofit). Energy efficient transformers provide improved power quality while minimizing losses.

Whole Plant Improvements (Fan Energy Management, Plant Energy Management, Integrated Plant Energy Management, Energy Project Management). These measures include synergistic savings of plant-wide energy management and improvements across multiple systems such as compressed air, pumping, and fan systems.

74 http://www.bpa.gov/energy/n/industrial/Green_motors/
75 http://www.greenmotors.org/downloads/RTFSubmittalMay_08%20_2_.pdf

10. Industrial Gas Measure Descriptions

Boiler Improvements. A boiler generally creates steam or hot water for process or non-process applications. Savings are generated by installation of a waste heat boiler to provide direct power or use of flue gas heat to preheat boiler feed water.

Boiler Operation and Maintenance. This measure includes analyzing flue gas for proper air/fuel ration, establishing maintenance schedules, or reducing excessive boiler blow down.

HVAC Improvements. Many measures can reduce a plants' HVAC energy consumption, such as conditioning only space in use, installing timers and/or thermostats, lowering ceilings to reduce conditioned space, and installing or upgrading insulation on distribution systems.

HVAC Operation and Maintenance. These measures include sizing air handling grills/ducts/coils to minimize air resistance, adjusting vents to minimize energy use, and maintaining air filters by cleaning or replacing.

Other Process Improvements/Operation and Maintenance. These measures include upgrading obsolete equipment, reducing fluid flow rates, and using optimum size and capacity equipment.

Process Heating Improvements. These measures decrease the energy required for process-related heating. Examples include optimizing the drying oven schedule, reducing the temperature of process equipment when on standby, and modifying equipment to improve the drying process.

Process Heating Operation and Maintenance. These measures improve the a plants overall energy efficiency. Examples include repairing faulty insulation, adjusting burners for efficient operation, and eliminating leaks in combustible gas lines.

Steam Distribution Systems. These measures include leak elimination and improved duct insulation to reduce distribution system loss.

Appendix B.3: Measure Details

The following tables show electric and gas technical measure inputs for the residential, commercial, and industrial sectors.

Table B.3.1. Residential Electric Measure Details

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	Existing	51	5	$24	100%	N/A	$0.12	4,076
Manufactured	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	New	51	5	$24	100%	N/A	$0.12	463
Manufactured	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	Existing	58	20	$282	100%	N/A	$0.55	2,703
Manufactured	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	New	58	20	$282	100%	N/A	$0.55	1,617
Manufactured	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	87	5	$576	25%	95%	$1.85	305
Manufactured	Cool Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	3	30	$25	95%	50%	$0.73	94
Manufactured	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	34	10	$93	85%	35%	$0.44	306
Manufactured	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	11	25	$338	40%	95%	$2.99	42
Manufactured	Cool Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	180	25	$1,559	75%	35%	$0.91	495
Manufactured	Cool Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	361	25	$1,559	75%	1%	$0.45	33
Manufactured	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	Existing	161	15	$1,490	100%	N/A	$1.21	1,154
Manufactured	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	Existing	78	5	$204	95%	75%	$0.72	825
Manufactured	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	10	20	$282	85%	95%	$3.12	76
Manufactured	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	9	20	$25	95%	80%	$0.30	90
Manufactured	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	6	20	$54	95%	60%	$0.97	35
Manufactured	Cool Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	4	6	$46	95%	50%	$2.72	37
Manufactured	Cool Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	25	20	$672	75%	75%	$3.03	132
Manufactured	Cool Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	87	18	$383	75%	60%	$0.52	469
Manufactured	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	17	25	$445	25%	85%	$2.68	36
Manufactured	Cool Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	344	25	$1,680	25%	20%	$0.51	209
Manufactured	Cool Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	87	11	$449	75%	50%	$0.81	369
Manufactured	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	82	15	$5	95%	65%	$0.00	454
Manufactured	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	52	25	$672	25%	90%	$1.35	116
Manufactured	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	59	11	$1,083	50%	95%	$2.87	271
Manufactured	Cool Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	205	25	$1,647	85%	25%	$0.84	355
Manufactured	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	Existing	131	20	$1,621	50%	95%	$1.42	458
Manufactured	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	65	25	$204	50%	50%	$0.32	203
Manufactured	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	25	$341	65%	85%	$24.34	7
Manufactured	Cool Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	15	25	$3,514	65%	50%	$23.46	46
Manufactured	Cool Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	24	25	$3,514	65%	20%	$14.97	29
Manufactured	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	64	5	$576	25%	95%	$2.50	106

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	25	10	$93	85%	35%	$0.60	106
Manufactured	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	12	25	$454	60%	95%	$3.93	35
Manufactured	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	New	148	15	$1,490	100%	N/A	$1.32	544
Manufactured	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	New	58	5	$204	95%	75%	$0.98	288
Manufactured	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	7	20	$375	85%	95%	$5.62	24
Manufactured	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	7	20	$25	95%	80%	$0.40	31
Manufactured	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	4	20	$54	95%	60%	$1.32	15
Manufactured	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	12	25	$599	75%	85%	$4.89	41
Manufactured	Cool Central	Green Roof	ecoroof	Standard Roof	Per installation	New	32	40	$19,076	20%	95%	$55.06	6
Manufactured	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	60	15	$5	95%	65%	$0.01	183
Manufactured	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	38	25	$893	50%	90%	$2.43	96
Manufactured	Cool Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	35	25	$795	75%	75%	$2.36	113
Manufactured	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	43	11	$1,083	50%	95%	$3.88	109
Manufactured	Cool Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	33	25	$973	50%	95%	$3.07	85
Manufactured	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	New	96	20	$1,621	50%	95%	$1.92	159
Manufactured	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	48	25	$204	75%	50%	$0.44	106
Manufactured	Cool Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	2	25	$458	95%	75%	$21.55	7
Manufactured	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	25	$395	95%	75%	$27.53	5
Manufactured	Cool Room	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	1	30	$25	95%	50%	$1.37	85
Manufactured	Cool Room	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	18	10	$93	85%	35%	$0.84	230
Manufactured	Cool Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	6	25	$338	40%	95%	$5.47	40
Manufactured	Cool Room	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	98	25	$1,559	75%	35%	$1.67	456
Manufactured	Cool Room	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	196	25	$1,559	75%	1%	$0.83	29
Manufactured	Cool Room	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	5	20	$282	85%	95%	$5.87	72
Manufactured	Cool Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	5	20	$25	95%	80%	$0.56	78
Manufactured	Cool Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	3	20	$54	95%	60%	$1.83	32
Manufactured	Cool Room	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	2	6	$46	95%	50%	$5.12	34
Manufactured	Cool Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	9	25	$445	25%	85%	$5.00	32
Manufactured	Cool Room	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	184	25	$1,680	25%	20%	$0.96	182
Manufactured	Cool Room	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	46	11	$449	75%	50%	$1.52	333
Manufactured	Cool Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	27	25	$672	25%	90%	$2.54	104

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Cool Room	Room AC conversion to Ductless Heat Pump	SEER 13	EER 9.8	Per installation	Existing	56	20	$5,621	75%	N/A	$11.37	734
Manufactured	Cool Room	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	111	25	$1,647	85%	25%	$1.55	327
Manufactured	Cool Room	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	34	25	$204	50%	50%	$0.61	175
Manufactured	Cool Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	0.81	25	$341	65%	85%	$44.33	7
Manufactured	Cool Room	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	8	25	$3,514	65%	50%	$42.73	45
Manufactured	Cool Room	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	13	25	$3,514	65%	20%	$27.26	28
Manufactured	Cool Room	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	14	10	$93	85%	35%	$1.06	82
Manufactured	Cool Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	7	25	$454	60%	95%	$6.66	33
Manufactured	Cool Room	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	4	20	$375	85%	95%	$9.82	22
Manufactured	Cool Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	4	20	$25	95%	80%	$0.71	27
Manufactured	Cool Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	2	20	$54	95%	60%	$2.30	13
Manufactured	Cool Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	7	25	$599	75%	85%	$8.46	37
Manufactured	Cool Room	Green Roof	ecoroof	Standard Roof	Per installation	New	18	40	$19,076	20%	95%	$96.10	5
Manufactured	Cool Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	22	25	$893	50%	90%	$4.25	84
Manufactured	Cool Room	Room AC conversion to Ductless Heat Pump	SEER 13	EER 9.8	Per installation	New	46	20	$5,621	75%	N/A	$14.02	145
Manufactured	Cool Room	Room AC, EER 10.8	EER 10.8	EER 9.8	Per installation	New	18	9	$7	100%	N/A	$0.06	30
Manufactured	Cool Room	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	20	25	$795	75%	75%	$4.13	100
Manufactured	Cool Room	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	19	25	$973	50%	95%	$5.24	76
Manufactured	Cool Room	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	27	25	$204	75%	50%	$0.77	94
Manufactured	Cool Room	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	1	25	$458	95%	75%	$36.08	7
Manufactured	Cool Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	0.89	25	$395	95%	75%	$46.55	4
Manufactured	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	Existing	50	14	$224	100%	N/A	$0.59	3,242
Manufactured	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	New	50	14	$224	100%	N/A	$0.59	1,179
Manufactured	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	Existing	46	20	$22	76%	N/A	$0.04	590
Manufactured	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	Per installation	Existing	535	8	$99	24%	**%	$0.02	5,877
Manufactured	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	New	46	20	$22	76%	N/A	$0.04	536
Manufactured	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	663	5	$576	25%	95%	$0.22	4,677
Manufactured	Heat Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	36	30	$25	95%	50%	$0.04	2,297
Manufactured	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	124	25	$338	40%	95%	$0.26	1,027
Manufactured	Heat Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	1,884	25	$1,559	75%	35%	$0.06	12,273
Manufactured	Heat Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	3,774	25	$1,559	75%	1%	$0.02	811

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Heat Central	Conversion Electric Furnace to ASHP	Air Source Heat Pump Seer 13 HSPF 7.7	Electric Furnace HSPF 1	Per installation	Existing	3,582	20	$2,883	100%	N/A	$0.06	49,273
Manufactured	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	99	20	$25	95%	80%	$0.00	2,192
Manufactured	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	66	20	$54	95%	60%	$0.07	868
Manufactured	Heat Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	43	6	$46	95%	50%	$0.23	895
Manufactured	Heat Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	265	20	$672	75%	75%	$0.26	3,218
Manufactured	Heat Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	663	18	$383	75%	60%	$0.04	8,286
Manufactured	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	182	25	$445	25%	85%	$0.23	854
Manufactured	Heat Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	3,596	25	$1,680	25%	20%	$0.02	5,129
Manufactured	Heat Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	663	11	$449	75%	50%	$0.08	5,680
Manufactured	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	132	15	$5	15%	65%	$-0.02	258
Manufactured	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	132	25	$672	25%	90%	$0.51	608
Manufactured	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	451	11	$1,083	50%	95%	$0.35	4,515
Manufactured	Heat Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	2,145	25	$1,647	85%	25%	$0.05	8,944
Manufactured	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	15	25	$341	65%	85%	$2.31	171
Manufactured	Heat Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	165	25	$3,514	65%	50%	$2.22	1,084
Manufactured	Heat Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	259	25	$3,514	65%	20%	$1.41	683
Manufactured	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	468	5	$576	25%	95%	$0.32	1,442
Manufactured	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	122	25	$454	60%	95%	$0.37	835
Manufactured	Heat Central	Conversion Electric Furnace to ASHP	Air Source Heat Pump Seer 13 HSPF 7.7	Electric Furnace HSPF 1	Per installation	New	2,531	20	$2,758	100%	N/A	$0.10	25,227
Manufactured	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	70	20	$25	95%	80%	$0.01	675
Manufactured	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	46	20	$54	95%	60%	$0.10	334
Manufactured	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	129	25	$599	75%	85%	$0.46	975
Manufactured	Heat Central	Green Roof	ecoroof	Standard Roof	Per installation	New	328	40	$19,076	20%	95%	$5.49	138
Manufactured	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	93	15	$5	15%	65%	$-0.02	100
Manufactured	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	93	25	$893	50%	90%	$0.98	474
Manufactured	Heat Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	14	25	$795	75%	75%	$5.75	90
Manufactured	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	318	11	$1,083	50%	95%	$0.51	1,760
Manufactured	Heat Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	334	25	$973	50%	95%	$0.28	1,975
Manufactured	Heat Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	22	25	$458	95%	75%	$2.13	178
Manufactured	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	15	25	$395	95%	75%	$2.73	120

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	556	5	$576	25%	95%	$0.27	1,484
Manufactured	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	29	30	$25	95%	50%	$0.06	697
Manufactured	Heat Pump	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	26	10	$93	85%	35%	$0.57	176
Manufactured	Heat Pump	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	41	25	$338	40%	95%	$0.83	130
Manufactured	Heat Pump	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	661	25	$1,559	75%	35%	$0.23	1,591
Manufactured	Heat Pump	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	1,325	25	$1,559	75%	1%	$0.10	96
Manufactured	Heat Pump	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	Existing	59	5	$204	95%	75%	$0.94	475
Manufactured	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	7	20	$282	85%	95%	$4.12	51
Manufactured	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	80	20	$25	95%	80%	$0.01	663
Manufactured	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	53	20	$54	95%	60%	$0.09	301
Manufactured	Heat Pump	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	36	6	$46	95%	50%	$0.29	303
Manufactured	Heat Pump	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	215	20	$672	75%	75%	$0.34	1,061
Manufactured	Heat Pump	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	556	18	$383	75%	60%	$0.06	2,601
Manufactured	Heat Pump	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	153	25	$445	25%	85%	$0.29	289
Manufactured	Heat Pump	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	3,014	25	$1,680	25%	20%	$0.04	1,610
Manufactured	Heat Pump	Heat Pump Premium Efficiency, SEER 16, HSPF 8.8	ASHP SEER 16, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	Existing	394	20	$1,233	100%	N/A	$0.34	1,587
Manufactured	Heat Pump	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	556	11	$449	75%	50%	$0.11	2,029
Manufactured	Heat Pump	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	524	15	$5	95%	65%	$-0.02	2,640
Manufactured	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	144	25	$672	25%	90%	$0.47	268
Manufactured	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	378	11	$1,083	50%	95%	$0.43	1,538
Manufactured	Heat Pump	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	749	25	$1,647	85%	25%	$0.21	1,118
Manufactured	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	Existing	99	20	$1,621	50%	95%	$1.86	264
Manufactured	Heat Pump	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	49	25	$204	50%	50%	$0.42	106
Manufactured	Heat Pump	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	5	25	$341	65%	85%	$6.70	24
Manufactured	Heat Pump	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	57	25	$3,514	65%	50%	$6.46	152
Manufactured	Heat Pump	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	89	25	$3,514	65%	20%	$4.11	95
Manufactured	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	347	5	$576	25%	95%	$0.44	420
Manufactured	Heat Pump	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	16	10	$93	85%	35%	$0.93	50
Manufactured	Heat Pump	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	34	25	$454	60%	95%	$1.38	87
Manufactured	Heat Pump	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	New	37	5	$204	95%	75%	$1.52	134
Manufactured	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	4	20	$375	85%	95%	$8.79	13

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	50	20	$25	95%	80%	$0.04	188
Manufactured	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	33	20	$54	95%	60%	$0.16	93
Manufactured	Heat Pump	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	96	25	$599	75%	85%	$0.64	294
Manufactured	Heat Pump	Green Roof	ecoroof	Standard Roof	Per installation	New	235	40	$19,076	20%	95%	$7.67	39
Manufactured	Heat Pump	Heat Pump Premium Efficiency, SEER 16, HSPF 8.8	ASHP SEER 16, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	New	258	20	$1,233	100%	N/A	$0.53	950
Manufactured	Heat Pump	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	327	15	$5	95%	65%	$-0.02	888
Manufactured	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	90	25	$893	50%	90%	$1.03	185
Manufactured	Heat Pump	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	25	25	$795	75%	75%	$3.30	63
Manufactured	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	236	11	$1,083	50%	95%	$0.70	529
Manufactured	Heat Pump	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	94	25	$973	50%	95%	$1.07	201
Manufactured	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	New	61	20	$1,621	50%	95%	$2.99	74
Manufactured	Heat Pump	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	30	25	$204	75%	50%	$0.68	54
Manufactured	Heat Pump	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	6	25	$458	95%	75%	$7.70	19
Manufactured	Heat Pump	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	4	25	$395	95%	75%	$9.47	13
Manufactured	Heat Room	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	28	30	$25	95%	50%	$0.06	778
Manufactured	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	98	25	$338	40%	95%	$0.34	356
Manufactured	Heat Room	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	1,484	25	$1,559	75%	35%	$0.08	4,249
Manufactured	Heat Room	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	2,974	25	$1,559	75%	1%	$0.03	268
Manufactured	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	Existing	2,580	20	$7,444	50%	N/A	$0.30	8,192
Manufactured	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	76	20	$25	95%	80%	$0.01	709
Manufactured	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	51	20	$54	95%	60%	$0.09	293
Manufactured	Heat Room	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	33	6	$46	95%	50%	$0.31	302
Manufactured	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	142	25	$445	25%	85%	$0.30	291
Manufactured	Heat Room	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	2,793	25	$1,680	25%	20%	$0.04	1,674
Manufactured	Heat Room	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	510	11	$449	75%	50%	$0.11	1,918
Manufactured	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	102	25	$672	25%	90%	$0.67	217
Manufactured	Heat Room	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	1,687	25	$1,647	85%	25%	$0.08	3,095
Manufactured	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	12	25	$341	65%	85%	$2.91	63
Manufactured	Heat Room	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	131	25	$3,514	65%	50%	$2.80	399
Manufactured	Heat Room	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	205	25	$3,514	65%	20%	$1.78	251

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	96	25	$454	60%	95%	$0.47	278
Manufactured	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	New	1,823	20	$7,444	50%	N/A	$0.44	3,946
Manufactured	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	54	20	$25	95%	80%	$0.03	218
Manufactured	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	36	20	$54	95%	60%	$0.14	108
Manufactured	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	100	25	$599	75%	85%	$0.60	318
Manufactured	Heat Room	Green Roof	ecoroof	Standard Roof	Per installation	New	252	40	$19,076	20%	95%	$7.14	46
Manufactured	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	72	25	$893	50%	90%	$1.28	158
Manufactured	Heat Room	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	11	25	$795	75%	75%	$7.48	30
Manufactured	Heat Room	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	263	25	$973	50%	95%	$0.36	652
Manufactured	Heat Room	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	18	25	$458	95%	75%	$2.66	62
Manufactured	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	12	25	$395	95%	75%	$3.44	41
Manufactured	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	Existing	56	5	$0.91	100%	N/A	$-0.01	3,948
Manufactured	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	Existing	8	10	$16	80%	85%	$0.31	402
Manufactured	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	New	56	5	$0.91	100%	N/A	$-0.01	618
Manufactured	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	New	11	10	$16	80%	85%	$0.23	223
Manufactured	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	Existing	49	5	$3	100%	N/A	$0.00	6,089
Manufactured	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	New	49	5	$3	100%	N/A	$0.00	787
Manufactured	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	Existing	7	20	$147	40%	95%	$2.31	56
Manufactured	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	Existing	47	5	$2	100%	N/A	$-0.00	11,644
Manufactured	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	Existing	56	20	$36	50%	N/A	$0.06	19,040
Manufactured	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	Existing	4	10	$32	85%	95%	$1.30	733
Manufactured	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	New	9	20	$147	40%	95%	$1.76	31
Manufactured	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	New	47	5	$2	100%	N/A	$-0.00	2,120
Manufactured	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	New	56	20	$36	50%	N/A	$0.06	3,092
Manufactured	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	New	5	10	$32	85%	95%	$0.99	407
Manufactured	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	Existing	9	15	$79	100%	N/A	$1.05	601

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	New	9	15	$79	100%	N/A	$1.05	244
Manufactured	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	Existing	36	5	$3	100%	N/A	$0.01	3,365
Manufactured	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	New	36	5	$3	100%	N/A	$0.01	390
Manufactured	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	Existing	17	7	$30	50%	50%	$0.35	1,900
Manufactured	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	Existing	1	7	$2	50%	80%	$0.43	463
Manufactured	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	Existing	39	6	$5	10%	50%	$0.01	180
Manufactured	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	Existing	5	5	$5	20%	50%	$0.26	46
Manufactured	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	Existing	102	5	$22	50%	85%	$0.04	3,991
Manufactured	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	New	17	7	$30	50%	50%	$0.35	829
Manufactured	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	New	1	7	$2	50%	80%	$0.43	202
Manufactured	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	New	39	6	$5	10%	50%	$0.01	78
Manufactured	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	New	5	5	$5	20%	50%	$0.26	20
Manufactured	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	New	102	5	$22	50%	85%	$0.04	1,742
Manufactured	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	Existing	122	20	$15	92%	N/A	$0.00	3,392
Manufactured	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	Per installation	Existing	474	9	$102	8%	**%	$0.03	2,891
Manufactured	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	New	122	20	$15	100%	N/A	$0.00	2,376
Manufactured	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	Existing	164	5	$12	100%	N/A	$0.01	19,763
Manufactured	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	New	164	5	$12	100%	N/A	$0.01	2,123
Manufactured	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	Existing	112	10	$19	100%	N/A	$0.01	12,414
Manufactured	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	New	112	10	$19	100%	N/A	$0.01	2,998
Manufactured	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	Existing	223	10	$19	100%	N/A	$0.00	4,594
Manufactured	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	New	223	10	$19	100%	N/A	$0.00	1,109
Manufactured	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	Existing	167	20	$172	50%	N/A	$0.10	3,792
Manufactured	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	Existing	502	20	$194	50%	N/A	$0.02	11,378
Manufactured	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	New	102	20	$172	50%	N/A	$0.17	1,430
Manufactured	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	New	307	20	$194	50%	N/A	$0.05	4,290
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	111	14	$227	100%	83%	$-0.25	2,008
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	148	14	$296	100%	90%	$-0.23	2,918
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	169	14	$317	100%	95%	$-0.21	3,509

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	71%	50%	$0.16	767
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	71%	50%	$3.50	74,969
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$2.77	41,990
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$0.13	5,873
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$0.15	1,644
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$3.33	23,861
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-1.21	16,975
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-0.06	4,504
Manufactured	Water Heat	Water Heater, Heat Pump EF 2.2	Heat Pump Water Heater EF = 2.2	Standard Storage Water Heater EF = 0.92	Per installation	Existing	1,878	15	$1,365	59%	N/A	$0.09	45,976
Manufactured	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	Existing	105	15	$47	100%	N/A	$0.05	832
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	198	5	$8	95%	45%	$0.27	49,148
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	198	5	$8	95%	45%	$-0.00	5,217
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	112	14	$227	100%	83%	$-0.24	921
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	149	14	$296	100%	90%	$-0.22	1,339
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	170	14	$317	100%	95%	$-0.21	1,610
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	71%	50%	$0.16	352
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	71%	50%	$3.45	88,297
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$459	59%	90%	$2.33	94,870
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$459	59%	90%	$0.10	5,320
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$3.28	69,188
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$0.15	713
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-1.48	838
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-0.08	2,066
Manufactured	Water Heat	Water Heater, Heat Pump EF 2.2	Heat Pump Water Heater EF = 2.2	Standard Storage Water Heater EF = 0.92	Per installation	New	1,622	15	$1,365	59%	N/A	$0.10	15,440
Manufactured	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	New	91	15	$47	100%	N/A	$0.06	223
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	167	5	$8	95%	45%	$0.22	24,795
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	167	5	$8	95%	45%	$0.00	1,978
Multi Family	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	Existing	51	5	$24	100%	N/A	$0.12	12,511
Multi Family	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	New	51	5	$24	100%	N/A	$0.12	1,423
Multi Family	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	Existing	58	20	$282	100%	N/A	$0.55	8,013

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	New	58	20	$282	100%	N/A	$0.55	4,796
Multi Family	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	71	5	$576	25%	95%	$2.27	106
Multi Family	Cool Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	7	30	$25	95%	50%	$0.35	33
Multi Family	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	28	10	$93	85%	50%	$0.55	151
Multi Family	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	9	30	$119	75%	95%	$1.23	27
Multi Family	Cool Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	146	30	$549	75%	35%	$0.37	188
Multi Family	Cool Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	294	30	$549	95%	1%	$0.18	14
Multi Family	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	Existing	139	15	$1,177	100%	N/A	$1.11	410
Multi Family	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	Existing	64	5	$204	95%	75%	$0.89	286
Multi Family	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	8	20	$104	85%	95%	$1.42	26
Multi Family	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	15	20	$25	95%	80%	$0.18	31
Multi Family	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	10	20	$54	95%	60%	$0.59	12
Multi Family	Cool Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	6	6	$46	95%	50%	$1.67	12
Multi Family	Cool Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	20	20	$672	75%	75%	$3.73	43
Multi Family	Cool Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	71	18	$383	75%	60%	$0.64	138
Multi Family	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	14	30	$157	25%	85%	$1.10	12
Multi Family	Cool Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	280	30	$592	25%	20%	$0.21	70
Multi Family	Cool Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	71	11	$358	75%	50%	$0.79	110
Multi Family	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	67	15	$5	95%	65%	$0.01	150
Multi Family	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	42	30	$249	50%	90%	$0.58	85
Multi Family	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	48	11	$1,083	50%	95%	$3.53	88
Multi Family	Cool Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	167	30	$978	85%	25%	$0.58	123
Multi Family	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	Existing	106	20	$1,621	50%	95%	$1.74	159
Multi Family	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	99	30	$204	50%	50%	$0.20	130
Multi Family	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	30	$202	51%	85%	$16.86	1
Multi Family	Cool Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	12	30	$2,086	51%	50%	$16.25	11
Multi Family	Cool Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	20	30	$2,086	51%	20%	$10.37	7
Multi Family	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	55	5	$576	25%	95%	$2.91	39
Multi Family	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	22	10	$93	85%	50%	$0.70	56
Multi Family	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	10	30	$166	90%	95%	$1.58	20
Multi Family	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	New	123	15	$1,281	100%	N/A	$1.37	183
Multi Family	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	New	50	5	$204	95%	75%	$1.14	106

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Cool Central	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	177	45	$3,569	50%	95%	$1.87	9
Multi Family	Cool Central	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	66	45	$1,387	50%	95%	$1.94	3
Multi Family	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	6	20	$143	85%	95%	$2.50	8
Multi Family	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	12	20	$25	95%	80%	$0.23	11
Multi Family	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	8	20	$54	95%	60%	$0.76	5
Multi Family	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	11	30	$219	75%	85%	$1.97	15
Multi Family	Cool Central	Green Roof	ecoroof	Standard Roof	Per installation	New	28	40	$7,290	50%	95%	$24.46	5
Multi Family	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	52	15	$5	95%	65%	$0.01	64
Multi Family	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	33	30	$341	75%	90%	$1.02	52
Multi Family	Cool Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	30	45	$795	40%	75%	$2.43	19
Multi Family	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	37	11	$1,083	50%	95%	$4.52	37
Multi Family	Cool Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	28	30	$588	50%	95%	$2.04	26
Multi Family	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	New	83	20	$1,621	50%	95%	$2.23	58
Multi Family	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	77	30	$204	75%	50%	$0.26	72
Multi Family	Cool Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	1	30	$277	95%	75%	$14.38	2
Multi Family	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$239	95%	75%	$18.38	1
Multi Family	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	Existing	50	14	$224	100%	N/A	$0.59	7,468
Multi Family	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	New	50	14	$224	100%	N/A	$0.59	2,476
Multi Family	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	Existing	46	20	$22	76%	N/A	$0.04	127
Multi Family	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	Per installation	Existing	535	8	$99	24%	**%	$0.02	1,265
Multi Family	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	New	46	20	$22	76%	N/A	$0.04	115
Multi Family	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	535	5	$576	25%	95%	$0.28	1,484
Multi Family	Heat Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	73	30	$25	95%	50%	$0.01	762
Multi Family	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	100	30	$119	75%	95%	$0.09	614
Multi Family	Heat Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	1,520	30	$549	75%	35%	$0.01	4,294
Multi Family	Heat Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	3,045	30	$549	95%	1%	$-0.01	325
Multi Family	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	160	20	$25	95%	80%	$-0.01	695
Multi Family	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	107	20	$54	95%	60%	$0.03	288
Multi Family	Heat Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	69	6	$46	95%	50%	$0.14	279
Multi Family	Heat Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	214	20	$672	75%	75%	$0.34	1,004
Multi Family	Heat Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	535	18	$383	75%	60%	$0.06	2,261
Multi Family	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	147	30	$157	25%	85%	$0.08	270
Multi Family	Heat Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	2,901	30	$592	25%	20%	$-0.01	1,625

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Heat Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	535	11	$358	75%	50%	$0.08	1,800
Multi Family	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	107	15	$5	15%	65%	$-0.02	81
Multi Family	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	107	30	$249	50%	90%	$0.21	405
Multi Family	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	364	11	$1,083	50%	95%	$0.44	1,409
Multi Family	Heat Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	1,731	30	$978	85%	25%	$0.03	2,746
Multi Family	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	12	30	$202	51%	85%	$1.60	41
Multi Family	Heat Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	133	30	$2,086	51%	50%	$1.54	265
Multi Family	Heat Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	209	30	$2,086	51%	20%	$0.98	166
Multi Family	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	336	5	$576	25%	95%	$0.46	406
Multi Family	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	87	30	$166	90%	95%	$0.17	365
Multi Family	Heat Central	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	1,478	45	$3,569	50%	95%	$0.20	167
Multi Family	Heat Central	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	403	45	$1,387	50%	95%	$0.30	43
Multi Family	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	100	20	$25	95%	80%	$0.00	190
Multi Family	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	67	20	$54	95%	60%	$0.07	94
Multi Family	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	92	30	$219	75%	85%	$0.21	279
Multi Family	Heat Central	Green Roof	ecoroof	Standard Roof	Per installation	New	235	40	$7,290	50%	95%	$2.91	95
Multi Family	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	67	15	$5	15%	65%	$-0.02	27
Multi Family	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	67	30	$341	75%	90%	$0.48	203
Multi Family	Heat Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	10	45	$795	40%	75%	$7.10	13
Multi Family	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	228	11	$1,083	50%	95%	$0.72	481
Multi Family	Heat Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	239	30	$588	50%	95%	$0.22	476
Multi Family	Heat Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	16	30	$277	95%	75%	$1.70	49
Multi Family	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	10	30	$239	95%	75%	$2.18	33
Multi Family	Heat Room	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	56	30	$25	95%	50%	$0.02	7,068
Multi Family	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	79	30	$119	75%	95%	$0.12	6,154
Multi Family	Heat Room	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	1,198	30	$549	75%	35%	$0.02	40,744
Multi Family	Heat Room	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	2,400	30	$549	95%	1%	$-0.00	3,129
Multi Family	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	Existing	2,082	20	$7,444	89%	N/A	$0.39	30,613
Multi Family	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	123	20	$25	95%	80%	$-0.00	6,415
Multi Family	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	82	20	$54	95%	60%	$0.05	2,663

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Heat Room	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	53	6	$46	95%	50%	$0.18	2,723
Multi Family	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	67	30	$157	25%	85%	$0.21	1,518
Multi Family	Heat Room	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	2,254	30	$592	25%	20%	$0.00	15,209
Multi Family	Heat Room	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	412	11	$358	75%	50%	$0.11	17,424
Multi Family	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	82	30	$249	50%	90%	$0.28	3,931
Multi Family	Heat Room	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	1,362	30	$978	85%	25%	$0.05	25,972
Multi Family	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	9	30	$202	51%	85%	$2.02	443
Multi Family	Heat Room	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	106	30	$2,086	51%	50%	$1.95	2,804
Multi Family	Heat Room	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	166	30	$2,086	51%	20%	$1.23	1,765
Multi Family	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	69	30	$166	90%	95%	$0.22	3,491
Multi Family	Heat Room	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	1,138	45	$3,569	50%	95%	$0.27	1,555
Multi Family	Heat Room	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	310	45	$1,387	50%	95%	$0.39	406
Multi Family	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	New	1,306	20	$7,444	89%	N/A	$0.63	55,673
Multi Family	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	77	20	$25	95%	80%	$0.01	1,767
Multi Family	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	51	20	$54	95%	60%	$0.09	873
Multi Family	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	42	30	$219	75%	85%	$0.50	1,479
Multi Family	Heat Room	Green Roof	ecoroof	Standard Roof	Per installation	New	181	40	$7,290	50%	95%	$3.79	918
Multi Family	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	51	30	$341	75%	90%	$0.64	1,901
Multi Family	Heat Room	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	8	45	$795	40%	75%	$9.23	127
Multi Family	Heat Room	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	188	30	$588	50%	95%	$0.29	4,589
Multi Family	Heat Room	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	12	30	$277	95%	75%	$2.13	494
Multi Family	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	8	30	$239	95%	75%	$2.75	329
Multi Family	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	Existing	56	5	$0.91	100%	N/A	$-0.01	6,543
Multi Family	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	Existing	16	10	$16	80%	85%	$0.16	569
Multi Family	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	New	56	5	$0.91	100%	N/A	$-0.01	1,059
Multi Family	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	New	22	10	$16	80%	85%	$0.11	325
Multi Family	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	Existing	49	5	$3	100%	N/A	$0.00	14,683
Multi Family	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	New	49	5	$3	100%	N/A	$0.00	1,949
Multi Family	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	Existing	20	20	$147	25%	95%	$0.81	89

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	Existing	47	5	$2	100%	N/A	$-0.00	38,600
Multi Family	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	Existing	56	20	$36	50%	N/A	$0.06	45,696
Multi Family	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	Existing	5	10	$32	85%	95%	$1.03	1,829
Multi Family	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	New	28	20	$147	25%	95%	$0.59	51
Multi Family	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	New	47	5	$2	100%	N/A	$-0.00	7,237
Multi Family	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	New	56	20	$36	50%	N/A	$0.06	7,663
Multi Family	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	New	7	10	$32	85%	95%	$0.75	1,047
Multi Family	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	Existing	9	15	$79	100%	N/A	$1.05	1,778
Multi Family	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	New	9	15	$79	100%	N/A	$1.05	703
Multi Family	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	Existing	36	5	$3	100%	N/A	$0.01	7,262
Multi Family	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	New	36	5	$3	100%	N/A	$0.01	843
Multi Family	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	Existing	17	7	$30	50%	50%	$0.35	5,032
Multi Family	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	Existing	0.55	7	$2	50%	80%	$0.98	598
Multi Family	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	Existing	39	6	$5	10%	50%	$0.01	522
Multi Family	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	Existing	5	5	$5	20%	50%	$0.26	133
Multi Family	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	Existing	102	5	$22	50%	85%	$0.04	11,494
Multi Family	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	New	17	7	$30	50%	50%	$0.35	2,196
Multi Family	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	New	0.55	7	$2	50%	80%	$0.98	261
Multi Family	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	New	39	6	$5	10%	50%	$0.01	227
Multi Family	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	New	5	5	$5	20%	50%	$0.26	58
Multi Family	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	New	102	5	$22	50%	85%	$0.04	5,016
Multi Family	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	Existing	122	20	$15	97%	N/A	$0.00	11,252
Multi Family	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	Per installation	Existing	473	9	$102	3%	**%	$0.03	2,939
Multi Family	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	New	122	20	$15	100%	N/A	$0.00	6,864
Multi Family	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	Existing	164	5	$12	100%	N/A	$0.01	53,480
Multi Family	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	New	164	5	$12	100%	N/A	$0.01	5,745
Multi Family	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	Existing	112	10	$19	100%	N/A	$0.01	39,584
Multi Family	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	New	112	10	$19	100%	N/A	$0.01	9,560
Multi Family	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	Existing	223	10	$19	100%	N/A	$0.00	7,715
Multi Family	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	New	223	10	$19	100%	N/A	$0.00	1,863

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	Existing	110	20	$172	50%	N/A	$0.16	7,312
Multi Family	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	Existing	330	20	$194	50%	N/A	$0.05	21,936
Multi Family	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	New	86	20	$172	50%	N/A	$0.21	3,470
Multi Family	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	New	258	20	$194	50%	N/A	$0.07	10,411
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	111	14	$227	79%	87%	$-0.25	4,151
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	148	14	$296	79%	95%	$-0.23	6,064
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	169	14	$317	79%	99%	$-0.21	7,200
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	58%	50%	$0.16	1,551
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	58%	50%	$3.50	6,553
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$0.13	14,161
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$2.77	91,576
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$0.15	3,880
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$3.33	28,001
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-0.06	11,232
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-1.21	41,776
Multi Family	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	Existing	62	15	$47	100%	N/A	$0.09	1,491
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	117	5	$8	95%	45%	$0.31	61,354
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	117	5	$8	95%	45%	$0.01	7,446
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	112	14	$227	79%	87%	$-0.24	1,906
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	149	14	$296	79%	95%	$-0.22	2,784
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	170	14	$317	79%	99%	$-0.21	3,306
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	58%	50%	$0.16	712
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	58%	50%	$3.45	71,756
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$459	59%	90%	$0.10	12,780

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$459	59%	90%	$2.33	44,355
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$0.15	1,628
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$3.28	90,470
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-0.08	5,157
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-1.48	9,304
Multi Family	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	New	55	15	$47	100%	N/A	$0.10	385
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	101	5	$8	95%	45%	$0.01	2,881
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	101	5	$8	95%	45%	$0.25	44,728
Single Family	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	Existing	48	5	$22	100%	N/A	$0.12	63,823
Single Family	Computer	Computer, Energy Star	Energy Star Computer	Standard Computer	Per installation	New	48	5	$22	100%	N/A	$0.12	7,262
Single Family	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	Existing	58	20	$282	100%	N/A	$0.55	25,020
Single Family	Cooking Oven	Cooking Oven, High Efficiency	High Efficiency Oven	Standard Oven	Per installation	New	58	20	$282	100%	N/A	$0.55	14,975
Single Family	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	99	5	$576	50%	95%	$1.62	5,311
Single Family	Cool Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	2	30	$25	95%	50%	$1.02	716
Single Family	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	26	10	$93	85%	50%	$0.58	3,802
Single Family	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	13	30	$564	75%	95%	$4.15	619
Single Family	Cool Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	206	30	$2,602	75%	35%	$1.26	4,048
Single Family	Cool Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	413	30	$2,602	95%	1%	$0.63	344
Single Family	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	Existing	235	15	$1,177	100%	N/A	$0.65	11,944
Single Family	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	Existing	89	5	$204	95%	75%	$0.63	7,175
Single Family	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	11	20	$462	85%	95%	$4.48	604
Single Family	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	10	20	$25	95%	80%	$0.26	732
Single Family	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	7	20	$54	95%	60%	$0.85	338
Single Family	Cool Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	4	6	$46	95%	50%	$2.38	308
Single Family	Cool Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	29	20	$672	75%	75%	$2.65	1,119
Single Family	Cool Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	99	18	$535	75%	60%	$0.64	3,927
Single Family	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	20	30	$743	25%	85%	$3.72	272
Single Family	Cool Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	393	30	$2,802	25%	20%	$0.71	1,642
Single Family	Cool Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	99	11	$575	75%	50%	$0.90	3,051
Single Family	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	94	15	$5	95%	65%	$0.00	3,609
Single Family	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	59	30	$1,101	50%	90%	$1.84	1,906
Single Family	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	67	11	$1,271	75%	95%	$2.95	3,259
Single Family	Cool Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	234	30	$2,128	85%	25%	$0.90	2,935
Single Family	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	Existing	149	20	$1,621	50%	95%	$1.24	3,983

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	139	30	$204	50%	50%	$0.14	3,204
Single Family	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	30	$440	65%	75%	$26.11	51
Single Family	Cool Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	18	30	$4,539	65%	25%	$25.17	183
Single Family	Cool Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	28	30	$4,539	65%	25%	$16.06	288
Single Family	Cool Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	89	5	$576	50%	95%	$1.80	2,273
Single Family	Cool Central	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	23	10	$93	85%	50%	$0.65	1,627
Single Family	Cool Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	17	30	$659	90%	95%	$3.89	450
Single Family	Cool Central	Central Cooling, SEER 18	SEER 18	SEER 13	Per installation	New	204	15	$1,281	100%	N/A	$0.82	4,546
Single Family	Cool Central	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	New	80	5	$204	95%	75%	$0.70	3,070
Single Family	Cool Central	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	287	45	$7,109	50%	95%	$2.31	239
Single Family	Cool Central	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	107	45	$2,763	50%	95%	$2.39	85
Single Family	Cool Central	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	10	20	$538	85%	95%	$5.80	206
Single Family	Cool Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	9	20	$25	95%	80%	$0.29	307
Single Family	Cool Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	6	20	$54	95%	60%	$0.94	152
Single Family	Cool Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	18	30	$869	75%	85%	$4.84	349
Single Family	Cool Central	Green Roof	ecoroof	Standard Roof	Per installation	New	45	40	$27,367	50%	95%	$56.82	129
Single Family	Cool Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	84	15	$5	95%	65%	$0.00	1,545
Single Family	Cool Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	53	30	$1,282	75%	90%	$2.38	1,264
Single Family	Cool Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	49	45	$795	75%	75%	$1.50	1,005
Single Family	Cool Central	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	127	30	$1,209	85%	95%	$0.95	4,190
Single Family	Cool Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	61	11	$1,271	75%	95%	$3.28	1,415
Single Family	Cool Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	46	30	$1,172	50%	95%	$2.52	662
Single Family	Cool Central	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	New	134	20	$1,621	50%	95%	$1.38	1,704
Single Family	Cool Central	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	125	30	$204	75%	50%	$0.16	2,057
Single Family	Cool Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	3	30	$552	95%	75%	$17.72	66
Single Family	Cool Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	2	30	$476	95%	75%	$22.64	44
Single Family	Cool Room	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	1	30	$25	95%	50%	$1.92	196
Single Family	Cool Room	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	14	10	$93	85%	50%	$1.11	846
Single Family	Cool Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	7	30	$564	75%	95%	$7.60	187
Single Family	Cool Room	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	112	30	$2,602	75%	35%	$2.33	1,138
Single Family	Cool Room	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	224	30	$2,602	95%	1%	$1.16	92

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Cool Room	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	6	20	$462	85%	95%	$8.44	177
Single Family	Cool Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	5	20	$25	95%	80%	$0.49	192
Single Family	Cool Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	3	20	$54	95%	60%	$1.60	93
Single Family	Cool Room	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	2	6	$46	95%	50%	$4.49	84
Single Family	Cool Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	10	30	$743	25%	85%	$6.95	80
Single Family	Cool Room	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	210	30	$2,802	25%	20%	$1.33	455
Single Family	Cool Room	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	53	11	$575	75%	50%	$1.71	806
Single Family	Cool Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	31	30	$1,101	50%	90%	$3.47	523
Single Family	Cool Room	Room AC conversion to Ductless Heat Pump	SEER 13	EER 9.8	Per installation	Existing	64	20	$7,204	75%	N/A	$12.90	1,833
Single Family	Cool Room	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	127	30	$2,128	85%	25%	$1.67	856
Single Family	Cool Room	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	74	30	$204	50%	50%	$0.27	841
Single Family	Cool Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	0.92	30	$440	65%	75%	$47.66	15
Single Family	Cool Room	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	9	30	$4,539	65%	25%	$45.94	55
Single Family	Cool Room	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	15	30	$4,539	65%	25%	$29.31	87
Single Family	Cool Room	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	13	10	$93	85%	50%	$1.14	371
Single Family	Cool Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	10	30	$659	90%	95%	$6.60	130
Single Family	Cool Room	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	164	45	$7,109	50%	95%	$4.03	64
Single Family	Cool Room	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	61	45	$2,763	50%	95%	$4.18	22
Single Family	Cool Room	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	6	20	$538	85%	95%	$10.13	58
Single Family	Cool Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	5	20	$25	95%	80%	$0.51	82
Single Family	Cool Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	3	20	$54	95%	60%	$1.65	36
Single Family	Cool Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	10	30	$869	75%	85%	$8.38	99
Single Family	Cool Room	Green Roof	ecoroof	Standard Roof	Per installation	New	26	40	$27,367	50%	95%	$99.14	36
Single Family	Cool Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	30	30	$1,282	75%	90%	$4.16	338
Single Family	Cool Room	Room AC conversion to Ductless Heat Pump	SEER 13	EER 9.8	Per installation	New	64	20	$7,204	75%	N/A	$12.92	378
Single Family	Cool Room	Room AC, EER 10.8	EER 10.8	EER 9.8	Per installation	New	17	9	$7	100%	N/A	$0.07	80
Single Family	Cool Room	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	28	45	$795	75%	75%	$2.62	269
Single Family	Cool Room	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	76	30	$1,209	85%	95%	$1.58	1,191
Single Family	Cool Room	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	27	30	$1,172	50%	95%	$4.31	181
Single Family	Cool Room	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	72	30	$204	75%	50%	$0.28	554
Single Family	Cool Room	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	1	30	$552	95%	75%	$29.67	19

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Cool Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$476	95%	75%	$38.27	12
Single Family	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	Existing	50	14	$224	100%	N/A	$0.59	26,174
Single Family	Dryer	Dryer, Advanced Efficiency EF 3.30	Advanced Efficiency Dryer 3.30	Standard Dryer EF 3.01	Per installation	New	50	14	$224	100%	N/A	$0.59	9,541
Single Family	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	Existing	46	20	$22	76%	N/A	$0.04	5,027
Single Family	Freezer	Stand-Alone Freezer - Removal	Proper Disposal of Freezer	Existing Non-Efficient Freezer	Per installation	Existing	535	8	$99	24%	**%	$0.02	50,032
Single Family	Freezer	Freezer, Energy Star	Energy Star Freezer	Standard Freezer	Per installation	New	46	20	$22	76%	N/A	$0.04	4,570
Single Family	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	900	5	$576	50%	95%	$0.15	21,233
Single Family	Heat Central	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	30	30	$25	95%	50%	$0.05	4,791
Single Family	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	168	30	$564	75%	95%	$0.30	3,962
Single Family	Heat Central	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	2,556	30	$2,602	75%	35%	$0.07	25,980
Single Family	Heat Central	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	5,119	30	$2,602	95%	1%	$0.02	2,274
Single Family	Heat Central	Conversion Electric Furnace to ASHP	Air Source Heat Pump Seer 13 HSPF 7.7	Electric Furnace HSPF 1	Per installation	Existing	4,860	20	$2,883	92%	N/A	$0.04	96,251
Single Family	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	135	20	$25	95%	80%	$-0.01	4,854
Single Family	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	90	20	$54	95%	60%	$0.04	2,321
Single Family	Heat Central	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	58	6	$46	95%	50%	$0.16	1,991
Single Family	Heat Central	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	360	20	$672	75%	75%	$0.18	7,211
Single Family	Heat Central	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	900	18	$535	75%	60%	$0.04	18,224
Single Family	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	248	30	$743	25%	85%	$0.27	1,835
Single Family	Heat Central	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	4,877	30	$2,802	25%	20%	$0.02	11,345
Single Family	Heat Central	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	900	11	$575	75%	50%	$0.07	13,576
Single Family	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	180	15	$5	15%	65%	$-0.03	558
Single Family	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	180	30	$1,101	50%	90%	$0.58	2,631
Single Family	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	612	11	$1,271	75%	95%	$0.29	15,089
Single Family	Heat Central	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	2,910	30	$2,128	85%	25%	$0.04	19,931
Single Family	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	20	30	$440	65%	75%	$2.08	325
Single Family	Heat Central	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	224	30	$4,539	65%	25%	$2.00	1,165
Single Family	Heat Central	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	351	30	$4,539	65%	25%	$1.26	1,838
Single Family	Heat Central	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	556	5	$576	50%	95%	$0.26	5,725
Single Family	Heat Central	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	144	30	$659	90%	95%	$0.42	2,026
Single Family	Heat Central	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	2,446	45	$7,109	50%	95%	$0.24	994
Single Family	Heat Central	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	667	45	$2,763	50%	95%	$0.35	260

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Heat Central	Conversion Electric Furnace to ASHP	Air Source Heat Pump Seer 13 HSPF 7.7	Electric Furnace HSPF 1	Per installation	New	3,002	20	$2,758	92%	N/A	$0.07	36,292
Single Family	Heat Central	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	83	20	$25	95%	80%	$0.00	1,308
Single Family	Heat Central	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	55	20	$54	95%	60%	$0.08	647
Single Family	Heat Central	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	153	30	$869	75%	85%	$0.54	1,488
Single Family	Heat Central	Green Roof	ecoroof	Standard Roof	Per installation	New	389	40	$27,367	50%	95%	$6.64	541
Single Family	Heat Central	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	111	15	$5	15%	65%	$-0.03	157
Single Family	Heat Central	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	111	30	$1,282	75%	90%	$1.12	1,122
Single Family	Heat Central	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	17	45	$795	75%	75%	$4.27	142
Single Family	Heat Central	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	1,082	30	$1,209	85%	95%	$0.08	17,738
Single Family	Heat Central	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	378	11	$1,271	75%	95%	$0.50	4,310
Single Family	Heat Central	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	396	30	$1,172	50%	95%	$0.26	2,871
Single Family	Heat Central	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	26	30	$552	95%	75%	$2.05	280
Single Family	Heat Central	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	17	30	$476	95%	75%	$2.63	188
Single Family	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	714	5	$576	50%	95%	$0.20	10,390
Single Family	Heat Pump	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	23	30	$25	95%	50%	$0.08	2,345
Single Family	Heat Pump	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	Existing	26	10	$93	85%	50%	$0.56	1,039
Single Family	Heat Pump	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	53	30	$564	75%	95%	$1.03	811
Single Family	Heat Pump	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	849	30	$2,602	75%	35%	$0.28	5,233
Single Family	Heat Pump	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	1,701	30	$2,602	95%	1%	$0.13	399
Single Family	Heat Pump	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	Existing	89	5	$204	95%	75%	$0.61	1,961
Single Family	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	Existing	11	20	$462	85%	95%	$4.46	201
Single Family	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	103	20	$25	95%	80%	$0.00	2,241
Single Family	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	68	20	$54	95%	60%	$0.06	1,081
Single Family	Heat Pump	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	46	6	$46	95%	50%	$0.22	1,064
Single Family	Heat Pump	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	274	20	$672	75%	75%	$0.25	3,706
Single Family	Heat Pump	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	714	18	$535	75%	60%	$0.06	8,796
Single Family	Heat Pump	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	197	30	$743	25%	85%	$0.35	952
Single Family	Heat Pump	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	3,870	30	$2,802	25%	20%	$0.05	5,473
Single Family	Heat Pump	Ground Source Heat Pump, EER 16.2, COP 3.6	GSHP EER 16.2, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	Existing	2,499	20	$10,045	40%	N/A	$0.43	13,401
Single Family	Heat Pump	Heat Pump Premium Efficiency, SEER 16, HSPF 8.8	ASHP SEER 16, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	Existing	506	20	$1,233	100%	N/A	$0.25	3,133

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Heat Pump	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	714	11	$575	75%	50%	$0.10	6,912
Single Family	Heat Pump	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	673	15	$5	95%	65%	$-0.03	8,732
Single Family	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	192	30	$1,101	50%	90%	$0.55	1,865
Single Family	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	485	11	$1,271	75%	95%	$0.39	7,820
Single Family	Heat Pump	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	962	30	$2,128	85%	25%	$0.19	3,781
Single Family	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	Existing	149	20	$1,621	50%	95%	$1.22	1,088
Single Family	Heat Pump	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	Existing	139	30	$204	50%	50%	$0.12	867
Single Family	Heat Pump	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	6	30	$440	65%	75%	$6.39	70
Single Family	Heat Pump	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	73	30	$4,539	65%	25%	$6.16	251
Single Family	Heat Pump	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	115	30	$4,539	65%	25%	$3.92	396
Single Family	Heat Pump	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	549	5	$576	50%	95%	$0.27	3,626
Single Family	Heat Pump	Ceiling Fan	Ceiling Fan (no lighting kit)	No Ceiling Fan	Per installation	New	20	10	$93	85%	50%	$0.74	362
Single Family	Heat Pump	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	54	30	$659	90%	95%	$1.19	494
Single Family	Heat Pump	Check Me! O&M Tune-up	Tune-up/Maintenance	No Tune-up Maintenance	Per installation	New	69	5	$204	95%	75%	$0.80	684
Single Family	Heat Pump	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	2,326	45	$7,109	50%	95%	$0.26	699
Single Family	Heat Pump	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	659	45	$2,763	50%	95%	$0.36	184
Single Family	Heat Pump	Cool Roofs	Lighter Colored Shingles (White)	Standard Roof Shingles	Per installation	New	9	20	$538	85%	95%	$6.76	61
Single Family	Heat Pump	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	79	20	$25	95%	80%	$0.01	782
Single Family	Heat Pump	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	53	20	$54	95%	60%	$0.09	387
Single Family	Heat Pump	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	151	30	$869	75%	85%	$0.55	1,082
Single Family	Heat Pump	Green Roof	ecoroof	Standard Roof	Per installation	New	369	40	$27,367	50%	95%	$7.00	368
Single Family	Heat Pump	Ground Source Heat Pump, EER 16.2, COP 3.6	GSHP EER 16.2, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	New	2,005	20	$10,169	40%	N/A	$0.56	7,108
Single Family	Heat Pump	Heat Pump Premium Efficiency, SEER 16, HSPF 8.8	ASHP SEER 16, HSPF 8.8	ASHP SEER 13, HSPF 7.7	Per installation	New	408	20	$1,233	100%	N/A	$0.32	2,139
Single Family	Heat Pump	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	518	15	$5	95%	65%	$-0.03	3,336
Single Family	Heat Pump	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	148	30	$1,282	75%	90%	$0.84	1,088
Single Family	Heat Pump	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	47	45	$795	75%	75%	$1.55	279
Single Family	Heat Pump	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	402	30	$1,209	85%	95%	$0.27	4,076
Single Family	Heat Pump	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	373	11	$1,271	75%	95%	$0.51	3,132
Single Family	Heat Pump	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	148	30	$1,172	50%	95%	$0.76	698
Single Family	Heat Pump	Whole-House Fan	Whole-House Fan	No Whole-House Fan	Per installation	New	115	20	$1,621	50%	95%	$1.59	380

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Heat Pump	Window Overhang	Overhangs over windows for shading	No window overhangs	Per installation	New	107	30	$204	75%	50%	$0.16	514
Single Family	Heat Pump	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	9	30	$552	95%	75%	$5.56	74
Single Family	Heat Pump	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	6	30	$476	95%	75%	$6.84	52
Single Family	Heat Room	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	23	30	$25	95%	50%	$0.07	8,164
Single Family	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	133	30	$564	75%	95%	$0.39	7,455
Single Family	Heat Room	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	2,014	30	$2,602	75%	35%	$0.10	47,063
Single Family	Heat Room	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	4,034	30	$2,602	95%	1%	$0.03	3,793
Single Family	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	Existing	3,500	20	$7,444	68%	N/A	$0.21	19,684
Single Family	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	103	20	$25	95%	80%	$-0.01	7,910
Single Family	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	69	20	$54	95%	60%	$0.06	3,782
Single Family	Heat Room	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	45	6	$46	95%	50%	$0.22	3,386
Single Family	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	192	30	$743	25%	85%	$0.35	3,223
Single Family	Heat Room	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	3,789	30	$2,802	25%	20%	$0.04	18,651
Single Family	Heat Room	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	693	11	$575	75%	50%	$0.10	21,367
Single Family	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	138	30	$1,101	50%	90%	$0.76	4,809
Single Family	Heat Room	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	2,289	30	$2,128	85%	25%	$0.06	34,737
Single Family	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	16	30	$440	65%	75%	$2.62	614
Single Family	Heat Room	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	178	30	$4,539	65%	25%	$2.52	2,198
Single Family	Heat Room	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	279	30	$4,539	65%	25%	$1.60	3,468
Single Family	Heat Room	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	114	30	$659	90%	95%	$0.54	3,364
Single Family	Heat Room	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	1,884	45	$7,109	50%	95%	$0.32	1,604
Single Family	Heat Room	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	513	45	$2,763	50%	95%	$0.47	419
Single Family	Heat Room	Conversion Baseboard Heating to DHP	Ductless Heat Pump HSPF 7.7	HSPF = 1	Per installation	New	1,841	20	$7,444	68%	N/A	$0.43	36,062
Single Family	Heat Room	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	64	20	$25	95%	80%	$0.01	2,133
Single Family	Heat Room	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	42	20	$54	95%	60%	$0.11	880
Single Family	Heat Room	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	119	30	$869	75%	85%	$0.70	2,545
Single Family	Heat Room	Green Roof	ecoroof	Standard Roof	Per installation	New	299	40	$27,367	50%	95%	$8.63	917
Single Family	Heat Room	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	85	30	$1,282	75%	90%	$1.47	1,902
Single Family	Heat Room	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	13	45	$795	75%	75%	$5.56	241
Single Family	Heat Room	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	875	30	$1,209	85%	95%	$0.11	30,529
Single Family	Heat Room	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	312	30	$1,172	50%	95%	$0.34	4,733

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Heat Room	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	21	30	$552	95%	75%	$2.56	494
Single Family	Heat Room	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	14	30	$476	95%	75%	$3.31	329
Single Family	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	Existing	56	5	$0.91	100%	N/A	$-0.01	76,701
Single Family	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	Existing	11	10	$16	80%	85%	$0.23	7,145
Single Family	Lighting Exterior	CFL, Flood (17 W)	CFL, Flood	Standard Incandescent Flood	Per installation	New	56	5	$0.91	100%	N/A	$-0.01	10,574
Single Family	Lighting Exterior	Time Clocks (Exterior Lighting)	Exterior Lighting on a Time Clock	Exterior Lighting (Manual Control)	Per installation	New	13	10	$16	80%	85%	$0.20	3,428
Single Family	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	Existing	49	5	$3	100%	N/A	$0.00	710
Single Family	Lighting Interior Specialty	CFL (13 W, 20 W, 25 W)	CFL (3-Way)	Standard Incandescent (3-Way)	Per installation	New	49	5	$3	100%	N/A	$0.00	11,798
Single Family	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	Existing	10	20	$147	60%	95%	$1.56	1,494
Single Family	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	Existing	47	5	$2	100%	N/A	$-0.00	46,860
Single Family	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	Existing	56	20	$36	50%	N/A	$0.06	21,814
Single Family	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	Existing	6	10	$32	85%	95%	$0.82	13,005
Single Family	Lighting Interior Standard	Daylighting Controls (Photocell) - Indoor/Outdoors	Install Photocell	No Daylighting Controls	Per installation	New	12	20	$147	60%	95%	$1.36	717
Single Family	Lighting Interior Standard	Lighting CFL 15 W	15 W CFL	Standard 60 W Incandescent	Per installation	New	47	5	$2	100%	N/A	$-0.00	39,096
Single Family	Lighting Interior Standard	Lighting LED 7 W	7 W LED	Standard 60 W Incandescent	Per installation	New	56	20	$36	50%	N/A	$0.06	46,297
Single Family	Lighting Interior Standard	Occupancy Sensors	Wall-Switch Occupancy Sensors	No Occupancy Sensor	Per installation	New	7	10	$32	85%	95%	$0.71	6,242
Single Family	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	Existing	9	15	$79	100%	N/A	$1.05	5,711
Single Family	Microwave	Microwave, High Efficiency	High Efficiency Microwave	Standard Microwave	Per installation	New	9	15	$79	100%	N/A	$1.05	2,320
Single Family	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	Existing	36	5	$3	100%	N/A	$0.01	37,788
Single Family	Monitor	Monitor, Energy Star	Energy Star Monitor	Standard Monitor	Per installation	New	36	5	$3	100%	N/A	$0.01	4,386
Single Family	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	Existing	17	7	$30	50%	50%	$0.35	28,900
Single Family	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	Existing	1	7	$2	50%	80%	$0.40	4,681
Single Family	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	Existing	39	6	$5	20%	50%	$0.01	3,431
Single Family	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	Existing	5	5	$5	50%	50%	$0.26	1,099
Single Family	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	Existing	102	5	$22	50%	85%	$0.04	37,797
Single Family	Plug Load Other	1-Watt Standby Power	1W or less standby power use for small appliances	Standard plug load appliance.	Per installation	New	17	7	$30	50%	50%	$0.35	12,612

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Plug Load Other	Energy Star Battery Chargers	Energy Star Battery Chargers	Standard Battery Chargers	Per installation	New	1	7	$2	50%	80%	$0.40	2,042
Single Family	Plug Load Other	Office Copier	Office Copier	Standard Copier	Per installation	New	39	6	$5	20%	50%	$0.01	1,497
Single Family	Plug Load Other	Office Printer	Office Printer	Standard Copier	Per installation	New	5	5	$5	50%	50%	$0.26	479
Single Family	Plug Load Other	Smart Strip	Smart Strip	Standard PowerStrip	Per installation	New	102	5	$22	50%	85%	$0.04	16,495
Single Family	Pool Pump	Pool Pump Timers	Pool Pump Timers	Pool Pump No Timers	Per installation	Existing	292	10	$45	95%	50%	$0.01	3,172
Single Family	Pool Pump	Pool Pump, 2 Speed	2 Speed Pool Pump	Standard 1 Speed Pool Pump	Per installation	Existing	570	10	$110	75%	N/A	$0.02	2,703
Single Family	Pool Pump	Pool Pump, VSD	VSD Pool Pump	Standard 1 Speed Pool Pump	Per installation	Existing	630	10	$819	75%	N/A	$0.20	10,371
Single Family	Pool Pump	Pool Pump Timers	Pool Pump Timers	Pool Pump No Timers	Per installation	New	293	10	$45	95%	50%	$0.01	1,396
Single Family	Pool Pump	Pool Pump, 2 Speed	2 Speed Pool Pump	Standard 1 Speed Pool Pump	Per installation	New	570	10	$110	75%	N/A	$0.02	634
Single Family	Pool Pump	Pool Pump, VSD	VSD Pool Pump	Standard 1 Speed Pool Pump	Per installation	New	630	10	$819	75%	N/A	$0.20	2,258
Single Family	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	Existing	122	20	$15	74%	N/A	$0.00	21,433
Single Family	Refrigerator	Refrigerator/Freezer - Removal of Secondary	Proper Disposal of Refrigerator/Freezer	Existing Non-Efficient Refrigerator/Freezer	Per installation	Existing	474	9	$102	26%	**%	$0.03	11,494
Single Family	Refrigerator	Refrigerator, Energy Star	Energy Star Refrigerator	Standard Refrigerator	Per installation	New	122	20	$15	100%	N/A	$0.00	27,382
Single Family	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	Existing	164	5	$12	100%	N/A	$0.01	21,251
Single Family	Set Top Box	Set Top Box, Energy Star	Energy Star Set Top Box	Standard Set Top Box	Per installation	New	164	5	$12	100%	N/A	$0.01	23,768
Single Family	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	Existing	112	10	$19	100%	N/A	$0.01	65,046
Single Family	Tv	TV CRT, Energy Star	Energy Star CRT TV	Standard CRT TV	Per installation	New	112	10	$19	100%	N/A	$0.01	39,861
Single Family	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	Existing	223	10	$19	100%	N/A	$0.00	70,403
Single Family	Tv Bigscreen	TV LCD, Energy Star	Energy Star LCD TV	Standard LCD TV	Per installation	New	223	10	$19	100%	N/A	$0.00	17,003
Single Family	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	Existing	139	20	$172	50%	N/A	$0.12	30,539
Single Family	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	Existing	417	20	$194	50%	N/A	$0.03	91,619
Single Family	Ventilation And Circulation	Motor, ECM	ECM Motor	Standard Motor	Per installation	New	120	20	$172	50%	N/A	$0.14	16,008
Single Family	Ventilation And Circulation	Motor, ECM - VFD	ECM/VFD Motor	Standard Motor	Per installation	New	362	20	$194	50%	N/A	$0.04	48,024
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	111	14	$227	99%	88%	$-0.25	10,082
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	148	14	$296	99%	90%	$-0.23	13,786
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	Existing	169	14	$317	99%	95%	$-0.21	16,581
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	71%	50%	$0.16	3,641
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	32	12	$42	71%	50%	$3.49	69,707

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$0.13	27,433
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	370	40	$540	29%	90%	$2.77	7,749
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$0.15	7,686
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	39	5	$23	95%	75%	$3.32	65,761
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-0.06	42,907
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	111	10	$16	95%	65%	$-1.21	36,331
Single Family	Water Heat	Water Heater, Heat Pump EF 2.2	Heat Pump Water Heater EF = 2.2	Standard Storage Water Heater EF = 0.92	Per installation	Existing	1,941	15	$1,365	59%	N/A	$0.08	22,484
Single Family	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	Existing	109	15	$47	100%	N/A	$0.04	4,074
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	205	5	$8	95%	45%	$-0.00	25,196
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	205	5	$8	95%	45%	$0.18	23,977
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	112	14	$227	99%	88%	$-0.24	4,628
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	149	14	$296	99%	90%	$-0.22	6,328
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Electric DHW & Dryer	MEF = 1.66 - Electric DHW & Dryer	Per installation	New	170	14	$317	99%	95%	$-0.21	7,611
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	71%	50%	$0.16	1,671
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	32	12	$42	71%	50%	$3.46	86,547
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$526	59%	90%	$0.12	24,760
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	373	40	$526	59%	90%	$2.67	66,255
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$0.15	3,327
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	39	5	$23	95%	75%	$3.29	76,325
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-0.07	19,697
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	111	10	$9	95%	65%	$-1.48	59,835
Single Family	Water Heat	Water Heater, Heat Pump EF 2.2	Heat Pump Water Heater EF = 2.2	Standard Storage Water Heater EF = 0.92	Per installation	New	1,682	15	$1,365	59%	N/A	$0.10	74,675
Single Family	Water Heat	Water Heater, Storage EF 0.95	Standard Storage Water Heater EF = 0.95	Standard Storage Water Heater EF = 0.92	Per installation	New	94	15	$47	100%	N/A	$0.05	1,078
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	173	5	$8	95%	45%	$0.00	9,545
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	173	5	$8	95%	45%	$0.15	52,116

Table B.3.2. Commercial Electric Measure Details

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Dry Goods Retail	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$28	100%	N/A	$0.06	1,610
Dry Goods Retail	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$28	100%	N/A	$0.06	154
Dry Goods Retail	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	620	15	$747	25%	94%	$0.15	2,672
Dry Goods Retail	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.62	15	$2	15%	67%	$0.63	2,437
Dry Goods Retail	Cooling Dx	DX Package 240 to 760 kBTU/hr - Premium Efficiency	DX Package 240 to 760 kBTU/hr - Premium Efficiency 10.8 EER	DX Package 240 to 760 kBTU/hr - Standard Efficiency 10.0 EER	Per installation	Existing	2,771	15	$8,231	100%	N/A	$0.39	7,193
Dry Goods Retail	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	62	10	$169	10%	80%	$0.45	1,131
Dry Goods Retail	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	310	4	$335	95%	72%	$0.41	6,951
Dry Goods Retail	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.51	15	$2	50%	94%	$0.51	10,956
Dry Goods Retail	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	100	5	$193	75%	59%	$0.53	1,359
Dry Goods Retail	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	67	15	$171	75%	76%	$0.33	6,099
Dry Goods Retail	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	100	5	$78	50%	80%	$0.21	1,665
Dry Goods Retail	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.05	18	$0.22	45%	65%	$0.52	603
Dry Goods Retail	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.20	40	$9	4%	98%	$4.50	212
Dry Goods Retail	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.31	10%	39%	$0.03	238
Dry Goods Retail	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.01	25	$1	75%	85%	$16.17	219
Dry Goods Retail	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.23	2,024
Dry Goods Retail	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	584	10	$137	95%	26%	$0.03	463
Dry Goods Retail	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.25	7	$0.18	90%	85%	$0.15	12,065
Dry Goods Retail	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.31	39
Dry Goods Retail	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	3	25	$30	15%	80%	$1.01	1,178
Dry Goods Retail	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.68 (Average Existing Conditions)	per window sqft	Existing	2	25	$64	15%	80%	$2.53	987
Dry Goods Retail	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	326	15	$399	25%	94%	$0.16	777
Dry Goods Retail	Cooling Dx	DX Package 240 to 760 kBTU/hr - Premium Efficiency	DX Package 240 to 760 kBTU/hr - Premium Efficiency 10.8 EER	DX Package 240 to 760 kBTU/hr - Standard Efficiency 10.0 EER	Per installation	New	1,507	15	$6,585	100%	N/A	$0.57	2,148
Dry Goods Retail	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.27	15	$2	50%	94%	$0.98	3,583
Dry Goods Retail	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	35	15	$171	75%	76%	$0.63	1,835
Dry Goods Retail	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.02	18	$0.22	45%	65%	$1.00	197

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Dry Goods Retail	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.10	40	$9	4%	98%	$8.56	68
Dry Goods Retail	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	6	30	$5	50%	95%	$0.08	2,588
Dry Goods Retail	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	307	10	$137	95%	13%	$0.07	131
Dry Goods Retail	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	80%	$1.92	2,156
Dry Goods Retail	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	Existing	5,607	15	$9,908	100%	N/A	$0.22	3,485
Dry Goods Retail	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	629	15	$747	25%	94%	$0.14	543
Dry Goods Retail	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.49	15	$2	15%	67%	$0.78	470
Dry Goods Retail	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	149	5	$193	75%	59%	$0.35	101
Dry Goods Retail	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	99	15	$171	75%	76%	$0.21	1,857
Dry Goods Retail	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	149	5	$78	50%	80%	$0.13	101
Dry Goods Retail	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.07	18	$0.22	45%	65%	$0.34	226
Dry Goods Retail	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.14	14	$0.93	5%	94%	$0.86	63
Dry Goods Retail	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.20	40	$9	4%	98%	$4.42	53
Dry Goods Retail	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	Existing	12,155	30	$18,825	5%	N/A	$2.56	354
Dry Goods Retail	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.31	10%	39%	$0.01	67
Dry Goods Retail	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.01	25	$0.49	25%	98%	$5.08	18
Dry Goods Retail	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.28	25	$1	75%	85%	$0.64	1,474
Dry Goods Retail	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.14	616
Dry Goods Retail	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.09	25	$0.93	35%	90%	$0.97	238
Dry Goods Retail	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.01	25	$0.29	35%	90%	$1.58	46
Dry Goods Retail	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.26	25	$2	10%	35%	$0.87	45
Dry Goods Retail	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	868	10	$137	95%	26%	$0.01	250
Dry Goods Retail	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.38	7	$0.18	90%	85%	$0.09	3,603
Dry Goods Retail	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.34	9
Dry Goods Retail	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	2	25	$30	15%	80%	$1.14	251
Dry Goods Retail	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.68 (Average Existing Conditions)	per window sqft	Existing	2	25	$64	15%	80%	$2.31	264
Dry Goods Retail	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	New	3,461	15	$7,926	100%	N/A	$0.29	1,143

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Dry Goods Retail	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	324	15	$399	25%	94%	$0.15	162
Dry Goods Retail	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	51	15	$171	75%	76%	$0.42	564
Dry Goods Retail	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.68	68
Dry Goods Retail	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.07	14	$0.93	5%	94%	$1.68	20
Dry Goods Retail	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.10	40	$9	4%	98%	$8.59	16
Dry Goods Retail	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	New	7,147	30	$65,046	5%	N/A	$2.22	110
Dry Goods Retail	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	98%	$9.91	17
Dry Goods Retail	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	90%	$3.11	14
Dry Goods Retail	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	6	30	$5	50%	95%	$0.08	503
Dry Goods Retail	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	447	10	$137	95%	13%	$0.04	39
Dry Goods Retail	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	80%	$2.23	441
Dry Goods Retail	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	2,556	10	$581	1%	85%	$0.03	68
Dry Goods Retail	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.33	15	$2	15%	67%	$1.17	3,490
Dry Goods Retail	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,909	18	$4,526	95%	65%	$0.28	2,970
Dry Goods Retail	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	27	15	$6	95%	76%	$0.03	1,698
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	Per HP	Existing	680	20	$110	65%	75%	$0.01	29,741
Dry Goods Retail	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	69	15	$178	5%	77%	$0.33	72
Dry Goods Retail	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	17	8	$4	65%	25%	$0.05	61
Dry Goods Retail	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	2,081	10	$581	1%	75%	$0.04	25
Dry Goods Retail	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,909	18	$4,526	95%	65%	$0.28	1,559
Dry Goods Retail	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.85	50	$2	8%	98%	$0.26	2,920
Dry Goods Retail	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	22	15	$6	95%	76%	$0.03	905
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	Per HP	New	554	20	$110	65%	75%	$0.02	12,690
Dry Goods Retail	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	56	15	$178	5%	77%	$0.41	30
Dry Goods Retail	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	9,601
Dry Goods Retail	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	72	8	$28	75%	70%	$0.06	1,551
Dry Goods Retail	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	247	15	$336	62%	90%	$0.17	13,487
Dry Goods Retail	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	7	14	$35	75%	95%	$0.60	253

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Dry Goods Retail	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	4,020
Dry Goods Retail	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	5,043
Dry Goods Retail	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	72	8	$28	75%	70%	$0.06	814
Dry Goods Retail	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	247	15	$336	62%	90%	$0.17	7,084
Dry Goods Retail	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	7	14	$35	75%	95%	$0.60	133
Dry Goods Retail	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	2,111
Dry Goods Retail	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	215	9	$110	10%	75%	$0.08	1,003
Dry Goods Retail	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	107	5	$12	70%	94%	$0.02	3,670
Dry Goods Retail	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.33	8	$0.98	30%	84%	$0.55	755
Dry Goods Retail	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.25	8	$0.73	30%	84%	$0.55	565
Dry Goods Retail	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	97	16	$16	95%	50%	$0.01	4,308
Dry Goods Retail	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	1,023
Dry Goods Retail	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	1	13	$0.84	90%	32%	$0.08	48,085
Dry Goods Retail	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.47	13	$0.05	90%	47%	$0.00	17,521
Dry Goods Retail	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.63	13	$0.18	90%	52%	$0.03	7,365
Dry Goods Retail	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.79	13	$0.36	75%	57%	$0.05	4,195
Dry Goods Retail	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.18	13	$0.16	70%	83%	$0.12	13,038
Dry Goods Retail	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	774	8	$70	45%	56%	$0.00	1,948
Dry Goods Retail	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	757	8	$201	85%	86%	$0.04	3,589
Dry Goods Retail	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	168	9	$110	10%	75%	$0.10	413
Dry Goods Retail	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	107	5	$12	70%	94%	$0.02	1,511
Dry Goods Retail	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.26	8	$0.98	30%	84%	$0.71	331
Dry Goods Retail	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.19	8	$0.73	30%	84%	$0.71	247
Dry Goods Retail	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	2,150
Dry Goods Retail	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.47	15	$0.03	90%	47%	$-0.00	9,203
Dry Goods Retail	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.63	15	$0.08	90%	52%	$0.01	3,868
Dry Goods Retail	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.79	15	$0.15	75%	57%	$0.01	2,203

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Dry Goods Retail	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.18	15	$0.04	70%	83%	$0.02	6,848
Dry Goods Retail	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	607	8	$70	45%	56%	$0.01	854
Dry Goods Retail	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	757	8	$200	85%	86%	$0.04	1,573
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$164	95%	45%	$0.52	89
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$0.00	95%	45%	$-0.01	95
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	46
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	140	5	$15	95%	40%	$0.02	559
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	87
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$164	95%	45%	$0.52	46
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$0.00	95%	45%	$-0.01	50
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	24
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	140	5	$15	95%	40%	$0.02	293
Dry Goods Retail	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	45
Dry Goods Retail	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.05	16
Dry Goods Retail	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	369	10	$0.00	95%	75%	$-0.01	553
Dry Goods Retail	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	4	4	$0.41	95%	86%	$0.02	262
Dry Goods Retail	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$123	3%	65%	$0.21	16
Dry Goods Retail	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,525	9	$566	25%	35%	$0.05	1,529
Dry Goods Retail	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	338	7	$566	25%	35%	$0.37	338
Dry Goods Retail	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	Existing	102	5	$22	60%	90%	$0.05	1,456
Dry Goods Retail	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	244	14	$165	5%	80%	$0.08	5
Dry Goods Retail	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	640	3	$175	5%	25%	$0.11	91
Dry Goods Retail	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.05	8
Dry Goods Retail	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	369	10	$0.00	95%	75%	$-0.01	290
Dry Goods Retail	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	4	4	$0.41	95%	86%	$0.02	138
Dry Goods Retail	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$123	3%	65%	$0.21	8
Dry Goods Retail	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	New	102	5	$22	60%	90%	$0.05	765

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Dry Goods Retail	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	244	14	$165	5%	80%	$0.08	2
Dry Goods Retail	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	620	15	$747	25%	94%	$0.12	1,062
Dry Goods Retail	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.26	15	$2	15%	67%	$1.42	360
Dry Goods Retail	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	100	5	$193	75%	59%	$0.50	907
Dry Goods Retail	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	67	15	$171	75%	76%	$0.29	1,849
Dry Goods Retail	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	100	5	$78	50%	80%	$0.18	1,093
Dry Goods Retail	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.05	18	$0.22	45%	65%	$0.49	223
Dry Goods Retail	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.31	14	$0.93	5%	94%	$0.37	216
Dry Goods Retail	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.31	10%	39%	$-0.02	189
Dry Goods Retail	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.05	25	$0.49	25%	98%	$0.96	138
Dry Goods Retail	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.58	25	$1	75%	85%	$0.28	5,593
Dry Goods Retail	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.19	729
Dry Goods Retail	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.57	25	$0.93	35%	90%	$0.13	3,128
Dry Goods Retail	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.10	25	$0.29	35%	90%	$0.25	516
Dry Goods Retail	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	1	25	$2	10%	35%	$0.13	544
Dry Goods Retail	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	583	10	$137	95%	26%	$-0.00	36
Dry Goods Retail	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.25	7	$0.18	90%	85%	$0.11	4,798
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	Building SQ.FT.	Existing	0.51	10	$2	25%	98%	$0.65	1,798
Dry Goods Retail	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.68 (Average Existing Conditions)	per window sqft	Existing	0.39	25	$64	15%	80%	$17.38	50
Dry Goods Retail	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	137	15	$399	25%	94%	$0.34	130
Dry Goods Retail	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	14	15	$171	75%	76%	$1.47	304
Dry Goods Retail	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$2.34	36
Dry Goods Retail	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.06	14	$0.93	5%	94%	$1.81	35
Dry Goods Retail	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.01	25	$0.49	75%	98%	$4.49	65
Dry Goods Retail	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.02	25	$0.29	35%	90%	$1.29	72
Dry Goods Retail	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.28	277
Dry Goods Retail	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	129	10	$137	95%	13%	$0.14	21

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	New	0.11	10	$2	50%	98%	$3.08	609
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	491	10	$8,170	5%	95%	$2.77	17
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	491	10	$8,170	5%	95%	$32.31	98,547
Dry Goods Retail	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	553	11	$243	95%	80%	$-0.22	112
Dry Goods Retail	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.01	10	$0.27	75%	94%	$3.22	808
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	24%	25%	$0.14	4
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	24%	25%	$3.50	6,784
Dry Goods Retail	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,164	10	$2,520	95%	95%	$0.01	139
Dry Goods Retail	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	20,007	10	$3,570	95%	94%	$-0.04	192
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	433	25	$817	5%	92%	$0.19	218
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	433	25	$817	5%	92%	$2.23	66,147
Dry Goods Retail	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	101	15	$131	100%	N/A	$0.16	151
Dry Goods Retail	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	1,863	15	$2,541	75%	N/A	$0.17	5,618
Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	4	12	$2	80%	90%	$0.10	172
Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	4	12	$2	80%	90%	$1.21	34,852
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$0.00	95%	83%	$-0.10	16
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$0.00	95%	83%	$0.79	11,162
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	35	10	$142	75%	95%	$10.34	87,136
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	35	10	$142	75%	95%	$0.66	442
Dry Goods Retail	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	124	5	$95	75%	45%	$0.20	610
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	492	10	$8,170	5%	95%	$2.77	9
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	492	10	$8,170	5%	95%	$32.38	44,707
Dry Goods Retail	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	555	11	$243	95%	80%	$-0.22	60
Dry Goods Retail	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.01	10	$0.27	75%	94%	$3.22	419
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	24%	55%	$0.14	5
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	24%	55%	$3.58	82,282

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Dry Goods Retail	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,197	10	$2,527	95%	95%	$0.01	74
Dry Goods Retail	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	20,101	10	$3,580	95%	94%	$-0.04	103
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	433	25	$654	25%	92%	$1.79	28,267
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	433	25	$654	25%	92%	$0.15	589
Dry Goods Retail	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	104	15	$131	100%	N/A	$0.15	101
Dry Goods Retail	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	1,921	15	$2,168	75%	N/A	$0.14	3,628
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$0.00	95%	83%	$-0.10	8
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$0.00	95%	83%	$0.81	65,379
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	35	10	$142	75%	95%	$0.66	237
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	35	10	$142	75%	95%	$10.36	35,711
Dry Goods Retail	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	125	5	$95	75%	45%	$0.20	317
Grocery	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$29	100%	N/A	$0.06	1,067
Grocery	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$29	100%	N/A	$0.06	102
Grocery	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	11,890	12	$1,931	90%	90%	$0.01	28
Grocery	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	1,021	12	$1,308	35%	90%	$0.18	4
Grocery	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,295	12	$814	95%	85%	$0.04	74
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,900	12	$2,035	19%	55%	$0.15	12
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,900	12	$2,035	19%	55%	$0.27	3,151
Grocery	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	3,986	12	$1,768	55%	21%	$0.05	37
Grocery	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,266	12	$2,564	14%	75%	$0.08	37
Grocery	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	11,890	12	$1,931	90%	90%	$0.01	15
Grocery	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	1,021	12	$1,308	35%	90%	$0.18	2
Grocery	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,295	12	$814	95%	85%	$0.04	39
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,900	12	$2,035	19%	55%	$0.27	89,765
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,900	12	$2,035	19%	55%	$0.15	6
Grocery	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	3,986	12	$1,768	55%	21%	$0.05	19
Grocery	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,266	12	$2,564	14%	75%	$0.08	19
Grocery	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	6,436	15	$6,020	100%	N/A	$0.12	993
Grocery	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	78	10	$169	10%	90%	$0.36	169
Grocery	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	390	4	$335	95%	72%	$0.32	927
Grocery	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.43	15	$2	50%	94%	$0.61	1,376
Grocery	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	84	5	$193	75%	61%	$0.64	175
Grocery	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	56	15	$171	75%	76%	$0.40	705

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	84	5	$78	50%	80%	$0.25	209
Grocery	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.04	18	$0.22	45%	65%	$0.63	75
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)	Per Kitchen Exhaust	Existing	2,499	10	$3,606	64%	85%	$0.24	350
Grocery	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.17	40	$9	4%	98%	$5.36	28
Grocery	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.04	23
Grocery	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	10%	$19.95	3
Grocery	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.92	20	$2	75%	60%	$0.28	259
Grocery	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,412	10	$136	95%	31%	$0.01	69
Grocery	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.21	7	$0.18	90%	85%	$0.18	1,520
Grocery	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.06	4
Grocery	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	3	25	$30	15%	85%	$0.85	162
Grocery	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	3	25	$64	15%	85%	$2.08	139
Grocery	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	5,831	15	$4,816	100%	N/A	$0.10	451
Grocery	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.37	15	$2	50%	94%	$0.72	747
Grocery	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	48	15	$171	75%	76%	$0.46	382
Grocery	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.73	41
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)	Per Kitchen Exhaust	New	2,149	10	$3,606	64%	85%	$0.28	169
Grocery	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.14	40	$9	4%	98%	$6.24	14
Grocery	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	9	30	$5	50%	95%	$0.06	540
Grocery	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	1,214	10	$136	95%	15%	$0.01	32
Grocery	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	3	25	$30	80%	85%	$0.99	477
Grocery	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	24,368	15	$22,274	100%	N/A	$0.11	886
Grocery	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	231	5	$193	75%	61%	$0.23	25
Grocery	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	154	15	$171	75%	76%	$0.14	472
Grocery	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	231	5	$78	50%	80%	$0.09	25
Grocery	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.11	18	$0.22	45%	65%	$0.22	55
Grocery	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.45	14	$0.93	5%	94%	$0.27	33

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	Existing	6,846	10	$3,606	64%	85%	$0.08	213
Grocery	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.17	40	$9	4%	98%	$5.39	7
Grocery	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	46,494	30	$88,204	5%	N/A	$1.23	80
Grocery	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	5	13	$0.32	10%	39%	$-0.00	27
Grocery	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.04	25	$0.49	25%	85%	$1.06	13
Grocery	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.83	25	$1	75%	10%	$0.21	85
Grocery	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	60%	$0.09	159
Grocery	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.63	25	$0.93	35%	45%	$0.15	139
Grocery	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.12	25	$0.29	35%	45%	$0.24	26
Grocery	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	1	25	$2	10%	35%	$0.14	43
Grocery	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	3,867	10	$136	95%	31%	$-0.00	76
Grocery	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.59	7	$0.18	90%	85%	$0.06	924
Grocery	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.05	1
Grocery	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	85%	$1.81	20
Grocery	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	3	25	$64	15%	85%	$1.82	43
Grocery	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	10,205	15	$17,820	100%	N/A	$0.22	196
Grocery	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	57	15	$171	75%	76%	$0.38	104
Grocery	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.04	18	$0.22	45%	65%	$0.61	12
Grocery	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.04	14	$0.93	5%	94%	$2.90	1
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)	Per Kitchen Exhaust	New	2,563	10	$3,606	64%	85%	$0.23	46
Grocery	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.14	40	$9	4%	98%	$6.25	3
Grocery	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	19,623	30	$4,184	5%	N/A	$1.49	17
Grocery	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	85%	$26.18	0.96
Grocery	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.00	25	$0.29	35%	45%	$19.72	0.19
Grocery	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	7	30	$5	50%	95%	$0.07	93
Grocery	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	1,448	10	$136	95%	15%	$0.01	8
Grocery	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	3	25	$30	80%	85%	$1.05	116
Grocery	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	1,993	10	$581	5%	85%	$0.04	51
Grocery	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,886	18	$4,022	95%	65%	$0.25	307

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	21	15	$6	95%	76%	$0.04	159
Grocery	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	530	20	$110	65%	75%	$0.02	2,998
Grocery	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	13	8	$4	65%	25%	$0.07	5
Grocery	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	2,389	10	$581	5%	75%	$0.04	28
Grocery	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,886	18	$4,022	95%	65%	$0.25	161
Grocery	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	25	15	$6	95%	76%	$0.03	125
Grocery	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	636	20	$110	65%	75%	$0.01	1,891
Grocery	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	1,161
Grocery	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	111	8	$28	75%	70%	$0.04	176
Grocery	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	244	15	$336	62%	90%	$0.17	1,535
Grocery	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	12	14	$35	75%	95%	$0.39	28
Grocery	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	486
Grocery	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	610
Grocery	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	111	8	$28	75%	70%	$0.04	92
Grocery	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	244	15	$336	62%	90%	$0.17	806
Grocery	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	12	14	$35	75%	95%	$0.39	15
Grocery	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	255
Grocery	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	324	9	$110	75%	75%	$0.05	1,422
Grocery	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	208	5	$12	70%	94%	$0.00	346
Grocery	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.98	8	$0.98	30%	96%	$0.18	163
Grocery	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.73	8	$0.73	30%	96%	$0.18	122
Grocery	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	96	16	$16	95%	50%	$0.01	535
Grocery	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	127
Grocery	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	277	8	$249	95%	80%	$0.16	12,972
Grocery	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	1	13	$0.89	90%	44%	$0.07	9,407
Grocery	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.75	13	$0.16	90%	58%	$0.02	4,302
Grocery	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	1	13	$0.38	90%	64%	$0.04	1,795
Grocery	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	1	13	$0.86	75%	67%	$0.09	975
Grocery	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.25	13	$0.15	70%	83%	$0.07	2,356

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	1,166	8	$70	45%	57%	$-0.00	378
Grocery	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	750	8	$201	85%	81%	$0.04	641
Grocery	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	258	9	$110	75%	75%	$0.06	595
Grocery	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	208	5	$12	70%	94%	$0.00	145
Grocery	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.78	8	$0.98	30%	96%	$0.23	71
Grocery	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	1	8	$0.73	30%	96%	$0.09	133
Grocery	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	267
Grocery	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	277	8	$249	95%	80%	$0.16	6,813
Grocery	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.75	15	$0.08	90%	58%	$0.00	2,259
Grocery	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	1	15	$0.15	90%	64%	$0.01	942
Grocery	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	1	15	$0.22	75%	67%	$0.01	512
Grocery	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.25	15	$0.03	70%	83%	$0.01	1,237
Grocery	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	930	8	$70	45%	57%	$0.00	164
Grocery	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	750	8	$201	85%	81%	$0.04	279
Grocery	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	73	6	$159	95%	45%	$0.51	6
Grocery	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	78	6	$0.00	95%	45%	$-0.01	7
Grocery	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.30	10
Grocery	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	138	5	$14	95%	40%	$0.02	23
Grocery	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	71	6	$0.00	95%	45%	$-0.01	6
Grocery	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	73	6	$159	95%	45%	$0.51	3
Grocery	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	78	6	$0.00	95%	45%	$-0.01	3
Grocery	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.30	5
Grocery	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	138	5	$14	95%	40%	$0.02	12
Grocery	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	71	6	$0.00	95%	45%	$-0.01	3
Grocery	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.06	2
Grocery	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	365	10	$0.00	95%	75%	$-0.01	23
Grocery	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	425	10	$142	95%	86%	$0.02	156
Grocery	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	6	4	$0.41	95%	86%	$0.01	40

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	80	12	$125	3%	65%	$0.22	0.71
Grocery	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,506	9	$567	25%	35%	$0.06	66
Grocery	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	1,639	7	$567	25%	35%	$0.07	72
Grocery	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	Existing	101	5	$22	60%	90%	$0.05	176
Grocery	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	241	14	$162	75%	80%	$0.08	54
Grocery	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	3,106	3	$174	75%	25%	$0.01	293
Grocery	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.06	1
Grocery	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	365	10	$0.00	95%	75%	$-0.01	12
Grocery	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	425	10	$142	95%	86%	$0.02	82
Grocery	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	6	4	$0.41	95%	86%	$0.01	21
Grocery	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	80	12	$125	3%	65%	$0.22	0.37
Grocery	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	New	101	5	$22	60%	90%	$0.05	92
Grocery	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	241	14	$162	75%	80%	$0.08	28
Grocery	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	Existing	989	12	$82	90%	45%	$0.00	5,370
Grocery	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 1,000 sqft	Existing	1,029	12	$243	100%	77%	$0.02	12,710
Grocery	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.98	15	$0.10	100%	98%	$0.00	13,914
Grocery	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.08	15	$0.05	100%	98%	$0.08	146
Grocery	Refrigeration	Compressor VSD Retrofit	VSD Compressor	Constant Speed Compressor	per refrigeration ton	Existing	1,385	13	$261	60%	77%	$0.02	13,152
Grocery	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	Existing	8,579	10	$115	95%	68%	$-0.01	2,774
Grocery	Refrigeration	Evaporative Condenser - High-Efficiency	High-Efficiency Evaporative Condenser	Air-Cooled Condenser	Tons of Refrigeration	Existing	89	15	$444	90%	65%	$0.64	1,401
Grocery	Refrigeration	Floating Condenser Head Pressure Controls	Floating Condenser Head Pressure Controls	No Floating Condenser Head Pressure Controls	1 unit per 1,000 sqft	Existing	1,810	15	$196	50%	81%	$0.00	9,604
Grocery	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	Existing	2,579	12	$724	95%	77%	$0.03	859
Grocery	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	Per Unit. Ea. Compressor	Existing	2,598	10	$726	85%	72%	$0.04	12,519
Grocery	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	Existing	407	5	$65	95%	85%	$0.03	8,575
Grocery	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	825	3	$119	95%	85%	$0.05	12,430
Grocery	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	6,431	10	$50	75%	95%	$-0.01	2,727
Grocery	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	Existing	1,169	12	$192	95%	81%	$0.01	411
Grocery	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.62	13	$0.09	80%	90%	$0.01	5,676
Grocery	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	13,199	4	$184	95%	20%	$-0.01	1,264

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.79	12	$0.17	95%	95%	$0.02	11,576
Grocery	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	New	989	12	$82	90%	45%	$0.00	2,968
Grocery	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 1,000 sqft	New	1,029	12	$243	100%	77%	$0.02	6,676
Grocery	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	New	8,579	10	$115	95%	68%	$-0.01	1,457
Grocery	Refrigeration	Evaporative Condenser - High-Efficiency	High-Efficiency Evaporative Condenser	Air-Cooled Condenser	Tons of Refrigeration	New	89	15	$444	90%	65%	$0.64	736
Grocery	Refrigeration	Floating Condenser Head Pressure Controls	Floating Condenser Head Pressure Controls	No Floating Condenser Head Pressure Controls	1 unit per 1,000 sqft	New	1,810	15	$196	50%	81%	$0.00	5,308
Grocery	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	New	2,579	12	$724	95%	77%	$0.03	451
Grocery	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	Per Unit. Ea. Compressor	New	4,820	10	$726	85%	72%	$0.01	7,456
Grocery	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	New	407	5	$65	95%	85%	$0.03	4,292
Grocery	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	464	3	$46	80%	90%	$0.03	3,711
Grocery	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	6,431	10	$50	75%	95%	$-0.01	1,432
Grocery	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	New	1,169	12	$192	95%	81%	$0.01	216
Grocery	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	13,199	4	$184	95%	20%	$-0.01	664
Grocery	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.79	12	$0.17	95%	95%	$0.02	6,080
Grocery	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	105	5	$193	75%	61%	$0.50	63
Grocery	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	70	15	$171	75%	76%	$0.30	126
Grocery	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	105	5	$78	50%	80%	$0.19	64
Grocery	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.05	18	$0.22	45%	65%	$0.49	15
Grocery	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.32	14	$0.93	5%	94%	$0.37	14
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)	Per Kitchen Exhaust	Existing	3,121	10	$3,606	64%	85%	$0.17	59
Grocery	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.32	10%	39%	$-0.00	8
Grocery	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.05	25	$0.49	25%	85%	$0.96	8
Grocery	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.59	25	$1	75%	10%	$0.29	39
Grocery	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	60%	$0.21	43
Grocery	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.58	25	$0.93	35%	45%	$0.15	92
Grocery	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.10	25	$0.29	35%	45%	$0.27	15
Grocery	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	1	25	$2	10%	35%	$0.13	30
Grocery	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,763	10	$136	95%	31%	$-0.01	2
Grocery	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.27	7	$0.18	90%	85%	$0.13	272

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	Existing	0.54	10	$2	25%	98%	$0.64	122
Grocery	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.27	25	$64	15%	85%	$24.62	1
Grocery	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	6	15	$171	75%	76%	$3.68	6
Grocery	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$5.81	0.81
Grocery	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.02	14	$0.93	5%	94%	$4.51	0.79
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)	Per Kitchen Exhaust	New	270	10	$3,606	64%	85%	$2.21	3
Grocery	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	85%	$11.27	1
Grocery	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.00	25	$0.29	35%	45%	$3.30	0.81
Grocery	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	0.75	30	$5	50%	95%	$0.76	6
Grocery	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	152	10	$136	95%	15%	$0.13	0.56
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	Building SQ.FT.	New	0.04	10	$2	50%	98%	$7.59	13
Grocery	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.01	10	$0.27	75%	94%	$3.04	49
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$44	24%	25%	$0.15	0.08
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$44	24%	25%	$3.62	78,799
Grocery	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,077	10	$2,721	95%	95%	$0.02	9
Grocery	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	19,765	10	$3,809	95%	94%	$-0.03	12
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	191	25	$817	5%	92%	$1.19	30,408
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	191	25	$817	5%	92%	$0.44	13
Grocery	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	302	15	$876	100%	N/A	$0.37	9
Grocery	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	5,569	15	$16,946	75%	N/A	$0.39	329
Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	2	12	$2	80%	90%	$0.39	92,319
Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	2	12	$2	80%	90%	$0.14	10
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	66	5	$4	95%	74%	$0.70	55,746
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	66	5	$4	95%	74%	$-0.08	11
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	37	10	$142	75%	95%	$2.31	3,317
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	37	10	$142	75%	95%	$0.62	27
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.03	10	$0.88	55%	94%	$11.49	20,184

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.03	10	$0.88	55%	94%	$4.34	80
Grocery	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	73	5	$95	75%	50%	$0.35	42
Grocery	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.01	10	$0.27	75%	94%	$3.01	25
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$44	24%	55%	$3.70	93,541
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$44	24%	55%	$0.14	0.10
Grocery	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,110	10	$2,528	95%	95%	$0.01	5
Grocery	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	19,858	10	$3,612	95%	94%	$-0.04	6
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	193	25	$653	25%	92%	$0.95	66,334
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	193	25	$653	25%	92%	$0.35	36
Grocery	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	313	15	$876	100%	N/A	$0.36	5
Grocery	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	5,782	15	$14,450	75%	N/A	$0.32	213
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	66	5	$4	95%	74%	$0.72	76,662
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	66	5	$4	95%	74%	$-0.08	6
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	37	10	$142	75%	95%	$2.31	53,319
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	37	10	$142	75%	95%	$0.62	14
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.03	10	$0.88	55%	94%	$4.30	41
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.03	10	$0.88	55%	94%	$11.52	42,923
Grocery	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	74	5	$95	75%	50%	$0.35	21
Hospital	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$29	100%	N/A	$0.06	19,167
Hospital	Computers	Network PC Power Management	Network PC Power Management	No Power Management	4.2 units per 1,000 sqft	Existing	4	5	$12	95%	30%	$0.85	217
Hospital	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$29	100%	N/A	$0.06	1,836
Hospital	Computers	Network PC Power Management	Network PC Power Management	No Power Management	4.2 units per 1,000 sqft	New	4	5	$12	95%	30%	$0.85	114
Hospital	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	11,974	12	$1,745	90%	90%	$0.01	6
Hospital	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	961	12	$1,309	25%	90%	$0.19	0.73
Hospital	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,311	12	$794	95%	85%	$0.04	44
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,913	12	$2,016	7%	55%	$0.53	71,394
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,913	12	$2,016	7%	55%	$0.14	2
Hospital	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,014	12	$1,772	15%	21%	$0.05	6
Hospital	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,296	12	$2,566	11%	75%	$0.08	17
Hospital	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	11,974	12	$1,745	90%	90%	$0.01	3

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	961	12	$1,309	25%	90%	$0.19	0.38
Hospital	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,311	12	$794	95%	85%	$0.04	23
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,913	12	$2,016	7%	55%	$0.14	1
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,913	12	$2,016	7%	55%	$0.53	59,473
Hospital	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	4,014	12	$1,772	15%	21%	$0.05	3
Hospital	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,296	12	$2,566	11%	75%	$0.08	8
Hospital	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	530	15	$747	5%	94%	$0.18	67
Hospital	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	22	5	$165	95%	81%	$2.09	106
Hospital	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	36	10	$210	25%	70%	$0.97	151
Hospital	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	23	15	$483	45%	90%	$2.66	223
Hospital	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	Existing	4,688	20	$9,232	100%	N/A	$0.22	1,090
Hospital	Cooling Chillers	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.53	15	$2	15%	67%	$0.73	379
Hospital	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	38	8	$27	10%	94%	$0.14	124
Hospital	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	66	15	$2	95%	35%	$-0.00	812
Hospital	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	19	13	$19	95%	75%	$0.14	467
Hospital	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	86	5	$193	35%	26%	$0.62	85
Hospital	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	57	15	$171	75%	76%	$0.38	778
Hospital	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	86	5	$78	75%	80%	$0.25	645
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)	Per Kitchen Exhaust	Existing	1,353	10	$3,606	62%	85%	$0.44	304
Hospital	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.17	40	$9	4%	98%	$5.26	22
Hospital	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.03	32
Hospital	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	13%	$27.85	2
Hospital	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	5	15	$3	65%	45%	$0.09	72
Hospital	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.22	7	$0.18	90%	85%	$0.17	1,529
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	Building SQ.FT.	Existing	0.44	10	$2	25%	98%	$0.80	744
Hospital	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.34	6
Hospital	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	2	25	$30	15%	60%	$1.09	127
Hospital	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	2	25	$64	15%	60%	$2.72	105

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	141	15	$399	5%	94%	$0.36	11
Hospital	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	5	5	$165	95%	81%	$7.88	17
Hospital	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	10	10	$210	25%	70%	$3.30	26
Hospital	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	New	1,309	20	$7,386	100%	N/A	$0.64	259
Hospital	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	11	8	$27	10%	94%	$0.48	18
Hospital	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	15	15	$171	75%	76%	$1.47	141
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)	Per Kitchen Exhaust	New	360	10	$3,606	62%	85%	$1.67	55
Hospital	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.04	40	$9	4%	98%	$19.77	3
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	Building SQ.FT.	New	0.11	10	$2	50%	98%	$3.03	281
Hospital	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.78	25	$30	80%	60%	$4.11	120
Hospital	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	577	15	$747	5%	94%	$0.16	172
Hospital	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.57	15	$2	15%	67%	$0.67	791
Hospital	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	3,763	15	$3,198	100%	N/A	$0.10	2,235
Hospital	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	86	10	$169	10%	30%	$0.32	147
Hospital	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	432	4	$335	95%	72%	$0.29	2,407
Hospital	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.48	15	$2	50%	94%	$0.55	3,521
Hospital	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	93	5	$193	35%	26%	$0.57	88
Hospital	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	62	15	$171	75%	76%	$0.35	1,847
Hospital	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	93	5	$78	75%	80%	$0.23	823
Hospital	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.04	18	$0.22	45%	65%	$0.56	194
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)	Per Kitchen Exhaust	Existing	1,471	10	$3,606	62%	85%	$0.40	722
Hospital	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.19	40	$9	4%	98%	$4.83	51
Hospital	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.03	79
Hospital	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	13%	$25.61	5
Hospital	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	60%	$0.24	674
Hospital	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	592	10	$136	95%	24%	$0.03	137

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.24	7	$0.18	90%	85%	$0.16	3,898
Hospital	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.37	12
Hospital	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	3	25	$30	15%	60%	$1.00	287
Hospital	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	2	25	$64	15%	60%	$2.50	243
Hospital	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	154	15	$399	5%	94%	$0.33	25
Hospital	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	1,047	15	$2,558	100%	N/A	$0.31	366
Hospital	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.12	15	$2	50%	94%	$2.08	593
Hospital	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	16	15	$171	75%	76%	$1.34	311
Hospital	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$2.12	32
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)	Per Kitchen Exhaust	New	393	10	$3,606	62%	85%	$1.53	121
Hospital	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$18.12	8
Hospital	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	3	30	$5	50%	95%	$0.18	430
Hospital	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	158	10	$136	95%	12%	$0.14	20
Hospital	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.85	25	$30	80%	60%	$3.76	267
Hospital	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	10,170	15	$11,833	100%	N/A	$0.14	1,002
Hospital	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	578	15	$747	5%	94%	$0.16	22
Hospital	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.60	15	$2	15%	67%	$0.64	133
Hospital	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	183	5	$193	35%	26%	$0.29	5
Hospital	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	122	15	$171	75%	76%	$0.17	524
Hospital	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	183	5	$78	75%	80%	$0.11	42
Hospital	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.09	18	$0.22	45%	65%	$0.28	62
Hospital	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.27	14	$0.93	5%	94%	$0.45	28
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)	Per Kitchen Exhaust	Existing	2,876	10	$3,606	62%	85%	$0.20	204
Hospital	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.19	40	$9	4%	98%	$4.82	8
Hospital	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	17,407	30	$12,483	5%	N/A	$1.75	80
Hospital	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	3	13	$0.32	10%	39%	$0.00	30
Hospital	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.03	25	$0.49	25%	85%	$1.46	9

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.45	25	$1	75%	13%	$0.40	60
Hospital	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	60%	$0.12	178
Hospital	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-19 (Average Existing Conditions)	per floor area	Existing	0.20	25	$0.93	35%	35%	$0.47	33
Hospital	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.08	25	$0.29	35%	35%	$0.37	13
Hospital	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	1	25	$2	10%	35%	$0.14	48
Hospital	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,158	10	$136	95%	24%	$0.01	64
Hospital	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.46	7	$0.18	90%	85%	$0.07	1,009
Hospital	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.38	2
Hospital	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	2	25	$30	15%	60%	$1.39	33
Hospital	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	3	25	$64	15%	60%	$2.20	45
Hospital	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	5,196	15	$9,466	100%	N/A	$0.23	280
Hospital	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	153	15	$399	5%	94%	$0.33	3
Hospital	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	54	15	$171	75%	76%	$0.40	139
Hospital	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.04	18	$0.22	45%	65%	$0.64	16
Hospital	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.17	14	$0.93	5%	94%	$0.72	10
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)	Per Kitchen Exhaust	New	1,279	10	$3,606	62%	85%	$0.46	54
Hospital	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$18.18	1
Hospital	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	8,289	30	$61,597	5%	N/A	$1.88	20
Hospital	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.02	25	$0.49	75%	85%	$1.95	13
Hospital	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.07	25	$0.29	35%	35%	$0.44	7
Hospital	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	6	30	$5	50%	95%	$0.08	122
Hospital	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	515	10	$136	95%	12%	$0.03	8
Hospital	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.27	25	$30	80%	60%	$11.81	13
Hospital	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	5,035	10	$581	20%	85%	$0.01	973
Hospital	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.65	15	$2	15%	67%	$0.59	2,468
Hospital	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,899	18	$4,278	95%	85%	$0.26	264
Hospital	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	53	15	$6	95%	76%	$0.01	1,205
Hospital	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	1,340	20	$110	65%	75%	$0.00	21,111
Hospital	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	136	15	$178	8%	77%	$0.16	81
Hospital	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	34	8	$4	65%	25%	$0.02	43

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	Existing	1,488	13	$1,669	65%	59%	$0.15	1,412
Hospital	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	3,926	10	$581	20%	75%	$0.02	351
Hospital	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,899	18	$4,528	95%	85%	$0.28	138
Hospital	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.85	50	$2	24%	98%	$0.26	3,147
Hospital	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	41	15	$6	95%	76%	$0.01	617
Hospital	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	1,045	20	$110	65%	75%	$0.00	8,647
Hospital	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	106	15	$178	8%	77%	$0.21	33
Hospital	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	New	1,160	15	$1,669	65%	59%	$0.18	578
Hospital	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.03	3,249
Hospital	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	53	8	$28	75%	70%	$0.09	249
Hospital	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	246	15	$336	62%	90%	$0.17	2,166
Hospital	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	5	14	$35	75%	95%	$0.83	44
Hospital	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	1,360
Hospital	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.03	1,706
Hospital	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	53	8	$28	75%	70%	$0.09	130
Hospital	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	246	15	$336	62%	90%	$0.17	1,137
Hospital	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	5	14	$35	75%	95%	$0.83	23
Hospital	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	714
Hospital	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	185	9	$110	85%	75%	$0.09	2,629
Hospital	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	194	5	$12	70%	94%	$0.00	2,262
Hospital	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.41	8	$0.98	30%	51%	$0.45	136
Hospital	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.92	8	$0.73	30%	51%	$0.14	307
Hospital	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	97	16	$16	95%	50%	$0.01	1,555
Hospital	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	369
Hospital	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	259	8	$248	15%	80%	$0.17	268
Hospital	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.91	13	$0.34	90%	51%	$0.04	18,539
Hospital	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.33	13	$0.03	90%	68%	$0.00	6,449
Hospital	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.44	13	$0.08	90%	70%	$0.01	2,527

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.56	13	$0.14	75%	72%	$0.02	1,352
Hospital	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.01	13	$0.01	70%	83%	$0.12	415
Hospital	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	666	8	$70	90%	42%	$0.01	873
Hospital	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	762	8	$201	85%	**%	$0.04	1,242
Hospital	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	116	9	$110	85%	75%	$0.16	865
Hospital	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	194	5	$12	70%	94%	$0.00	745
Hospital	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.25	8	$0.98	30%	51%	$0.73	48
Hospital	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.48	8	$0.73	30%	51%	$0.28	90
Hospital	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	776
Hospital	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	259	8	$248	15%	80%	$0.17	140
Hospital	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.33	15	$0.00	90%	68%	$-0.01	3,387
Hospital	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.44	15	$0.03	90%	70%	$-0.01	1,327
Hospital	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.56	15	$0.08	75%	72%	$0.01	710
Hospital	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.01	15	$0.00	70%	83%	$0.02	218
Hospital	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	417	8	$70	90%	42%	$0.02	307
Hospital	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	762	8	$201	85%	**%	$0.04	437
Hospital	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$161	95%	45%	$0.51	124
Hospital	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$1	95%	45%	$-0.01	133
Hospital	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	156
Hospital	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$15	95%	40%	$0.02	173
Hospital	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	121
Hospital	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$161	95%	45%	$0.51	65
Hospital	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$1	95%	45%	$-0.01	70
Hospital	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	82
Hospital	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$15	95%	40%	$0.02	91
Hospital	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	63
Hospital	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.07	18
Hospital	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	368	10	$2	95%	75%	$-0.01	514

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	428	10	$140	95%	86%	$0.02	45
Hospital	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	15	4	$0.41	95%	86%	$-0.00	282
Hospital	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$124	13%	65%	$0.22	18
Hospital	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,517	9	$567	25%	35%	$0.06	350
Hospital	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	635	7	$567	25%	35%	$0.19	146
Hospital	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	Existing	2,291	4	$2,090	72%	85%	$0.65	591
Hospital	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 1,500 sqft	Existing	101	5	$22	60%	90%	$0.05	1,643
Hospital	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	243	14	$157	10%	80%	$0.08	5
Hospital	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	1,204	3	$175	50%	25%	$0.05	396
Hospital	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.07	9
Hospital	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	368	10	$2	95%	75%	$-0.01	270
Hospital	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	428	10	$140	95%	86%	$0.02	24
Hospital	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	15	4	$0.41	95%	86%	$-0.00	148
Hospital	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$124	13%	65%	$0.22	9
Hospital	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	New	2,291	4	$2,090	72%	85%	$0.65	310
Hospital	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 1,500 sqft	New	101	5	$22	60%	90%	$0.05	863
Hospital	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	243	14	$157	10%	80%	$0.08	2
Hospital	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	Existing	996	12	$79	15%	45%	$0.00	71
Hospital	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	Existing	1,036	12	$243	5%	77%	$0.02	177
Hospital	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.01	15	$0.10	5%	98%	$0.71	38
Hospital	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.00	15	$0.05	5%	98%	$4.37	0.41
Hospital	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	Existing	112	10	$61	5%	68%	$0.08	10
Hospital	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	Existing	2,597	12	$706	95%	77%	$0.03	110
Hospital	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	831	3	$118	10%	85%	$0.05	125
Hospital	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	60	10	$50	75%	95%	$0.13	186
Hospital	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	Existing	1,177	12	$157	95%	81%	$0.01	53
Hospital	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.01	13	$0.00	5%	90%	$0.01	27

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	173	4	$185	15%	20%	$0.35	13
Hospital	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.01	12	$0.17	5%	95%	$1.34	41
Hospital	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	New	996	12	$79	15%	45%	$0.00	37
Hospital	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	New	1,036	12	$243	5%	77%	$0.02	93
Hospital	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	New	112	10	$61	5%	68%	$0.08	5
Hospital	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	New	2,597	12	$706	95%	77%	$0.03	58
Hospital	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	467	3	$45	5%	90%	$0.03	19
Hospital	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	60	10	$50	75%	95%	$0.13	98
Hospital	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	New	1,177	12	$157	95%	81%	$0.01	27
Hospital	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	173	4	$185	15%	20%	$0.35	7
Hospital	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.01	12	$0.17	5%	95%	$1.34	21
Hospital	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	385	15	$747	5%	94%	$0.24	99
Hospital	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.16	15	$2	15%	67%	$2.33	211
Hospital	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	62	5	$193	35%	26%	$0.85	106
Hospital	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	41	15	$171	75%	76%	$0.53	1,104
Hospital	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	62	5	$78	75%	80%	$0.34	849
Hospital	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.03	18	$0.22	45%	65%	$0.84	128
Hospital	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.19	14	$0.93	5%	94%	$0.65	124
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)	Per Kitchen Exhaust	Existing	983	10	$3,606	62%	85%	$0.60	425
Hospital	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.01	92
Hospital	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.03	25	$0.49	25%	85%	$1.35	61
Hospital	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.31	25	$1	75%	13%	$0.58	263
Hospital	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.68	20	$2	75%	60%	$0.36	380
Hospital	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-19 (Average Existing Conditions)	per floor area	Existing	0.19	25	$0.93	35%	35%	$0.50	218
Hospital	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.08	25	$0.29	35%	35%	$0.38	91
Hospital	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	1	25	$2	10%	35%	$0.14	350
Hospital	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	396	10	$136	95%	24%	$0.04	15
Hospital	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.16	7	$0.18	90%	85%	$0.23	2,236

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	Existing	0.32	10	$2	25%	98%	$1.10	1,059
Hospital	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.21	25	$64	15%	60%	$31.35	18
Hospital	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	211	15	$399	5%	94%	$0.23	30
Hospital	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	22	15	$171	75%	76%	$0.97	365
Hospital	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.54	43
Hospital	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.10	14	$0.93	5%	94%	$1.19	41
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)	Per Kitchen Exhaust	New	539	10	$3,606	62%	85%	$1.11	143
Hospital	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.02	25	$0.49	75%	85%	$2.48	58
Hospital	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.04	25	$0.29	35%	35%	$0.70	30
Hospital	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	2	30	$5	50%	95%	$0.19	324
Hospital	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	217	10	$136	95%	12%	$0.09	23
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	Building SQ.FT.	New	0.17	10	$2	50%	98%	$2.01	716
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	3,538	10	$8,170	15%	95%	$0.37	62
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	3,538	10	$8,170	15%	95%	$1.46	73,547
Hospital	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	550	11	$255	95%	80%	$-0.22	54
Hospital	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.06	10	$0.27	55%	94%	$0.65	674
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	11%	25%	$0.14	0.43
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	11%	25%	$3.48	20,615
Hospital	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,127	10	$2,599	95%	95%	$0.01	109
Hospital	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	19,904	10	$3,740	95%	94%	$-0.04	151
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	322	25	$817	5%	92%	$0.25	242
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	322	25	$817	5%	92%	$0.97	51,889
Hospital	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	732	15	$1,273	100%	N/A	$0.21	178
Hospital	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	13,490	15	$24,570	75%	N/A	$0.23	6,537
Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	5	12	$2	80%	70%	$0.07	155
Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	5	12	$2	80%	70%	$0.31	8,739

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	66	5	$5	95%	83%	$0.70	48,666
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	66	5	$5	95%	83%	$-0.08	19
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	126	10	$30	95%	73%	$-0.05	73
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	126	10	$30	95%	73%	$0.28	20,893
Hospital	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	506	10	$15	95%	35%	$-0.08	141
Hospital	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	506	10	$15	95%	35%	$0.09	82,535
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	68	10	$142	75%	90%	$0.33	486
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	68	10	$142	75%	90%	$1.72	24,124
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.15	10	$0.88	3%	94%	$0.93	1
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.15	10	$0.88	3%	94%	$139.93	5,550
Hospital	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	119	5	$95	75%	80%	$0.21	1,273
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	3,597	10	$8,170	15%	95%	$0.37	33
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	3,597	10	$8,170	15%	95%	$1.46	32,817
Hospital	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	553	11	$255	95%	80%	$-0.22	29
Hospital	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.06	10	$0.27	55%	94%	$0.64	356
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	11%	55%	$3.56	20,053
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	11%	55%	$0.14	0.51
Hospital	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,160	10	$2,568	95%	95%	$0.01	59
Hospital	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	19,997	10	$3,696	95%	94%	$-0.04	82
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	328	25	$653	25%	92%	$0.20	697
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	328	25	$653	25%	92%	$0.78	42,237
Hospital	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	766	15	$1,273	100%	N/A	$0.20	120
Hospital	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	14,116	15	$20,955	75%	N/A	$0.18	4,296
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$5	95%	83%	$-0.08	10
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$5	95%	83%	$0.72	3,954
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	127	10	$30	95%	73%	$-0.05	39
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	127	10	$30	95%	73%	$0.28	91,972
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	69	10	$142	75%	90%	$0.33	264
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	69	10	$142	75%	90%	$1.72	61,251

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.15	10	$0.88	3%	94%	$0.92	0.88
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.15	10	$0.88	3%	94%	$140.25	62,522
Hospital	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	121	5	$95	75%	80%	$0.21	667
Hotel Motel	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$28	100%	N/A	$0.06	1,145
Hotel Motel	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$28	100%	N/A	$0.06	109
Hotel Motel	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	12,036	12	$1,959	90%	90%	$0.01	3
Hotel Motel	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	1,041	12	$1,259	55%	90%	$0.17	0.82
Hotel Motel	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,324	12	$836	95%	85%	$0.04	8
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,923	12	$2,012	19%	55%	$0.14	1
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,923	12	$2,012	19%	55%	$0.28	19,147
Hotel Motel	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,035	12	$1,750	55%	21%	$0.05	4
Hotel Motel	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,319	12	$2,569	11%	75%	$0.08	3
Hotel Motel	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	12,036	12	$1,959	90%	90%	$0.01	1
Hotel Motel	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	1,041	12	$1,259	55%	90%	$0.17	0.43
Hotel Motel	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,324	12	$836	95%	85%	$0.04	4
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,923	12	$2,012	19%	55%	$0.14	0.71
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,923	12	$2,012	19%	55%	$0.28	37,467
Hotel Motel	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	4,035	12	$1,750	55%	21%	$0.05	2
Hotel Motel	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,319	12	$2,569	11%	75%	$0.08	1
Hotel Motel	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	96	15	$747	50%	94%	$1.02	73
Hotel Motel	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	20	5	$165	95%	81%	$2.31	73
Hotel Motel	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	32	10	$210	25%	70%	$1.07	103
Hotel Motel	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	21	15	$483	45%	30%	$2.93	50
Hotel Motel	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	Existing	4,177	20	$9,503	100%	N/A	$0.26	747
Hotel Motel	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	34	8	$27	10%	94%	$0.15	80
Hotel Motel	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	60	15	$2	95%	35%	$-0.00	528
Hotel Motel	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	17	13	$19	95%	75%	$0.16	304
Hotel Motel	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	78	5	$193	5%	52%	$0.69	16
Hotel Motel	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	52	15	$171	75%	76%	$0.43	517
Hotel Motel	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	78	5	$78	50%	80%	$0.28	281

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	Existing	1,263	10	$3,606	58%	85%	$0.47	189
Hotel Motel	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.16	40	$9	4%	98%	$5.80	9
Hotel Motel	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.51	13	$0.31	10%	39%	$0.09	20
Hotel Motel	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.01	25	$1	75%	25%	$18.52	3
Hotel Motel	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	4	15	$3	65%	45%	$0.10	47
Hotel Motel	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.20	7	$0.18	90%	85%	$0.19	995
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	Building SQ.FT.	Existing	0.40	10	$2	25%	98%	$0.89	513
Hotel Motel	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.01	9
Hotel Motel	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	50%	$2.48	72
Hotel Motel	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	50%	$6.06	61
Hotel Motel	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	30	15	$399	50%	94%	$1.71	17
Hotel Motel	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	6	5	$165	95%	81%	$7.28	14
Hotel Motel	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	11	10	$210	25%	70%	$3.05	20
Hotel Motel	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	New	1,464	20	$7,603	100%	N/A	$0.59	191
Hotel Motel	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	12	8	$27	10%	94%	$0.45	15
Hotel Motel	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	16	15	$171	75%	76%	$1.36	113
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)	Per Kitchen Exhaust	New	402	10	$3,606	58%	85%	$1.50	41
Hotel Motel	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$18.24	1
Hotel Motel	Cooling Chillers	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.05	15	$0.98	20%	75%	$2.52	27
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	Building SQ.FT.	New	0.12	10	$2	50%	98%	$2.80	220
Hotel Motel	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.41	25	$30	80%	50%	$7.82	77
Hotel Motel	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	104	15	$747	50%	94%	$0.94	38
Hotel Motel	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	3,353	15	$3,292	100%	N/A	$0.12	357
Hotel Motel	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	78	10	$169	10%	30%	$0.36	22
Hotel Motel	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	391	4	$335	95%	72%	$0.32	374
Hotel Motel	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.43	15	$2	50%	94%	$0.61	549

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	84	5	$193	5%	52%	$0.64	4
Hotel Motel	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	56	15	$171	75%	76%	$0.39	287
Hotel Motel	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	84	5	$78	50%	80%	$0.25	84
Hotel Motel	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.04	18	$0.22	45%	65%	$0.62	30
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)	Per Kitchen Exhaust	Existing	1,371	10	$3,606	58%	85%	$0.44	105
Hotel Motel	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.17	40	$9	4%	98%	$5.35	5
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	per room	Existing	141	15	$139	60%	97%	$0.12	935
Hotel Motel	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.55	13	$0.31	10%	39%	$0.08	13
Hotel Motel	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.01	25	$1	75%	25%	$17.07	1
Hotel Motel	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.93	20	$2	75%	60%	$0.27	105
Hotel Motel	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	333	10	$137	95%	31%	$0.06	31
Hotel Motel	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.21	7	$0.18	90%	85%	$0.18	599
Hotel Motel	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.06	4
Hotel Motel	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	50%	$2.29	38
Hotel Motel	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	50%	$5.58	33
Hotel Motel	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	33	15	$399	50%	94%	$1.57	9
Hotel Motel	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	1,175	15	$2,634	100%	N/A	$0.29	63
Hotel Motel	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.13	15	$2	50%	94%	$1.93	112
Hotel Motel	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	18	15	$171	75%	76%	$1.24	59
Hotel Motel	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.96	6
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)	Per Kitchen Exhaust	New	438	10	$3,606	58%	85%	$1.37	21
Hotel Motel	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$16.72	0.97
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	per room	New	45	15	$139	60%	97%	$0.40	156
Hotel Motel	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	3	30	$5	50%	95%	$0.17	94
Hotel Motel	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.05	15	$0.98	20%	75%	$2.31	12
Hotel Motel	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	106	10	$137	95%	15%	$0.21	5
Hotel Motel	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.44	25	$30	80%	50%	$7.16	41

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	13,147	15	$12,181	100%	N/A	$0.11	2,810
Hotel Motel	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	100	15	$747	50%	94%	$0.97	74
Hotel Motel	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	197	5	$193	5%	52%	$0.26	3
Hotel Motel	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	131	15	$171	75%	76%	$0.16	1,214
Hotel Motel	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	197	5	$78	50%	80%	$0.10	66
Hotel Motel	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.10	18	$0.22	45%	65%	$0.26	142
Hotel Motel	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.35	14	$0.93	5%	94%	$0.35	79
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)	Per Kitchen Exhaust	Existing	3,184	10	$3,606	58%	85%	$0.18	443
Hotel Motel	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.16	40	$9	4%	98%	$5.55	9
Hotel Motel	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	20,503	30	$21,674	5%	N/A	$1.53	206
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	per room	Existing	328	15	$139	60%	97%	$0.04	3,721
Hotel Motel	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.31	10%	39%	$0.01	98
Hotel Motel	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.07	25	$0.49	25%	85%	$0.72	26
Hotel Motel	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.73	25	$1	75%	25%	$0.24	245
Hotel Motel	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	60%	$0.11	411
Hotel Motel	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	per floor area	Existing	1	25	$0.93	35%	45%	$0.06	453
Hotel Motel	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.18	25	$0.29	35%	45%	$0.16	52
Hotel Motel	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	2	25	$2	10%	35%	$0.10	219
Hotel Motel	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	773	10	$137	95%	31%	$0.02	229
Hotel Motel	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.50	7	$0.18	90%	85%	$0.07	2,341
Hotel Motel	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$10.97	10
Hotel Motel	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.77	25	$30	15%	50%	$4.12	43
Hotel Motel	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	50%	$5.16	73
Hotel Motel	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	7,753	15	$9,745	100%	N/A	$0.15	888
Hotel Motel	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	33	15	$399	50%	94%	$1.57	14
Hotel Motel	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	69	15	$171	75%	76%	$0.31	393
Hotel Motel	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.05	18	$0.22	45%	65%	$0.50	46

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.23	14	$0.93	5%	94%	$0.52	33
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)	Per Kitchen Exhaust	New	1,695	10	$3,606	58%	85%	$0.34	144
Hotel Motel	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$16.80	1
Hotel Motel	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	12,088	30	$66,350	5%	N/A	$1.32	64
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	per room	New	174	15	$139	60%	97%	$0.09	1,040
Hotel Motel	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.05	25	$0.49	75%	85%	$1.01	34
Hotel Motel	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.14	25	$0.29	35%	45%	$0.21	26
Hotel Motel	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	8	30	$5	50%	95%	$0.06	398
Hotel Motel	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.21	15	$0.98	20%	75%	$0.59	94
Hotel Motel	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	412	10	$137	95%	15%	$0.04	37
Hotel Motel	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.05	25	$30	80%	50%	$53.68	10
Hotel Motel	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	3,055	10	$581	20%	85%	$0.03	562
Hotel Motel	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,909	18	$8,798	95%	45%	$0.55	697
Hotel Motel	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	32	15	$6	95%	76%	$0.02	431
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	Per HP	Existing	813	20	$110	65%	75%	$0.01	8,105
Hotel Motel	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	21	8	$4	65%	25%	$0.04	15
Hotel Motel	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	1,902	10	$581	20%	75%	$0.05	162
Hotel Motel	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,909	18	$8,798	95%	45%	$0.55	366
Hotel Motel	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	20	15	$6	95%	76%	$0.04	175
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	Per HP	New	506	20	$110	65%	75%	$0.02	2,640
Hotel Motel	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.03	2,022
Hotel Motel	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	80	8	$28	75%	70%	$0.06	180
Hotel Motel	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	247	15	$337	62%	90%	$0.17	1,573
Hotel Motel	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	8	14	$36	75%	95%	$0.55	31
Hotel Motel	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	846
Hotel Motel	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.03	1,062
Hotel Motel	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	80	8	$28	75%	70%	$0.06	95
Hotel Motel	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	247	15	$337	62%	90%	$0.17	826
Hotel Motel	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	8	14	$36	75%	95%	$0.55	16
Hotel Motel	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	444

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	117	9	$110	85%	75%	$0.16	1,019
Hotel Motel	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	258	5	$13	70%	94%	$0.00	219
Hotel Motel	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.41	8	$0.98	30%	92%	$0.44	124
Hotel Motel	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.31	8	$0.73	30%	92%	$0.44	93
Hotel Motel	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	98	16	$16	95%	50%	$0.01	956
Hotel Motel	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	227
Hotel Motel	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.67	13	$0.01	90%	25%	$-0.01	4,204
Hotel Motel	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.25	13	$0.00	90%	28%	$-0.01	1,248
Hotel Motel	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.34	13	$0.00	90%	37%	$-0.01	618
Hotel Motel	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.42	13	$0.00	75%	42%	$-0.01	371
Hotel Motel	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.00	13	$0.01	70%	83%	$0.17	126
Hotel Motel	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	421	8	$70	90%	58%	$0.02	616
Hotel Motel	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	765	8	$201	85%	**%	$0.04	634
Hotel Motel	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	77	9	$110	85%	75%	$0.24	353
Hotel Motel	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	258	5	$13	70%	94%	$0.00	76
Hotel Motel	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.27	8	$0.98	30%	92%	$0.68	45
Hotel Motel	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.20	8	$0.73	30%	92%	$0.68	33
Hotel Motel	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	477
Hotel Motel	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.25	15	$0.00	90%	28%	$-0.01	655
Hotel Motel	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.34	15	$0.00	90%	37%	$-0.01	324
Hotel Motel	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.42	15	$0.00	75%	42%	$-0.01	195
Hotel Motel	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.00	15	$0.00	70%	83%	$0.03	66
Hotel Motel	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	278	8	$70	90%	58%	$0.04	222
Hotel Motel	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	765	8	$200	85%	**%	$0.04	228
Hotel Motel	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$161	95%	45%	$0.51	125
Hotel Motel	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$0.73	95%	45%	$-0.01	133
Hotel Motel	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.30	10

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	140	5	$14	95%	40%	$0.02	173
Hotel Motel	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$1	95%	45%	$-0.01	121
Hotel Motel	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$161	95%	45%	$0.51	65
Hotel Motel	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$0.73	95%	45%	$-0.01	70
Hotel Motel	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.30	5
Hotel Motel	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	140	5	$14	95%	40%	$0.02	91
Hotel Motel	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$1	95%	45%	$-0.01	63
Hotel Motel	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.05	5
Hotel Motel	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	369	10	$0.00	95%	75%	$-0.01	57
Hotel Motel	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	431	10	$142	95%	86%	$0.02	499
Hotel Motel	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	6	4	$0.41	95%	86%	$0.01	77
Hotel Motel	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$122	24%	65%	$0.21	20
Hotel Motel	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,525	9	$566	25%	35%	$0.05	211
Hotel Motel	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	549	7	$566	25%	35%	$0.22	76
Hotel Motel	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 4,000 sqft	Existing	102	5	$22	60%	90%	$0.05	383
Hotel Motel	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	244	14	$162	90%	80%	$0.08	251
Hotel Motel	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	1,042	3	$174	90%	25%	$0.06	371
Hotel Motel	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.05	2
Hotel Motel	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	369	10	$0.00	95%	75%	$-0.01	30
Hotel Motel	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	431	10	$142	95%	86%	$0.02	262
Hotel Motel	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	6	4	$0.41	95%	86%	$0.01	40
Hotel Motel	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$122	24%	65%	$0.21	10
Hotel Motel	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 4,000 sqft	New	102	5	$22	60%	90%	$0.05	201
Hotel Motel	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	244	14	$162	90%	80%	$0.08	131
Hotel Motel	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	246	15	$747	50%	94%	$0.38	186
Hotel Motel	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	200	5	$193	5%	52%	$0.25	37
Hotel Motel	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	133	15	$171	75%	76%	$0.15	1,327

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	200	5	$78	50%	80%	$0.09	675
Hotel Motel	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.10	18	$0.22	45%	65%	$0.25	157
Hotel Motel	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.61	14	$0.93	5%	94%	$0.19	152
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)	Per Kitchen Exhaust	Existing	3,236	10	$3,606	58%	85%	$0.17	486
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	per room	Existing	333	15	$139	60%	97%	$0.04	4,241
Hotel Motel	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.31	10%	39%	$-0.00	131
Hotel Motel	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.15	25	$0.49	25%	85%	$0.32	61
Hotel Motel	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	1	25	$1	75%	25%	$0.13	499
Hotel Motel	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	60%	$0.10	459
Hotel Motel	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	per floor area	Existing	2	25	$0.93	35%	45%	$0.02	1,261
Hotel Motel	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.34	25	$0.29	35%	45%	$0.07	120
Hotel Motel	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	3	25	$2	10%	35%	$0.04	537
Hotel Motel	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	786	10	$137	95%	31%	$0.01	29
Hotel Motel	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.51	7	$0.18	90%	85%	$0.06	2,666
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	Building SQ.FT.	Existing	1	10	$2	25%	98%	$0.33	1,295
Hotel Motel	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.19	25	$64	15%	50%	$34.86	11
Hotel Motel	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	156	15	$399	50%	94%	$0.32	80
Hotel Motel	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	84	15	$171	75%	76%	$0.25	529
Hotel Motel	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.06	18	$0.22	45%	65%	$0.40	62
Hotel Motel	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.39	14	$0.93	5%	94%	$0.31	60
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)	Per Kitchen Exhaust	New	2,059	10	$3,606	58%	85%	$0.27	194
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	per room	New	212	15	$139	60%	97%	$0.07	1,402
Hotel Motel	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.09	25	$0.49	75%	85%	$0.52	71
Hotel Motel	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.21	25	$0.29	35%	45%	$0.13	44
Hotel Motel	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	10	30	$5	50%	95%	$0.04	537
Hotel Motel	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.26	15	$0.98	20%	75%	$0.47	126
Hotel Motel	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	500	10	$137	95%	15%	$0.03	50

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	New	0.65	10	$2	50%	98%	$0.53	1,004
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	4,584	10	$8,171	35%	95%	$0.29	91
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	4,584	10	$8,171	35%	95%	$1.86	90,093
Hotel Motel	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	553	11	$266	95%	80%	$-0.21	247
Hotel Motel	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.08	10	$0.27	55%	80%	$0.51	298
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	24%	25%	$3.46	85,907
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	24%	25%	$0.14	0.78
Hotel Motel	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,164	10	$2,606	95%	95%	$0.02	121
Hotel Motel	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	20,008	10	$3,735	95%	94%	$-0.03	167
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	440	25	$817	5%	92%	$1.18	87,156
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	440	25	$817	5%	92%	$0.18	125
Hotel Motel	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	943	15	$1,208	100%	N/A	$0.16	112
Hotel Motel	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	17,388	15	$23,298	75%	N/A	$0.16	3,416
Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	6	12	$2	80%	90%	$0.38	4,105
Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	6	12	$2	80%	90%	$0.05	99
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	93%	$0.71	32,438
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	93%	$-0.07	53
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	161	10	$31	95%	73%	$-0.06	1,175
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	161	10	$31	95%	73%	$0.16	48,037
Hotel Motel	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	644	10	$17	95%	35%	$-0.08	2,253
Hotel Motel	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	644	10	$17	95%	35%	$0.07	67,468
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	21	10	$142	75%	85%	$1.09	290
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	21	10	$142	75%	85%	$9.06	47,373
Hotel Motel	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	166	5	$95	75%	5%	$0.15	39
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	4,656	10	$8,171	35%	95%	$0.28	49
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	4,656	10	$8,171	35%	95%	$1.87	82,884
Hotel Motel	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	555	11	$266	95%	80%	$-0.21	133
Hotel Motel	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.08	10	$0.27	55%	80%	$0.51	182

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	24%	55%	$0.14	0.93
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	24%	55%	$3.54	6,529
Hotel Motel	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,198	10	$2,606	95%	95%	$0.02	65
Hotel Motel	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	20,102	10	$3,695	95%	94%	$-0.04	90
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	447	25	$653	25%	92%	$0.94	53,326
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	447	25	$653	25%	92%	$0.14	402
Hotel Motel	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	986	15	$1,208	100%	N/A	$0.15	71
Hotel Motel	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	18,174	15	$19,871	75%	N/A	$0.13	2,567
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	93%	$-0.07	28
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	93%	$0.72	16,120
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	161	10	$31	95%	73%	$0.16	52,171
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	161	10	$31	95%	73%	$-0.06	631
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	21	10	$142	75%	85%	$1.07	157
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	21	10	$142	75%	85%	$9.08	25,708
Hotel Motel	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	169	5	$95	75%	5%	$0.15	24
Office	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$28	100%	N/A	$0.06	79,012
Office	Computers	Network PC Power Management	Network PC Power Management	No Power Management	4.2 units per 1,000 sqft	Existing	2	5	$12	95%	30%	$1.55	993
Office	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$28	100%	N/A	$0.06	7,570
Office	Computers	Network PC Power Management	Network PC Power Management	No Power Management	4.2 units per 1,000 sqft	New	2	5	$12	95%	30%	$1.55	521
Office	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	467	15	$747	75%	94%	$0.21	7,521
Office	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	19	5	$165	95%	81%	$2.38	760
Office	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	31	10	$210	25%	70%	$1.11	1,082
Office	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	21	15	$483	45%	45%	$3.02	794
Office	Cooling Chillers	Chillers >300 tons (centrifugal) with VSD - Advanced Efficiency	0.47 kW/ton w/VSD (full load)	0.576 kW/ton (full load)	Per installation	Existing	3,730	20	$6,161	100%	N/A	$0.19	7,835
Office	Cooling Chillers	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.46	15	$2	15%	67%	$0.83	2,729
Office	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	33	8	$27	10%	94%	$0.16	920
Office	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	58	15	$2	95%	35%	$0.00	6,013
Office	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	16	13	$19	95%	75%	$0.16	3,461

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	75	5	$193	45%	28%	$0.71	851
Office	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	50	15	$171	75%	76%	$0.44	5,463
Office	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	75	5	$78	50%	80%	$0.28	2,975
Office	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.15	40	$9	4%	98%	$5.97	144
Office	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.81	13	$0.31	10%	39%	$0.05	238
Office	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	4%	$28.76	5
Office	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	4	15	$3	65%	45%	$0.10	539
Office	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.19	7	$0.18	90%	85%	$0.20	11,317
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	Building SQ.FT.	Existing	0.38	10	$2	25%	98%	$0.91	5,337
Office	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$13.60	51
Office	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	2	25	$30	15%	95%	$1.55	1,451
Office	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.6 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	95%	$3.64	1,274
Office	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	175	15	$399	75%	94%	$0.29	1,854
Office	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	7	5	$165	95%	81%	$6.36	169
Office	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	13	10	$210	25%	70%	$2.66	261
Office	Cooling Chillers	Chillers >300 tons (centrifugal) with VSD - Advanced Efficiency	0.47 kW/ton w/VSD (full load)	0.576 kW/ton (full load)	Per installation	New	1,475	20	$4,904	100%	N/A	$0.38	2,383
Office	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	14	8	$27	10%	94%	$0.39	183
Office	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	18	15	$171	75%	76%	$1.18	1,378
Office	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.05	40	$9	4%	98%	$15.95	32
Office	Cooling Chillers	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.05	15	$0.98	20%	75%	$2.20	343
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	Building SQ.FT.	New	0.14	10	$2	50%	98%	$2.44	2,761
Office	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.77	25	$30	80%	95%	$4.16	1,871
Office	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	508	15	$747	75%	94%	$0.19	15,139
Office	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.50	15	$2	15%	67%	$0.77	4,458
Office	Cooling Dx	DX Package 240 to 760 kBTU/hr - Premium Efficiency	DX Package 240 to 760 kBTU/hr - Premium Efficiency 10.8 EER	DX Package 240 to 760 kBTU/hr - Standard Efficiency 10.0 EER	Per installation	Existing	2,994	15	$7,395	100%	N/A	$0.32	12,572
Office	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	76	10	$169	10%	20%	$0.37	535

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	381	4	$335	95%	72%	$0.33	13,144
Office	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.42	15	$2	50%	94%	$0.63	19,717
Office	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	82	5	$193	5%	28%	$0.65	76
Office	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	55	15	$171	75%	76%	$0.40	10,100
Office	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	82	5	$78	75%	80%	$0.26	4,491
Office	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.04	18	$0.22	45%	65%	$0.64	1,086
Office	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.16	40	$9	4%	98%	$5.49	259
Office	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.88	13	$0.31	10%	39%	$0.05	462
Office	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	4%	$26.45	9
Office	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.90	20	$2	75%	59%	$0.28	3,610
Office	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	433	10	$137	95%	26%	$0.05	875
Office	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.21	7	$0.18	90%	85%	$0.18	22,780
Office	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$13.64	84
Office	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	2	25	$30	15%	95%	$1.43	2,559
Office	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.6 (Average Existing Conditions)	per window sqft	Existing	2	25	$64	15%	95%	$3.35	2,293
Office	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	191	15	$399	75%	94%	$0.27	3,190
Office	Cooling Dx	DX Package 240 to 760 kBTU/hr - Premium Efficiency	DX Package 240 to 760 kBTU/hr - Premium Efficiency 10.8 EER	DX Package 240 to 760 kBTU/hr - Standard Efficiency 10.0 EER	Per installation	New	1,187	15	$5,916	100%	N/A	$0.65	2,669
Office	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.15	15	$2	50%	94%	$1.68	4,663
Office	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	20	15	$171	75%	76%	$1.09	2,389
Office	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.71	256
Office	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.06	40	$9	4%	98%	$14.62	58
Office	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	3	30	$5	50%	95%	$0.15	3,539
Office	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.06	15	$0.98	20%	75%	$2.02	521
Office	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	162	10	$137	95%	13%	$0.14	179
Office	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.84	25	$30	80%	95%	$3.81	3,282
Office	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	Existing	9,805	15	$8,904	100%	N/A	$0.11	35,618
Office	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	508	15	$747	75%	94%	$0.18	10,303
Office	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.52	15	$2	15%	67%	$0.74	4,053

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	159	5	$193	5%	28%	$0.33	26
Office	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	106	15	$171	75%	76%	$0.20	15,420
Office	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	159	5	$78	75%	80%	$0.13	1,297
Office	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.08	18	$0.22	45%	65%	$0.32	1,862
Office	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.23	14	$0.93	5%	94%	$0.53	852
Office	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.16	40	$9	4%	98%	$5.48	237
Office	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	Existing	17,030	30	$86,481	5%	N/A	$1.64	2,972
Office	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.31	10%	39%	$0.01	900
Office	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.03	25	$0.49	25%	65%	$1.56	223
Office	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.41	25	$1	75%	4%	$0.44	522
Office	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.14	5,312
Office	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.39	25	$0.93	35%	15%	$0.24	901
Office	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.07	25	$0.29	35%	15%	$0.39	173
Office	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.86	25	$2	10%	35%	$0.26	1,401
Office	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	836	10	$137	95%	26%	$0.02	2,122
Office	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.40	7	$0.18	90%	85%	$0.09	30,593
Office	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$13.65	77
Office	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	95%	$1.98	1,655
Office	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.6 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	95%	$3.47	1,998
Office	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	New	3,655	15	$7,122	100%	N/A	$0.25	7,175
Office	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	190	15	$399	75%	94%	$0.27	2,293
Office	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	46	15	$171	75%	76%	$0.48	4,010
Office	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.76	488
Office	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.11	14	$0.93	5%	94%	$1.07	253
Office	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.06	40	$9	4%	98%	$14.65	52
Office	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	New	7,774	30	$48,302	5%	N/A	$1.84	711
Office	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.01	25	$0.49	75%	65%	$2.96	214
Office	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.04	25	$0.29	35%	15%	$0.71	58

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	5	30	$5	50%	95%	$0.09	3,635
Office	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.14	15	$0.98	20%	75%	$0.90	990
Office	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	364	10	$137	95%	13%	$0.05	282
Office	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.52	25	$30	80%	95%	$6.09	1,733
Office	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	1,448	10	$581	20%	85%	$0.06	2,125
Office	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.18	15	$2	15%	67%	$2.07	5,448
Office	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	15	15	$6	95%	76%	$0.05	2,651
Office	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	385	20	$110	65%	75%	$0.03	46,430
Office	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	39	15	$178	11%	77%	$0.59	247
Office	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	10	8	$4	65%	25%	$0.09	96
Office	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	1,219	10	$581	20%	75%	$0.07	828
Office	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.94	50	$2	17%	98%	$0.24	18,739
Office	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	12	15	$6	95%	76%	$0.06	1,465
Office	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	324	20	$110	65%	75%	$0.03	20,529
Office	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	33	15	$178	11%	77%	$0.71	99
Office	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	27,318
Office	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	47	8	$28	75%	70%	$0.10	1,788
Office	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	248	15	$337	62%	90%	$0.16	15,551
Office	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	5	14	$35	75%	95%	$0.94	331
Office	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	11,439
Office	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	14,348
Office	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	47	8	$28	75%	70%	$0.10	939
Office	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	248	15	$337	62%	90%	$0.16	8,168
Office	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	5	14	$35	75%	95%	$0.94	173
Office	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	6,008
Office	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	154	9	$110	85%	75%	$0.12	17,621
Office	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	99	5	$12	70%	94%	$0.02	7,582
Office	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.96	8	$0.98	30%	78%	$0.19	3,774
Office	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.72	8	$0.73	30%	78%	$0.19	2,821

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	98	16	$16	95%	50%	$0.01	12,485
Office	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	2,966
Office	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	1	13	$0.75	90%	49%	$0.09	64,722
Office	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.30	13	$0.09	90%	59%	$0.03	41,072
Office	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.41	13	$0.14	90%	63%	$0.04	16,824
Office	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.51	13	$0.24	75%	67%	$0.05	9,200
Office	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.02	13	$0.02	70%	83%	$0.14	5,800
Office	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	557	8	$70	90%	42%	$0.01	6,253
Office	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	764	8	$201	85%	88%	$0.04	7,933
Office	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	95	9	$110	85%	75%	$0.20	5,703
Office	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	99	5	$12	70%	94%	$0.02	2,454
Office	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.59	8	$0.98	30%	78%	$0.31	1,349
Office	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.44	8	$0.73	30%	78%	$0.31	1,008
Office	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	6,231
Office	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.30	15	$0.00	90%	59%	$-0.01	21,573
Office	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.41	15	$0.05	90%	63%	$0.00	8,837
Office	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.51	15	$0.10	75%	67%	$0.01	4,832
Office	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.02	15	$0.00	70%	83%	$0.02	3,046
Office	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	343	8	$70	90%	42%	$0.03	2,236
Office	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	764	8	$201	85%	88%	$0.04	2,836
Office	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	75	6	$161	95%	45%	$0.51	1,264
Office	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	80	6	$1	95%	45%	$-0.01	1,351
Office	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	1,598
Office	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	140	5	$15	95%	40%	$0.02	1,757
Office	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	73	6	$0.97	95%	45%	$-0.01	1,230
Office	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	75	6	$161	95%	45%	$0.51	664
Office	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	80	6	$1	95%	45%	$-0.01	709
Office	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	839

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	140	5	$15	95%	40%	$0.02	923
Office	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	73	6	$0.97	95%	45%	$-0.01	646
Office	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.06	39
Office	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	371	10	$1	95%	75%	$-0.01	7,534
Office	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	4	4	$0.41	95%	86%	$0.02	607
Office	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	82	12	$124	19%	65%	$0.21	242
Office	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,531	9	$566	25%	35%	$0.05	3,227
Office	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	557	7	$566	25%	35%	$0.22	1,175
Office	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualized servers	Existing	2,313	4	$2,096	72%	85%	$0.65	5,454
Office	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 500 sqft	Existing	102	5	$22	60%	90%	$0.05	41,444
Office	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	245	14	$159	10%	80%	$0.08	47
Office	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	1,057	3	$175	10%	25%	$0.06	636
Office	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.06	20
Office	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	371	10	$1	95%	75%	$-0.01	3,957
Office	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	4	4	$0.41	95%	86%	$0.02	319
Office	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	82	12	$124	19%	65%	$0.21	127
Office	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualized servers	New	2,313	4	$2,096	72%	85%	$0.65	2,865
Office	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 500 sqft	New	102	5	$22	60%	90%	$0.05	21,768
Office	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	245	14	$159	10%	80%	$0.08	24
Office	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	990	15	$747	75%	94%	$0.08	26,169
Office	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.42	15	$2	15%	67%	$0.90	3,694
Office	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	160	5	$193	5%	28%	$0.32	281
Office	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	107	15	$171	75%	76%	$0.19	18,421
Office	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	160	5	$78	75%	80%	$0.12	13,973
Office	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.08	18	$0.22	45%	65%	$0.32	2,220

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.49	14	$0.93	5%	94%	$0.24	2,147
Office	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	3	13	$0.31	10%	39%	$-0.00	1,640
Office	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.10	25	$0.49	25%	65%	$0.49	782
Office	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.84	25	$1	75%	4%	$0.20	1,289
Office	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.13	6,113
Office	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	1	25	$0.93	35%	15%	$0.07	4,331
Office	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.21	25	$0.29	35%	15%	$0.13	633
Office	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	2	25	$2	10%	35%	$0.08	6,499
Office	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	844	10	$137	95%	26%	$0.01	309
Office	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.41	7	$0.18	90%	85%	$0.08	39,376
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	Building SQ.FT.	Existing	0.82	10	$2	25%	98%	$0.42	18,371
Office	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	204	15	$399	75%	94%	$0.24	3,065
Office	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	22	15	$171	75%	76%	$1.01	2,291
Office	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.59	277
Office	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.10	14	$0.93	5%	94%	$1.23	268
Office	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.02	25	$0.49	75%	65%	$2.45	270
Office	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.04	25	$0.29	35%	15%	$0.68	77
Office	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	2	30	$5	50%	95%	$0.20	2,168
Office	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.06	15	$0.98	20%	75%	$1.88	562
Office	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	173	10	$137	95%	13%	$0.12	168
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	Building SQ.FT.	New	0.17	10	$2	50%	98%	$2.09	4,525
Office	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.02	10	$0.27	55%	80%	$1.93	2,945
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	8%	25%	$0.14	22
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	8%	25%	$3.56	75,152
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	583	25	$817	5%	92%	$0.13	1,243
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	583	25	$817	5%	92%	$2.17	20,757
Office	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	226	15	$220	100%	N/A	$0.11	877
Office	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	4,168	15	$4,236	75%	N/A	$0.12	33,265

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Office	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	9	12	$2	80%	30%	$0.04	332
Office	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	9	12	$2	80%	30%	$0.72	60,043
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$-0.03	176
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$0.47	65,450
Office	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	339	10	$20	95%	35%	$-0.08	339
Office	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	339	10	$20	95%	35%	$0.12	96,753
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	58	10	$142	75%	85%	$0.39	2,254
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	58	10	$142	75%	85%	$8.16	8,049
Office	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	187	5	$95	75%	40%	$0.13	3,192
Office	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.02	10	$0.27	55%	80%	$1.91	1,540
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	8%	55%	$3.64	77,252
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	8%	55%	$0.14	26
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	590	25	$654	25%	92%	$0.10	3,457
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	590	25	$654	25%	92%	$1.74	59,369
Office	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	235	15	$220	100%	N/A	$0.11	605
Office	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	4,339	15	$3,612	75%	N/A	$0.10	21,638
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	85	10	$30	95%	73%	$-0.03	95
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	85	10	$30	95%	73%	$0.48	43,278
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	59	10	$142	75%	85%	$0.39	1,219
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	59	10	$142	75%	85%	$8.17	56,256
Office	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	189	5	$95	75%	40%	$0.13	1,654
Other	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$29	100%	N/A	$0.06	14,212
Other	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	Existing	5	5	$12	95%	30%	$0.68	211
Other	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$29	100%	N/A	$0.06	1,361
Other	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	New	5	5	$12	95%	30%	$0.68	110
Other	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	83	5	$193	5%	66%	$0.64	56
Other	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	83	5	$78	50%	80%	$0.26	709
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)	Per Kitchen Exhaust	Existing	929	10	$3,606	100%	85%	$0.64	874
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	Building SQ.FT.	Existing	0.43	10	$2	25%	98%	$0.83	1,347
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)	Per Kitchen Exhaust	New	424	10	$3,606	100%	85%	$1.42	223

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	New	0.19	10	$2	50%	98%	$1.81	687
Other	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	561	15	$747	50%	94%	$0.17	4,659
Other	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.56	15	$2	15%	67%	$0.69	2,048
Other	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	2,605	15	$2,540	100%	N/A	$0.12	6,116
Other	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	74	10	$169	10%	70%	$0.37	842
Other	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	374	4	$335	95%	72%	$0.33	6,268
Other	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.46	15	$2	50%	94%	$0.57	9,209
Other	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	91	5	$193	45%	66%	$0.59	758
Other	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	60	15	$171	75%	76%	$0.37	4,831
Other	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	91	5	$78	50%	80%	$0.24	1,417
Other	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.04	18	$0.22	45%	65%	$0.58	507
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)	Per Kitchen Exhaust	Existing	1,011	10	$3,606	5%	85%	$0.59	129
Other	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.18	40	$9	4%	98%	$4.97	182
Other	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.03	139
Other	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	30%	$35.66	33
Other	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.25	1,724
Other	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	552	10	$137	95%	28%	$0.04	446
Other	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.23	7	$0.18	90%	85%	$0.16	10,515
Other	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.86	18
Other	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	5	25	$30	15%	70%	$0.57	1,051
Other	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	4	25	$64	15%	70%	$1.39	761
Other	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	257	15	$399	50%	94%	$0.20	1,188
Other	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	1,246	15	$2,032	100%	N/A	$0.21	1,624
Other	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.21	15	$2	50%	94%	$1.25	2,482
Other	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	27	15	$171	75%	76%	$0.80	1,368
Other	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.02	18	$0.22	45%	65%	$1.27	136

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	New	463	10	$3,606	5%	85%	$1.30	35
Other	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.08	40	$9	4%	98%	$10.85	51
Other	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	5	30	$5	50%	95%	$0.11	1,977
Other	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.08	15	$0.98	20%	75%	$1.50	276
Other	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	253	10	$137	95%	14%	$0.09	110
Other	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	2	25	$30	80%	70%	$1.24	1,605
Other	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	6,721	15	$9,397	100%	N/A	$0.17	5,833
Other	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	566	15	$747	50%	94%	$0.16	1,405
Other	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.50	15	$2	15%	67%	$0.76	703
Other	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	153	5	$193	45%	66%	$0.34	100
Other	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	102	15	$171	75%	76%	$0.20	2,759
Other	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	153	5	$78	50%	80%	$0.13	153
Other	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.07	18	$0.22	45%	65%	$0.33	336
Other	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.19	14	$0.93	5%	94%	$0.66	126
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)	Per Kitchen Exhaust	Existing	1,704	10	$3,606	5%	85%	$0.34	86
Other	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.18	40	$9	4%	98%	$4.92	71
Other	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	11,368	30	$48,148	5%	N/A	$2.13	469
Other	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	2	13	$0.32	10%	39%	$0.00	87
Other	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.01	25	$0.49	25%	85%	$3.38	35
Other	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.26	25	$1	75%	30%	$0.68	695
Other	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.14	943
Other	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	per floor area	Existing	0.23	25	$0.93	35%	50%	$0.41	476
Other	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.03	25	$0.29	35%	50%	$0.93	65
Other	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.54	25	$2	10%	35%	$0.41	110
Other	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	930	10	$137	95%	28%	$0.01	415
Other	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.39	7	$0.18	90%	85%	$0.08	5,418
Other	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	2	10	$150	90%	66%	$11.89	7
Other	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	4	25	$30	15%	70%	$0.70	277

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	5	25	$64	15%	70%	$1.29	314
Other	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	3,221	15	$7,518	100%	N/A	$0.29	1,521
Other	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	256	15	$399	50%	94%	$0.19	376
Other	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	48	15	$171	75%	76%	$0.45	774
Other	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.72	94
Other	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.09	14	$0.93	5%	94%	$1.31	37
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)	Per Kitchen Exhaust	New	808	10	$3,606	5%	85%	$0.73	24
Other	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.08	40	$9	4%	98%	$10.87	19
Other	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	5,834	30	$28,325	5%	N/A	$2.11	128
Other	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	85%	$6.41	34
Other	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	50%	$1.72	21
Other	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	5	30	$5	50%	95%	$0.08	698
Other	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.14	15	$0.98	20%	75%	$0.85	191
Other	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	441	10	$137	95%	14%	$0.04	59
Other	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	70%	$1.60	391
Other	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	1,993	10	$581	5%	85%	$0.04	397
Other	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.26	15	$2	15%	67%	$1.50	4,059
Other	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,903	18	$4,005	95%	65%	$0.25	845
Other	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	21	15	$6	95%	76%	$0.04	1,983
Other	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	530	20	$110	65%	75%	$0.02	34,733
Other	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	54	15	$178	13%	77%	$0.43	219
Other	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	13	8	$4	65%	25%	$0.07	72
Other	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	Existing	416	13	$1,669	5%	59%	$0.57	177
Other	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	1,642	10	$581	5%	75%	$0.05	151
Other	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,903	18	$4,022	95%	50%	$0.25	2,048
Other	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.85	50	$2	16%	98%	$0.26	8,650
Other	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	17	15	$6	95%	76%	$0.04	1,061
Other	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	437	20	$110	65%	75%	$0.02	14,876
Other	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	44	15	$178	13%	77%	$0.52	88
Other	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	New	342	15	$1,669	5%	59%	$0.64	76

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	15,163
Other	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	82	8	$28	75%	70%	$0.05	2,740
Other	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	247	15	$336	62%	90%	$0.17	23,833
Other	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	9	14	$35	75%	95%	$0.54	443
Other	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	6,349
Other	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	7,964
Other	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	82	8	$28	75%	70%	$0.05	1,439
Other	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	247	15	$336	62%	90%	$0.17	12,518
Other	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	9	14	$35	75%	95%	$0.54	232
Other	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	3,335
Other	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	111	9	$110	25%	75%	$0.17	2,080
Other	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	112	5	$12	70%	94%	$0.02	6,086
Other	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.47	8	$0.98	30%	84%	$0.39	1,666
Other	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.35	8	$0.73	30%	84%	$0.39	1,245
Other	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	97	16	$16	95%	50%	$0.01	6,924
Other	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	1,644
Other	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	150	8	$249	10%	80%	$0.31	185
Other	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.43	13	$0.31	90%	33%	$0.09	25,382
Other	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.18	13	$0.04	90%	44%	$0.02	10,498
Other	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.25	13	$0.10	90%	51%	$0.05	4,630
Other	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.31	13	$0.21	75%	55%	$0.09	2,594
Other	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.14	13	$0.21	70%	83%	$0.20	16,872
Other	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	400	8	$70	90%	52%	$0.02	3,230
Other	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	758	8	$201	85%	**%	$0.04	3,687
Other	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	79	9	$110	25%	75%	$0.24	776
Other	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	112	5	$13	70%	94%	$0.02	2,271
Other	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.33	8	$0.98	30%	84%	$0.56	635

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.25	8	$0.73	30%	84%	$0.56	475
Other	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	3,456
Other	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	150	8	$249	10%	80%	$0.31	97
Other	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.18	15	$0.02	90%	44%	$0.00	5,514
Other	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.25	15	$0.05	90%	51%	$0.02	2,432
Other	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.31	15	$0.10	75%	55%	$0.03	1,362
Other	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.14	15	$0.05	70%	83%	$0.04	8,862
Other	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	284	8	$70	90%	52%	$0.04	1,232
Other	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	758	8	$201	85%	**%	$0.04	1,406
Other	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$162	95%	45%	$0.52	67
Other	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$0.00	95%	45%	$-0.01	72
Other	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	168
Other	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$14	95%	40%	$0.02	846
Other	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	65
Other	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$162	95%	45%	$0.52	35
Other	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$0.00	95%	45%	$-0.01	37
Other	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	88
Other	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$14	95%	40%	$0.02	444
Other	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	34
Other	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.06	36
Other	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	368	10	$0.00	95%	75%	$-0.01	557
Other	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	6	4	$0.41	95%	86%	$0.01	560
Other	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$123	10%	65%	$0.21	92
Other	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,520	9	$566	25%	35%	$0.05	2,314
Other	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	931	7	$566	25%	35%	$0.13	1,417
Other	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	Existing	2,296	4	$2,094	72%	85%	$0.65	3,910
Other	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	Existing	102	5	$22	60%	90%	$0.05	2,300

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	243	14	$160	10%	80%	$0.08	33
Other	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	1,765	3	$175	10%	25%	$0.03	767
Other	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.06	19
Other	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	368	10	$0.00	95%	75%	$-0.01	293
Other	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	6	4	$0.41	95%	86%	$0.01	294
Other	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$123	10%	65%	$0.21	48
Other	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	New	2,296	4	$2,094	72%	85%	$0.65	2,054
Other	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	New	102	5	$22	60%	90%	$0.05	1,208
Other	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	243	14	$160	10%	80%	$0.08	17
Other	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	Existing	1,039	12	$243	3%	77%	$0.02	414
Other	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.01	15	$0.10	3%	98%	$0.71	90
Other	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.00	15	$0.05	3%	98%	$4.36	0.95
Other	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	Existing	411	5	$71	5%	85%	$0.04	57
Other	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	23	10	$50	75%	95%	$0.36	349
Other	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.00	13	$0.00	3%	90%	$0.01	25
Other	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.00	12	$0.17	3%	95%	$3.37	38
Other	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	New	1,039	12	$243	3%	77%	$0.02	217
Other	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	New	411	5	$69	5%	85%	$0.04	37
Other	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	23	10	$50	75%	95%	$0.36	183
Other	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.00	12	$0.17	3%	95%	$3.37	20
Other	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	800	15	$747	50%	94%	$0.08	7,012
Other	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.34	15	$2	15%	67%	$1.09	1,444
Other	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	130	5	$193	45%	66%	$0.38	2,399
Other	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	86	15	$171	75%	76%	$0.22	7,655
Other	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	130	5	$78	50%	80%	$0.13	3,839
Other	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.06	18	$0.22	45%	65%	$0.37	891
Other	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.40	14	$0.93	5%	94%	$0.28	896
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)	Per Kitchen Exhaust	Existing	1,441	10	$3,606	5%	85%	$0.38	225

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	4	13	$0.32	10%	39%	$-0.03	450
Other	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.06	25	$0.49	25%	85%	$0.74	482
Other	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.54	25	$1	75%	30%	$0.30	4,789
Other	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	59%	$0.14	2,564
Other	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	per floor area	Existing	1	25	$0.93	35%	50%	$0.05	10,269
Other	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.13	25	$0.29	35%	50%	$0.19	1,007
Other	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	2	25	$2	10%	35%	$0.06	2,058
Other	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	787	10	$137	95%	28%	$-0.01	143
Other	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.33	7	$0.18	90%	85%	$0.08	15,827
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	Building SQ.FT.	Existing	0.66	10	$2	25%	98%	$0.49	7,222
Other	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.47	25	$64	15%	70%	$14.37	85
Other	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	169	15	$399	50%	94%	$0.27	884
Other	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	18	15	$171	75%	76%	$1.18	1,010
Other	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.89	122
Other	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.08	14	$0.93	5%	94%	$1.46	118
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)	Per Kitchen Exhaust	New	305	10	$3,606	5%	85%	$1.93	31
Other	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.01	25	$0.49	75%	85%	$3.63	186
Other	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.02	25	$0.29	35%	50%	$1.04	132
Other	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	2	30	$5	50%	95%	$0.22	937
Other	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.05	15	$0.98	20%	75%	$2.24	247
Other	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	166	10	$137	95%	14%	$0.10	80
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	Building SQ.FT.	New	0.14	10	$2	50%	98%	$2.48	1,992
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	679	10	$8,169	5%	95%	$2.00	33
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	679	10	$8,169	5%	95%	$27.15	38,746
Other	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	551	11	$254	95%	80%	$-0.22	150
Other	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.01	10	$0.27	55%	94%	$2.43	1,089
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	5%	25%	$3.49	94,967

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	5%	25%	$0.14	1
Other	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,142	10	$2,307	95%	95%	$0.01	35
Other	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	19,948	10	$3,461	95%	94%	$-0.04	49
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	326	25	$817	5%	92%	$3.43	24,880
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	326	25	$817	5%	92%	$0.25	391
Other	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	140	15	$242	100%	N/A	$0.21	284
Other	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	2,586	15	$4,659	75%	N/A	$0.22	10,552
Other	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	5	12	$2	80%	90%	$1.12	94,144
Other	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	5	12	$2	80%	90%	$0.07	318
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$4	95%	93%	$0.66	29,317
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$4	95%	93%	$-0.08	605
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$-0.03	72
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$0.46	53,091
Other	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$20	95%	35%	$-0.08	138
Other	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$20	95%	35%	$0.12	60,724
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	46	10	$142	75%	95%	$9.06	5,296
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	46	10	$142	75%	95%	$0.50	822
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.04	10	$0.88	3%	94%	$3.45	1
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.04	10	$0.88	3%	94%	$4,603.40	10,150
Other	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	115	5	$95	75%	55%	$0.22	1,393
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	685	10	$8,169	5%	95%	$27.21	17,847
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	685	10	$8,169	5%	95%	$1.99	17
Other	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	554	11	$254	95%	80%	$-0.22	80
Other	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.01	10	$0.27	55%	94%	$2.41	571
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	5%	55%	$0.14	1
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	5%	55%	$3.57	72,861
Other	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,176	10	$2,300	95%	95%	$0.01	19
Other	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	20,042	10	$3,450	95%	94%	$-0.04	26

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	329	25	$654	25%	92%	$0.20	1,100
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	329	25	$654	25%	92%	$2.75	31,546
Other	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	145	15	$242	100%	N/A	$0.21	192
Other	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	2,682	15	$3,974	75%	N/A	$0.18	6,877
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$4	95%	93%	$-0.08	325
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$4	95%	93%	$0.68	29,373
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$-0.03	38
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$0.47	4,507
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	47	10	$142	75%	95%	$0.49	442
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	47	10	$142	75%	95%	$9.08	16,890
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.04	10	$0.88	3%	94%	$3.42	0.56
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.04	10	$0.88	3%	94%	$4,613.63	89,303
Other	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	116	5	$95	75%	55%	$0.22	723
Restaurant	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$28	100%	N/A	$0.06	1,067
Restaurant	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$28	100%	N/A	$0.06	102
Restaurant	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	11,989	12	$1,908	90%	90%	$0.01	897
Restaurant	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	1,037	12	$1,309	70%	86%	$0.17	286
Restaurant	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,314	12	$824	95%	85%	$0.04	1,088
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,915	12	$2,035	40%	45%	$1.01	30,362
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,915	12	$2,035	40%	45%	$0.14	318
Restaurant	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,019	12	$1,765	35%	21%	$0.05	348
Restaurant	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,302	12	$2,565	39%	75%	$0.07	1,516
Restaurant	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	11,989	12	$1,908	90%	90%	$0.01	471
Restaurant	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	1,037	12	$1,309	70%	86%	$0.17	150
Restaurant	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,314	12	$824	95%	85%	$0.04	571
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,915	12	$2,035	40%	45%	$0.14	167
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,915	12	$2,035	40%	45%	$1.01	21,902
Restaurant	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	4,019	12	$1,765	35%	21%	$0.05	182
Restaurant	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,302	12	$2,565	39%	75%	$0.07	796
Restaurant	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	1,686	15	$1,316	100%	N/A	$0.10	2,861
Restaurant	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	94	10	$169	10%	50%	$0.29	252
Restaurant	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	471	4	$335	95%	72%	$0.26	2,479
Restaurant	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	1	15	$2	50%	94%	$0.25	4,857

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	204	5	$193	5%	**%	$0.26	67
Restaurant	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	204	5	$78	50%	**%	$0.10	803
Restaurant	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.10	18	$0.22	45%	65%	$0.25	267
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)	Per Kitchen Exhaust	Existing	660	10	$3,606	100%	85%	$0.91	1,258
Restaurant	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.41	40	$9	4%	98%	$2.21	84
Restaurant	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.31	10%	39%	$0.02	92
Restaurant	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.01	25	$1	75%	85%	$15.36	45
Restaurant	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	56%	$0.11	739
Restaurant	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	347	10	$137	95%	25%	$0.06	172
Restaurant	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.52	7	$0.18	90%	85%	$0.07	4,547
Restaurant	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.32	9
Restaurant	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	4	25	$30	15%	80%	$0.72	505
Restaurant	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	3	25	$64	15%	80%	$1.77	419
Restaurant	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	682	15	$1,053	100%	N/A	$0.20	615
Restaurant	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.40	15	$2	50%	94%	$0.66	1,084
Restaurant	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.04	18	$0.22	45%	65%	$0.67	59
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)	Per Kitchen Exhaust	New	253	10	$3,606	100%	85%	$2.38	279
Restaurant	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.16	40	$9	4%	98%	$5.78	19
Restaurant	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	9	30	$5	50%	95%	$0.05	723
Restaurant	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.16	15	$0.98	20%	75%	$0.79	121
Restaurant	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	133	10	$137	95%	13%	$0.16	33
Restaurant	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	80%	$1.89	642
Restaurant	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	2,978	15	$4,873	100%	N/A	$0.21	1,654
Restaurant	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	248	5	$193	5%	**%	$0.21	4
Restaurant	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	248	5	$78	50%	**%	$0.08	51
Restaurant	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.12	18	$0.22	45%	65%	$0.21	98
Restaurant	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.12	14	$1	5%	94%	$1.90	14

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	Existing	802	10	$3,606	100%	85%	$0.75	508
Restaurant	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.42	40	$9	4%	98%	$2.19	27
Restaurant	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	5,551	30	$28,670	5%	N/A	$2.27	143
Restaurant	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.31	10%	39%	$0.04	14
Restaurant	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.00	25	$0.49	25%	98%	$7.42	3
Restaurant	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.19	25	$1	75%	85%	$0.97	238
Restaurant	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	2	20	$2	75%	56%	$0.09	239
Restaurant	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.02	25	$0.93	35%	90%	$3.86	15
Restaurant	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.00	25	$0.29	35%	90%	$5.73	3
Restaurant	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.09	25	$2	10%	35%	$2.37	5
Restaurant	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	422	10	$137	95%	25%	$0.05	99
Restaurant	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.63	7	$0.18	90%	85%	$0.05	1,453
Restaurant	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.37	2
Restaurant	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	4	25	$30	15%	80%	$0.76	151
Restaurant	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	3	25	$64	15%	80%	$1.71	139
Restaurant	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	2,227	15	$3,898	100%	N/A	$0.22	594
Restaurant	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.05	18	$0.22	45%	65%	$0.48	25
Restaurant	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.09	14	$1	5%	94%	$2.46	6
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)	Per Kitchen Exhaust	New	354	10	$3,606	100%	85%	$1.70	134
Restaurant	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.15	40	$9	4%	98%	$5.84	6
Restaurant	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	3,356	30	$66,539	5%	N/A	$1.91	41
Restaurant	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	98%	$7.45	5
Restaurant	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	90%	$2.50	4
Restaurant	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	8	30	$5	50%	95%	$0.06	176
Restaurant	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	186	10	$137	95%	13%	$0.12	12
Restaurant	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	80%	$2.18	169
Restaurant	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	3,348	10	$581	1%	85%	$0.02	25
Restaurant	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,901	18	$6,284	95%	25%	$0.39	2,669
Restaurant	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	35	15	$6	95%	76%	$0.02	383

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	891	20	$110	65%	75%	$0.01	7,219
Restaurant	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	23	8	$4	65%	25%	$0.03	13
Restaurant	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	2,668	10	$581	1%	75%	$0.03	9
Restaurant	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,901	18	$6,284	95%	25%	$0.39	1,402
Restaurant	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	28	15	$6	95%	76%	$0.02	199
Restaurant	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	710	20	$110	65%	75%	$0.01	2,994
Restaurant	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.03	1,679
Restaurant	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	86	8	$28	75%	70%	$0.05	607
Restaurant	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	246	15	$336	62%	90%	$0.17	5,283
Restaurant	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	9	14	$35	75%	95%	$0.50	94
Restaurant	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	703
Restaurant	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.03	882
Restaurant	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	86	8	$28	75%	70%	$0.05	319
Restaurant	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	246	15	$336	62%	90%	$0.17	2,775
Restaurant	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	9	14	$35	75%	95%	$0.50	49
Restaurant	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	369
Restaurant	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	229	9	$110	10%	75%	$0.07	190
Restaurant	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	147	5	$12	70%	94%	$0.01	1,394
Restaurant	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.29	8	$0.98	30%	98%	$0.63	216
Restaurant	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.11	8	$0.73	30%	98%	$1.28	81
Restaurant	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	96	16	$16	95%	50%	$0.01	764
Restaurant	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	181
Restaurant	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	197	8	$249	25%	80%	$0.23	464
Restaurant	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.83	13	$0.01	90%	27%	$-0.01	4,440
Restaurant	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.39	13	$0.00	90%	38%	$-0.01	2,093
Restaurant	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.52	13	$0.01	90%	38%	$-0.01	797
Restaurant	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.65	13	$0.01	75%	38%	$-0.01	415
Restaurant	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.04	13	$0.04	70%	83%	$0.15	543
Restaurant	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	826	8	$70	45%	64%	$0.00	548

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	753	8	$201	85%	**%	$0.04	1,027
Restaurant	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	130	9	$110	10%	75%	$0.14	56
Restaurant	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	147	5	$13	70%	94%	$0.01	414
Restaurant	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.16	8	$0.98	30%	98%	$1.13	65
Restaurant	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.06	8	$0.73	30%	98%	$2.27	24
Restaurant	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	381
Restaurant	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	197	8	$249	25%	80%	$0.23	243
Restaurant	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.35	15	$0.00	90%	38%	$-0.01	989
Restaurant	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.47	15	$0.00	90%	38%	$-0.01	377
Restaurant	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.59	15	$0.01	75%	38%	$-0.01	196
Restaurant	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.04	15	$0.01	70%	83%	$0.02	285
Restaurant	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	468	8	$70	45%	64%	$0.01	165
Restaurant	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	753	8	$200	85%	**%	$0.04	309
Restaurant	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$165	95%	45%	$0.53	13
Restaurant	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$5	95%	45%	$0.01	14
Restaurant	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	11
Restaurant	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$15	95%	40%	$0.02	333
Restaurant	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	12
Restaurant	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$165	95%	45%	$0.53	6
Restaurant	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$5	95%	45%	$0.01	7
Restaurant	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	6
Restaurant	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$15	95%	40%	$0.02	175
Restaurant	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	6
Restaurant	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.06	5
Restaurant	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	368	10	$0.81	95%	75%	$-0.01	769
Restaurant	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	429	10	$142	95%	86%	$0.02	1,959
Restaurant	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	8	4	$0.41	95%	86%	$0.00	79
Restaurant	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$123	19%	65%	$0.21	66

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,519	9	$566	25%	35%	$0.06	879
Restaurant	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	443	7	$566	25%	35%	$0.28	256
Restaurant	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	Existing	101	5	$22	60%	90%	$0.05	254
Restaurant	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	840	3	$175	5%	25%	$0.08	69
Restaurant	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.06	2
Restaurant	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	368	10	$0.81	95%	75%	$-0.01	403
Restaurant	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	429	10	$142	95%	86%	$0.02	1,029
Restaurant	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	8	4	$0.41	95%	86%	$0.00	41
Restaurant	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$123	19%	65%	$0.21	34
Restaurant	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 5,000 sqft	New	101	5	$22	60%	90%	$0.05	133
Restaurant	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	Existing	997	12	$82	25%	45%	$0.00	642
Restaurant	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 5,000 sqft	Existing	1,038	12	$243	10%	77%	$0.02	367
Restaurant	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.04	15	$0.10	10%	98%	$0.28	100
Restaurant	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.00	15	$0.05	10%	98%	$1.74	1
Restaurant	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	Existing	255	10	$12	5%	68%	$-0.00	56
Restaurant	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	Existing	2,600	12	$726	95%	77%	$0.03	3,065
Restaurant	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	Per Unit. Ea. Compressor	Existing	179	10	$726	85%	72%	$0.67	6,057
Restaurant	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	Existing	411	5	$65	30%	85%	$0.03	1,056
Restaurant	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	832	3	$119	10%	85%	$0.05	671
Restaurant	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	178	10	$50	75%	95%	$0.04	1,063
Restaurant	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	Existing	1,179	12	$191	95%	81%	$0.01	1,467
Restaurant	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.15	13	$0.02	10%	90%	$0.01	292
Restaurant	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	392	4	$185	5%	20%	$0.15	25
Restaurant	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.21	12	$0.17	75%	95%	$0.11	3,563
Restaurant	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	New	997	12	$82	25%	45%	$0.00	336
Restaurant	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 5,000 sqft	New	1,038	12	$243	10%	77%	$0.02	193
Restaurant	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	New	255	10	$12	5%	68%	$-0.00	29
Restaurant	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	New	2,600	12	$726	95%	77%	$0.03	1,610
Restaurant	Refrigeration	High-Efficiency Compressor	High-Efficiency Compressor (15% More Efficient)	Standard Compressor, 40% Efficiency	Per Unit. Ea. Compressor	New	77	10	$726	85%	72%	$1.56	3,198
Restaurant	Refrigeration	Night Covers for Display Cases	Night Covers for Display Cases	No Night Covers	per installation	New	411	5	$65	30%	85%	$0.03	677

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	467	3	$46	5%	90%	$0.03	105
Restaurant	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	178	10	$50	75%	95%	$0.04	558
Restaurant	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	New	1,179	12	$191	95%	81%	$0.01	770
Restaurant	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	392	4	$185	5%	20%	$0.15	13
Restaurant	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.21	12	$0.17	75%	95%	$0.11	1,871
Restaurant	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	67	5	$193	5%	**%	$0.80	6
Restaurant	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	67	5	$78	50%	**%	$0.32	80
Restaurant	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.03	18	$0.22	45%	65%	$0.79	14
Restaurant	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.20	14	$1	5%	94%	$1.16	12
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)	Per Kitchen Exhaust	Existing	217	10	$3,606	100%	85%	$2.78	69
Restaurant	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.31	10%	39%	$0.03	11
Restaurant	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.03	25	$0.49	25%	98%	$1.47	9
Restaurant	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	per roof sqft	Existing	0.29	25	$1	75%	85%	$0.64	234
Restaurant	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.73	20	$2	75%	56%	$0.35	40
Restaurant	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.39	25	$0.93	35%	90%	$0.25	182
Restaurant	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.07	25	$0.29	35%	90%	$0.43	29
Restaurant	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.68	25	$2	10%	35%	$0.33	29
Restaurant	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	114	10	$137	95%	25%	$0.20	2
Restaurant	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.17	7	$0.18	90%	85%	$0.22	273
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	Building SQ.FT.	Existing	0.34	10	$2	25%	98%	$1.03	120
Restaurant	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.08	25	$64	15%	80%	$79.42	1
Restaurant	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$3.46	2
Restaurant	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.04	14	$1	5%	94%	$5.09	1
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)	Per Kitchen Exhaust	New	49	10	$3,606	100%	85%	$12.13	10
Restaurant	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	98%	$6.43	4
Restaurant	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	90%	$1.88	4
Restaurant	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.46	16
Restaurant	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	26	10	$137	95%	13%	$0.87	1

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	New	0.07	10	$2	50%	98%	$4.52	39
Restaurant	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.43	10	$0.27	75%	94%	$0.09	1,969
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	46%	25%	$0.14	2
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	46%	25%	$3.50	68,412
Restaurant	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,136	10	$2,601	95%	95%	$0.01	5,579
Restaurant	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	19,929	10	$3,709	95%	94%	$-0.04	7,713
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	2,723	25	$817	5%	92%	$0.70	72,498
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	2,723	25	$817	5%	92%	$0.02	542
Restaurant	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	957	15	$197	100%	N/A	$0.01	406
Restaurant	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	17,648	15	$3,812	75%	N/A	$0.01	13,589
Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	38	12	$2	80%	90%	$-0.00	427
Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	38	12	$2	80%	90%	$0.25	57,219
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	911	5	$5	95%	46%	$-0.10	1,878
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	911	5	$5	95%	46%	$0.05	95,179
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	383	10	$142	75%	75%	$1.89	79,780
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	383	10	$142	75%	75%	$0.05	1,063
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.70	10	$0.88	45%	94%	$0.20	492
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.70	10	$0.88	45%	94%	$17.43	58,320
Restaurant	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	785	5	$95	75%	75%	$0.02	2,527
Restaurant	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.43	10	$0.27	75%	94%	$0.09	1,014
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	46%	55%	$0.13	3
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	46%	55%	$3.57	34,458
Restaurant	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,169	10	$2,601	95%	95%	$0.01	2,963
Restaurant	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	20,023	10	$3,709	95%	94%	$-0.04	4,097
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	2,706	25	$653	25%	92%	$0.01	1,450
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	2,706	25	$653	25%	92%	$0.56	32,551
Restaurant	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	979	15	$197	100%	N/A	$0.01	242

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Restaurant	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	18,043	15	$3,251	75%	N/A	$0.01	8,662
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	915	5	$5	95%	46%	$-0.10	1,008
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	915	5	$5	95%	46%	$0.05	6,314
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	380	10	$142	75%	75%	$0.05	564
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	380	10	$142	75%	75%	$1.90	19,925
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.69	10	$0.88	45%	94%	$0.20	253
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.69	10	$0.88	45%	94%	$17.47	16,629
Restaurant	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	780	5	$95	75%	75%	$0.02	1,301
School	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$27	100%	N/A	$0.06	16,186
School	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	Existing	11	5	$12	95%	30%	$0.28	203
School	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$27	100%	N/A	$0.06	1,550
School	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	New	11	5	$12	95%	30%	$0.28	106
School	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	11,989	12	$1,839	90%	90%	$0.00	10
School	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	447	12	$1,839	35%	90%	$0.59	0.73
School	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,314	12	$944	95%	85%	$0.04	19
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,915	12	$2,124	26%	40%	$0.15	3
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,915	12	$2,124	26%	40%	$0.07	51,314
School	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,019	12	$1,888	75%	21%	$0.05	13
School	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,302	12	$2,478	14%	75%	$0.07	9
School	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	11,989	12	$1,839	90%	90%	$0.00	5
School	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	447	12	$1,839	35%	90%	$0.59	0.38
School	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,314	12	$944	95%	85%	$0.04	9
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,915	12	$2,124	26%	40%	$0.15	1
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,915	12	$2,124	26%	40%	$0.07	54,200
School	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	4,019	12	$1,888	75%	21%	$0.05	6
School	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,302	12	$2,478	14%	75%	$0.07	5
School	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	98	15	$747	25%	94%	$1.00	129
School	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	4	5	$165	95%	81%	$11.35	40
School	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	5	10	$210	25%	70%	$7.05	56
School	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	3	15	$483	45%	90%	$19.19	83
School	Cooling Chillers	Chillers 150-300 tons (screw) - Advanced Efficiency	0.50 kW/ton (full load)	0.680 kW/Ton (full load)	Per installation	Existing	2,596	20	$21,436	100%	N/A	$0.94	409
School	Cooling Chillers	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.09	15	$2	15%	67%	$3.99	143

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	5	8	$27	10%	94%	$1.04	40
School	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	9	15	$2	95%	35%	$0.03	307
School	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	2	13	$19	95%	75%	$1.05	152
School	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	15	5	$193	5%	34%	$3.40	6
School	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	10	15	$171	75%	76%	$2.12	285
School	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	15	5	$78	50%	80%	$1.37	155
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)	Per Kitchen Exhaust	Existing	788	10	$3,604	73%	85%	$0.76	174
School	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$28.45	12
School	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.21	13	$0.31	10%	39%	$0.21	12
School	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	15%	$108.84	2
School	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	0.98	15	$3	65%	45%	$0.52	27
School	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.04	7	$0.18	90%	85%	$0.96	583
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	Building SQ.FT.	Existing	0.08	10	$2	25%	98%	$4.36	281
School	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.30	10
School	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.53	25	$30	15%	60%	$6.02	48
School	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.45	25	$64	15%	60%	$14.99	40
School	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	47	15	$399	25%	94%	$1.11	41
School	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	1	5	$165	95%	81%	$23.68	12
School	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	2	10	$210	25%	70%	$13.24	16
School	Cooling Chillers	Chillers 150-300 tons (screw) - Advanced Efficiency	0.50 kW/ton (full load)	0.680 kW/Ton (full load)	Per installation	New	1,263	20	$17,148	100%	N/A	$1.55	150
School	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	2	8	$27	10%	94%	$1.96	12
School	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	5	15	$171	75%	76%	$4.42	94
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)	Per Kitchen Exhaust	New	377	10	$3,604	73%	85%	$1.59	48
School	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$59.37	3
School	Cooling Chillers	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.01	15	$0.98	20%	75%	$8.22	23

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	New	0.03	10	$2	50%	98%	$9.11	190
School	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.25	25	$30	80%	60%	$12.57	82
School	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	106	15	$747	25%	94%	$0.92	123
School	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.10	15	$2	15%	67%	$3.68	114
School	Cooling Dx	DX Package 135 to 240 kBTU/hr - Premium Efficiency	DX Package 135 to 240 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 135 to 240 kBTU/hr - Standard Efficiency 11.0 EER	Per installation	Existing	2,084	15	$9,949	100%	N/A	$0.62	327
School	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	11	10	$169	10%	60%	$2.37	39
School	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	59	4	$335	95%	72%	$2.12	321
School	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.08	15	$2	50%	94%	$3.02	508
School	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	17	5	$193	5%	34%	$3.14	2
School	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	11	15	$171	75%	76%	$1.95	282
School	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	17	5	$78	50%	80%	$1.26	77
School	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.00	18	$0.22	45%	65%	$3.08	28
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)	Per Kitchen Exhaust	Existing	855	10	$3,604	73%	85%	$0.70	166
School	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$26.22	10
School	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.22	13	$0.31	10%	39%	$0.20	11
School	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	15%	$100.30	1
School	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.19	20	$2	75%	55%	$1.37	88
School	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	497	10	$134	95%	21%	$0.04	17
School	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.04	7	$0.18	90%	85%	$0.89	557
School	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.37	8
School	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.57	25	$30	15%	60%	$5.55	41
School	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.49	25	$64	15%	60%	$13.81	35
School	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	51	15	$399	25%	94%	$1.02	35
School	Cooling Dx	DX Package 135 to 240 kBTU/hr - Premium Efficiency	DX Package 135 to 240 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 135 to 240 kBTU/hr - Standard Efficiency 11.0 EER	Per installation	New	956	15	$7,964	100%	N/A	$1.09	78
School	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.04	15	$2	50%	94%	$6.28	159
School	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	5	15	$171	75%	76%	$4.05	81
School	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$6.39	8

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	New	412	10	$3,604	73%	85%	$1.46	41
School	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$54.43	3
School	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.56	118
School	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.01	15	$0.98	20%	75%	$7.54	17
School	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	239	10	$134	95%	10%	$0.09	4
School	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.27	25	$30	80%	60%	$11.52	70
School	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	Existing	22,843	15	$40,977	100%	N/A	$0.22	4,885
School	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	103	15	$747	25%	94%	$0.94	118
School	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.45	15	$2	15%	67%	$0.85	677
School	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	137	5	$193	5%	34%	$0.38	5
School	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	91	15	$171	75%	76%	$0.23	2,623
School	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	137	5	$78	50%	80%	$0.14	142
School	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.07	18	$0.22	45%	65%	$0.37	310
School	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.37	14	$0.93	5%	94%	$0.33	263
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)	Per Kitchen Exhaust	Existing	6,805	10	$3,604	73%	85%	$0.07	1,541
School	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$26.98	14
School	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	Existing	31,775	30	$18,430	5%	N/A	$4.06	326
School	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	4	13	$0.31	10%	39%	$-0.01	287
School	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.05	25	$0.49	25%	85%	$1.01	137
School	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.67	25	$1	75%	15%	$0.26	1,013
School	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	55%	$0.16	823
School	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	0.70	25	$0.93	35%	35%	$0.12	1,300
School	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.13	25	$0.29	35%	35%	$0.21	241
School	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	3	25	$2	10%	35%	$0.04	576
School	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	3,956	10	$134	95%	21%	$-0.01	299
School	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.35	7	$0.18	90%	85%	$0.10	5,165
School	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.28	11

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.95	25	$64	15%	60%	$7.15	96
School	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	New	11,243	15	$32,780	100%	N/A	$0.37	1,357
School	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	51	15	$399	25%	94%	$1.01	37
School	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	40	15	$171	75%	76%	$0.54	716
School	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.87	86
School	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.16	14	$0.93	5%	94%	$0.78	72
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)	Per Kitchen Exhaust	New	2,988	10	$3,604	73%	85%	$0.19	363
School	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$54.61	4
School	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	New	16,434	30	$82,509	5%	N/A	$4.01	92
School	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.02	25	$0.49	75%	85%	$2.40	111
School	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.05	25	$0.29	35%	35%	$0.53	63
School	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	4	30	$5	50%	95%	$0.10	650
School	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.12	15	$0.98	20%	75%	$1.02	175
School	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	1,737	10	$134	95%	10%	$-0.00	40
School	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	1,243	10	$581	1%	85%	$0.07	24
School	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.16	15	$2	15%	67%	$2.41	1,222
School	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,901	18	$4,529	95%	85%	$0.28	1,457
School	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	13	15	$6	95%	76%	$0.06	597
School	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	330	20	$110	65%	75%	$0.03	10,455
School	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	33	15	$178	11%	77%	$0.69	55
School	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	8	8	$4	65%	25%	$0.11	21
School	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	Existing	1,156	13	$1,664	65%	59%	$0.20	705
School	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	837	10	$581	1%	75%	$0.11	7
School	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,901	18	$4,529	95%	85%	$0.28	765
School	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.40	50	$2	15%	98%	$0.55	1,817
School	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	8	15	$6	95%	76%	$0.09	262
School	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	222	20	$110	65%	75%	$0.05	3,677
School	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	22	15	$178	11%	77%	$1.03	18
School	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	New	779	15	$1,664	63%	59%	$0.28	239

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	6,199
School	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	104	8	$28	75%	70%	$0.04	654
School	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	246	15	$336	62%	90%	$0.17	5,687
School	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	11	14	$35	75%	95%	$0.42	112
School	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	2,596
School	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	3,256
School	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	104	8	$28	75%	70%	$0.04	343
School	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	246	15	$336	62%	90%	$0.17	2,987
School	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	11	14	$35	75%	95%	$0.42	58
School	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	1,363
School	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	111	9	$110	50%	75%	$0.17	1,743
School	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	62	5	$12	70%	94%	$0.05	637
School	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	1	8	$0.98	30%	81%	$0.17	765
School	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.81	8	$0.73	30%	81%	$0.17	575
School	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	98	16	$16	95%	50%	$0.01	2,922
School	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	694
School	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	83	8	$248	10%	80%	$0.57	107
School	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.42	13	$0.24	90%	31%	$0.07	10,032
School	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.24	13	$0.12	90%	50%	$0.06	6,368
School	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.32	13	$0.18	90%	58%	$0.07	2,830
School	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.40	13	$0.25	75%	62%	$0.08	1,579
School	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.06	13	$0.09	70%	83%	$0.21	3,052
School	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	399	8	$70	90%	35%	$0.02	1,025
School	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	762	8	$201	85%	95%	$0.04	1,665
School	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	79	9	$110	50%	75%	$0.24	657
School	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	62	5	$12	70%	94%	$0.05	240
School	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.77	8	$0.98	30%	81%	$0.24	294

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.70	8	$0.73	30%	81%	$0.20	266
School	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	1,458
School	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	83	8	$248	10%	80%	$0.57	56
School	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.24	15	$0.01	90%	50%	$-0.00	3,345
School	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.32	15	$0.06	90%	58%	$0.02	1,486
School	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.40	15	$0.12	75%	62%	$0.03	829
School	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.06	15	$0.02	70%	83%	$0.04	1,603
School	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	287	8	$70	90%	35%	$0.04	395
School	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	762	8	$201	85%	95%	$0.04	641
School	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$160	95%	45%	$0.51	52
School	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$5	95%	45%	$0.00	56
School	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	153
School	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$12	95%	40%	$0.01	72
School	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	51
School	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$160	95%	45%	$0.51	27
School	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$5	95%	45%	$0.00	29
School	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	80
School	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$12	95%	40%	$0.01	38
School	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	26
School	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$0.00	20%	90%	$-0.01	3
School	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	368	10	$0.00	95%	75%	$-0.01	48
School	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	429	10	$139	95%	86%	$0.02	417
School	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	1	4	$0.41	95%	86%	$0.08	55
School	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$126	40%	65%	$0.22	34
School	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,519	9	$567	25%	35%	$0.06	212
School	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	160	7	$567	25%	35%	$0.80	22
School	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	Existing	2,294	4	$2,101	72%	85%	$0.65	358
School	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 3,000 sqft	Existing	101	5	$22	60%	90%	$0.05	1,567

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	243	14	$161	75%	80%	$0.08	174
School	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	303	3	$176	75%	25%	$0.24	90
School	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$0.00	20%	90%	$-0.01	1
School	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	368	10	$0.00	95%	75%	$-0.01	25
School	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	429	10	$139	95%	86%	$0.02	219
School	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	1	4	$0.41	95%	86%	$0.08	28
School	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$126	40%	65%	$0.22	17
School	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of virualizated servers	New	2,294	4	$2,101	72%	85%	$0.65	188
School	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 3,000 sqft	New	101	5	$22	60%	90%	$0.05	823
School	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	243	14	$161	75%	80%	$0.08	91
School	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	Existing	997	12	$79	15%	45%	$0.00	136
School	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	Existing	1,038	12	$243	5%	77%	$0.02	339
School	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.04	15	$0.10	5%	98%	$0.28	185
School	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.00	15	$0.05	5%	98%	$1.74	1
School	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	Existing	354	10	$192	5%	68%	$0.08	19
School	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	Existing	2,600	12	$741	95%	77%	$0.03	67
School	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	832	3	$118	10%	85%	$0.05	237
School	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	273	10	$52	75%	95%	$0.02	356
School	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	Existing	1,179	12	$247	95%	81%	$0.02	32
School	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.01	13	$0.00	25%	90%	$0.01	259
School	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	545	4	$187	95%	20%	$0.10	165
School	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.01	12	$0.17	10%	95%	$1.34	159
School	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	New	997	12	$79	15%	45%	$0.00	72
School	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	New	1,038	12	$243	5%	77%	$0.02	178
School	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	New	354	10	$192	5%	68%	$0.08	10
School	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	New	2,600	12	$741	95%	77%	$0.03	35
School	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	467	3	$45	5%	90%	$0.03	37
School	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	273	10	$52	75%	95%	$0.02	187
School	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	New	1,179	12	$247	95%	81%	$0.02	16

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	545	4	$187	95%	20%	$0.10	86
School	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.01	12	$0.17	10%	95%	$1.34	83
School	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	1,735	15	$747	25%	94%	$0.04	693
School	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.75	15	$2	15%	67%	$0.50	294
School	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	281	5	$193	5%	34%	$0.17	27
School	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	187	15	$171	75%	76%	$0.10	1,472
School	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	281	5	$78	50%	80%	$0.06	756
School	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.14	18	$0.22	45%	65%	$0.17	178
School	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.86	14	$0.93	5%	94%	$0.13	172
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)	Per Kitchen Exhaust	Existing	13,925	10	$3,604	73%	85%	$0.03	934
School	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	7	13	$0.31	10%	39%	$-0.01	132
School	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.13	25	$0.49	25%	85%	$0.35	101
School	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	1	25	$1	75%	15%	$0.10	707
School	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	3	20	$2	75%	55%	$0.07	474
School	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	1	25	$0.93	35%	35%	$0.05	821
School	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.28	25	$0.29	35%	35%	$0.09	142
School	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	9	25	$2	10%	35%	$0.01	401
School	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	8,095	10	$134	95%	21%	$-0.02	20
School	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.72	7	$0.18	90%	85%	$0.04	3,131
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	Building SQ.FT.	Existing	1	10	$2	25%	98%	$0.23	1,474
School	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.96	25	$64	15%	60%	$7.07	25
School	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	562	15	$399	25%	94%	$0.08	129
School	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	60	15	$171	75%	76%	$0.35	296
School	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.04	18	$0.22	45%	65%	$0.57	35
School	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.28	14	$0.93	5%	94%	$0.44	34
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)	Per Kitchen Exhaust	New	4,513	10	$3,604	73%	85%	$0.12	149
School	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.04	25	$0.49	75%	85%	$1.13	56

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School	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.09	25	$0.29	35%	35%	$0.32	27
School	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	7	30	$5	50%	95%	$0.06	275
School	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.18	15	$0.98	20%	75%	$0.67	72
School	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	2,623	10	$134	95%	10%	$-0.01	17
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	Building SQ.FT.	New	0.46	10	$2	50%	98%	$0.74	584
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	11,734	10	$8,168	35%	95%	$0.11	209
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	11,734	10	$8,168	35%	95%	$3.33	5,269
School	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	553	11	$264	95%	80%	$-0.21	59
School	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.07	10	$0.27	55%	94%	$0.62	1,014
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	35%	25%	$0.14	0.42
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	35%	25%	$3.50	621
School	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,168	10	$2,576	95%	95%	$0.02	170
School	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	20,018	10	$3,696	95%	94%	$-0.03	236
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,633	25	$817	5%	92%	$0.05	364
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,633	25	$817	5%	92%	$1.45	42,871
School	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	2,492	15	$832	100%	N/A	$0.04	251
School	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	45,908	15	$16,095	75%	N/A	$0.04	9,775
School	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	25	12	$2	80%	8%	$0.01	25
School	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	25	12	$2	80%	8%	$0.47	74,926
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	65%	$-0.07	39
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	65%	$0.78	75,189
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$-0.02	120
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$0.26	29,618
School	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	338	10	$17	95%	35%	$-0.07	230
School	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	338	10	$17	95%	35%	$0.13	92,418
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	181	10	$142	75%	75%	$0.12	585
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	181	10	$142	75%	75%	$4.95	7,799
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.16	10	$0.88	25%	94%	$0.89	25

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.16	10	$0.88	25%	94%	$1,005.84	71,696
School	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	596	5	$95	75%	15%	$0.04	345
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	11,711	10	$8,168	35%	95%	$0.11	109
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	11,711	10	$8,168	35%	95%	$3.33	29,675
School	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	553	11	$264	95%	80%	$-0.21	31
School	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.07	10	$0.27	55%	94%	$0.62	515
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	35%	55%	$0.14	0.49
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	35%	55%	$3.57	66,541
School	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,169	10	$2,638	95%	95%	$0.02	89
School	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	20,023	10	$3,761	95%	94%	$-0.03	123
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,630	25	$653	25%	92%	$0.04	970
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,630	25	$653	25%	92%	$1.16	14,407
School	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	2,490	15	$832	100%	N/A	$0.04	171
School	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	45,889	15	$13,730	75%	N/A	$0.03	6,136
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	65%	$-0.07	21
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	65%	$0.80	39,550
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$-0.02	63
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$0.27	44,150
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	180	10	$142	75%	75%	$0.13	307
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	180	10	$142	75%	75%	$4.96	12,491
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.16	10	$0.88	25%	94%	$1,008.10	29,436
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.16	10	$0.88	25%	94%	$0.89	12
School	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	595	5	$95	75%	15%	$0.04	174
University	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$28	100%	N/A	$0.06	5,293
University	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	Existing	11	5	$12	95%	30%	$0.28	66
University	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$28	100%	N/A	$0.06	507
University	Computers	Network PC Power Management	Network PC Power Management	No Power Management	0.7 units per 1,000 sqft	New	11	5	$12	95%	30%	$0.28	34
University	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	Existing	11,949	12	$2,016	90%	90%	$0.01	6

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	Existing	445	12	$1,008	35%	90%	$0.32	0.43
University	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	Existing	2,307	12	$776	95%	85%	$0.03	11
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,909	12	$2,070	26%	40%	$0.14	1
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	1,909	12	$2,070	26%	40%	$0.09	79,757
University	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,006	12	$1,811	75%	21%	$0.05	7
University	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	Existing	4,288	12	$2,593	14%	75%	$0.07	5
University	Cooking	Combination Oven	60% cooking efficiency	Non ENERGY STAR	per installation	New	11,949	12	$2,016	90%	90%	$0.01	3
University	Cooking	Fryers - New CEE Efficient Electric Deep Fat Fryers	15 inch width Deep Fryer CEE 2006 rating: 80% under heavy load, Less than 1000 watt at idle	15 inch width standard electric deep fat fryers	per installation	New	445	12	$1,008	35%	90%	$0.32	0.23
University	Cooking	Griddle	70% cooking efficiency	Non ENERGY STAR	per installation	New	2,307	12	$776	95%	85%	$0.03	5
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,909	12	$2,070	26%	40%	$0.09	94,559
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	1,909	12	$2,070	26%	40%	$0.14	1
University	Cooking	Hot Food Holding Cabinet	ENERGY STAR	Non ENERGY STAR	per installation	New	4,006	12	$1,811	75%	21%	$0.05	4
University	Cooking	Steam Cooker	ENERGY STAR	Non ENERGY STAR	per installation	New	4,288	12	$2,593	14%	75%	$0.07	3
University	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	97	15	$747	25%	94%	$1.00	5
University	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	4	5	$165	95%	81%	$11.38	1
University	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	4	10	$210	25%	70%	$7.07	2
University	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	3	15	$483	45%	90%	$19.25	3
University	Cooling Chillers	Chillers 150-300 tons (screw) - Advanced Efficiency	0.50 kW/ton (full load)	0.680 kW/Ton (full load)	Per installation	Existing	2,717	20	$22,438	100%	N/A	$0.94	18
University	Cooling Chillers	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.09	15	$2	15%	67%	$4.00	6
University	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	5	8	$27	10%	94%	$1.04	1
University	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	9	15	$2	95%	35%	$0.03	14
University	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	2	13	$19	95%	75%	$1.05	6
University	Cooling Chillers	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	15	5	$193	5%	34%	$3.41	0.27
University	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	10	15	$171	75%	76%	$2.12	13
University	Cooling Chillers	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	15	5	$78	50%	80%	$1.38	7
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)	Per Kitchen Exhaust	Existing	822	10	$3,606	73%	85%	$0.73	7
University	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$28.55	0.24
University	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.21	13	$0.31	10%	39%	$0.22	0.55
University	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	13%	$48.67	0.08
University	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	0.97	15	$3	65%	45%	$0.52	1
University	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.04	7	$0.18	90%	85%	$0.97	26

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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	Building SQ.FT.	Existing	0.08	10	$2	25%	98%	$4.38	12
University	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.35	0.47
University	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.53	25	$30	15%	60%	$6.04	2
University	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.45	25	$64	15%	60%	$15.04	1
University	Cooling Chillers	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	46	15	$399	25%	94%	$1.12	1
University	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	1	5	$165	95%	81%	$23.76	0.55
University	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	2	10	$210	25%	70%	$13.29	0.77
University	Cooling Chillers	Chillers 150-300 tons (screw) - Advanced Efficiency	0.50 kW/ton (full load)	0.680 kW/Ton (full load)	Per installation	New	1,322	20	$17,949	100%	N/A	$1.55	6
University	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	2	8	$27	10%	94%	$1.96	0.57
University	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	5	15	$171	75%	76%	$4.44	4
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)	Per Kitchen Exhaust	New	394	10	$3,606	73%	85%	$1.53	2
University	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$59.56	0.07
University	Cooling Chillers	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.01	15	$0.98	20%	75%	$8.25	1
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	Building SQ.FT.	New	0.03	10	$2	50%	98%	$9.14	8
University	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.25	25	$30	80%	60%	$12.61	3
University	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	106	15	$747	25%	94%	$0.92	8
University	Cooling Dx	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.10	15	$2	15%	67%	$3.69	8
University	Cooling Dx	DX Package 135 to 240 kBTU/hr - Premium Efficiency	DX Package 135 to 240 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 135 to 240 kBTU/hr - Standard Efficiency 11.0 EER	Per installation	Existing	2,182	15	$10,414	100%	N/A	$0.62	23
University	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	11	10	$169	10%	60%	$2.38	2
University	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	59	4	$335	95%	72%	$2.13	22
University	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.08	15	$2	50%	94%	$3.03	36
University	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	17	5	$193	5%	34%	$3.15	0.17
University	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	11	15	$171	75%	76%	$1.96	20
University	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	17	5	$78	50%	80%	$1.27	5
University	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.00	18	$0.22	45%	65%	$3.09	1

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
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)	Per Kitchen Exhaust	Existing	892	10	$3,606	73%	85%	$0.67	11
University	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$26.30	0.34
University	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.22	13	$0.31	10%	39%	$0.20	0.82
University	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	13%	$44.85	0.11
University	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.18	20	$2	75%	55%	$1.37	6
University	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	231	10	$139	95%	21%	$0.10	1
University	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.04	7	$0.18	90%	85%	$0.89	39
University	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.42	0.58
University	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.57	25	$30	15%	60%	$5.57	2
University	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.49	25	$64	15%	60%	$13.86	2
University	Cooling Dx	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	51	15	$399	25%	94%	$1.02	2
University	Cooling Dx	DX Package 135 to 240 kBTU/hr - Premium Efficiency	DX Package 135 to 240 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 135 to 240 kBTU/hr - Standard Efficiency 11.0 EER	Per installation	New	1,001	15	$8,337	100%	N/A	$1.09	5
University	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.04	15	$2	50%	94%	$6.30	11
University	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	5	15	$171	75%	76%	$4.07	5
University	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$6.41	0.62
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)	Per Kitchen Exhaust	New	429	10	$3,606	73%	85%	$1.40	2
University	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$54.61	0.10
University	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.56	8
University	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.01	15	$0.98	20%	75%	$7.56	1
University	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	111	10	$139	95%	10%	$0.20	0.34
University	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.27	25	$30	80%	60%	$11.56	5
University	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	Existing	23,910	15	$42,891	100%	N/A	$0.22	89
University	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	103	15	$747	25%	94%	$0.94	2
University	Heat Pump	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.45	15	$2	15%	67%	$0.85	12
University	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	137	5	$193	5%	34%	$0.38	0.09
University	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	91	15	$171	75%	76%	$0.23	46
University	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	137	5	$78	50%	80%	$0.14	2

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.07	18	$0.22	45%	65%	$0.37	5
University	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.37	14	$0.93	5%	94%	$0.33	4
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)	Per Kitchen Exhaust	Existing	7,100	10	$3,606	73%	85%	$0.07	27
University	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.03	40	$9	4%	98%	$27.07	0.12
University	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	Existing	33,260	30	$80,039	5%	N/A	$4.06	5
University	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	4	13	$0.31	10%	39%	$-0.01	5
University	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.08	25	$0.49	25%	85%	$0.63	1
University	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	1	25	$1	75%	13%	$0.17	11
University	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	1	20	$2	75%	55%	$0.16	14
University	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	1	25	$0.93	35%	35%	$0.07	20
University	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.23	25	$0.29	35%	35%	$0.12	3
University	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	6	25	$2	10%	35%	$0.02	17
University	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,839	10	$139	95%	21%	$-0.00	5
University	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.35	7	$0.18	90%	85%	$0.10	91
University	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	1	10	$150	90%	66%	$14.33	0.21
University	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.95	25	$64	15%	60%	$7.18	1
University	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	10.6 EER, 3.2 COP	Per installation	New	11,768	15	$34,312	100%	N/A	$0.37	24
University	Heat Pump	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	51	15	$399	25%	94%	$1.02	0.68
University	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	40	15	$171	75%	76%	$0.55	13
University	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.03	18	$0.22	45%	65%	$0.87	1
University	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.16	14	$0.93	5%	94%	$0.78	1
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)	Per Kitchen Exhaust	New	3,117	10	$3,606	73%	85%	$0.18	6
University	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.01	40	$9	4%	98%	$54.79	0.03
University	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	10.6 EER, 3.2 COP	Per installation	New	17,202	30	$14,402	5%	N/A	$4.01	1
University	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.03	25	$0.49	75%	85%	$1.48	1
University	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.10	25	$0.29	35%	35%	$0.30	0.88
University	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	4	30	$5	50%	95%	$0.10	11

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.12	15	$0.98	20%	75%	$1.03	3
University	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	807	10	$139	95%	10%	$0.01	0.73
University	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	1,238	10	$581	20%	85%	$0.07	154
University	Hvac Aux	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.16	15	$2	15%	67%	$2.42	386
University	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	Existing	1,895	18	$4,529	95%	85%	$0.28	441
University	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	13	15	$6	95%	76%	$0.06	188
University	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	329	20	$110	65%	75%	$0.03	3,302
University	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	Existing	33	15	$178	11%	77%	$0.70	17
University	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	8	8	$4	65%	25%	$0.11	6
University	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	Existing	1,206	13	$1,667	65%	59%	$0.19	223
University	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	834	10	$581	20%	75%	$0.11	48
University	Hvac Aux	Cooking Hood Controls	Demand-Ventilation Control	No Controls	per installation	New	1,895	18	$4,529	95%	85%	$0.28	231
University	Hvac Aux	Low Pressure Distribution Complex HVAC	Low Pressure Distribution Complex HVAC	VAV/CV	per building sqft	New	0.40	50	$2	15%	98%	$0.55	574
University	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	8	15	$6	95%	76%	$0.09	82
University	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	222	20	$110	65%	75%	$0.05	1,162
University	Hvac Aux	Motor - VAV Box High Efficiency (ECM)	ECM Motor	Standard Efficiency Motor	per installation	New	22	15	$178	11%	77%	$1.03	5
University	Hvac Aux	Optimized Variable Volume Lab Hood Design	Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	per installation	New	812	15	$1,667	63%	59%	$0.26	76
University	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.04	2,027
University	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	158	8	$28	75%	70%	$0.03	213
University	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	245	15	$336	62%	90%	$0.17	1,860
University	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	17	14	$36	75%	95%	$0.28	36
University	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.15	849
University	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.04	1,064
University	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	158	8	$28	75%	70%	$0.03	112
University	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	245	15	$336	62%	90%	$0.17	976
University	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	17	14	$36	75%	95%	$0.28	19
University	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.15	445
University	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	154	9	$110	50%	75%	$0.12	808
University	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	62	5	$12	70%	94%	$0.05	295
University	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	2	8	$0.98	30%	81%	$0.07	364

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	1	8	$0.73	30%	81%	$0.07	274
University	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	97	16	$16	95%	50%	$0.01	976
University	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	232
University	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	Existing	83	8	$248	10%	80%	$0.57	36
University	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.30	13	$0.00	90%	30%	$-0.01	2,296
University	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.34	13	$0.02	90%	52%	$0.00	3,159
University	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.45	15	$0.08	90%	67%	$0.02	1,547
University	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.57	13	$0.16	75%	74%	$0.03	895
University	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.06	13	$0.07	70%	83%	$0.15	1,069
University	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	554	8	$70	90%	35%	$0.02	488
University	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	762	8	$201	85%	95%	$0.04	793
University	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	110	9	$110	50%	75%	$0.17	305
University	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	62	5	$12	70%	94%	$0.05	111
University	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	1	8	$0.98	30%	81%	$0.11	136
University	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	1	8	$0.73	30%	81%	$0.09	123
University	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	487
University	Lighting Interior	LED Refrigeration Case Lights	LED Refrigeration Case Lights	Fluorescent Refrigeration Case	per installation	New	83	8	$248	10%	80%	$0.57	18
University	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.34	15	$0.00	90%	52%	$-0.01	1,659
University	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.45	15	$0.07	90%	67%	$0.01	812
University	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.57	15	$0.13	75%	74%	$0.02	470
University	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.06	15	$0.01	70%	83%	$0.03	561
University	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	398	8	$70	90%	35%	$0.02	183
University	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	762	8	$200	85%	95%	$0.04	298
University	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$161	95%	45%	$0.52	36
University	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$0.00	95%	45%	$-0.01	39
University	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	50
University	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$14	95%	40%	$0.02	51

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	35
University	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$161	95%	45%	$0.52	19
University	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$0.00	95%	45%	$-0.01	20
University	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	26
University	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$14	95%	40%	$0.02	26
University	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	18
University	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$0.00	20%	90%	$-0.01	1
University	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	367	10	$0.00	95%	75%	$-0.01	33
University	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	Existing	427	10	$138	95%	86%	$-0.03	130
University	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	1	4	$0.41	95%	86%	$0.08	18
University	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$121	40%	65%	$0.21	10
University	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,514	9	$565	25%	35%	$0.06	66
University	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	202	7	$565	25%	35%	$0.63	8
University	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of viruralized servers	Existing	2,286	4	$2,091	72%	85%	$0.65	112
University	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 3,000 sqft	Existing	101	5	$22	60%	90%	$0.05	512
University	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	242	14	$161	75%	80%	$0.08	54
University	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	383	3	$173	90%	25%	$0.18	43
University	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$0.00	20%	90%	$-0.01	0.61
University	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	367	10	$0.00	95%	75%	$-0.01	17
University	Other Plug Load	Ice Maker	High-Efficiency Ice Maker	Standard Ice Maker	per installation	New	427	10	$138	95%	86%	$-0.03	68
University	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	1	4	$0.41	95%	86%	$0.08	9
University	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$121	40%	65%	$0.21	5
University	Other Plug Load	Server Virtualization	Server Virtualization	No Virtualization	number of viruralized servers	New	2,286	4	$2,091	72%	85%	$0.65	58
University	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 3,000 sqft	New	101	5	$22	60%	90%	$0.05	269
University	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	242	14	$161	75%	80%	$0.08	28
University	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	Existing	994	12	$79	15%	45%	$0.00	44

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	Existing	1,034	12	$243	5%	77%	$0.02	110
University	Refrigeration	Case Replacement Low Temp	Case Replacement Low Temp	No replacement	per square foot	Existing	0.04	15	$0.10	5%	98%	$0.28	60
University	Refrigeration	Case Replacement Med Temp	Case Replacement Med Temp	No replacement	per square foot	Existing	0.00	15	$0.05	5%	98%	$1.74	0.63
University	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	Existing	369	10	$201	5%	68%	$0.08	6
University	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	Existing	2,592	12	$776	95%	77%	$0.03	21
University	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	829	3	$118	10%	85%	$0.05	77
University	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	127	10	$51	75%	95%	$0.06	116
University	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	Existing	1,175	12	$258	95%	81%	$0.02	10
University	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.01	13	$0.00	25%	90%	$0.01	84
University	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	569	4	$184	95%	20%	$0.10	54
University	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.01	12	$0.17	10%	95%	$1.35	52
University	Refrigeration	Anti-Sweat (Humidistat) Controls	Anti-Sweat (Humidistat) Controls	No Anti-Sweat (Humidistat) Controls	1 unit per 1,000 sqft	New	994	12	$79	15%	45%	$0.00	23
University	Refrigeration	Case Electronically Commutated Motor	ECM Case Fans	Standard Efficiency Motor	1 unit per 10,000 sqft	New	1,034	12	$243	5%	77%	$0.02	58
University	Refrigeration	Demand Control Defrost - Hot Gas	Refrigerant Defrost	Defrost - Electric	per installation	New	369	10	$201	5%	68%	$0.08	3
University	Refrigeration	Glass Door ES Refrigerators/Freezers	Glass Door ES Refrigerators/Freezers	Standard Glass Doors	per installation	New	2,592	12	$776	95%	77%	$0.03	11
University	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	466	3	$45	5%	90%	$0.03	12
University	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	127	10	$51	75%	95%	$0.06	61
University	Refrigeration	Solid Door ES Refrigerators/Freezers	Solid Door ES Refrigerators/Freezers	Standard Solid Door	per installation	New	1,175	12	$258	95%	81%	$0.02	5
University	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	569	4	$184	95%	20%	$0.10	28
University	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.01	12	$0.17	10%	95%	$1.35	27
University	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	1,729	15	$747	25%	94%	$0.04	283
University	Space Heat	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.74	15	$2	15%	67%	$0.51	125
University	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	281	5	$193	5%	34%	$0.18	11
University	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	187	15	$171	75%	76%	$0.10	627
University	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	281	5	$78	50%	80%	$0.06	316
University	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.14	18	$0.22	45%	65%	$0.17	75
University	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.86	14	$0.93	5%	94%	$0.13	73
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)	Per Kitchen Exhaust	Existing	14,527	10	$3,606	73%	85%	$0.02	381
University	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	7	13	$0.31	10%	39%	$-0.01	55
University	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.20	25	$0.49	25%	85%	$0.23	28

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	per roof sqft	Existing	2	25	$1	75%	13%	$0.06	176
University	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	3	20	$2	75%	55%	$0.07	195
University	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	per floor area	Existing	2	25	$0.93	35%	35%	$0.02	288
University	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.46	25	$0.29	35%	35%	$0.05	45
University	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	14	25	$2	10%	35%	$-0.00	262
University	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	3,764	10	$139	95%	21%	$-0.01	8
University	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.72	7	$0.18	90%	85%	$0.04	1,279
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	Building SQ.FT.	Existing	1	10	$2	25%	98%	$0.23	628
University	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	per window sqft	Existing	0.96	25	$64	15%	60%	$7.09	11
University	Space Heat	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	560	15	$399	25%	94%	$0.08	54
University	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	60	15	$171	75%	76%	$0.35	124
University	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.04	18	$0.22	45%	65%	$0.57	15
University	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.28	14	$0.93	5%	94%	$0.44	14
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)	Per Kitchen Exhaust	New	4,708	10	$3,606	73%	85%	$0.11	62
University	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.06	25	$0.49	75%	85%	$0.75	15
University	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.15	25	$0.29	35%	35%	$0.19	8
University	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	7	30	$5	50%	95%	$0.06	115
University	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.18	15	$0.98	20%	75%	$0.67	30
University	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	1,220	10	$139	95%	10%	$0.00	7
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	Building SQ.FT.	New	0.46	10	$2	50%	98%	$0.75	245
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	12,242	10	$8,169	35%	95%	$1.88	62,453
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	12,242	10	$8,169	35%	95%	$0.11	68
University	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	Existing	551	11	$264	95%	80%	$-0.65	19
University	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.07	10	$0.27	55%	94%	$0.63	331
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$42	35%	25%	$0.13	0.29
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$42	35%	25%	$3.45	55,416
University	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	7,144	10	$2,579	95%	95%	$-0.05	53

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	Existing	19,952	10	$3,693	95%	94%	$-0.00	73
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,618	25	$817	5%	92%	$0.86	42,190
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,618	25	$817	5%	92%	$0.05	119
University	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	2,608	15	$876	100%	N/A	$0.04	82
University	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	48,053	15	$16,939	75%	N/A	$0.04	3,198
University	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	25	12	$2	80%	8%	$0.01	8
University	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	25	12	$2	80%	8%	$0.28	18,423
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	65%	$-0.23	12
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	Existing	67	5	$6	95%	65%	$0.82	52,910
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$0.26	80,724
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$30	95%	73%	$-1.25	39
University	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$17	95%	35%	$-0.72	75
University	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$17	95%	35%	$0.13	20,567
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	180	10	$142	75%	75%	$0.13	191
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	180	10	$142	75%	75%	$2.93	3,896
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.16	10	$0.88	25%	94%	$0.90	8
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.16	10	$0.88	25%	94%	$594.52	46,434
University	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	622	5	$95	75%	15%	$0.04	113
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	12,217	10	$8,169	35%	95%	$0.11	35
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	12,217	10	$8,169	35%	95%	$1.88	33,712
University	Water Heat	Clothes Washer Commercial	ENERGY STAR Commercial Clothes Washer MEF=1.80	Standard Clothes Washers	per installation	New	551	11	$264	95%	80%	$-0.65	10
University	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.07	10	$0.27	55%	94%	$0.63	168
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$42	35%	55%	$0.13	0.34
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$42	35%	55%	$3.53	99,848
University	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	7,146	10	$2,644	95%	95%	$-0.05	27
University	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost) - (ENERGY STAR)	Standard High Temp Commercial Dishwasher	per installation	New	19,957	10	$3,760	95%	94%	$-0.00	38
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,615	25	$653	25%	92%	$0.69	25,066
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,615	25	$653	25%	92%	$0.04	317

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
University	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	2,606	15	$876	100%	N/A	$0.04	56
University	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	48,033	15	$14,447	75%	N/A	$0.03	2,007
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	65%	$0.84	94,433
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	per installation	New	67	5	$6	95%	65%	$-0.23	6
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$-1.25	20
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$30	95%	73%	$0.27	72,788
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	180	10	$142	75%	75%	$2.93	69,624
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	180	10	$142	75%	75%	$0.13	100
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.16	10	$0.88	25%	94%	$595.84	34,514
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.16	10	$0.88	25%	94%	$0.90	4
University	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	621	5	$95	75%	15%	$0.04	56
Warehouse	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	Existing	137	4	$31	100%	N/A	$0.07	3,562
Warehouse	Computers	Computer ENERGY STAR	Computer ENERGY STAR	Computer standard non-ENERGY STAR	Per installation	New	137	4	$31	100%	N/A	$0.07	341
Warehouse	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	Existing	2	5	$165	95%	81%	$21.02	7
Warehouse	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	Existing	4	10	$210	25%	70%	$7.34	11
Warehouse	Cooling Chillers	Chiller-Water Side Economizer	Install Economizer	No Economizer	per chiller ton	Existing	3	15	$483	45%	90%	$19.99	17
Warehouse	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	Existing	1,663	20	$24,640	100%	N/A	$1.70	93
Warehouse	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	Existing	5	8	$27	10%	94%	$1.08	8
Warehouse	Cooling Chillers	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	per chiller ton	Existing	8	15	$2	95%	35%	$0.03	52
Warehouse	Cooling Chillers	Cooling Tower-VSD Fan Control	Variable-Speed Tower Fans replace Two-Speed	Cooling Tower-Two-Speed Fan Motor	per chiller ton	Existing	2	13	$19	95%	75%	$1.09	30
Warehouse	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	5	15	$171	75%	76%	$3.93	52
Warehouse	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.01	40	$9	4%	98%	$52.69	2
Warehouse	Cooling Chillers	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.13	13	$0.32	10%	39%	$0.35	0.65
Warehouse	Cooling Chillers	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	30%	$203.44	0.84
Warehouse	Cooling Chillers	Pipe Insulation	1.5" of Insulation, assuming R-6 (WA State Code)	No Insulation	per linear feet of insulation	Existing	0.53	15	$3	65%	45%	$0.96	4
Warehouse	Cooling Chillers	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.02	7	$0.18	90%	85%	$1.79	99
Warehouse	Cooling Chillers	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	0.61	10	$150	90%	66%	$40.95	0.35
Warehouse	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	70%	$2.98	12

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Cooling Chillers	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.94	25	$64	15%	70%	$7.26	10
Warehouse	Cooling Chillers	Chilled Water / Condenser Water Settings-Optimization	Additional Control Features	EMS already installed - No Optimization	1 control point per 1000 sqft	New	2	5	$165	95%	81%	$17.01	6
Warehouse	Cooling Chillers	Chilled Water Piping Loop w/ VSD Control	VSD for secondary chilled water loop	Primary loop only w/ constant speed pump	per chiller ton	New	6	10	$210	25%	70%	$5.35	8
Warehouse	Cooling Chillers	Chillers <150 tons (screw) - Advanced Efficiency	0.58 kW/ton (full load)	0.790 kW/Ton (full load)	Per installation	New	2,173	20	$19,715	100%	N/A	$1.04	86
Warehouse	Cooling Chillers	Cooling Tower-Decrease Approach Temperature	6 Deg F	10 Deg F	per chiller ton	New	6	8	$27	10%	94%	$0.79	5
Warehouse	Cooling Chillers	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	7	15	$171	75%	76%	$3.18	39
Warehouse	Cooling Chillers	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.02	40	$9	4%	98%	$42.65	1
Warehouse	Cooling Chillers	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.02	15	$0.98	20%	75%	$5.90	9
Warehouse	Cooling Chillers	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	70%	$2.41	53
Warehouse	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	Existing	1,335	15	$8,539	100%	N/A	$0.84	275
Warehouse	Cooling Dx	DX Package-Air Side Economizer	Air-Side Economizer	No Economizer	per DX ton	Existing	11	10	$169	10%	40%	$2.46	19
Warehouse	Cooling Dx	DX Tune-Up / Diagnostics	DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	per installation	Existing	57	4	$335	95%	72%	$2.20	247
Warehouse	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	Existing	0.04	15	$2	50%	94%	$5.59	350
Warehouse	Cooling Dx	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	9	5	$193	5%	93%	$5.80	4
Warehouse	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	6	15	$171	75%	76%	$3.61	179
Warehouse	Cooling Dx	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	9	5	$78	50%	98%	$2.34	61
Warehouse	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.00	18	$0.22	45%	65%	$5.69	19
Warehouse	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.01	40	$9	4%	98%	$48.45	7
Warehouse	Cooling Dx	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.14	13	$0.32	10%	39%	$0.32	2
Warehouse	Cooling Dx	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	per roof sqft	Existing	0.00	25	$1	75%	10%	$187.08	0.87
Warehouse	Cooling Dx	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.10	20	$2	75%	58%	$2.53	60
Warehouse	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	307	10	$137	95%	24%	$0.07	13
Warehouse	Cooling Dx	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.02	7	$0.18	90%	85%	$1.64	383
Warehouse	Cooling Dx	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	0.61	10	$150	90%	66%	$41.06	1
Warehouse	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	1	25	$30	15%	98%	$2.74	59
Warehouse	Cooling Dx	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	98%	$6.68	42
Warehouse	Cooling Dx	DX Package 65 to 135 kBTU/hr - Premium Efficiency	DX Package 65 to 135 kBTU/hr - Premium Efficiency - 12.0 EER	DX Package 65 to 135 kBTU/hr - Standard Efficiency - 11.2 EER	Per installation	New	1,744	15	$6,825	100%	N/A	$0.51	157
Warehouse	Cooling Dx	Direct / Indirect Evaporative Cooling, Pre-Cooling	Evaporative Cooler	Standard DX cooling	per building CFM	New	0.05	15	$2	50%	94%	$4.51	250
Warehouse	Cooling Dx	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	7	15	$171	75%	76%	$2.91	128

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Cooling Dx	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$4.59	13
Warehouse	Cooling Dx	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.02	40	$9	4%	98%	$39.09	5
Warehouse	Cooling Dx	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.40	196
Warehouse	Cooling Dx	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.02	15	$0.98	20%	75%	$5.41	28
Warehouse	Cooling Dx	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	380	10	$137	95%	12%	$0.06	9
Warehouse	Cooling Dx	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	1	25	$30	80%	98%	$2.21	248
Warehouse	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	Existing	7,115	15	$31,584	100%	N/A	$0.55	603
Warehouse	Heat Pump	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	37	5	$193	5%	93%	$1.42	1
Warehouse	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	24	15	$171	75%	76%	$0.87	296
Warehouse	Heat Pump	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	37	5	$78	50%	98%	$0.55	19
Warehouse	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.01	18	$0.22	45%	65%	$1.39	35
Warehouse	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.08	14	$0.93	5%	94%	$1.45	25
Warehouse	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	Existing	0.01	40	$9	4%	98%	$48.05	3
Warehouse	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	Existing	12,294	30	$34,055	5%	N/A	$6.62	48
Warehouse	Heat Pump	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$0.00	8
Warehouse	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.01	25	$0.49	25%	85%	$5.09	11
Warehouse	Heat Pump	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	per roof sqft	Existing	0.15	25	$1	75%	10%	$1.17	65
Warehouse	Heat Pump	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.41	20	$2	75%	58%	$0.60	97
Warehouse	Heat Pump	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-8 (Average Existing Conditions)	per floor area	Existing	0.19	25	$0.93	35%	45%	$0.48	192
Warehouse	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.02	25	$0.29	35%	45%	$1.15	23
Warehouse	Heat Pump	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.38	25	$2	10%	35%	$0.57	38
Warehouse	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,225	10	$137	95%	24%	$-0.02	37
Warehouse	Heat Pump	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.09	7	$0.18	90%	85%	$0.38	590
Warehouse	Heat Pump	Window Film	Window Film	No Film	per 100 sqft of window glazing	Existing	0.61	10	$150	90%	66%	$41.12	0.46
Warehouse	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	Existing	0.13	25	$30	15%	98%	$24.35	2
Warehouse	Heat Pump	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	1	25	$64	15%	98%	$5.25	24
Warehouse	Heat Pump	Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP	Per installation	New	5,747	15	$25,269	100%	N/A	$0.54	251
Warehouse	Heat Pump	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	18	15	$171	75%	76%	$1.18	136
Warehouse	Heat Pump	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.01	18	$0.22	45%	65%	$1.88	16

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Heat Pump	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.04	14	$0.93	5%	94%	$2.52	9
Warehouse	Heat Pump	Green Roof	Vegetation on Roof	Standard Dark Colored Roof	per roof sqft	New	0.02	40	$9	4%	98%	$39.14	2
Warehouse	Heat Pump	Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	16.2 EER 4.0 COP	11.0 EER, 3.3 COP	Per installation	New	9,510	30	$31,314	5%	N/A	$4.36	19
Warehouse	Heat Pump	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	85%	$10.82	10
Warehouse	Heat Pump	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	45%	$2.62	6
Warehouse	Heat Pump	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	2	30	$5	50%	95%	$0.22	120
Warehouse	Heat Pump	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.05	15	$0.98	20%	75%	$2.23	33
Warehouse	Heat Pump	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	911	10	$137	95%	12%	$-0.01	8
Warehouse	Heat Pump	Windows-High Efficiency	U-0.32	U-0.40 (WA State Code)	per window sqft	New	0.84	25	$30	80%	98%	$3.79	52
Warehouse	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	Existing	545	10	$581	1%	85%	$0.17	16
Warehouse	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	Existing	5	15	$6	95%	76%	$0.14	250
Warehouse	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	Existing	145	20	$110	65%	75%	$0.08	4,711
Warehouse	Hvac Aux	Motor Rewind	>15, <500 HP	No Rewind	per HP	Existing	3	8	$4	65%	25%	$0.25	9
Warehouse	Hvac Aux	Automated Exhaust VFD Control - Parking Garage CO sensor	CO Sensors	No CO Sensors	Per Total Fan HP	New	530	10	$581	1%	75%	$0.18	7
Warehouse	Hvac Aux	Motor - CEE Premium-Efficiency Plus	CEE PE+ Motor for HVAC Applications	NEMA Efficiency Motors	per HP	New	5	15	$6	95%	76%	$0.15	159
Warehouse	Hvac Aux	Motor - Pump & Fan System - Variable Speed Control	Pump And Fan System Optimization w/ VSD	No Pump And Fan System VSD Optimization	Per HP	New	141	20	$110	65%	75%	$0.08	2,405
Warehouse	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	Existing	0.09	10	$0.02	80%	95%	$0.03	11,081
Warehouse	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	Existing	40	8	$28	75%	70%	$0.12	317
Warehouse	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	Existing	246	15	$336	62%	90%	$0.16	2,759
Warehouse	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	Existing	4	14	$35	75%	95%	$1.09	73
Warehouse	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	Existing	0.05	19	$0.07	62%	95%	$0.14	4,640
Warehouse	Lighting Exterior	Covered Parking Lighting	Covered Parking Lighting	Normal Lighting	per building sqft	New	0.09	10	$0.02	80%	95%	$0.03	5,820
Warehouse	Lighting Exterior	Daylighting Controls, Outdoors (Photocell)	Photocell	No Controls	per installation	New	40	8	$28	75%	70%	$0.12	166
Warehouse	Lighting Exterior	Exterior Building Lighting	30% savings	Normal Lighting	per installation	New	246	15	$336	62%	90%	$0.16	1,449
Warehouse	Lighting Exterior	Solid State LED White Lighting	Landscape, merchandise, signage, structure & task lighting (2.5 W)	50W 10hrs/day, 365 day/yr	per installation	New	4	14	$35	75%	95%	$1.09	38
Warehouse	Lighting Exterior	Surface Parking Lighting	Surface Parking Lighting	Normal Lighting	per building sqft	New	0.05	19	$0.07	62%	95%	$0.14	2,437
Warehouse	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	Existing	507	9	$110	10%	75%	$0.02	565
Warehouse	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	Existing	148	5	$13	70%	94%	$0.01	1,034
Warehouse	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.33	8	$0.98	30%	98%	$0.55	490

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	Existing	0.12	8	$0.73	30%	98%	$1.11	183
Warehouse	Lighting Interior	Exit Sign - LED	LED Exit Sign (2 Watts)	CFL Exit Sign (9 Watts)	per installation	Existing	97	16	$16	95%	50%	$0.00	5,180
Warehouse	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	Existing	35	13	$30	95%	98%	$0.11	1,230
Warehouse	Lighting Interior	Lighting Package, Below Code	Code Required LPD And Control Strategies	Existing Lighting Design LPD	per building sqft	Existing	0.46	13	$0.47	90%	16%	$0.13	9,865
Warehouse	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.13	13	$0.00	90%	44%	$-0.01	5,513
Warehouse	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.17	13	$0.02	90%	49%	$0.01	2,315
Warehouse	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.22	13	$0.09	75%	50%	$0.04	1,234
Warehouse	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	Existing	0.22	13	$0.27	70%	79%	$0.15	18,566
Warehouse	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	Existing	365	8	$70	90%	50%	$0.02	1,940
Warehouse	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	Existing	761	8	$201	85%	**%	$0.03	2,323
Warehouse	Lighting Interior	Bi-Level Control, Stairwell Lighting	Occupancy Sensor Control, 50% Lighting Power during unoccupied Time	Continuous Full Power Lighting in Stairways	Unit ea.: number bi-fixtures	New	340	9	$110	10%	75%	$0.04	199
Warehouse	Lighting Interior	Cold Cathode Lighting	Cold Cathode Lighting 5 watts	30 W Incandescent Bulb	per installation	New	148	5	$12	70%	94%	$0.01	364
Warehouse	Lighting Interior	Dimming-Continuous, Fluorescent Fixtures	Continuous Dimming, Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.22	8	$0.98	30%	98%	$0.83	170
Warehouse	Lighting Interior	Dimming-Stepped, Fluorescent Fixtures	3-stepped Dimming of Fluorescent Fixtures (Day-Lighting)	No Dimming Controls	per sqft of dimmable perimeter	New	0.08	8	$0.73	30%	98%	$1.67	63
Warehouse	Lighting Interior	Exit Sign - Photoluminescent or Tritium	Photoluminescent or Tritium	LED Exit Sign (2 Watts)	per installation	New	35	13	$30	95%	98%	$0.11	2,585
Warehouse	Lighting Interior	Lighting Package, High Efficiency	15% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.13	15	$0.00	90%	44%	$-0.01	2,895
Warehouse	Lighting Interior	Lighting Package, Premium Efficiency	20% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.17	15	$0.01	90%	49%	$-0.00	1,216
Warehouse	Lighting Interior	Lighting Package, Super Premium Efficiency	25% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.22	15	$0.03	75%	50%	$0.00	648
Warehouse	Lighting Interior	Lighting Package, Super Premium High Bay	35% Reduction in W/sqft	Baseline Lighting Power density	per building sqft	New	0.22	15	$0.06	70%	79%	$0.02	9,752
Warehouse	Lighting Interior	Occupancy Sensor Control, Fluorescent	Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	per occupancy sensor	New	244	8	$70	90%	50%	$0.04	668
Warehouse	Lighting Interior	Time Clock	Time Clock	No Controls	per 10,000 Watts	New	761	8	$200	85%	**%	$0.03	810
Warehouse	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	Existing	74	6	$219	95%	45%	$0.70	4
Warehouse	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	Existing	79	6	$0.00	95%	45%	$-0.01	4
Warehouse	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	Existing	15	5	$16	64%	15%	$0.29	33
Warehouse	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	Existing	139	5	$14	95%	40%	$0.02	114
Warehouse	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	Existing	72	6	$0.00	95%	45%	$-0.01	4
Warehouse	Other Office Equipment	ENERGY STAR - Copiers	ENERGY STAR Copiers	Standard Copier	per installation	New	74	6	$219	95%	45%	$0.70	2

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Other Office Equipment	ENERGY STAR - Fax	ENERGY STAR Fax	Standard Fax	per installation	New	79	6	$0.00	95%	45%	$-0.01	2
Warehouse	Other Office Equipment	ENERGY STAR - Monitors	ENERGY STAR Features Enabled	Non-ENERGY STAR Features	per installation	New	15	5	$16	64%	15%	$0.29	17
Warehouse	Other Office Equipment	ENERGY STAR - Printers	ENERGY STAR Printers	Standard Printers	per installation	New	139	5	$14	95%	40%	$0.02	59
Warehouse	Other Office Equipment	ENERGY STAR - Scanners	ENERGY STAR Scanners	Standard Scanner	per installation	New	72	6	$0.00	95%	45%	$-0.01	2
Warehouse	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	Existing	7	7	$2	20%	90%	$0.05	10
Warehouse	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	Existing	368	10	$0.00	95%	75%	$-0.01	564
Warehouse	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	Existing	2	4	$0.41	95%	86%	$0.04	155
Warehouse	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	Existing	81	12	$124	20%	65%	$0.22	26
Warehouse	Other Plug Load	Residential Refrigerator/Freezer Recycling	Recycling Existing Refrigerator/Freezer	Existing Refrigerator/Freezer	per installation	Existing	1,520	9	$567	25%	35%	$0.06	335
Warehouse	Other Plug Load	Residential-Size Refrigerator/Freezer - Early Replacement	Energy Star Refrigerator/Freezer	Baseline Refrigerator/Freezer	Per unit. Ea.	Existing	1,548	7	$567	25%	35%	$0.07	341
Warehouse	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 15,000 sqft	Existing	102	5	$23	60%	90%	$0.05	560
Warehouse	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	Existing	243	14	$186	10%	80%	$0.09	4
Warehouse	Other Plug Load	Vending Miser	Passive Infrared Sensor on Vending Machine Monitoring Vacancy of Area And Cycles Cooling - Controls	No Vending Miser - No controls	Per unit. Ea.	Existing	2,933	3	$174	10%	25%	$0.01	184
Warehouse	Other Plug Load	ENERGY STAR - Battery Charging System	ENERGY STAR Battery Charging System	Non-ENERGY STAR Battery Chargers	per installation	New	7	7	$2	20%	90%	$0.05	5
Warehouse	Other Plug Load	ENERGY STAR - Water Cooler	ENERGY STAR Water Cooler (Hot/Cold Water)	Non-ENERGY STAR Water Cooler	per installation	New	368	10	$0.00	95%	75%	$-0.01	296
Warehouse	Other Plug Load	Power Supply Transformer/Converter	80 Plus	85% efficient power supply (> 51W)	1 unit per 2,000 sqft	New	2	4	$0.41	95%	86%	$0.04	81
Warehouse	Other Plug Load	Residential Refrigerator	ENERGY STAR	Federal Standard	per installation	New	81	12	$124	20%	65%	$0.22	14
Warehouse	Other Plug Load	Smart Strips	Smart Strip Power Strip	Standard surge protector	1 unit per 15,000 sqft	New	102	5	$23	60%	90%	$0.05	294
Warehouse	Other Plug Load	Vending Machines- High Efficiency	ENERGY STAR (Tier 2) Vending Machines- High Efficiency 500 can capacity Under 5.92 kWh/day	Vending Machines- Standard 13 kWh/day	per installation	New	243	14	$186	10%	80%	$0.09	2
Warehouse	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	Existing	832	3	$119	5%	85%	$0.05	23
Warehouse	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	Existing	33	10	$49	75%	95%	$0.24	67
Warehouse	Refrigeration	Standalone to Multiplex Compressor	Standalone to Multiplex Compressor	Standalone compressor	per building sqft	Existing	0.00	13	$0.00	3%	90%	$0.01	5
Warehouse	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	Existing	65	4	$186	5%	20%	$0.96	1
Warehouse	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	Existing	0.00	12	$0.17	5%	95%	$12.76	15
Warehouse	Refrigeration	Refrigeration Commissioning or Re-commissioning	Commissioning / Re-commissioning	No Commissioning / Re-commissioning	per refrigeration ton	New	468	3	$47	3%	90%	$0.03	3
Warehouse	Refrigeration	Refrigerator eCube	Refrigerator eCube	No Refrigerator eCube	Per Refrigerator	New	33	10	$49	75%	95%	$0.24	35
Warehouse	Refrigeration	Strip Curtains for Walk-Ins	Strip Curtains for Walk-Ins	No Strip Curtains for Walk-In	per installation	New	65	4	$186	5%	20%	$0.96	0.86
Warehouse	Refrigeration	Walk-In Electronically Commutated Motor	ECM Evaporator Fans	Standard Efficiency Motor	per installation	New	0.00	12	$0.17	5%	95%	$12.76	7

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Warehouse	Space Heat	Direct Digital Control System-Installation	DDC Retrofit	Pnuematic	Number of Points	Existing	56	5	$193	5%	93%	$0.93	51
Warehouse	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	Existing	37	15	$171	75%	76%	$0.56	993
Warehouse	Space Heat	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	56	5	$78	50%	98%	$0.35	624
Warehouse	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	Existing	0.02	18	$0.22	45%	65%	$0.91	120
Warehouse	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	Existing	0.17	14	$0.93	5%	94%	$0.70	116
Warehouse	Space Heat	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	1	13	$0.32	10%	39%	$-0.01	27
Warehouse	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	Existing	0.02	25	$0.49	25%	85%	$1.84	68
Warehouse	Space Heat	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	per roof sqft	Existing	0.31	25	$1	75%	10%	$0.56	316
Warehouse	Space Heat	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.61	20	$2	75%	58%	$0.38	334
Warehouse	Space Heat	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-8 (Average Existing Conditions)	per floor area	Existing	0.44	25	$0.93	35%	45%	$0.18	1,193
Warehouse	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	Existing	0.05	25	$0.29	35%	45%	$0.51	122
Warehouse	Space Heat	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	per wall surface area	Existing	0.93	25	$2	10%	35%	$0.21	248
Warehouse	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	Existing	1,844	10	$137	95%	24%	$-0.03	15
Warehouse	Space Heat	Re-Commissioning	Re-Commissioning	Average Existing Conditions	per building sqft	Existing	0.14	7	$0.18	90%	85%	$0.23	2,004
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	Building SQ.FT.	Existing	0.28	10	$2	25%	98%	$1.20	992
Warehouse	Space Heat	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	per window sqft	Existing	0.41	25	$64	15%	98%	$16.36	16
Warehouse	Space Heat	Direct Digital Control System-Optimization	Premium Efficiency EMS System	High Efficiency EMS System	Number of Points	New	12	15	$171	75%	76%	$1.78	207
Warehouse	Space Heat	Duct Repair and Sealing	Reduction In Duct Losses to 5 %	No Repair or Sealing 15% duct losses	per building sqft	New	0.00	18	$0.22	45%	65%	$2.83	25
Warehouse	Space Heat	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	per building CFM	New	0.05	14	$0.93	5%	94%	$2.19	24
Warehouse	Space Heat	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	per roof sqft	New	0.00	25	$0.49	75%	85%	$5.65	39
Warehouse	Space Heat	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	per floor area	New	0.01	25	$0.29	35%	45%	$1.64	25
Warehouse	Space Heat	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Standard Duct Fittings	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.35	183
Warehouse	Space Heat	Natural Ventilation	Natural Ventilation Design Reduction in Cooling	None - Standard Ventilation	per building sqft	New	0.03	15	$0.98	20%	75%	$3.35	50
Warehouse	Space Heat	Programmable Thermostat	Programmable Thermostat	No Programmable Thermostat	per installation	New	608	10	$137	95%	12%	$-0.00	13
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	Building SQ.FT.	New	0.09	10	$2	50%	98%	$3.71	410
Warehouse	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	Existing	0.00	10	$0.27	55%	94%	$4.67	577
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	3%	25%	$0.13	0.48
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	31	12	$43	3%	25%	$3.52	19,160

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (kWh)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,347	25	$819	5%	92%	$0.04	207
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	Existing	1,347	25	$819	5%	92%	$0.70	60,442
Warehouse	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	Existing	368	15	$155	100%	N/A	$0.03	150
Warehouse	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	Existing	6,785	15	$2,967	75%	N/A	$0.04	5,592
Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	14	12	$2	80%	90%	$0.26	84,595
Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	14	12	$2	80%	90%	$0.00	167
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$20	95%	73%	$0.00	38,100
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	Existing	84	10	$20	95%	73%	$-0.06	35
Warehouse	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$20	95%	35%	$-0.09	68
Warehouse	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	per installation	Existing	337	10	$20	95%	35%	$0.23	38,822
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	121	10	$141	75%	95%	$0.17	424
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	121	10	$141	75%	95%	$2.92	48,887
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.02	10	$0.87	3%	94%	$6.57	0.15
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	Existing	0.02	10	$0.87	3%	94%	$27,956.67	5,686
Warehouse	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	Existing	453	5	$93	75%	45%	$0.04	600
Warehouse	Water Heat	Demand Controlled Circulating Systems	Demand Controlled Circulating Systems (VFD control by demand)	Constant Circulation	per building sqft	New	0.00	10	$0.27	55%	94%	$4.59	304
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	3%	55%	$0.13	0.57
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	31	12	$43	3%	55%	$3.60	62,346
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,368	25	$655	25%	92%	$0.03	583
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Number of WH (40 gal per unit)	New	1,368	25	$655	25%	92%	$0.56	8,996
Warehouse	Water Heat	Electric Water Heater - High Efficiency	EF = 0.95	EF = 0.92	Per installation	New	385	15	$155	100%	N/A	$0.03	102
Warehouse	Water Heat	Heat Pump Water Heater - Advanced-Efficiency	EF = 2.2	EF = 0.92	Per installation	New	7,092	15	$2,530	75%	N/A	$0.03	3,671
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$20	95%	73%	$0.00	20,815
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	per installation	New	84	10	$20	95%	73%	$-0.05	19
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	123	10	$141	75%	95%	$0.17	230
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	123	10	$141	75%	95%	$2.93	82,861
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.02	10	$0.87	3%	94%	$28,017.75	58,082
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	per sqft of refrigerated area	New	0.02	10	$0.87	3%	94%	$6.47	0.07
Warehouse	Water Heat	Water Heater Temperature Setback	Water Heater Temperature Setback (120 F)	No Change in Water Temperature	per installation	New	460	5	$93	75%	45%	$0.04	314

Table B.3.3. Industrial Electric Measure Details

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Chemical Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	27
Chemical Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	80
Chemical Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	10%	$-0.01	0.51
Chemical Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.59
Chemical Mfg	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.59
Chemical Mfg	Fans	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.41
Chemical Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.33
Chemical Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	34
Chemical Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	4
Chemical Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Chemical Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Chemical Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Chemical Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Chemical Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	20%	$-0.01	78
Chemical Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	29%	$-0.01	73
Chemical Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	18
Chemical Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	0.61
Chemical Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.56
Chemical Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	10%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	10%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	10%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	6%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	6%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	6%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	11%	$-0.01	1
Chemical Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Handling	1%	10	$0.00	8%	$-0.01	0.92
Chemical Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Processing	1%	10	$0.00	8%	$-0.01	0.92
Chemical Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Other_Motors	1%	10	$0.00	8%	$-0.01	0.92
Chemical Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	6%	$-0.01	0.74
Chemical Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	6%	$-0.01	0.74
Chemical Mfg	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	6%	$-0.01	0.74
Chemical Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	74
Chemical Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	72
Chemical Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	70
Chemical Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	9

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Chemical Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	9
Chemical Mfg	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	9
Chemical Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	3
Chemical Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	3
Chemical Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	3
Chemical Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	3
Chemical Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	3
Chemical Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	3
Chemical Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.57
Chemical Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.52
Chemical Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	126
Chemical Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	10%	$-0.01	1
Chemical Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	1
Chemical Mfg	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	1
Chemical Mfg	Process Aircomp	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.96
Chemical Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.78
Chemical Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	75
Chemical Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	10
Chemical Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Chemical Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Chemical Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Chemical Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Chemical Mfg	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	10%	$-0.01	0.07
Chemical Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.08
Chemical Mfg	Process Other	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.08
Chemical Mfg	Process Other	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.05
Chemical Mfg	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.04
Chemical Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	4
Chemical Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.62
Chemical Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.22
Chemical Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.20
Chemical Mfg	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	10%	$-0.01	1
Chemical Mfg	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	1
Chemical Mfg	Pumps	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	1
Chemical Mfg	Pumps	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.83
Chemical Mfg	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.67
Chemical Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	68
Chemical Mfg	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	44
Chemical Mfg	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	137
Chemical Mfg	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	178
Chemical Mfg	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	8
Chemical Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Chemical Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Computer Electronic Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	52
Computer Electronic Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Computer Electronic Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Computer Electronic Mfg	Hvac	Clean Room: Change Filter Strategy	40%	1	$0.00	10%	$-0.01	367
Computer Electronic Mfg	Hvac	Clean Room: Chiller Optimize	15%	10	$0.00	28%	$-0.01	370

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Computer Electronic Mfg	Hvac	Clean Room: Clean Room HVAC	9%	20	$0.00	30%	$-0.01	228
Computer Electronic Mfg	Hvac	Elec Chip Fab: Eliminate Exhaust	5%	10	$0.00	80%	$-0.01	329
Computer Electronic Mfg	Hvac	Elec Chip Fab: Solidstate Chiller	90%	10	$0.00	20%	$-0.13	2,017
Computer Electronic Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Computer Electronic Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Computer Electronic Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	200
Computer Electronic Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Computer Electronic Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Computer Electronic Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	103
Computer Electronic Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	100
Computer Electronic Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	96
Computer Electronic Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	4
Computer Electronic Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	4
Computer Electronic Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	4
Computer Electronic Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Computer Electronic Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	18
Computer Electronic Mfg	Process Aircomp	Elec Chip Fab: Reduce Gas Pressure	10%	10	$0.00	50%	$-0.03	18
Computer Electronic Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	10
Computer Electronic Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	0.54
Computer Electronic Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.50
Computer Electronic Mfg	Process Heat	Elec Chip Fab: Exhaust Injector	**%	10	$0.00	35%	$-0.14	1,514
Computer Electronic Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Computer Electronic Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	97
Computer Electronic Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Computer Electronic Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Computer Electronic Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	83
Computer Electronic Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Computer Electronic Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Electrical Equipment Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	15
Electrical Equipment Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	0.75
Electrical Equipment Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.69
Electrical Equipment Mfg	Hvac	Clean Room: Change Filter Strategy	40%	1	$0.00	10%	$-0.01	53
Electrical Equipment Mfg	Hvac	Clean Room: Chiller Optimize	15%	10	$0.00	28%	$-0.01	54
Electrical Equipment Mfg	Hvac	Clean Room: Clean Room HVAC	9%	20	$0.00	30%	$-0.01	33
Electrical Equipment Mfg	Hvac	Elec Chip Fab: Eliminate Exhaust	5%	10	$0.00	80%	$-0.01	48
Electrical Equipment Mfg	Hvac	Elec Chip Fab: Solidstate Chiller	90%	10	$0.00	20%	$-0.13	294
Electrical Equipment Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Electrical Equipment Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	56
Electrical Equipment Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Electrical Equipment Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	35
Electrical Equipment Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	34
Electrical Equipment Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	33
Electrical Equipment Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	1
Electrical Equipment Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	1
Electrical Equipment Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	1
Electrical Equipment Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.62
Electrical Equipment Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.57
Electrical Equipment Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	56
Electrical Equipment Mfg	Process Aircomp	Elec Chip Fab: Reduce Gas Pressure	10%	10	$0.00	50%	$-0.03	57
Electrical Equipment Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	33
Electrical Equipment Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Electrical Equipment Mfg	Process Heat	Elec Chip Fab: Exhaust Injector	**%	10	$0.00	35%	$-0.14	890
Electrical Equipment Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Electrical Equipment Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Electrical Equipment Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	11
Electrical Equipment Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.55
Electrical Equipment Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.50
Electrical Equipment Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	34
Electrical Equipment Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Electrical Equipment Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Fabricated Metal Products	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	74
Fabricated Metal Products	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	13%	$-0.01	1
Fabricated Metal Products	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	20%	$-0.01	5
Fabricated Metal Products	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	4%	$-0.01	0.51
Fabricated Metal Products	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	5%	$-0.01	0.75
Fabricated Metal Products	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	91
Fabricated Metal Products	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	11
Fabricated Metal Products	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Fabricated Metal Products	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Fabricated Metal Products	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Fabricated Metal Products	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Fabricated Metal Products	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	1%	$-0.01	36
Fabricated Metal Products	Lighting	Efficient Lighting 2 Shift	70%	10	$0.00	3%	$-0.01	79
Fabricated Metal Products	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	15%	$-0.01	422
Fabricated Metal Products	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	2%	$-0.01	34
Fabricated Metal Products	Lighting	HighBay Lighting 2 Shift	51%	10	$0.00	4%	$-0.01	75
Fabricated Metal Products	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	23%	$-0.01	398
Fabricated Metal Products	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	128
Fabricated Metal Products	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Fabricated Metal Products	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Fabricated Metal Products	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	13%	$-0.01	5

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Fabricated Metal Products	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	13%	$-0.01	5
Fabricated Metal Products	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	13%	$-0.01	5
Fabricated Metal Products	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	20%	$-0.01	14
Fabricated Metal Products	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	20%	$-0.01	14
Fabricated Metal Products	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	20%	$-0.01	14
Fabricated Metal Products	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	4%	$-0.01	1
Fabricated Metal Products	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	4%	$-0.01	1
Fabricated Metal Products	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	4%	$-0.01	1
Fabricated Metal Products	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	5%	$-0.01	2
Fabricated Metal Products	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	5%	$-0.01	2
Fabricated Metal Products	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	5%	$-0.01	2
Fabricated Metal Products	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	255
Fabricated Metal Products	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	247
Fabricated Metal Products	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	239
Fabricated Metal Products	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	33
Fabricated Metal Products	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	33
Fabricated Metal Products	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	33
Fabricated Metal Products	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Fabricated Metal Products	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Fabricated Metal Products	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	169
Fabricated Metal Products	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	13%	$-0.01	2
Fabricated Metal Products	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	20%	$-0.01	6
Fabricated Metal Products	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	4%	$-0.01	0.58
Fabricated Metal Products	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	5%	$-0.01	0.87
Fabricated Metal Products	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	100
Fabricated Metal Products	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	13
Fabricated Metal Products	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Fabricated Metal Products	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Fabricated Metal Products	Process Electro Chemical	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Fabricated Metal Products	Process Electro Chemical	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	12
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	11
Fabricated Metal Products	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	13%	$-0.01	0.83
Fabricated Metal Products	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	20%	$-0.01	2
Fabricated Metal Products	Process Other	Motors: Rewind 201-500 HP	1%	10	$0.00	4%	$-0.01	0.22
Fabricated Metal Products	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	5%	$-0.01	0.33
Fabricated Metal Products	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	39
Fabricated Metal Products	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	5
Fabricated Metal Products	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Fabricated Metal Products	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Food Mfg	Fans	Energy Project Management	29%	11	$0.00	27%	$0.01	101
Food Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	32
Food Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	94
Food Mfg	Fans	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	167
Food Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	0.81
Food Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	12%	$-0.01	1
Food Mfg	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	10%	$-0.01	0.65
Food Mfg	Fans	Motors: Rewind 501-5000 HP	1%	10	$0.00	11%	$-0.01	0.77
Food Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	11%	$-0.01	0.72
Food Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	43
Food Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	5
Food Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Food Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Food Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Food Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	5
Food Mfg	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	4%	$-0.01	104
Food Mfg	Lighting	Efficient Lighting 2 Shift	70%	10	$0.00	3%	$-0.01	75
Food Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	12%	$-0.01	259
Food Mfg	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	7%	$-0.01	98
Food Mfg	Lighting	HighBay Lighting 2 Shift	51%	10	$0.00	5%	$-0.01	71
Food Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	18%	$-0.01	244
Food Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	107
Food Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Food Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Food Mfg	Motors Other	Energy Project Management -- Material_Handling	29%	11	$0.00	27%	$0.01	449

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Food Mfg	Motors Other	Energy Project Management -- Material_Processing	29%	11	$0.00	27%	$0.01	414
Food Mfg	Motors Other	Integrated Plant Energy Management -- Material_Handling	50%	11	$0.00	22%	$-0.04	869
Food Mfg	Motors Other	Integrated Plant Energy Management -- Material_Processing	50%	11	$0.00	22%	$-0.04	773
Food Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	12%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	12%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	12%	$-0.01	7
Food Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	12%	$-0.01	7
Food Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	10%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	10%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	3
Food Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	3
Food Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	198
Food Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	192
Food Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	26
Food Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	26
Food Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	9
Food Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	9
Food Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	8
Food Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	8
Food Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Food Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Food Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	71
Food Mfg	Process Aircomp	Energy Project Management	29%	11	$0.00	27%	$0.01	98
Food Mfg	Process Aircomp	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	171
Food Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	0.84
Food Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	12%	$-0.01	1
Food Mfg	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	10%	$-0.01	0.66
Food Mfg	Process Aircomp	Motors: Rewind 501-5000 HP	1%	10	$0.00	11%	$-0.01	0.79
Food Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	11%	$-0.01	0.74
Food Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	42
Food Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	5
Food Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Food Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Food Mfg	Process Refrig	Energy Project Management	29%	11	$0.00	27%	$0.01	312
Food Mfg	Process Refrig	Food: Cooling and Storage	15%	10	$0.00	100%	$-0.01	795

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Food Mfg	Process Refrig	Food: Refrig Storage Tuneup	8%	3	$0.00	100%	$-0.01	337
Food Mfg	Process Refrig	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	655
Food Mfg	Process Refrig	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	2
Food Mfg	Process Refrig	Motors: Rewind 20-50 HP	1%	10	$0.00	12%	$-0.01	4
Food Mfg	Process Refrig	Motors: Rewind 201-500 HP	1%	10	$0.00	10%	$-0.01	2
Food Mfg	Process Refrig	Motors: Rewind 501-5000 HP	1%	10	$0.00	11%	$-0.01	2
Food Mfg	Process Refrig	Motors: Rewind 51-100 HP	1%	10	$0.00	11%	$-0.01	2
Food Mfg	Process Refrig	Plant Energy Management	12%	10	$0.00	27%	$0.01	133
Food Mfg	Process Refrig	Synchronous Belts	2%	10	$0.00	21%	$-0.01	17
Food Mfg	Process Refrig	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Food Mfg	Process Refrig	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	5
Food Mfg	Pumps	Energy Project Management	29%	11	$0.00	27%	$0.01	221
Food Mfg	Pumps	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	365
Food Mfg	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	1
Food Mfg	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	12%	$-0.01	3
Food Mfg	Pumps	Motors: Rewind 201-500 HP	1%	10	$0.00	10%	$-0.01	1
Food Mfg	Pumps	Motors: Rewind 501-5000 HP	1%	10	$0.00	11%	$-0.01	1
Food Mfg	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	11%	$-0.01	1
Food Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	94
Food Mfg	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	56
Food Mfg	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	175
Food Mfg	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	12
Food Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Food Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Industrial Machinery	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	87
Industrial Machinery	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	254
Industrial Machinery	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	583
Industrial Machinery	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	2
Industrial Machinery	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	3
Industrial Machinery	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.03
Industrial Machinery	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	107
Industrial Machinery	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	14
Industrial Machinery	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Industrial Machinery	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Industrial Machinery	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	21
Industrial Machinery	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	20
Industrial Machinery	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	13%	$-0.01	817
Industrial Machinery	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	19%	$-0.01	814
Industrial Machinery	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	329
Industrial Machinery	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	11
Industrial Machinery	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	10
Industrial Machinery	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	17%	$-0.01	9
Industrial Machinery	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	17%	$-0.01	9
Industrial Machinery	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	11
Industrial Machinery	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	11
Industrial Machinery	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	0%	$-0.01	0.11
Industrial Machinery	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	0%	$-0.01	0.11

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Industrial Machinery	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	357
Industrial Machinery	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	345
Industrial Machinery	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	46
Industrial Machinery	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	46
Industrial Machinery	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	16
Industrial Machinery	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	16
Industrial Machinery	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	15
Industrial Machinery	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	15
Industrial Machinery	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Industrial Machinery	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Industrial Machinery	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	233
Industrial Machinery	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	3
Industrial Machinery	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	4
Industrial Machinery	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.04
Industrial Machinery	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	138
Industrial Machinery	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	19
Industrial Machinery	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Industrial Machinery	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Industrial Machinery	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Industrial Machinery	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	6
Industrial Machinery	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	7
Industrial Machinery	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.07
Industrial Machinery	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	229
Industrial Machinery	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	148
Industrial Machinery	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	459
Industrial Machinery	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	29
Industrial Machinery	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	10
Industrial Machinery	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	9
Miscellaneous Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	129
Miscellaneous Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	375
Miscellaneous Mfg	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	861
Miscellaneous Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	4
Miscellaneous Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	5
Miscellaneous Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.04
Miscellaneous Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	159
Miscellaneous Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	20
Miscellaneous Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	7
Miscellaneous Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	6
Miscellaneous Mfg	Hvac	Clean Room: Change Filter Strategy	40%	1	$0.00	10%	$-0.01	1,144
Miscellaneous Mfg	Hvac	Clean Room: Chiller Optimize	15%	10	$0.00	28%	$-0.01	1,153

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Miscellaneous Mfg	Hvac	Clean Room: Clean Room HVAC	9%	20	$0.00	30%	$-0.01	710
Miscellaneous Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	39
Miscellaneous Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	35
Miscellaneous Mfg	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	5%	$-0.01	708
Miscellaneous Mfg	Lighting	Efficient Lighting 2 Shift	70%	10	$0.00	2%	$-0.01	226
Miscellaneous Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	13%	$-0.01	1,630
Miscellaneous Mfg	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	8%	$-0.01	671
Miscellaneous Mfg	Lighting	HighBay Lighting 2 Shift	51%	10	$0.00	3%	$-0.01	214
Miscellaneous Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	19%	$-0.01	1,538
Miscellaneous Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	622
Miscellaneous Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	20
Miscellaneous Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	19
Miscellaneous Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	17%	$-0.01	20
Miscellaneous Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	17%	$-0.01	20
Miscellaneous Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	23
Miscellaneous Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	23
Miscellaneous Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	0%	$-0.01	0.22
Miscellaneous Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	0%	$-0.01	0.22
Miscellaneous Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	745
Miscellaneous Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	721
Miscellaneous Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	98
Miscellaneous Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	97
Miscellaneous Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	35
Miscellaneous Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	35
Miscellaneous Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	32
Miscellaneous Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	32
Miscellaneous Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	10
Miscellaneous Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	9
Miscellaneous Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	279
Miscellaneous Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	4
Miscellaneous Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	5
Miscellaneous Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.05
Miscellaneous Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	165
Miscellaneous Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	22
Miscellaneous Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	8
Miscellaneous Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	7
Miscellaneous Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	17
Miscellaneous Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	17
Miscellaneous Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	17
Miscellaneous Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	17
Miscellaneous Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	16
Miscellaneous Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	16

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Miscellaneous Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	16
Miscellaneous Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	16
Miscellaneous Mfg	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	0.86
Miscellaneous Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	1
Miscellaneous Mfg	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.00
Miscellaneous Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	31
Miscellaneous Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	4
Miscellaneous Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Miscellaneous Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Miscellaneous Mfg	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	2
Miscellaneous Mfg	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	3
Miscellaneous Mfg	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.03
Miscellaneous Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	98
Miscellaneous Mfg	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	68
Miscellaneous Mfg	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	191
Miscellaneous Mfg	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	255
Miscellaneous Mfg	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	12
Miscellaneous Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Miscellaneous Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Nonmetallic Mineral Products	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	40
Nonmetallic Mineral Products	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	131
Nonmetallic Mineral Products	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	292
Nonmetallic Mineral Products	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	1
Nonmetallic Mineral Products	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	1
Nonmetallic Mineral Products	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.01
Nonmetallic Mineral Products	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	54
Nonmetallic Mineral Products	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	7
Nonmetallic Mineral Products	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Nonmetallic Mineral Products	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Nonmetallic Mineral Products	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Nonmetallic Mineral Products	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Nonmetallic Mineral Products	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	13%	$-0.01	118
Nonmetallic Mineral Products	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	19%	$-0.01	117
Nonmetallic Mineral Products	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	47
Nonmetallic Mineral Products	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Nonmetallic Mineral Products	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	17%	$-0.01	4

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	17%	$-0.01	4
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	5
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	5
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	0%	$-0.01	0.05
Nonmetallic Mineral Products	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	0%	$-0.01	0.05
Nonmetallic Mineral Products	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	178
Nonmetallic Mineral Products	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	173
Nonmetallic Mineral Products	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	23
Nonmetallic Mineral Products	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	23
Nonmetallic Mineral Products	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	8
Nonmetallic Mineral Products	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	8
Nonmetallic Mineral Products	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	7
Nonmetallic Mineral Products	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	7
Nonmetallic Mineral Products	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	117
Nonmetallic Mineral Products	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	1
Nonmetallic Mineral Products	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	2
Nonmetallic Mineral Products	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.02
Nonmetallic Mineral Products	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	69
Nonmetallic Mineral Products	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	9
Nonmetallic Mineral Products	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Nonmetallic Mineral Products	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Nonmetallic Mineral Products	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	0.71
Nonmetallic Mineral Products	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	0.84
Nonmetallic Mineral Products	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.00
Nonmetallic Mineral Products	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	26
Nonmetallic Mineral Products	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	3
Nonmetallic Mineral Products	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Nonmetallic Mineral Products	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Nonmetallic Mineral Products	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	3

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Nonmetallic Mineral Products	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	3
Nonmetallic Mineral Products	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.03
Nonmetallic Mineral Products	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	114
Nonmetallic Mineral Products	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	74
Nonmetallic Mineral Products	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	230
Nonmetallic Mineral Products	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	14
Nonmetallic Mineral Products	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Nonmetallic Mineral Products	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Paper Mfg	Fans	Energy Project Management	29%	11	$0.00	27%	$0.01	58
Paper Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	18
Paper Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	54
Paper Mfg	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	141
Paper Mfg	Fans	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	118
Paper Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	9%	$-0.01	0.37
Paper Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.46
Paper Mfg	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	13%	$-0.01	0.52
Paper Mfg	Fans	Motors: Rewind 501-5000 HP	1%	10	$0.00	23%	$-0.01	0.95
Paper Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.40
Paper Mfg	Fans	Paper: Premium Fan	20%	10	$0.00	25%	$-0.01	40
Paper Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	24
Paper Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	3
Paper Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Paper Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Paper Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	0.52
Paper Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.48
Paper Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	20%	$-0.01	42
Paper Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	29%	$-0.01	40
Paper Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	9
Paper Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	0.33
Paper Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.30
Paper Mfg	Motors Other	Efficient Centrifugal Fan -- Material_Handling	20%	10	$0.00	11%	$-0.01	31
Paper Mfg	Motors Other	Energy Project Management -- Material_Handling	29%	11	$0.00	27%	$0.01	78
Paper Mfg	Motors Other	Energy Project Management -- Material_Processing	29%	11	$0.00	27%	$0.01	71
Paper Mfg	Motors Other	Energy Project Management -- Other_Motors	29%	11	$0.00	27%	$0.01	66
Paper Mfg	Motors Other	Integrated Plant Energy Management -- Material_Handling	50%	11	$0.00	22%	$-0.04	234
Paper Mfg	Motors Other	Integrated Plant Energy Management -- Material_Processing	50%	11	$0.00	22%	$-0.04	208
Paper Mfg	Motors Other	Integrated Plant Energy Management -- Other_Motors	50%	11	$0.00	22%	$-0.04	185
Paper Mfg	Motors Other	Material Handling VFD2 -- Material_Handling	19%	10	$0.00	53%	$-0.01	147
Paper Mfg	Motors Other	Material Handling2 -- Material_Handling	5%	10	$0.00	53%	$-0.01	35

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Paper Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	9%	$-0.01	0.58
Paper Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	9%	$-0.01	0.58
Paper Mfg	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	9%	$-0.01	0.58
Paper Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	6%	$-0.01	0.73
Paper Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	6%	$-0.01	0.73
Paper Mfg	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	6%	$-0.01	0.73
Paper Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	13%	$-0.01	0.82
Paper Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	13%	$-0.01	0.82
Paper Mfg	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	13%	$-0.01	0.82
Paper Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Handling	1%	10	$0.00	23%	$-0.01	1
Paper Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Processing	1%	10	$0.00	23%	$-0.01	1
Paper Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Other_Motors	1%	10	$0.00	23%	$-0.01	1
Paper Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	10%	$-0.01	0.63
Paper Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	10%	$-0.01	0.63
Paper Mfg	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	10%	$-0.01	0.63
Paper Mfg	Motors Other	Paper: Efficient Pulp Screen -- Material_Processing	15%	10	$0.00	14%	$-0.01	27
Paper Mfg	Motors Other	Paper: Large Material Handling -- Material_Handling	10%	10	$0.00	25%	$-0.01	30
Paper Mfg	Motors Other	Paper: Material Handling -- Material_Handling	13%	10	$0.00	25%	$-0.01	39
Paper Mfg	Motors Other	Paper: Premium Control Large Material -- Material_Handling	19%	10	$0.00	25%	$-0.01	55
Paper Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	35
Paper Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	34
Paper Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	33
Paper Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	4
Paper Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	4
Paper Mfg	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	4
Paper Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	1
Paper Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	1
Paper Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	1
Paper Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	1
Paper Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	1
Paper Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	1
Paper Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.25

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Paper Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.23
Paper Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	8
Paper Mfg	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	10
Paper Mfg	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	39
Paper Mfg	Process Aircomp	Energy Project Management	29%	11	$0.00	27%	$0.01	12
Paper Mfg	Process Aircomp	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	27
Paper Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	9%	$-0.01	0.08
Paper Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.10
Paper Mfg	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	13%	$-0.01	0.11
Paper Mfg	Process Aircomp	Motors: Rewind 501-5000 HP	1%	10	$0.00	23%	$-0.01	0.21
Paper Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.09
Paper Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	5
Paper Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.76
Paper Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	0.27
Paper Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.25
Paper Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	0.37
Paper Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.34
Paper Mfg	Process Other	Energy Project Management	29%	11	$0.00	27%	$0.01	5
Paper Mfg	Process Other	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	8
Paper Mfg	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	9%	$-0.01	0.03
Paper Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.04
Paper Mfg	Process Other	Motors: Rewind 201-500 HP	1%	10	$0.00	13%	$-0.01	0.04
Paper Mfg	Process Other	Motors: Rewind 501-5000 HP	1%	10	$0.00	23%	$-0.01	0.08
Paper Mfg	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.03
Paper Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	2
Paper Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.30
Paper Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.10
Paper Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.10
Paper Mfg	Pumps	Energy Project Management	29%	11	$0.00	27%	$0.01	105
Paper Mfg	Pumps	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	173
Paper Mfg	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	9%	$-0.01	0.63
Paper Mfg	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.80
Paper Mfg	Pumps	Motors: Rewind 201-500 HP	1%	10	$0.00	13%	$-0.01	0.89
Paper Mfg	Pumps	Motors: Rewind 501-5000 HP	1%	10	$0.00	23%	$-0.01	1
Paper Mfg	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.70
Paper Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	45
Paper Mfg	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	26
Paper Mfg	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	83
Paper Mfg	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	131
Paper Mfg	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	5
Paper Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Paper Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Petroleum Coal Products	Fans	Energy Project Management	29%	11	$0.00	27%	$0.01	22
Petroleum Coal Products	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	6
Petroleum Coal Products	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	21
Petroleum Coal Products	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	52
Petroleum Coal Products	Fans	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	44
Petroleum Coal Products	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	0.17
Petroleum Coal Products	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	8%	$-0.01	0.23
Petroleum Coal Products	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	12%	$-0.01	0.18
Petroleum Coal Products	Fans	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.11

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Petroleum Coal Products	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.14
Petroleum Coal Products	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	9
Petroleum Coal Products	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	1
Petroleum Coal Products	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	0.46
Petroleum Coal Products	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.42
Petroleum Coal Products	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	0.17
Petroleum Coal Products	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.15
Petroleum Coal Products	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	20%	$-0.01	11
Petroleum Coal Products	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	29%	$-0.01	10
Petroleum Coal Products	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	2
Petroleum Coal Products	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	0.08
Petroleum Coal Products	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.08
Petroleum Coal Products	Motors Other	Energy Project Management -- Material_Processing	29%	11	$0.00	27%	$0.01	64
Petroleum Coal Products	Motors Other	Energy Project Management -- Other_Motors	29%	11	$0.00	27%	$0.01	59
Petroleum Coal Products	Motors Other	Integrated Plant Energy Management -- Material_Processing	50%	11	$0.00	22%	$-0.04	125
Petroleum Coal Products	Motors Other	Integrated Plant Energy Management -- Other_Motors	50%	11	$0.00	22%	$-0.04	111
Petroleum Coal Products	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	12%	$-0.01	0.52
Petroleum Coal Products	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	12%	$-0.01	0.52
Petroleum Coal Products	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	8%	$-0.01	0.68
Petroleum Coal Products	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	8%	$-0.01	0.68
Petroleum Coal Products	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	12%	$-0.01	0.55
Petroleum Coal Products	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	12%	$-0.01	0.55
Petroleum Coal Products	Motors Other	Motors: Rewind 501-5000 HP -- Material_Processing	1%	10	$0.00	8%	$-0.01	0.34
Petroleum Coal Products	Motors Other	Motors: Rewind 501-5000 HP -- Other_Motors	1%	10	$0.00	8%	$-0.01	0.34
Petroleum Coal Products	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	10%	$-0.01	0.44
Petroleum Coal Products	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	10%	$-0.01	0.44
Petroleum Coal Products	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	28
Petroleum Coal Products	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	27
Petroleum Coal Products	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	3
Petroleum Coal Products	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	3
Petroleum Coal Products	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	1
Petroleum Coal Products	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	1
Petroleum Coal Products	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	1
Petroleum Coal Products	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	1
Petroleum Coal Products	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.04
Petroleum Coal Products	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.03
Petroleum Coal Products	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	16

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Petroleum Coal Products	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	20
Petroleum Coal Products	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	73
Petroleum Coal Products	Process Aircomp	Energy Project Management	29%	11	$0.00	27%	$0.01	22
Petroleum Coal Products	Process Aircomp	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	50
Petroleum Coal Products	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	0.19
Petroleum Coal Products	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	8%	$-0.01	0.25
Petroleum Coal Products	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	12%	$-0.01	0.20
Petroleum Coal Products	Process Aircomp	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.12
Petroleum Coal Products	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.16
Petroleum Coal Products	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	9
Petroleum Coal Products	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	1
Petroleum Coal Products	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	0.51
Petroleum Coal Products	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.47
Petroleum Coal Products	Pumps	Energy Project Management	29%	11	$0.00	27%	$0.01	44
Petroleum Coal Products	Pumps	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	73
Petroleum Coal Products	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	12%	$-0.01	0.34
Petroleum Coal Products	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	8%	$-0.01	0.45
Petroleum Coal Products	Pumps	Motors: Rewind 201-500 HP	1%	10	$0.00	12%	$-0.01	0.36
Petroleum Coal Products	Pumps	Motors: Rewind 501-5000 HP	1%	10	$0.00	8%	$-0.01	0.22
Petroleum Coal Products	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	10%	$-0.01	0.29
Petroleum Coal Products	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	19
Petroleum Coal Products	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	12
Petroleum Coal Products	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	34
Petroleum Coal Products	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	56
Petroleum Coal Products	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	2
Petroleum Coal Products	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	0.90
Petroleum Coal Products	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.83
Plastics Rubber Products	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	26
Plastics Rubber Products	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	87
Plastics Rubber Products	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	194
Plastics Rubber Products	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	0.97
Plastics Rubber Products	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	1
Plastics Rubber Products	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.01
Plastics Rubber Products	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	35
Plastics Rubber Products	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	4
Plastics Rubber Products	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Plastics Rubber Products	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Plastics Rubber Products	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Plastics Rubber Products	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Plastics Rubber Products	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	13%	$-0.01	144
Plastics Rubber Products	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	19%	$-0.01	144
Plastics Rubber Products	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	58
Plastics Rubber Products	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Plastics Rubber Products	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Plastics Rubber Products	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Plastics Rubber Products	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Plastics Rubber Products	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	77
Plastics Rubber Products	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	1
Plastics Rubber Products	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	1
Plastics Rubber Products	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.01
Plastics Rubber Products	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	46

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Plastics Rubber Products	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	6
Plastics Rubber Products	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Plastics Rubber Products	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Plastics Rubber Products	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Plastics Rubber Products	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Plastics Rubber Products	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	2
Plastics Rubber Products	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	2
Plastics Rubber Products	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.02
Plastics Rubber Products	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	76
Plastics Rubber Products	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	53
Plastics Rubber Products	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	149
Plastics Rubber Products	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	9
Plastics Rubber Products	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Plastics Rubber Products	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Primary Metal Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	7
Primary Metal Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	8%	$-0.01	0.12
Primary Metal Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.17
Primary Metal Mfg	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.17
Primary Metal Mfg	Fans	Motors: Rewind 501-5000 HP	1%	10	$0.00	21%	$-0.01	0.31
Primary Metal Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.09
Primary Metal Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	9
Primary Metal Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	1
Primary Metal Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	0.46
Primary Metal Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.42
Primary Metal Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	0.35
Primary Metal Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.32
Primary Metal Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	20%	$-0.01	31
Primary Metal Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	29%	$-0.01	29
Primary Metal Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	7
Primary Metal Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	0.24
Primary Metal Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.22
Primary Metal Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	8%	$-0.01	0.49
Primary Metal Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	8%	$-0.01	0.49
Primary Metal Mfg	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	8%	$-0.01	0.49
Primary Metal Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	6%	$-0.01	0.68
Primary Metal Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	6%	$-0.01	0.68
Primary Metal Mfg	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	6%	$-0.01	0.68
Primary Metal Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	11%	$-0.01	0.70
Primary Metal Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	11%	$-0.01	0.70
Primary Metal Mfg	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	11%	$-0.01	0.70
Primary Metal Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Handling	1%	10	$0.00	21%	$-0.01	1
Primary Metal Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Material_Processing	1%	10	$0.00	21%	$-0.01	1

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Primary Metal Mfg	Motors Other	Motors: Rewind 501-5000 HP -- Other_Motors	1%	10	$0.00	21%	$-0.01	1
Primary Metal Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	6%	$-0.01	0.39
Primary Metal Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	6%	$-0.01	0.39
Primary Metal Mfg	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	6%	$-0.01	0.39
Primary Metal Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	38
Primary Metal Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	37
Primary Metal Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	36
Primary Metal Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	5
Primary Metal Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	5
Primary Metal Mfg	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	5
Primary Metal Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	1
Primary Metal Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	1
Primary Metal Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	1
Primary Metal Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	1
Primary Metal Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	1
Primary Metal Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	1
Primary Metal Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.12
Primary Metal Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.11
Primary Metal Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	11
Primary Metal Mfg	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	13
Primary Metal Mfg	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	51
Primary Metal Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	8%	$-0.01	0.09
Primary Metal Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.13
Primary Metal Mfg	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.13
Primary Metal Mfg	Process Aircomp	Motors: Rewind 501-5000 HP	1%	10	$0.00	21%	$-0.01	0.24
Primary Metal Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.07
Primary Metal Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	6
Primary Metal Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.98
Primary Metal Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	0.35
Primary Metal Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.32
Primary Metal Mfg	Process Electro Chemical	Metal: New Arc Furnace	45%	10	$0.00	10%	$-1.88	98
Primary Metal Mfg	Process Electro Chemical	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Primary Metal Mfg	Process Electro Chemical	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Primary Metal Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Primary Metal Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Primary Metal Mfg	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	8%	$-0.01	0.02
Primary Metal Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.03
Primary Metal Mfg	Process Other	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.03
Primary Metal Mfg	Process Other	Motors: Rewind 501-5000 HP	1%	10	$0.00	21%	$-0.01	0.05
Primary Metal Mfg	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.01
Primary Metal Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	1

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Primary Metal Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.23
Primary Metal Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.08
Primary Metal Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.07
Primary Metal Mfg	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	8%	$-0.01	0.06
Primary Metal Mfg	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	6%	$-0.01	0.09
Primary Metal Mfg	Pumps	Motors: Rewind 201-500 HP	1%	10	$0.00	11%	$-0.01	0.09
Primary Metal Mfg	Pumps	Motors: Rewind 501-5000 HP	1%	10	$0.00	21%	$-0.01	0.17
Primary Metal Mfg	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	6%	$-0.01	0.05
Primary Metal Mfg	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	5
Primary Metal Mfg	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	3
Primary Metal Mfg	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.73
Primary Metal Mfg	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	0.26
Primary Metal Mfg	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.24
Printing Related Support	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	62
Printing Related Support	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	182
Printing Related Support	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	418
Printing Related Support	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	2
Printing Related Support	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	2
Printing Related Support	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.02
Printing Related Support	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	77
Printing Related Support	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	10
Printing Related Support	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Printing Related Support	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Printing Related Support	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	11
Printing Related Support	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	10
Printing Related Support	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	13%	$-0.01	425
Printing Related Support	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	19%	$-0.01	423
Printing Related Support	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	171
Printing Related Support	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Printing Related Support	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	5
Printing Related Support	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Printing Related Support	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Printing Related Support	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	167
Printing Related Support	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	2
Printing Related Support	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	3
Printing Related Support	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.03
Printing Related Support	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	99
Printing Related Support	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	13
Printing Related Support	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Printing Related Support	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Printing Related Support	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Printing Related Support	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Printing Related Support	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	0.13
Printing Related Support	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	0.15
Printing Related Support	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.00
Printing Related Support	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	4
Printing Related Support	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.62
Printing Related Support	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.22
Printing Related Support	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.20
Printing Related Support	Pumps	Motors: Rewind 101-200 HP	1%	10	$0.00	17%	$-0.01	4
Printing Related Support	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	5

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Printing Related Support	Pumps	Motors: Rewind 51-100 HP	1%	10	$0.00	0%	$-0.01	0.05
Printing Related Support	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	164
Printing Related Support	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	106
Printing Related Support	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	329
Printing Related Support	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	21
Printing Related Support	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	7
Printing Related Support	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	7
Transportation Equipment Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	44
Transportation Equipment Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	130
Transportation Equipment Mfg	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	298
Transportation Equipment Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	13%	$-0.01	1
Transportation Equipment Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	55
Transportation Equipment Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	7
Transportation Equipment Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Transportation Equipment Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Transportation Equipment Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	13
Transportation Equipment Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	12
Transportation Equipment Mfg	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	1%	$-0.01	60
Transportation Equipment Mfg	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	2%	$-0.01	65
Transportation Equipment Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	283
Transportation Equipment Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	9
Transportation Equipment Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	8
Transportation Equipment Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	13%	$-0.01	5
Transportation Equipment Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	13%	$-0.01	5
Transportation Equipment Mfg	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	13%	$-0.01	5
Transportation Equipment Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	142
Transportation Equipment Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	138
Transportation Equipment Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	133
Transportation Equipment Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	18
Transportation Equipment Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	18
Transportation Equipment Mfg	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	18
Transportation Equipment Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	6

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Transportation Equipment Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	6
Transportation Equipment Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	6
Transportation Equipment Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	6
Transportation Equipment Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	6
Transportation Equipment Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	6
Transportation Equipment Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Transportation Equipment Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Transportation Equipment Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	186
Transportation Equipment Mfg	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	228
Transportation Equipment Mfg	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	834
Transportation Equipment Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	13%	$-0.01	4
Transportation Equipment Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	110
Transportation Equipment Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	16
Transportation Equipment Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Transportation Equipment Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	5
Transportation Equipment Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	9
Transportation Equipment Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	8
Transportation Equipment Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	13%	$-0.01	1
Transportation Equipment Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	37
Transportation Equipment Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	4
Transportation Equipment Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Transportation Equipment Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Wastewater	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	1%	$-0.01	9
Wastewater	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	2%	$-0.01	13
Wastewater	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	56
Wastewater	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	1
Wastewater	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Wastewater	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	14
Wastewater	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	13
Wastewater	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	1,661
Wastewater	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	1,817
Wastewater	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	6,988
Wastewater	Process Aircomp	Energy Project Management	29%	11	$0.00	27%	$0.01	2,162
Wastewater	Process Aircomp	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	4,854
Wastewater	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	31

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Wastewater	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	924
Wastewater	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	135
Wastewater	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	48
Wastewater	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	45
Wastewater	Pumps	Energy Project Management	29%	11	$0.00	27%	$0.01	724
Wastewater	Pumps	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	1,190
Wastewater	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	9
Wastewater	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	309
Wastewater	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	184
Wastewater	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	572
Wastewater	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	905
Wastewater	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	40
Wastewater	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	14
Wastewater	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	13
Water	Fans	Energy Project Management	29%	11	$0.00	27%	$0.01	2,221
Water	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	653
Water	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	2,123
Water	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	5,135
Water	Fans	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	4,288
Water	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	29
Water	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	950
Water	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	124
Water	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	44
Water	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	41
Water	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	1%	$-0.01	55
Water	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	2%	$-0.01	79
Water	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	335
Water	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	11
Water	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	10
Water	Motors Other	Energy Project Management -- Other_Motors	29%	11	$0.00	27%	$0.01	2,607
Water	Motors Other	Integrated Plant Energy Management -- Other_Motors	50%	11	$0.00	22%	$-0.04	4,288
Water	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	11%	$-0.01	34
Water	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	1,115
Water	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	145
Water	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	52
Water	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	48
Water	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	84
Water	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	77
Water	Pumps	Energy Project Management	29%	11	$0.00	27%	$0.01	15,555
Water	Pumps	Integrated Plant Energy Management	50%	11	$0.00	22%	$-0.04	25,583
Water	Pumps	Motors: Rewind 20-50 HP	1%	10	$0.00	11%	$-0.01	204
Water	Pumps	Plant Energy Management	12%	10	$0.00	27%	$0.01	6,652
Water	Pumps	Pump Energy Management	8%	10	$0.00	31%	$0.02	3,972
Water	Pumps	Pump Equipment Upgrade	20%	10	$0.00	34%	$0.02	12,290
Water	Pumps	Pump System Optimization	50%	12	$0.00	15%	$-0.07	19,447
Water	Pumps	Synchronous Belts	2%	10	$0.00	21%	$-0.01	868
Water	Pumps	Transformers-New	0%	32	$0.00	37%	$-0.01	313
Water	Pumps	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	289

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Wood Product Mfg	Fans	Fan Energy Mangement	10%	10	$0.00	27%	$0.02	72
Wood Product Mfg	Fans	Fan Equipment Upgrade	35%	10	$0.00	23%	$0.02	237
Wood Product Mfg	Fans	Fan System Optimization	50%	10	$0.00	30%	$-0.02	529
Wood Product Mfg	Fans	Motors: Rewind 101-200 HP	1%	10	$0.00	29%	$-0.01	4
Wood Product Mfg	Fans	Motors: Rewind 20-50 HP	1%	10	$0.00	9%	$-0.01	2
Wood Product Mfg	Fans	Motors: Rewind 201-500 HP	1%	10	$0.00	8%	$-0.01	1
Wood Product Mfg	Fans	Motors: Rewind 51-100 HP	1%	10	$0.00	12%	$-0.01	1
Wood Product Mfg	Fans	Plant Energy Management	12%	10	$0.00	27%	$0.01	97
Wood Product Mfg	Fans	Synchronous Belts	2%	10	$0.00	21%	$-0.01	12
Wood Product Mfg	Fans	Transformers-New	0%	32	$0.00	37%	$-0.01	4
Wood Product Mfg	Fans	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Wood Product Mfg	Hvac	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Wood Product Mfg	Hvac	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Wood Product Mfg	Lighting	Efficient Lighting 1 Shift	70%	10	$0.00	4%	$-0.01	74
Wood Product Mfg	Lighting	Efficient Lighting 2 Shift	70%	10	$0.00	5%	$-0.01	79
Wood Product Mfg	Lighting	Efficient Lighting 3 Shift	70%	10	$0.00	10%	$-0.01	159
Wood Product Mfg	Lighting	HighBay Lighting 1 Shift	51%	10	$0.00	7%	$-0.01	70
Wood Product Mfg	Lighting	HighBay Lighting 2 Shift	51%	10	$0.00	7%	$-0.01	75
Wood Product Mfg	Lighting	HighBay Lighting 3 Shift	51%	10	$0.00	15%	$-0.01	150
Wood Product Mfg	Lighting	Lighting Controls	28%	10	$0.00	15%	$-0.01	76
Wood Product Mfg	Lighting	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Wood Product Mfg	Lighting	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	2
Wood Product Mfg	Motors Other	Efficient Centrifugal Fan -- Material_Handling	20%	10	$0.00	11%	$-0.01	182
Wood Product Mfg	Motors Other	Material Handling VFD2 -- Material_Handling	19%	10	$0.00	53%	$-0.01	854
Wood Product Mfg	Motors Other	Material Handling2 -- Material_Handling	5%	10	$0.00	53%	$-0.01	205
Wood Product Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Handling	1%	10	$0.00	29%	$-0.01	10
Wood Product Mfg	Motors Other	Motors: Rewind 101-200 HP -- Material_Processing	1%	10	$0.00	29%	$-0.01	10
Wood Product Mfg	Motors Other	Motors: Rewind 101-200 HP -- Other_Motors	1%	10	$0.00	29%	$-0.01	10
Wood Product Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Handling	1%	10	$0.00	9%	$-0.01	6
Wood Product Mfg	Motors Other	Motors: Rewind 20-50 HP -- Material_Processing	1%	10	$0.00	9%	$-0.01	6
Wood Product Mfg	Motors Other	Motors: Rewind 20-50 HP -- Other_Motors	1%	10	$0.00	9%	$-0.01	6
Wood Product Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Handling	1%	10	$0.00	8%	$-0.01	3
Wood Product Mfg	Motors Other	Motors: Rewind 201-500 HP -- Material_Processing	1%	10	$0.00	8%	$-0.01	3
Wood Product Mfg	Motors Other	Motors: Rewind 201-500 HP -- Other_Motors	1%	10	$0.00	8%	$-0.01	3
Wood Product Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Handling	1%	10	$0.00	12%	$-0.01	4
Wood Product Mfg	Motors Other	Motors: Rewind 51-100 HP -- Material_Processing	1%	10	$0.00	12%	$-0.01	4
Wood Product Mfg	Motors Other	Motors: Rewind 51-100 HP -- Other_Motors	1%	10	$0.00	12%	$-0.01	4
Wood Product Mfg	Motors Other	Plant Energy Management -- Material_Handling	12%	10	$0.00	27%	$0.01	234
Wood Product Mfg	Motors Other	Plant Energy Management -- Material_Processing	12%	10	$0.00	27%	$0.01	226

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per kWh	Measure Applicability	Levelized Cost ($ per kWh)	2031 Achievable Technical Potential (MWh)
Wood Product Mfg	Motors Other	Plant Energy Management -- Other_Motors	12%	10	$0.00	27%	$0.01	219
Wood Product Mfg	Motors Other	Synchronous Belts -- Material_Handling	2%	10	$0.00	21%	$-0.01	31
Wood Product Mfg	Motors Other	Synchronous Belts -- Material_Processing	2%	10	$0.00	21%	$-0.01	30
Wood Product Mfg	Motors Other	Synchronous Belts -- Other_Motors	2%	10	$0.00	21%	$-0.01	30
Wood Product Mfg	Motors Other	Transformers-New -- Material_Handling	0%	32	$0.00	37%	$-0.01	11
Wood Product Mfg	Motors Other	Transformers-New -- Material_Processing	0%	32	$0.00	37%	$-0.01	11
Wood Product Mfg	Motors Other	Transformers-New -- Other_Motors	0%	32	$0.00	37%	$-0.01	11
Wood Product Mfg	Motors Other	Transformers-Retrofit -- Material_Handling	2%	10	$0.00	9%	$-0.01	10
Wood Product Mfg	Motors Other	Transformers-Retrofit -- Material_Processing	2%	10	$0.00	9%	$-0.01	10
Wood Product Mfg	Motors Other	Transformers-Retrofit -- Other_Motors	2%	10	$0.00	9%	$-0.01	10
Wood Product Mfg	Motors Other	Wood: Replace Pneumatic Conveyor -- Material_Handling	29%	10	$0.00	50%	$-0.07	1,477
Wood Product Mfg	Other	Transformers-New	0%	32	$0.00	37%	$-0.01	2
Wood Product Mfg	Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	1
Wood Product Mfg	Process Aircomp	Air Compressor Demand Reduction	20%	10	$0.00	26%	$0.01	174
Wood Product Mfg	Process Aircomp	Air Compressor Equipment2	35%	10	$0.00	17%	$0.01	190
Wood Product Mfg	Process Aircomp	Air Compressor Optimization	50%	10	$0.00	36%	$-0.04	734
Wood Product Mfg	Process Aircomp	Motors: Rewind 101-200 HP	1%	10	$0.00	29%	$-0.01	4
Wood Product Mfg	Process Aircomp	Motors: Rewind 20-50 HP	1%	10	$0.00	9%	$-0.01	2
Wood Product Mfg	Process Aircomp	Motors: Rewind 201-500 HP	1%	10	$0.00	8%	$-0.01	1
ood Product Mfg	Process Aircomp	Motors: Rewind 51-100 HP	1%	10	$0.00	12%	$-0.01	2
Wood Product Mfg	Process Aircomp	Plant Energy Management	12%	10	$0.00	27%	$0.01	97
Wood Product Mfg	Process Aircomp	Synchronous Belts	2%	10	$0.00	21%	$-0.01	14
Wood Product Mfg	Process Aircomp	Transformers-New	0%	32	$0.00	37%	$-0.01	5
Wood Product Mfg	Process Aircomp	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	4
Wood Product Mfg	Process Heat	Transformers-New	0%	32	$0.00	37%	$-0.01	3
Wood Product Mfg	Process Heat	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	3
Wood Product Mfg	Process Other	Motors: Rewind 101-200 HP	1%	10	$0.00	29%	$-0.01	0.20
Wood Product Mfg	Process Other	Motors: Rewind 20-50 HP	1%	10	$0.00	9%	$-0.01	0.12
Wood Product Mfg	Process Other	Motors: Rewind 201-500 HP	1%	10	$0.00	8%	$-0.01	0.06
Wood Product Mfg	Process Other	Motors: Rewind 51-100 HP	1%	10	$0.00	12%	$-0.01	0.08
Wood Product Mfg	Process Other	Plant Energy Management	12%	10	$0.00	27%	$0.01	4
Wood Product Mfg	Process Other	Synchronous Belts	2%	10	$0.00	21%	$-0.01	0.60
Wood Product Mfg	Process Other	Transformers-New	0%	32	$0.00	37%	$-0.01	0.21
Wood Product Mfg	Process Other	Transformers-Retrofit	2%	10	$0.00	9%	$-0.01	0.20

Table B.3.4. Residential Gas Measure Details

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Manufactured	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	Existing	3	14	$224	100%	N/A	$9.96	1,926
Manufactured	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	New	3	14	$224	100%	N/A	$9.96	933
Manufactured	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	61	5	$576	25%	95%	$2.81	1,245
Manufactured	Heat Central Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	3	30	$25	95%	50%	$0.81	640
Manufactured	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	11	25	$338	40%	95%	$3.31	286
Manufactured	Heat Central Boiler	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	173	25	$1,559	75%	35%	$1.01	3,421
Manufactured	Heat Central Boiler	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	348	25	$1,559	75%	1%	$0.50	215
Manufactured	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	Existing	81	20	$1,053	100%	N/A	$1.59	1,823
Manufactured	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	9	20	$25	95%	80%	$0.33	583
Manufactured	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	6	20	$54	95%	60%	$1.08	242
Manufactured	Heat Central Boiler	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	3	6	$46	95%	50%	$3.01	249
Manufactured	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	16	25	$445	25%	85%	$2.97	238
Manufactured	Heat Central Boiler	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	331	25	$1,680	25%	20%	$0.57	1,365
Manufactured	Heat Central Boiler	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	61	11	$449	75%	50%	$1.23	1,583
Manufactured	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	12	15	$5	95%	65%	$0.06	467
Manufactured	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	12	25	$672	25%	90%	$6.17	173
Manufactured	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	41	11	$1,083	50%	95%	$4.36	1,287
Manufactured	Heat Central Boiler	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	197	25	$1,647	85%	25%	$0.94	2,493
Manufactured	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	25	$341	65%	85%	$26.89	48
Manufactured	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	15	25	$3,514	65%	50%	$25.92	309
Manufactured	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	23	25	$3,514	65%	20%	$16.54	194
Manufactured	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	56	5	$576	25%	95%	$3.04	705
Manufactured	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	14	25	$454	60%	95%	$3.46	408
Manufactured	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	New	76	20	$1,053	100%	N/A	$1.69	1,931
Manufactured	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	8	20	$25	95%	80%	$0.36	330
Manufactured	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	5	20	$54	95%	60%	$1.16	163
Manufactured	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	15	25	$599	75%	85%	$4.31	476

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Manufactured	Heat Central Boiler	Green Roof	ecoroof	Standard Roof	Per installation	New	39	40	$19,076	20%	95%	$48.47	67
Manufactured	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	11	15	$5	95%	65%	$0.07	312
Manufactured	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	11	25	$893	50%	90%	$8.86	232
Manufactured	Heat Central Boiler	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	1	25	$795	75%	75%	$50.76	44
Manufactured	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	38	11	$1,083	50%	95%	$4.71	860
Manufactured	Heat Central Boiler	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	40	25	$973	50%	95%	$2.70	966
Manufactured	Heat Central Boiler	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	2	25	$458	95%	75%	$18.97	87
Manufactured	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	25	$395	95%	75%	$24.24	58
Manufactured	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	46	5	$576	25%	95%	$3.69	34,799
Manufactured	Heat Central Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	2	30	$25	95%	50%	$1.06	17,089
Manufactured	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	8	25	$338	40%	95%	$4.34	7,641
Manufactured	Heat Central Furnace	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	132	25	$1,559	75%	35%	$1.32	91,305
Manufactured	Heat Central Furnace	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	265	25	$1,559	75%	1%	$0.66	6,033
Manufactured	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	Existing	78	20	$596	100%	N/A	$0.93	60,995
Manufactured	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	7	20	$25	95%	80%	$0.44	16,307
Manufactured	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	4	20	$54	95%	60%	$1.41	6,460
Manufactured	Heat Central Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	3	6	$46	95%	50%	$3.95	6,658
Manufactured	Heat Central Furnace	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	18	20	$672	75%	75%	$4.40	23,939
Manufactured	Heat Central Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	46	18	$383	75%	60%	$1.05	61,647
Manufactured	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	12	25	$445	25%	85%	$3.89	6,356
Manufactured	Heat Central Furnace	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	253	25	$1,680	25%	20%	$0.75	38,158
Manufactured	Heat Central Furnace	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	46	11	$449	75%	50%	$1.61	42,258
Manufactured	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	9	15	$5	95%	65%	$0.08	12,195
Manufactured	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	9	25	$672	25%	90%	$8.10	4,529
Manufactured	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	31	11	$1,083	50%	95%	$5.72	33,593
Manufactured	Heat Central Furnace	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	150	25	$1,647	85%	25%	$1.23	66,540
Manufactured	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	25	$341	65%	85%	$35.26	1,273
Manufactured	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	11	25	$3,514	65%	50%	$33.99	8,071

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Manufactured	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	18	25	$3,514	65%	20%	$21.69	5,085
Manufactured	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	42	5	$576	25%	95%	$4.08	19,345
Manufactured	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	11	25	$454	60%	95%	$4.65	11,209
Manufactured	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	New	70	20	$596	100%	N/A	$1.04	65,467
Manufactured	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	6	20	$25	95%	80%	$0.48	9,065
Manufactured	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	4	20	$54	95%	60%	$1.56	4,480
Manufactured	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	11	25	$599	75%	85%	$5.78	13,078
Manufactured	Heat Central Furnace	Green Roof	ecoroof	Standard Roof	Per installation	New	29	40	$19,076	20%	95%	$65.08	1,853
Manufactured	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	8	15	$5	95%	65%	$0.09	8,568
Manufactured	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	8	25	$893	50%	90%	$11.90	6,365
Manufactured	Heat Central Furnace	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	1	25	$795	75%	75%	$68.17	1,214
Manufactured	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	28	11	$1,083	50%	95%	$6.32	23,606
Manufactured	Heat Central Furnace	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	30	25	$973	50%	95%	$3.63	26,494
Manufactured	Heat Central Furnace	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	2	25	$458	95%	75%	$25.48	2,393
Manufactured	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	25	$395	95%	75%	$32.55	1,609
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	4	14	$227	100%	83%	$-6.85	3,136
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$296	100%	90%	$-6.31	4,510
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$317	100%	95%	$-5.95	5,313
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	71%	50%	$3.50	1,755
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	71%	50%	$0.16	0.08
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$0.13	0.67
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$2.77	13,566
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$0.15	0.18
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$3.33	3,781
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-1.21	8,711
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-0.06	0.51
Manufactured	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	Existing	34	11	$208	100%	N/A	$1.02	25,160
Manufactured	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	Existing	44	11	$594	75%	N/A	$2.22	4,764

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	9	5	$8	95%	45%	$-0.00	0.59
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	9	5	$8	95%	45%	$0.27	10,587
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	4	14	$227	100%	83%	$-6.76	1,915
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	5	14	$296	100%	90%	$-6.23	2,754
Manufactured	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	6	14	$317	100%	95%	$-5.87	3,244
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	71%	50%	$3.45	1,071
Manufactured	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	71%	50%	$0.16	0.04
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$459	59%	90%	$0.10	0.60
Manufactured	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$459	59%	90%	$2.33	16,734
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$0.15	0.08
Manufactured	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$3.28	2,279
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-1.48	5,319
Manufactured	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-0.08	0.23
Manufactured	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	New	41	11	$208	100%	N/A	$0.83	9,849
Manufactured	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	New	55	11	$390	75%	N/A	$1.18	41,012
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	11	5	$8	95%	45%	$0.00	0.22
Manufactured	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	11	5	$8	95%	45%	$0.22	7,936
Multi Family	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	Existing	3	14	$224	100%	N/A	$9.96	4,130
Multi Family	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	New	3	14	$224	100%	N/A	$9.96	2,001
Multi Family	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	44	5	$576	25%	95%	$3.89	15,537
Multi Family	Heat Central Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	6	30	$25	95%	50%	$0.45	7,980
Multi Family	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	8	30	$119	75%	95%	$1.53	6,732
Multi Family	Heat Central Boiler	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	125	30	$549	75%	35%	$0.47	44,956
Multi Family	Heat Central Boiler	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	251	30	$549	95%	1%	$0.23	3,412
Multi Family	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	Existing	59	20	$1,053	100%	N/A	$2.18	22,409
Multi Family	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	13	20	$25	95%	80%	$0.23	7,281
Multi Family	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	8	20	$54	95%	60%	$0.75	3,016
Multi Family	Heat Central Boiler	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	5	6	$46	95%	50%	$2.08	3,067
Multi Family	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	12	30	$157	25%	85%	$1.37	2,968

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Multi Family	Heat Central Boiler	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	239	30	$592	25%	20%	$0.26	17,018
Multi Family	Heat Central Boiler	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	44	11	$358	75%	50%	$1.36	19,735
Multi Family	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	8	15	$5	95%	65%	$0.08	5,782
Multi Family	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	8	30	$249	50%	90%	$3.01	4,443
Multi Family	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	30	11	$1,083	50%	95%	$6.04	15,805
Multi Family	Heat Central Boiler	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	143	30	$978	85%	25%	$0.73	28,757
Multi Family	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	30	$202	51%	85%	$20.96	469
Multi Family	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	11	30	$2,086	51%	50%	$20.20	2,972
Multi Family	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	17	30	$2,086	51%	20%	$12.89	1,870
Multi Family	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	37	5	$576	25%	95%	$4.55	8,129
Multi Family	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	9	30	$166	90%	95%	$1.80	7,313
Multi Family	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	New	51	20	$1,053	100%	N/A	$2.52	21,927
Multi Family	Heat Central Boiler	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	166	45	$3,569	50%	95%	$2.13	3,355
Multi Family	Heat Central Boiler	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	45	45	$1,387	50%	95%	$3.04	862
Multi Family	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	11	20	$25	95%	80%	$0.27	3,809
Multi Family	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	7	20	$54	95%	60%	$0.87	1,882
Multi Family	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	10	30	$219	75%	85%	$2.24	5,586
Multi Family	Heat Central Boiler	Green Roof	ecoroof	Standard Roof	Per installation	New	26	40	$7,290	50%	95%	$27.76	1,905
Multi Family	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	7	15	$5	95%	65%	$0.10	3,511
Multi Family	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	7	30	$341	75%	90%	$4.81	4,074
Multi Family	Heat Central Boiler	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	1	45	$795	40%	75%	$67.24	265
Multi Family	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	25	11	$1,083	50%	95%	$7.05	9,616
Multi Family	Heat Central Boiler	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	27	30	$588	50%	95%	$2.33	9,524
Multi Family	Heat Central Boiler	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	1	30	$277	95%	75%	$16.32	983
Multi Family	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$239	95%	75%	$20.85	661
Multi Family	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	35	5	$576	25%	95%	$4.88	36,736
Multi Family	Heat Central Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	4	30	$25	95%	50%	$0.56	70,233
Multi Family	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	6	30	$119	75%	95%	$1.92	56,581

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Multi Family	Heat Central Furnace	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	100	30	$549	75%	35%	$0.59	95,628
Multi Family	Heat Central Furnace	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	200	30	$549	95%	1%	$0.29	30,029
Multi Family	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	Existing	59	20	$596	100%	N/A	$1.23	36,957
Multi Family	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	10	20	$25	95%	80%	$0.29	64,074
Multi Family	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	7	20	$54	95%	60%	$0.93	26,549
Multi Family	Heat Central Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	4	6	$46	95%	50%	$2.61	25,783
Multi Family	Heat Central Furnace	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	14	20	$672	75%	75%	$5.82	92,527
Multi Family	Heat Central Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	35	18	$383	75%	60%	$1.39	8,405
Multi Family	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	9	30	$157	25%	85%	$1.72	24,946
Multi Family	Heat Central Furnace	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	191	30	$592	25%	20%	$0.33	49,763
Multi Family	Heat Central Furnace	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	35	11	$358	75%	50%	$1.70	65,856
Multi Family	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	7	15	$5	95%	65%	$0.11	47,501
Multi Family	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	7	30	$249	50%	90%	$3.77	37,347
Multi Family	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	24	11	$1,083	50%	95%	$7.57	29,839
Multi Family	Heat Central Furnace	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	114	30	$978	85%	25%	$0.91	53,073
Multi Family	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	0.82	30	$202	51%	85%	$26.27	3,858
Multi Family	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	8	30	$2,086	51%	50%	$25.32	24,416
Multi Family	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	13	30	$2,086	51%	20%	$16.16	15,367
Multi Family	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	31	5	$576	25%	95%	$5.44	75,329
Multi Family	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	8	30	$166	90%	95%	$2.15	67,771
Multi Family	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	New	53	20	$596	100%	N/A	$1.37	51,289
Multi Family	Heat Central Furnace	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	139	45	$3,569	50%	95%	$2.55	31,098
Multi Family	Heat Central Furnace	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	38	45	$1,387	50%	95%	$3.63	7,993
Multi Family	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	9	20	$25	95%	80%	$0.32	35,299
Multi Family	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	6	20	$54	95%	60%	$1.04	17,448
Multi Family	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	8	30	$219	75%	85%	$2.68	51,771
Multi Family	Heat Central Furnace	Green Roof	ecoroof	Standard Roof	Per installation	New	22	40	$7,290	50%	95%	$33.18	17,653
Multi Family	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	6	15	$5	95%	65%	$0.12	32,536

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Multi Family	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	6	30	$341	75%	90%	$5.76	37,756
Multi Family	Heat Central Furnace	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	0.98	45	$795	40%	75%	$80.38	2,457
Multi Family	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	21	11	$1,083	50%	95%	$8.43	89,117
Multi Family	Heat Central Furnace	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	22	30	$588	50%	95%	$2.78	88,256
Multi Family	Heat Central Furnace	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	1	30	$277	95%	75%	$19.51	9,117
Multi Family	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$239	95%	75%	$24.92	6,132
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	4	14	$227	79%	87%	$-6.86	24,728
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$296	79%	95%	$-6.32	35,747
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$317	79%	99%	$-5.95	41,568
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	58%	50%	$0.16	0.17
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	58%	50%	$3.50	13,528
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$0.13	1
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$2.77	28,983
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$0.15	0.44
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$3.33	35,790
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-0.06	1
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-1.21	82,847
Multi Family	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	Existing	30	11	$208	100%	N/A	$1.15	11,440
Multi Family	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	Existing	39	11	$594	75%	N/A	$2.51	80,402
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	8	5	$8	95%	45%	$0.01	0.85
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	8	5	$8	95%	45%	$0.31	89,310
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	4	14	$227	79%	87%	$-6.76	15,101
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	5	14	$296	79%	95%	$-6.23	21,830
Multi Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	6	14	$317	79%	99%	$-5.87	25,385
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	58%	50%	$0.16	0.08
Multi Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	58%	50%	$3.45	8,261

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$459	59%	90%	$0.10	1
Multi Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$459	59%	90%	$2.33	59,137
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$0.15	0.18
Multi Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$3.28	21,517
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-0.08	0.58
Multi Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-1.48	50,594
Multi Family	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	New	37	11	$208	100%	N/A	$0.94	82,659
Multi Family	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	New	49	11	$390	75%	N/A	$1.33	44,181
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	10	5	$8	95%	45%	$0.01	0.32
Multi Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	10	5	$8	95%	45%	$0.25	67,025
Single Family	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	Existing	3	14	$224	100%	N/A	$9.96	62,352
Single Family	Dryer	Dryer, Advanced Efficiency EF = 2.93	Advanced Efficiency Dryer EF = 2.93	Standard Dryer EF = 2.67	Per installation	New	3	14	$224	100%	N/A	$9.96	75,534
Single Family	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	75	5	$576	50%	95%	$2.28	85,915
Single Family	Heat Central Boiler	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	2	30	$25	95%	50%	$1.05	38,454
Single Family	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	14	30	$564	75%	95%	$4.25	17,121
Single Family	Heat Central Boiler	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	214	30	$2,602	75%	35%	$1.29	50,674
Single Family	Heat Central Boiler	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	429	30	$2,602	95%	1%	$0.65	62,773
Single Family	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	Existing	101	20	$1,053	100%	N/A	$1.27	2,633
Single Family	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	11	20	$25	95%	80%	$0.27	33,940
Single Family	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	7	20	$54	95%	60%	$0.87	64,064
Single Family	Heat Central Boiler	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	4	6	$46	95%	50%	$2.44	57,538
Single Family	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	20	30	$743	25%	85%	$3.81	54,267
Single Family	Heat Central Boiler	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	409	30	$2,802	25%	20%	$0.73	13,060
Single Family	Heat Central Boiler	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	75	11	$575	75%	50%	$1.28	92,285
Single Family	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	15	15	$5	95%	65%	$0.05	4,565
Single Family	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	15	30	$1,101	50%	90%	$7.78	77,787
Single Family	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	51	11	$1,271	75%	95%	$4.15	46,039
Single Family	Heat Central Boiler	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	244	30	$2,128	85%	25%	$0.93	75,902
Single Family	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	30	$440	65%	75%	$26.71	9,631
Single Family	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	18	30	$4,539	65%	25%	$25.74	34,456

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Single Family	Heat Central Boiler	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	29	30	$4,539	65%	25%	$16.43	54,346
Single Family	Heat Central Boiler	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	60	5	$576	50%	95%	$2.86	85,236
Single Family	Heat Central Boiler	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	15	30	$659	90%	95%	$4.50	935
Single Family	Heat Central Boiler	Central Heat Boiler, AFUE = 94%	AFUE = 94%	AFUE = 82%	Per installation	New	80	20	$1,053	100%	N/A	$1.61	3,487
Single Family	Heat Central Boiler	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	264	45	$7,109	50%	95%	$2.67	49,519
Single Family	Heat Central Boiler	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	72	45	$2,763	50%	95%	$3.81	12,956
Single Family	Heat Central Boiler	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	9	20	$25	95%	80%	$0.34	65,205
Single Family	Heat Central Boiler	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	6	20	$54	95%	60%	$1.10	32,230
Single Family	Heat Central Boiler	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	16	30	$869	75%	85%	$5.60	74,145
Single Family	Heat Central Boiler	Green Roof	ecoroof	Standard Roof	Per installation	New	42	40	$27,367	50%	95%	$65.57	26,978
Single Family	Heat Central Boiler	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	12	15	$5	95%	65%	$0.06	49,769
Single Family	Heat Central Boiler	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	12	30	$1,282	75%	90%	$11.38	55,934
Single Family	Heat Central Boiler	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	1	45	$795	75%	75%	$42.32	7,102
Single Family	Heat Central Boiler	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	117	30	$1,209	85%	95%	$1.10	83,647
Single Family	Heat Central Boiler	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	40	11	$1,271	75%	95%	$5.21	14,740
Single Family	Heat Central Boiler	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	42	30	$1,172	50%	95%	$2.92	43,048
Single Family	Heat Central Boiler	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	2	30	$552	95%	75%	$20.46	13,957
Single Family	Heat Central Boiler	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$476	95%	75%	$26.13	9,388
Single Family	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	Existing	61	5	$576	50%	95%	$2.80	72,121
Single Family	Heat Central Furnace	Canned Lighting Air Tight Sealing	Canned Lighting Air Tight Sealing	No Air tight Sealing	Per installation	Existing	2	30	$25	95%	50%	$1.29	84,985
Single Family	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	Existing	11	30	$564	75%	95%	$5.22	29,749
Single Family	Heat Central Furnace	Ceiling Insulation (WA) ave to code	R-49	R-10	Per installation	Existing	174	30	$2,602	75%	35%	$1.59	21,449
Single Family	Heat Central Furnace	Ceiling Insulation (WA) zero to code	R-49	R-0	Per installation	Existing	349	30	$2,602	95%	1%	$0.79	96,912
Single Family	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	Existing	102	20	$596	100%	N/A	$0.71	23,426
Single Family	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	9	20	$25	95%	80%	$0.33	34,106
Single Family	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	Existing	6	20	$54	95%	60%	$1.07	33,875
Single Family	Heat Central Furnace	Doors - Weatherization	Weatherstripping And Adding Door Sweeps	Existing Non-Efficient door	Per installation	Existing	3	6	$46	95%	50%	$3.00	72,952
Single Family	Heat Central Furnace	Duct Insulation Upgrade	R-8 (code)	R-4	Per installation	Existing	24	20	$672	75%	75%	$3.34	96,015

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Single Family	Heat Central Furnace	Duct Sealing	Duct Sealing	No Duct Sealing	Per installation	Existing	61	18	$535	75%	60%	$1.11	95,443
Single Family	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	Existing	16	30	$743	25%	85%	$4.68	50,162
Single Family	Heat Central Furnace	Floor Insulation (WA) zero to code	R-30	R-0	Per installation	Existing	333	30	$2,802	25%	20%	$0.90	61,522
Single Family	Heat Central Furnace	Infiltration Control (Caulk, Weather Strip, etc.) Blower-Door test	Install Caulking And Weatherstripping	Existing Infiltration Conditions	Per installation	Existing	61	11	$575	75%	50%	$1.57	24,050
Single Family	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	Existing	12	15	$5	95%	65%	$0.06	94,213
Single Family	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	Existing	12	30	$1,101	50%	90%	$9.56	78,650
Single Family	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	Existing	41	11	$1,271	75%	95%	$5.10	19,187
Single Family	Heat Central Furnace	Wall Insulation 2x4 (WA) zero to max feasible	R-13	R-0	Per installation	Existing	198	30	$2,128	85%	25%	$1.14	43,632
Single Family	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	Existing	1	30	$440	65%	75%	$32.81	57,381
Single Family	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Double Pane	Per installation	Existing	15	30	$4,539	65%	25%	$31.63	20,745
Single Family	Heat Central Furnace	Windows (Same for all Building Types)	CL30	Single Pane	Per installation	Existing	24	30	$4,539	65%	25%	$20.18	52,260
Single Family	Heat Central Furnace	Air-to-Air Heat Exchangers	Air-to-Air Heat Exchangers	No Air to Air Heat Exchangers	Per installation	New	45	5	$576	50%	95%	$3.74	4,291
Single Family	Heat Central Furnace	Ceiling Insulation (WA) above code	R-60	R-49	Per installation	New	11	30	$659	90%	95%	$5.88	26,271
Single Family	Heat Central Furnace	Central Heat Furnace, AFUE = 95%	AFUE = 95%	AFUE = 80%	Per installation	New	77	20	$596	100%	N/A	$0.95	73,333
Single Family	Heat Central Furnace	Construction - ICF	Concrete Framing	Standard Wood Framing	Per installation	New	202	45	$7,109	50%	95%	$3.49	37,517
Single Family	Heat Central Furnace	Construction - SIP	Specialty Framing	Standard Wood Framing	Per installation	New	55	45	$2,763	50%	95%	$4.98	49,953
Single Family	Heat Central Furnace	Doors	R-11 (Steel Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	6	20	$25	95%	80%	$0.44	61,201
Single Family	Heat Central Furnace	Doors	R-5 (Composite Doors with foam core)	Standard non-thermal wood door (R-2.5)	Per installation	New	4	20	$54	95%	60%	$1.43	70,561
Single Family	Heat Central Furnace	Floor Insulation (WA) above code	R-38	R-30	Per installation	New	12	30	$869	75%	85%	$7.32	2,678
Single Family	Heat Central Furnace	Green Roof	ecoroof	Standard Roof	Per installation	New	32	40	$27,367	50%	95%	$85.77	28,697
Single Family	Heat Central Furnace	Proper Sizing - HVAC Unit	Proper Sizing - HVAC Unit	Oversized HVAC Unit	Per installation	New	9	15	$5	95%	65%	$0.08	44,295
Single Family	Heat Central Furnace	Radiant Barrier (Ceiling)	Install Radiant Barrier	No Radiant Barrier	Per installation	New	9	30	$1,282	75%	90%	$14.88	10,808
Single Family	Heat Central Furnace	Smart Siting	Siting house to minimize heating/cooling costs	No smart siting	Per installation	New	1	45	$795	75%	75%	$55.35	91,839
Single Family	Heat Central Furnace	Thermal Shell - Infiltration @0.2 ACH w/HRV	0.2 ACH w/HRV	Standard New Construction Home 0.35 ACH	Per installation	New	89	30	$1,209	85%	95%	$1.44	67,467
Single Family	Heat Central Furnace	Thermostat - Multi-Zone	Individual Room Temperature Control for Major Occupied Rooms	Programmable Thermostat - Central Control Only	Per installation	New	31	11	$1,271	75%	95%	$6.81	171
Single Family	Heat Central Furnace	Wall Insulation 2x6 (WA) above code	R-21+R-5 sheathing	R-21	Per installation	New	32	30	$1,172	50%	95%	$3.81	63,767
Single Family	Heat Central Furnace	Windows (Same for all Building Types)	CL22	CL30	Per installation	New	2	30	$552	95%	75%	$26.76	77,003

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Single Family	Heat Central Furnace	Windows (Same for all Building Types)	CL25	CL30	Per installation	New	1	30	$476	95%	75%	$34.18	53,585
Single Family	Pool Heat	Pool Heaters, Standard Heaters - 88% efficiency	88% efficiency	83% efficiency	Per installation	Existing	14	8	$460	100%	N/A	$6.85	31,437
Single Family	Pool Heat	Pool Heaters, Standard Heaters - 88% efficiency	88% efficiency	83% efficiency	Per installation	New	14	8	$460	100%	N/A	$6.85	52,813
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	4	14	$227	99%	88%	$-6.84	52,556
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$296	99%	90%	$-6.30	83,089
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	Existing	5	14	$317	99%	95%	$-5.94	40,156
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	71%	50%	$0.16	0.41
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	Existing	1	12	$42	71%	50%	$3.49	45,007
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$2.77	91,998
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	Existing	19	40	$540	29%	90%	$0.13	3
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$0.15	0.87
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	Existing	2	5	$23	95%	75%	$3.32	59,265
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-0.06	4
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	Existing	4	10	$16	95%	65%	$-1.21	39,022
Single Family	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	Existing	51	11	$208	100%	N/A	$0.67	20,518
Single Family	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	Existing	68	11	$594	75%	N/A	$1.46	46,903
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	14	5	$8	95%	45%	$-0.00	2
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	Existing	14	5	$8	95%	45%	$0.18	90,836
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 1 (MEF 2.0 - 2.19) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	4	14	$227	99%	88%	$-6.77	96,850
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 2 (MEF 2.2 - 2.45) - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	5	14	$296	99%	90%	$-6.24	37,048
Single Family	Water Heat	Clothes Washer	Energy Star - Tier 3 (MEF 2.46 or higher) Top 10% of Energy Star Model - Gas DHW & Gas Dryer	MEF = 1.66 - Gas DHW & Gas Dryer	Per installation	New	6	14	$317	99%	95%	$-5.88	32,568
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	71%	50%	$0.16	0.19
Single Family	Water Heat	Dishwasher	Energy Star, July 1st 2011, <= 307 kWh/year , <= 5.0 gallons/cycle	Energy Star - EF65 (6th Plan Baseline)	Per installation	New	1	12	$42	71%	50%	$3.46	9,815
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$526	59%	90%	$0.12	2
Single Family	Water Heat	Drain Water Heat Recovery (GFX)	Gravity Film Heat Exchanger	No Heat Exchanger	Per installation	New	19	40	$526	59%	90%	$2.67	5,258
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$0.15	0.37
Single Family	Water Heat	Hot Water Pipe Insulation	R-4 Wrap	No insulation	Per installation	New	2	5	$23	95%	75%	$3.29	59,449

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-0.07	2
Single Family	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM	Per installation	New	5	10	$9	95%	65%	$-1.48	91,433
Single Family	Water Heat	Water Heater, EF = 0.80	EF = 0.80	EF = 0.62	Per installation	New	64	11	$208	100%	N/A	$0.54	53,851
Single Family	Water Heat	Water Heater, Tankless EF = 0.82 2.5 GPM	EF = 0.82	EF = 0.62	Per installation	New	84	11	$390	75%	N/A	$0.77	15,710
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	17	5	$8	95%	45%	$0.00	1
Single Family	Water Heat	Water_Heater Thermostat Setback	120 degrees	135 degrees	Per installation	New	17	5	$8	95%	45%	$0.15	3,955

Table B.3.5. Commercial Gas Measure Details

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Dry Goods Retail	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	6	20	$93	10%	90%	$1.77	9,619
Dry Goods Retail	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.00	15	$2	15%	67%	$44.73	14,358
Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.00	15	$0.26	75%	59%	$10.63	12,832
Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	2	5	$169	75%	80%	$22.01	71,112
Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	3	5	$122	50%	80%	$10.59	35,639
Dry Goods Retail	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$26.57	5,640
Dry Goods Retail	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.01	10	$0.91	5%	94%	$15.46	8,964
Dry Goods Retail	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	157	20	$1,719	100%	N/A	$1.33	39,533
Dry Goods Retail	Space Heat Boiler	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.08	10	$0.21	10%	39%	$0.47	7,357
Dry Goods Retail	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	98%	$29.89	17,222
Dry Goods Retail	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.02	25	$1	75%	85%	$9.53	34,879
Dry Goods Retail	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.01	25	$0.92	35%	90%	$5.26	21,534
Dry Goods Retail	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.04	25	$2	10%	35%	$5.46	18,457
Dry Goods Retail	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	19	15	$135	95%	26%	$0.95	1,428
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	Building SQ.FT.	Existing	0.01	10	$2	25%	98%	$21.19	77,330
Dry Goods Retail	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	0.91	20	$13	75%	65%	$1.83	13,605
Dry Goods Retail	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	12	3	$129	90%	45%	$5.00	25,318
Dry Goods Retail	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.68 (Average Existing Conditions)	Per Window SQFT	Existing	0.01	25	$63	10%	80%	$533.81	1,348
Dry Goods Retail	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	6	20	$93	10%	90%	$1.84	2,738
Dry Goods Retail	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	1	5	$169	75%	80%	$40.18	27,719
Dry Goods Retail	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$48.51	2,198
Dry Goods Retail	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.00	10	$0.91	5%	94%	$28.23	3,738
Dry Goods Retail	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	88	20	$977	100%	N/A	$1.35	68,433
Dry Goods Retail	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	98%	$54.58	6,713
Dry Goods Retail	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	90%	$16.51	7,173

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Dry Goods Retail	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	33	15	$2,001	50%	95%	$8.31	13,073
Dry Goods Retail	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	10	15	$135	95%	13%	$1.74	2,039
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	Building SQ.FT.	New	0.00	10	$2	50%	98%	$38.70	64,495
Dry Goods Retail	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$18.39	79,241
Dry Goods Retail	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.01	10	$0.91	5%	94%	$10.70	11,135
Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	160	18	$1,298	28%	N/A	$1.03	56,547
Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	224	18	$1,298	28%	N/A	$0.74	30,967
Dry Goods Retail	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	98%	$20.68	41,968
Dry Goods Retail	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.02	25	$1	75%	85%	$6.59	5,056
Dry Goods Retail	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.05	25	$2	10%	15%	$4.60	11,705
Dry Goods Retail	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.02	25	$0.92	35%	90%	$3.64	52,341
Dry Goods Retail	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.06	25	$2	10%	35%	$3.78	20,569
Dry Goods Retail	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	28	15	$135	95%	26%	$0.66	64,675
Dry Goods Retail	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.01	7	$0.18	90%	80%	$3.25	3,096
Dry Goods Retail	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.68 (Average Existing Conditions)	Per Window SQFT	Existing	0.01	25	$63	10%	80%	$369.38	19,194
Dry Goods Retail	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$32.68	30,329
Dry Goods Retail	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.00	10	$0.91	5%	94%	$19.02	42,536
Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	90	18	$2,213	28%	N/A	$3.12	69,550
Dry Goods Retail	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	126	18	$2,213	28%	N/A	$2.24	51,556
Dry Goods Retail	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	98%	$36.76	92,612
Dry Goods Retail	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	90%	$11.12	81,623
Dry Goods Retail	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.22	30	$5	50%	95%	$2.69	4,957
Dry Goods Retail	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	16	15	$135	95%	13%	$1.17	23,663
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	46	10	$8,367	5%	95%	$2.77	0.00
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	46	10	$8,367	5%	95%	$32.31	2,362

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
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)	per installation	Existing	11	10	$240	5%	75%	$3.76	160
Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.26	75%	94%	$36.07	4,079
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	24%	25%	$3.50	388
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	24%	25%	$0.14	0.00
Dry Goods Retail	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	517	10	$2,558	95%	80%	$0.88	97,711
Dry Goods Retail	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	407	10	$3,647	95%	95%	$1.59	45,673
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	40	25	$805	5%	92%	$2.23	27,416
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	40	25	$805	5%	92%	$0.19	0.02
Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.38	12	$2	75%	90%	$0.10	0.01
Dry Goods Retail	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.38	12	$2	75%	90%	$1.21	20,791
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	83%	$0.79	3,745
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	83%	$-0.10	0.00
Dry Goods Retail	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	36	14	$204	75%	N/A	$0.81	36,224
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$192	75%	95%	$10.34	58,583
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$192	75%	95%	$0.66	0.05
Dry Goods Retail	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	105	13	$594	75%	N/A	$0.85	16,926
Dry Goods Retail	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	15	5	$94	75%	45%	$1.80	79,428
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	46	10	$8,367	5%	95%	$2.77	0.00
Dry Goods Retail	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	46	10	$8,367	5%	95%	$32.38	1,260
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)	per installation	New	11	10	$240	5%	75%	$3.84	84
Dry Goods Retail	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.26	90%	94%	$36.15	63,072
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	24%	25%	$0.14	0.00
Dry Goods Retail	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	24%	25%	$3.58	203
Dry Goods Retail	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	506	10	$2,558	95%	80%	$0.90	52,138

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Dry Goods Retail	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	398	10	$3,650	95%	95%	$1.63	24,371
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	40	25	$644	25%	92%	$0.15	0.06
Dry Goods Retail	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	40	25	$644	25%	92%	$1.79	75,608
Dry Goods Retail	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	23	15	$2,001	50%	95%	$12.16	36,274
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	83%	$0.81	1,959
Dry Goods Retail	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	83%	$-0.10	0.00
Dry Goods Retail	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	39	14	$291	75%	N/A	$1.08	15,530
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$192	75%	95%	$0.66	0.02
Dry Goods Retail	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$192	75%	95%	$10.36	31,259
Dry Goods Retail	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	113	13	$594	75%	N/A	$0.79	23,365
Dry Goods Retail	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	15	5	$94	75%	45%	$1.80	40,708
Grocery	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	2,168	10	$186	95%	75%	$0.02	33,772
Grocery	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	191	8	$1,121	45%	65%	$1.22	1,223
Grocery	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	17	12	$1,186	45%	75%	$10.89	341
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	250	12	$418	85%	85%	$0.15	0.00
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	250	12	$418	85%	85%	$0.27	12,728
Grocery	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	12,187	10	$2,741	5%	85%	$0.04	1,132
Grocery	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	4,379	12	$5,234	25%	90%	$0.19	6,462
Grocery	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	1,442	12	$2,142	25%	75%	$0.24	33,177
Grocery	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	2,168	10	$186	95%	75%	$0.02	17,140
Grocery	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	191	8	$1,121	45%	65%	$1.22	620
Grocery	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	17	12	$1,186	45%	75%	$10.89	173
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	250	12	$418	85%	85%	$0.15	0.00
Grocery	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	250	12	$418	85%	85%	$0.27	6,460
Grocery	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	12,187	10	$2,741	5%	85%	$0.04	574
Grocery	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	4,379	12	$5,234	25%	90%	$0.19	3,280
Grocery	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	1,442	12	$2,142	25%	75%	$0.24	16,838

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Grocery	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	21	20	$94	10%	90%	$0.54	195
Grocery	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.01	15	$0.27	75%	61%	$3.23	334
Grocery	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	7	5	$171	75%	80%	$6.69	1,800
Grocery	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	11	5	$123	50%	80%	$3.22	902
Grocery	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.37	45%	45%	$8.07	142
Grocery	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.03	10	$0.93	5%	94%	$4.70	227
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)	Per Kitchen Exhaust	Existing	339	10	$5,374	64%	85%	$2.82	853
Grocery	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	1,481	20	$4,853	100%	N/A	$0.40	3,399
Grocery	Space Heat Boiler	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.30	10	$0.22	10%	39%	$0.13	124
Grocery	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.49	75%	85%	$9.69	367
Grocery	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.06	25	$1	75%	10%	$3.09	586
Grocery	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.06	25	$0.93	35%	45%	$1.64	1,313
Grocery	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.16	25	$2	10%	35%	$1.46	473
Grocery	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	192	15	$136	95%	31%	$0.10	36
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	Building SQ.FT.	Existing	0.05	10	$2	25%	98%	$6.44	1,958
Grocery	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	5	20	$13	75%	65%	$0.33	2,467
Grocery	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	40	3	$131	90%	45%	$1.52	2,676
Grocery	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.03	25	$64	10%	85%	$240.58	17
Grocery	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	20	20	$94	10%	90%	$0.56	22
Grocery	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	1	5	$171	75%	80%	$31.92	224
Grocery	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.37	45%	45%	$38.54	17
Grocery	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.00	10	$0.93	5%	94%	$22.43	30
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)	Per Kitchen Exhaust	New	71	10	$5,374	64%	85%	$13.45	107
Grocery	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	322	20	$1,055	100%	N/A	$0.40	556

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Grocery	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.49	75%	85%	$46.24	45
Grocery	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	45%	$13.42	29
Grocery	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	112	15	$2,033	50%	95%	$2.53	107
Grocery	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	40	15	$136	95%	15%	$0.48	19
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	Building SQ.FT.	New	0.01	10	$2	50%	98%	$30.74	523
Grocery	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.37	45%	45%	$5.59	29,244
Grocery	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.05	10	$0.93	5%	94%	$3.25	41,014
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)	Per Kitchen Exhaust	Existing	491	10	$5,374	64%	85%	$1.95	48,553
Grocery	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,506	18	$3,666	28%	N/A	$0.31	21,963
Grocery	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	2,116	18	$3,666	28%	N/A	$0.22	82,570
Grocery	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.49	75%	85%	$6.70	75,167
Grocery	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.09	25	$1	75%	10%	$2.14	2,102
Grocery	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.18	25	$2	10%	15%	$1.40	3,825
Grocery	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.09	25	$0.93	35%	45%	$1.13	28,672
Grocery	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.25	25	$2	10%	35%	$0.99	78,642
Grocery	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	277	15	$136	95%	31%	$0.07	61,519
Grocery	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.04	7	$0.18	90%	80%	$0.99	30,941
Grocery	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.04	25	$64	10%	85%	$166.46	3,613
Grocery	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.37	45%	45%	$25.96	3,591
Grocery	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.93	5%	94%	$15.11	5,036
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)	Per Kitchen Exhaust	New	105	10	$5,374	64%	85%	$9.06	17,927
Grocery	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	325	18	$2,393	28%	N/A	$0.94	19,322
Grocery	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	459	18	$2,393	28%	N/A	$0.67	29,119
Grocery	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.49	75%	85%	$31.15	9,230
Grocery	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	45%	$9.04	4,980

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Grocery	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.29	30	$5	50%	95%	$2.13	36,768
Grocery	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	59	15	$136	95%	15%	$0.32	3,381
Grocery	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.27	75%	94%	$8.05	73,208
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$44	24%	25%	$3.62	20
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$44	24%	25%	$0.15	0.00
Grocery	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	520	10	$2,608	95%	80%	$0.89	24,024
Grocery	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	409	10	$3,715	95%	95%	$1.62	11,229
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	77	25	$817	5%	92%	$0.44	0.00
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	77	25	$817	5%	92%	$1.19	19,284
Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.39	14,668
Grocery	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.14	0.00
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	74%	$-0.08	0.00
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	74%	$0.70	1,718
Grocery	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	468	14	$1,381	75%	N/A	$0.43	24,537
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	15	10	$195	75%	95%	$2.31	40,080
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	15	10	$195	75%	95%	$0.62	0.00
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.01	10	$0.88	75%	55%	$11.49	93,826
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.01	10	$0.88	75%	55%	$4.34	0.00
Grocery	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	1,350	13	$4,018	75%	N/A	$0.45	50,002
Grocery	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	29	5	$95	75%	50%	$0.96	62,260
Grocery	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.27	90%	94%	$8.07	44,364
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$44	24%	25%	$0.14	0.00
Grocery	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$44	24%	25%	$3.70	10
Grocery	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	508	10	$2,604	95%	80%	$0.91	12,819

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Grocery	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	400	10	$3,720	95%	95%	$1.66	5,992
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	77	25	$653	25%	92%	$0.95	53,340
Grocery	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	77	25	$653	25%	92%	$0.35	0.00
Grocery	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	273	15	$2,033	50%	95%	$1.04	25,515
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	74%	$-0.08	0.00
Grocery	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	74%	$0.72	899
Grocery	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	502	14	$1,971	75%	N/A	$0.57	10,509
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	15	10	$195	75%	95%	$2.31	21,387
Grocery	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	15	10	$195	75%	95%	$0.62	0.00
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.01	10	$0.88	75%	55%	$4.30	0.00
Grocery	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.01	10	$0.88	75%	55%	$11.52	47,036
Grocery	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	1,449	13	$4,018	75%	N/A	$0.42	51,288
Grocery	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	29	5	$95	75%	50%	$0.96	31,910
Hospital	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	2,870	10	$423	95%	75%	$0.03	20,161
Hospital	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	19	8	$847	45%	65%	$9.17	55
Hospital	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	3	12	$1,126	45%	75%	$52.17	81
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	124	12	$415	85%	55%	$0.53	4,916
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	124	12	$415	85%	55%	$0.14	0.00
Hospital	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	16,137	10	$2,965	5%	85%	$0.03	675
Hospital	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	5,799	12	$5,083	25%	90%	$0.14	3,858
Hospital	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	716	12	$2,066	25%	75%	$0.46	19,806
Hospital	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	2,870	10	$423	95%	75%	$0.03	10,232
Hospital	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	19	8	$847	45%	65%	$9.17	28
Hospital	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	3	12	$1,126	45%	75%	$52.17	41
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	124	12	$415	85%	55%	$0.53	2,495
Hospital	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	124	12	$415	85%	55%	$0.14	0.00

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hospital	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	16,137	10	$2,965	5%	85%	$0.03	343
Hospital	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	5,799	12	$5,083	25%	90%	$0.14	1,958
Hospital	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	716	12	$2,066	25%	75%	$0.46	10,052
Hospital	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	96	15	$726	5%	94%	$1.05	25,388
Hospital	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	29	20	$92	10%	90%	$0.38	27,390
Hospital	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.04	15	$2	15%	67%	$9.68	51,322
Hospital	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.01	15	$0.26	35%	26%	$2.30	9,490
Hospital	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	10	5	$166	75%	80%	$4.76	54,567
Hospital	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	15	5	$120	75%	80%	$2.29	97,156
Hospital	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$5.75	19,922
Hospital	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.04	10	$0.90	5%	94%	$3.35	32,863
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)	Per Kitchen Exhaust	Existing	246	10	$5,215	62%	85%	$3.78	8,951
Hospital	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	1,059	20	$2,502	100%	N/A	$0.29	3,389
Hospital	Space Heat Boiler	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.42	10	$0.21	10%	39%	$0.09	22,884
Hospital	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.01	25	$0.47	75%	85%	$4.85	52,917
Hospital	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.09	25	$1	75%	13%	$2.11	83,479
Hospital	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-19 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.04	25	$0.90	35%	35%	$2.11	54,675
Hospital	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.47	25	$2	10%	35%	$0.51	4,359
Hospital	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	99	15	$132	95%	24%	$0.19	3,973
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	Building SQ.FT.	Existing	0.08	10	$2	25%	98%	$4.59	76,826
Hospital	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	5	20	$13	75%	65%	$0.33	45,376
Hospital	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	54	3	$127	90%	45%	$1.08	70,164
Hospital	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.05	25	$62	10%	60%	$129.32	3,001
Hospital	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	91	15	$387	5%	94%	$0.59	13,551

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hospital	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	28	20	$91	10%	90%	$0.40	14,343
Hospital	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	9	5	$166	75%	80%	$5.03	42,354
Hospital	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$6.07	11,140
Hospital	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.04	10	$0.90	5%	94%	$3.53	19,659
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)	Per Kitchen Exhaust	New	233	10	$5,215	62%	85%	$3.98	65,178
Hospital	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	748	20	$2,459	100%	N/A	$0.40	61,632
Hospital	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.01	25	$0.47	75%	85%	$5.12	29,591
Hospital	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.01	25	$0.29	35%	35%	$1.71	13,306
Hospital	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	153	15	$1,972	50%	95%	$1.80	67,841
Hospital	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	93	15	$132	95%	12%	$0.20	9,819
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	Building SQ.FT.	New	0.07	10	$2	50%	98%	$4.84	31,213
Hospital	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	139	15	$726	5%	94%	$0.73	53,202
Hospital	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.01	18	$0.36	45%	45%	$3.98	53,028
Hospital	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.06	10	$0.90	5%	94%	$2.32	77,188
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)	Per Kitchen Exhaust	Existing	355	10	$5,215	62%	85%	$2.61	55,905
Hospital	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,076	18	$1,890	22%	N/A	$0.22	87,089
Hospital	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,513	18	$1,890	22%	N/A	$0.16	76,456
Hospital	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.01	25	$0.47	75%	85%	$3.36	40,852
Hospital	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.13	25	$1	75%	13%	$1.46	87,752
Hospital	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.24	25	$2	10%	15%	$1.00	7,097
Hospital	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-19 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.06	25	$0.90	35%	35%	$1.46	22,969
Hospital	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.43	25	$2	10%	35%	$0.56	51,630
Hospital	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	143	15	$132	95%	24%	$0.13	85,623
Hospital	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.05	7	$0.17	90%	80%	$0.70	19,533

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hospital	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.07	25	$62	10%	60%	$89.47	8,095
Hospital	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	135	15	$387	5%	94%	$0.40	28,130
Hospital	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.01	18	$0.36	45%	45%	$4.09	28,718
Hospital	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.06	10	$0.90	5%	94%	$2.38	41,803
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)	Per Kitchen Exhaust	New	346	10	$5,215	62%	85%	$2.68	38,591
Hospital	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	1,057	18	$1,858	22%	N/A	$0.22	26,248
Hospital	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	1,049	18	$1,858	22%	N/A	$0.23	35,904
Hospital	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.01	25	$0.47	75%	85%	$3.45	76,282
Hospital	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.02	25	$0.29	35%	35%	$1.15	27,622
Hospital	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.34	98,479
Hospital	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	139	15	$132	95%	12%	$0.13	21,293
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	1,008	10	$8,243	15%	95%	$0.37	0.00
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	1,008	10	$8,243	15%	95%	$1.46	32,245
Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	Existing	27	10	$247	15%	75%	$1.62	720
Hospital	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.01	10	$0.26	55%	94%	$2.40	52,616
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	11%	25%	$0.14	0.00
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	11%	25%	$3.48	48
Hospital	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	510	10	$2,522	95%	80%	$0.88	228
Hospital	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	401	10	$3,599	95%	95%	$1.60	46,849
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	91	25	$793	5%	92%	$0.25	0.02
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	91	25	$793	5%	92%	$0.97	26,661
Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	70%	$0.07	0.01
Hospital	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	70%	$0.31	76,176

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	83%	$-0.08	0.00
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	83%	$0.70	3,841
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	4	10	$7	95%	73%	$0.28	5,082
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	4	10	$7	95%	73%	$-0.05	0.00
Hospital	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	19	10	$10	95%	35%	$-0.08	0.01
Hospital	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	19	10	$10	95%	35%	$0.09	9,746
Hospital	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	800	14	$1,943	75%	N/A	$0.35	70,309
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	19	10	$189	75%	90%	$0.33	0.05
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	19	10	$189	75%	90%	$1.72	52,468
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.86	75%	50%	$0.93	0.00
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.86	75%	50%	$139.93	13,927
Hospital	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	2,309	13	$5,655	75%	N/A	$0.37	30,990
Hospital	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	35	5	$92	75%	80%	$0.78	66,170
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	1,006	10	$8,243	15%	95%	$0.37	0.00
Hospital	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	1,006	10	$8,243	15%	95%	$1.46	17,206
Hospital	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	New	26	10	$247	15%	75%	$1.66	376
Hospital	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.01	10	$0.26	55%	94%	$2.41	77,925
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	11%	25%	$0.14	0.00
Hospital	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	11%	25%	$3.56	25
Hospital	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	498	10	$2,523	95%	80%	$0.90	53,483
Hospital	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	392	10	$3,594	95%	95%	$1.63	24,999
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	91	25	$634	25%	92%	$0.20	0.07
Hospital	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	91	25	$634	25%	92%	$0.78	56,408
Hospital	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	196	15	$1,972	50%	95%	$1.40	67,448
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	83%	$-0.08	0.00
Hospital	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	83%	$0.72	2,009
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	4	10	$7	95%	73%	$-0.05	0.00

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hospital	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	4	10	$7	95%	73%	$0.28	2,658
Hospital	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	858	14	$2,772	75%	N/A	$0.47	73,754
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	19	10	$189	75%	90%	$0.33	0.03
Hospital	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	19	10	$189	75%	90%	$1.72	34,721
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.86	75%	50%	$0.92	0.00
Hospital	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.86	75%	50%	$140.25	7,027
Hospital	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	2,477	13	$5,655	75%	N/A	$0.35	58,400
Hospital	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	35	5	$92	75%	80%	$0.79	41,151
Hotel Motel	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	1,994	10	$135	95%	75%	$0.01	20,417
Hotel Motel	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	42	8	$951	35%	65%	$4.61	140
Hotel Motel	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	4	12	$1,166	45%	75%	$44.63	53
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	230	12	$405	85%	55%	$0.14	0.00
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	230	12	$405	85%	55%	$0.28	4,979
Hotel Motel	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	11,213	10	$2,717	5%	85%	$0.04	684
Hotel Motel	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	4,029	12	$5,027	15%	90%	$0.20	2,344
Hotel Motel	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	1,326	12	$2,081	25%	75%	$0.25	20,058
Hotel Motel	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	1,994	10	$135	95%	75%	$0.01	10,362
Hotel Motel	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	42	8	$951	35%	65%	$4.61	71
Hotel Motel	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	4	12	$1,166	45%	75%	$44.63	27
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	230	12	$405	85%	55%	$0.14	0.00
Hotel Motel	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	230	12	$405	85%	55%	$0.28	2,527
Hotel Motel	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	11,213	10	$2,717	5%	85%	$0.04	347
Hotel Motel	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	4,029	12	$5,027	15%	90%	$0.20	1,189
Hotel Motel	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	1,326	12	$2,081	25%	75%	$0.25	10,179
Hotel Motel	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	Existing	0.99	10	$2	95%	35%	$0.38	59,755
Hotel Motel	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	New	0.54	10	$2	95%	35%	$0.68	44,421

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hotel Motel	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	10	15	$726	50%	94%	$10.09	7,930
Hotel Motel	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	15	20	$92	10%	30%	$0.74	1,966
Hotel Motel	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.00	15	$0.26	5%	52%	$4.41	588
Hotel Motel	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	5	5	$166	75%	80%	$9.14	53,851
Hotel Motel	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	8	5	$120	50%	80%	$4.40	27,653
Hotel Motel	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$11.03	4,230
Hotel Motel	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.02	10	$0.90	5%	94%	$6.42	7,021
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)	Per Kitchen Exhaust	Existing	132	10	$5,216	58%	85%	$7.04	21,573
Hotel Motel	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	565	20	$2,576	100%	N/A	$0.56	8,857
Hotel Motel	Space Heat Boiler	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.10	10	$0.21	10%	39%	$0.36	4,929
Hotel Motel	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.47	75%	85%	$6.52	11,293
Hotel Motel	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.06	25	$1	75%	25%	$2.84	29,069
Hotel Motel	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.10	25	$0.90	35%	45%	$0.94	44,343
Hotel Motel	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.10	25	$2	10%	35%	$2.31	13,140
Hotel Motel	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	32	15	$133	95%	31%	$0.58	1,119
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	Building SQ.FT.	Existing	0.04	10	$2	25%	98%	$8.80	58,560
Hotel Motel	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	2	20	$13	75%	65%	$0.62	74,373
Hotel Motel	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	28	3	$127	90%	45%	$2.07	78,852
Hotel Motel	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.00	25	$62	10%	50%	$881.86	311
Hotel Motel	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	7	15	$387	50%	94%	$7.61	4,247
Hotel Motel	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	14	20	$92	10%	30%	$0.76	772
Hotel Motel	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	3	5	$166	75%	80%	$12.90	22,623
Hotel Motel	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$15.57	1,794
Hotel Motel	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.90	5%	94%	$9.06	3,155

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
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)	Per Kitchen Exhaust	New	93	10	$5,216	58%	85%	$9.94	9,695
Hotel Motel	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	415	20	$1,895	100%	N/A	$0.56	59,161
Hotel Motel	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.47	75%	85%	$9.21	5,075
Hotel Motel	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	45%	$3.30	2,220
Hotel Motel	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	79	15	$1,972	50%	95%	$3.45	10,992
Hotel Motel	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	22	15	$133	95%	15%	$0.82	2,063
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	Building SQ.FT.	New	0.02	10	$2	50%	98%	$12.42	52,637
Hotel Motel	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	14	15	$726	50%	94%	$6.98	4,933
Hotel Motel	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$7.63	2,631
Hotel Motel	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.03	10	$0.90	5%	94%	$4.44	3,854
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)	Per Kitchen Exhaust	Existing	190	10	$5,216	58%	85%	$4.87	11,842
Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	573	18	$1,946	12%	N/A	$0.43	4,370
Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	808	18	$1,946	12%	N/A	$0.31	7,238
Hotel Motel	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.01	25	$0.47	75%	85%	$4.51	6,199
Hotel Motel	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.09	25	$1	75%	25%	$1.96	15,517
Hotel Motel	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.12	25	$2	10%	15%	$1.91	354
Hotel Motel	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.15	25	$0.90	35%	45%	$0.65	24,296
Hotel Motel	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.18	25	$2	10%	35%	$1.33	9,294
Hotel Motel	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	46	15	$133	95%	31%	$0.40	5,808
Hotel Motel	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.03	7	$0.17	90%	80%	$1.35	55,640
Hotel Motel	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.01	25	$62	10%	50%	$610.17	193
Hotel Motel	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	10	15	$387	50%	94%	$5.13	2,168
Hotel Motel	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$10.49	1,110
Hotel Motel	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.02	10	$0.90	5%	94%	$6.10	1,610

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
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)	Per Kitchen Exhaust	New	138	10	$5,216	58%	85%	$6.69	4,949
Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	422	18	$1,431	12%	N/A	$0.43	2,356
Hotel Motel	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	594	18	$1,431	12%	N/A	$0.31	3,894
Hotel Motel	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.47	75%	85%	$6.20	2,590
Hotel Motel	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.01	25	$0.29	35%	45%	$2.22	1,106
Hotel Motel	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.70	30	$5	50%	95%	$0.86	11,558
Hotel Motel	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	33	15	$133	95%	15%	$0.55	1,079
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	788	10	$8,244	35%	95%	$1.86	21,859
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	788	10	$8,244	35%	95%	$0.29	0.01
Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	Existing	27	10	$258	35%	75%	$1.69	5,855
Hotel Motel	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.01	10	$0.26	55%	80%	$3.16	85,762
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	24%	25%	$3.46	66
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	24%	25%	$0.14	0.00
Hotel Motel	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	512	10	$2,528	95%	80%	$0.88	50,917
Hotel Motel	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	403	10	$3,605	95%	95%	$1.59	23,800
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	75	25	$793	5%	92%	$0.18	0.01
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	75	25	$793	5%	92%	$1.18	36,197
Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.05	0.01
Hotel Motel	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.38	26,815
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	93%	$0.71	2,709
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	93%	$-0.07	0.00
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	6	10	$6	95%	73%	$0.16	68,373
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	6	10	$6	95%	73%	$-0.06	0.13
Hotel Motel	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	27	10	$10	95%	35%	$-0.08	0.25
Hotel Motel	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	27	10	$10	95%	35%	$0.07	31,126
Hotel Motel	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	623	14	$1,841	75%	N/A	$0.43	49,092

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$189	75%	85%	$1.09	0.03
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$189	75%	85%	$9.06	69,274
Hotel Motel	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	1,797	13	$5,362	75%	N/A	$0.45	94,956
Hotel Motel	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	29	5	$92	75%	5%	$0.95	11,382
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	787	10	$8,244	35%	95%	$1.87	11,664
Hotel Motel	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	787	10	$8,244	35%	95%	$0.28	0.00
Hotel Motel	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	New	26	10	$258	35%	75%	$1.73	3,063
Hotel Motel	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.01	10	$0.26	55%	80%	$3.17	44,756
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	24%	25%	$3.54	34
Hotel Motel	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	24%	25%	$0.14	0.00
Hotel Motel	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	501	10	$2,522	95%	80%	$0.90	27,170
Hotel Motel	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	394	10	$3,600	95%	95%	$1.62	12,700
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	75	25	$634	25%	92%	$0.14	0.04
Hotel Motel	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	75	25	$634	25%	92%	$0.94	770
Hotel Motel	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	200	15	$1,972	50%	95%	$1.38	49,491
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	93%	$0.72	1,417
Hotel Motel	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	93%	$-0.07	0.00
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	6	10	$6	95%	73%	$0.16	35,770
Hotel Motel	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	6	10	$6	95%	73%	$-0.06	0.07
Hotel Motel	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	668	14	$2,626	75%	N/A	$0.57	21,653
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$189	75%	85%	$1.07	0.01
Hotel Motel	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$189	75%	85%	$9.08	36,966
Hotel Motel	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	1,927	13	$5,362	75%	N/A	$0.42	11,218
Hotel Motel	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	29	5	$92	75%	5%	$0.95	6,028
Office	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	66	15	$747	75%	94%	$1.58	1,776
Office	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	20	20	$94	10%	45%	$0.58	56,957

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Office	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.02	15	$2	15%	67%	$14.56	11,680
Office	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.01	15	$0.27	5%	28%	$3.46	5,833
Office	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	7	5	$171	75%	80%	$7.16	38,974
Office	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	10	5	$123	75%	80%	$3.45	87,005
Office	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.37	45%	45%	$8.65	82,403
Office	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.03	10	$0.93	5%	94%	$5.03	30,968
Office	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	668	20	$2,350	100%	N/A	$0.43	15,630
Office	Space Heat Boiler	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.23	10	$0.22	10%	39%	$0.17	95,180
Office	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.49	75%	65%	$10.18	7,180
Office	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.04	25	$1	75%	4%	$4.43	62,379
Office	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.07	25	$0.93	35%	15%	$1.34	35,983
Office	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.12	25	$2	10%	35%	$1.99	32,207
Office	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	56	15	$137	95%	26%	$0.34	17,970
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	Building SQ.FT.	Existing	0.05	10	$2	25%	98%	$6.90	29,821
Office	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	3	20	$13	75%	65%	$0.51	36,372
Office	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	37	3	$131	90%	45%	$1.63	54,005
Office	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	32	15	$399	75%	94%	$1.75	32,776
Office	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	19	20	$94	10%	45%	$0.60	15,287
Office	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	3	5	$171	75%	80%	$14.80	90,655
Office	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.37	45%	45%	$17.86	23,052
Office	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.93	5%	94%	$10.40	39,196
Office	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	338	20	$1,181	100%	N/A	$0.43	28,365
Office	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.49	75%	65%	$21.02	29,983
Office	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	15%	$4.75	10,658
Office	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	104	15	$2,031	50%	95%	$2.71	35,514

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Office	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	27	15	$137	95%	13%	$0.70	22,626
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	Building SQ.FT.	New	0.02	10	$2	50%	98%	$14.25	76,264
Office	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	95	15	$747	75%	94%	$1.10	63,326
Office	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.37	45%	45%	$5.99	89,014
Office	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.04	10	$0.93	5%	94%	$3.48	65,088
Office	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	676	18	$1,775	26%	N/A	$0.34	68,237
Office	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	954	18	$1,775	26%	N/A	$0.24	59,083
Office	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.49	75%	65%	$7.04	45,845
Office	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.06	25	$1	75%	4%	$3.06	26,260
Office	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.17	25	$2	10%	15%	$1.50	23,783
Office	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.11	25	$0.93	35%	15%	$0.93	63,563
Office	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.28	25	$2	10%	35%	$0.86	71,206
Office	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	81	15	$137	95%	26%	$0.24	40,101
Office	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.03	7	$0.18	90%	80%	$1.06	16,825
Office	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	47	15	$399	75%	94%	$1.18	87,079
Office	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.37	45%	45%	$12.03	52,064
Office	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.02	10	$0.93	5%	94%	$7.00	73,019
Office	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	344	18	$2,678	26%	N/A	$0.99	70,007
Office	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	484	18	$2,678	26%	N/A	$0.71	5,194
Office	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.49	75%	65%	$14.16	67,718
Office	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.01	25	$0.29	35%	15%	$3.20	19,856
Office	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.63	30	$5	50%	95%	$0.99	56,747
Office	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	40	15	$137	95%	13%	$0.47	43,201
Office	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.27	55%	80%	$28.46	43,110

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$43	8%	25%	$3.56	933
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$43	8%	25%	$0.14	0.00
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	42	25	$817	5%	92%	$2.17	60,401
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	42	25	$817	5%	92%	$0.13	0.14
Office	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.66	12	$2	75%	30%	$0.72	15,155
Office	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.66	12	$2	75%	30%	$0.04	0.03
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$10	95%	73%	$0.47	5,464
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$10	95%	73%	$-0.03	0.02
Office	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$10	95%	35%	$0.12	10,479
Office	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$10	95%	35%	$-0.08	0.03
Office	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	64	14	$343	75%	N/A	$0.78	80,535
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	4	10	$195	75%	85%	$8.16	9,361
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	4	10	$195	75%	85%	$0.39	0.25
Office	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	185	13	$1,004	75%	N/A	$0.82	51,436
Office	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	16	5	$95	75%	40%	$1.76	55,088
Office	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.27	55%	80%	$28.52	72,065
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$43	8%	25%	$3.64	488
Office	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$43	8%	25%	$0.14	0.00
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	42	25	$654	25%	92%	$0.10	0.39
Office	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	42	25	$654	25%	92%	$1.74	65,611
Office	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	33	15	$2,031	50%	95%	$8.48	79,690
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$10	95%	73%	$0.48	2,858
Office	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$10	95%	73%	$-0.03	0.01
Office	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	68	14	$491	75%	N/A	$1.04	34,796
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	4	10	$195	75%	85%	$0.39	0.13
Office	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	4	10	$195	75%	85%	$8.17	58,362
Office	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	198	13	$1,004	75%	N/A	$0.77	942
Office	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	16	5	$95	75%	40%	$1.76	79,261

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Other	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	43	15	$736	50%	94%	$2.37	1,225
Other	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	13	20	$93	10%	90%	$0.86	60,536
Other	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.01	15	$2	15%	67%	$21.80	99,921
Other	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.00	15	$0.26	45%	66%	$5.18	61,084
Other	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	4	5	$169	75%	80%	$10.72	95,384
Other	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	7	5	$122	50%	80%	$5.16	55,512
Other	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$12.95	39,215
Other	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.02	10	$0.91	5%	94%	$7.54	64,485
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)	Per Kitchen Exhaust	Existing	78	10	$5,295	5%	85%	$12.05	14,842
Other	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	337	20	$1,793	100%	N/A	$0.65	61,768
Other	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$18.02	84,036
Other	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.02	25	$1	75%	30%	$7.84	87,216
Other	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.05	25	$0.92	35%	50%	$1.77	63,254
Other	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.12	25	$2	10%	35%	$2.02	26,596
Other	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	42	15	$135	95%	28%	$0.44	9,918
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	Building SQ.FT.	Existing	0.03	10	$2	25%	98%	$10.33	38,700
Other	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	1	20	$13	75%	65%	$0.87	14,917
Other	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	24	3	$129	90%	45%	$2.43	99,732
Other	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.02	25	$63	10%	70%	$277.93	3,946
Other	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	21	15	$393	50%	94%	$2.53	47,937
Other	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	12	20	$93	10%	90%	$0.90	15,658
Other	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	2	5	$169	75%	80%	$21.46	51,958
Other	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$25.92	12,029
Other	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.91	5%	94%	$15.08	20,492

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
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)	Per Kitchen Exhaust	New	39	10	$5,295	5%	85%	$24.11	4,553
Other	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	175	20	$930	100%	N/A	$0.65	95,340
Other	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$36.06	25,778
Other	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	50%	$8.83	21,720
Other	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	69	15	$2,001	50%	95%	$4.05	71,242
Other	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	21	15	$135	95%	14%	$0.89	12,868
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	Building SQ.FT.	New	0.01	10	$2	50%	98%	$20.67	53,560
Other	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	62	15	$736	50%	94%	$1.64	95,278
Other	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$8.96	37,368
Other	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.03	10	$0.91	5%	94%	$5.21	99,329
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)	Per Kitchen Exhaust	Existing	113	10	$5,295	5%	85%	$8.34	51,994
Other	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	341	18	$1,354	31%	N/A	$0.51	90,103
Other	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	481	18	$1,354	31%	N/A	$0.36	26,444
Other	Space Heat Furnace	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.32	10	$0.21	10%	39%	$0.12	90,099
Other	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$12.47	94,376
Other	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.03	25	$1	75%	30%	$5.42	87,813
Other	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.11	25	$2	10%	15%	$2.24	17,823
Other	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-7 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.08	25	$0.92	35%	50%	$1.22	5,124
Other	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.23	25	$2	10%	35%	$1.05	48,189
Other	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	61	15	$135	95%	28%	$0.31	87,374
Other	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.02	7	$0.18	90%	80%	$1.58	36,054
Other	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.03	25	$63	10%	70%	$192.31	14,009
Other	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	32	15	$393	50%	94%	$1.71	15,622
Other	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$17.46	41,968

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Other	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.91	5%	94%	$10.16	58,972
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)	Per Kitchen Exhaust	New	58	10	$5,295	5%	85%	$16.24	15,885
Other	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	178	18	$2,108	31%	N/A	$1.51	78,896
Other	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	250	18	$2,108	31%	N/A	$1.08	12,670
Other	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$24.29	89,936
Other	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	50%	$5.95	62,507
Other	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.43	30	$5	50%	95%	$1.44	40,990
Other	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	31	15	$135	95%	14%	$0.60	37,768
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	54	10	$8,365	5%	95%	$2.00	0.00
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	54	10	$8,365	5%	95%	$27.15	4,068
Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	Existing	11	10	$250	5%	75%	$3.92	232
Other	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.26	75%	94%	$31.63	84,103
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	5%	25%	$0.14	0.00
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	5%	25%	$3.49	124
Other	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	517	10	$2,608	95%	80%	$0.90	21,497
Other	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	407	10	$3,651	95%	95%	$1.60	10,048
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	26	25	$805	5%	92%	$0.25	0.04
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	26	25	$805	5%	92%	$3.43	48,495
Other	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.41	12	$2	75%	90%	$0.07	0.03
Other	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.41	12	$2	75%	90%	$1.12	36,997
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$4	95%	93%	$-0.08	0.06
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$4	95%	93%	$0.66	30,117
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$10	95%	73%	$-0.03	0.00
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$10	95%	73%	$0.46	5,063
Other	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$10	95%	35%	$-0.08	0.01

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Other	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$10	95%	35%	$0.12	9,710
Other	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	43	14	$373	75%	N/A	$1.25	64,496
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$192	75%	95%	$0.50	0.09
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	3	10	$192	75%	95%	$9.06	868
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	**%	$3.45	0.00
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	**%	$4,603.40	4,224
Other	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	125	13	$1,088	75%	N/A	$1.31	21,038
Other	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	10	5	$93	75%	55%	$2.76	72,743
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	54	10	$8,365	5%	95%	$1.99	0.00
Other	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	54	10	$8,365	5%	95%	$27.21	2,170
Other	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	New	11	10	$250	5%	75%	$4.01	121
Other	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.26	90%	94%	$31.70	11,782
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	5%	25%	$0.14	0.00
Other	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	5%	25%	$3.57	65
Other	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	506	10	$2,557	95%	80%	$0.90	11,471
Other	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	398	10	$3,750	95%	95%	$1.68	5,362
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	26	25	$644	25%	92%	$0.20	0.12
Other	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	26	25	$644	25%	92%	$2.75	34,798
Other	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	28	15	$2,001	50%	95%	$9.73	64,288
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$4	95%	93%	$-0.08	0.03
Other	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$4	95%	93%	$0.68	15,756
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$10	95%	73%	$0.47	2,648
Other	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$10	95%	73%	$-0.03	0.00
Other	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	46	14	$533	75%	N/A	$1.66	27,757
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$192	75%	95%	$9.08	53,826
Other	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	3	10	$192	75%	95%	$0.49	0.05

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	**%	$3.42	0.00
Other	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	**%	$4,613.63	2,122
Other	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	134	13	$1,088	75%	N/A	$1.22	99,444
Other	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	10	5	$93	75%	55%	$2.77	88,706
Restaurant	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	256	10	$199	95%	75%	$0.14	34,697
Restaurant	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	169	8	$1,057	65%	65%	$1.30	31,297
Restaurant	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	59	12	$1,164	75%	75%	$3.11	77,226
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	63	12	$400	85%	85%	$1.01	26,145
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	63	12	$400	85%	85%	$0.14	0.03
Restaurant	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	1,441	10	$2,696	35%	85%	$0.33	78,551
Restaurant	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	517	12	$5,100	45%	80%	$1.56	2,479
Restaurant	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	362	12	$2,074	65%	75%	$0.91	54,887
Restaurant	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	256	10	$199	95%	75%	$0.14	69,864
Restaurant	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	169	8	$1,057	65%	65%	$1.30	66,635
Restaurant	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	59	12	$1,164	75%	75%	$3.11	39,193
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	63	12	$400	85%	85%	$1.01	64,020
Restaurant	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	63	12	$400	85%	85%	$0.14	0.01
Restaurant	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	1,441	10	$2,696	35%	85%	$0.33	39,866
Restaurant	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	517	12	$5,100	45%	80%	$1.56	52,010
Restaurant	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	362	12	$2,074	65%	75%	$0.91	33,870
Restaurant	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$30.30	3,879
Restaurant	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.00	10	$1	5%	94%	$33.42	5,375
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)	Per Kitchen Exhaust	Existing	9	10	$5,216	100%	85%	$96.65	28,522
Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	28	18	$1,167	86%	N/A	$5.33	7,055
Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	40	18	$1,167	86%	N/A	$3.69	79,383

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Restaurant	Space Heat Furnace	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.05	10	$0.21	10%	39%	$0.76	4,031
Restaurant	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.47	75%	98%	$33.88	11,419
Restaurant	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-11 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.01	25	$1	75%	85%	$14.74	92,307
Restaurant	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.03	25	$2	10%	15%	$7.58	548
Restaurant	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.01	25	$0.90	35%	90%	$5.87	66,300
Restaurant	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.02	25	$2	10%	35%	$8.12	10,712
Restaurant	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	5	15	$133	95%	25%	$3.68	7,523
Restaurant	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.00	7	$0.17	90%	80%	$5.36	92,594
Restaurant	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.00	25	$62	10%	80%	$1,852.47	430
Restaurant	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$40.34	1,892
Restaurant	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.00	10	$1	5%	94%	$44.50	2,621
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)	Per Kitchen Exhaust	New	7	10	$5,216	100%	85%	$128.71	13,910
Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	21	18	$886	86%	N/A	$5.20	4,249
Restaurant	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	31	18	$886	86%	N/A	$3.64	47,337
Restaurant	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.47	75%	98%	$45.12	5,569
Restaurant	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.28	35%	90%	$13.43	4,992
Restaurant	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.18	30	$5	50%	95%	$3.32	18,956
Restaurant	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	3	15	$133	95%	13%	$4.90	1,379
Restaurant	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.02	10	$0.26	75%	94%	$2.31	31,990
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	46%	25%	$0.14	0.00
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	46%	25%	$3.50	247
Restaurant	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	506	10	$2,525	95%	80%	$0.89	65,514
Restaurant	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	398	10	$3,600	95%	95%	$1.61	11,083
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	126	25	$793	5%	92%	$0.02	0.06

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	126	25	$793	5%	92%	$0.70	34,768
Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.25	26,844
Restaurant	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$-0.00	0.04
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	29	5	$4	95%	46%	$-0.10	0.21
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	29	5	$4	95%	46%	$0.05	87,476
Restaurant	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	172	14	$301	75%	N/A	$0.25	46,162
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	17	10	$189	75%	75%	$0.05	0.12
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	17	10	$189	75%	75%	$1.89	71,904
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.86	75%	**%	$0.20	0.05
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.86	75%	**%	$17.43	58,454
Restaurant	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	497	13	$877	75%	N/A	$0.27	50,500
Restaurant	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	48	5	$92	75%	75%	$0.57	70,918
Restaurant	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.02	10	$0.26	90%	94%	$2.32	80,022
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	46%	25%	$0.13	0.00
Restaurant	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	46%	25%	$3.57	129
Restaurant	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	495	10	$2,525	95%	80%	$0.91	55,135
Restaurant	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	390	10	$3,599	95%	95%	$1.64	66,002
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	126	25	$634	25%	92%	$0.01	0.16
Restaurant	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	126	25	$634	25%	92%	$0.56	97,663
Restaurant	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	178	15	$1,972	50%	95%	$1.54	46,023
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	28	5	$4	95%	46%	$-0.10	0.11
Restaurant	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	28	5	$4	95%	46%	$0.05	45,765
Restaurant	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	185	14	$429	75%	N/A	$0.34	19,443
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	17	10	$189	75%	75%	$0.05	0.06
Restaurant	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	17	10	$189	75%	75%	$1.90	38,369

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.86	75%	**%	$0.20	0.02
Restaurant	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.86	75%	**%	$17.47	29,316
Restaurant	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	533	13	$877	75%	N/A	$0.25	78,770
Restaurant	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	48	5	$92	75%	75%	$0.57	87,639
School	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	3,568	10	$0.00	95%	75%	$0.00	15,287
School	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	35	8	$905	45%	65%	$5.28	62
School	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	1	12	$1,395	65%	75%	$157.34	8
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	567	12	$232	85%	40%	$0.07	2,711
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	567	12	$232	85%	40%	$0.15	0.00
School	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	20,058	10	$2,717	5%	85%	$0.02	512
School	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	7,208	12	$5,435	25%	90%	$0.12	2,925
School	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	3,263	12	$1,997	25%	75%	$0.10	15,017
School	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	3,568	10	$0.00	95%	75%	$0.00	7,758
School	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	35	8	$905	45%	65%	$5.28	31
School	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	1	12	$1,395	65%	75%	$157.34	4
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	567	12	$232	85%	40%	$0.15	0.00
School	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	567	12	$232	85%	40%	$0.07	1,376
School	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	20,058	10	$2,717	5%	85%	$0.02	260
School	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	7,208	12	$5,435	25%	90%	$0.12	1,484
School	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	3,263	12	$1,997	25%	75%	$0.10	7,621
School	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	Existing	4	10	$2	95%	35%	$0.08	31,353
School	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	New	0.72	10	$2	95%	35%	$0.52	33,956
School	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	34	15	$736	25%	94%	$2.99	8,856
School	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	10	20	$93	10%	65%	$1.09	31,886
School	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.01	15	$2	15%	67%	$27.55	81,601

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
School	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.00	15	$0.26	5%	34%	$6.55	2,793
School	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	3	5	$169	75%	80%	$13.55	4,594
School	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	5	5	$122	50%	80%	$6.52	6,073
School	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$16.36	32,089
School	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.01	10	$0.91	5%	94%	$9.52	51,001
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)	Per Kitchen Exhaust	Existing	276	10	$5,294	73%	85%	$3.42	18,402
School	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	1,198	20	$7,999	100%	N/A	$0.82	5,379
School	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$20.51	81,259
School	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.02	25	$1	75%	15%	$6.54	89,284
School	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.03	25	$0.92	35%	35%	$3.38	30,376
School	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.29	25	$2	10%	35%	$0.84	72,317
School	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	160	15	$132	95%	21%	$0.12	5,691
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	Building SQ.FT.	Existing	0.02	10	$2	25%	98%	$13.05	39,971
School	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	3	20	$13	75%	65%	$0.52	67,462
School	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	19	3	$129	90%	45%	$3.08	97,526
School	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.01	25	$63	10%	60%	$374.21	4,772
School	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	28	15	$393	25%	94%	$1.93	97,093
School	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	10	20	$93	10%	65%	$1.13	14,823
School	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	3	5	$169	75%	80%	$16.36	99,120
School	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$19.75	15,792
School	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.91	5%	94%	$11.49	26,852
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)	Per Kitchen Exhaust	New	228	10	$5,294	73%	85%	$4.12	12,237
School	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	887	20	$6,875	100%	N/A	$0.95	42,065
School	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$24.76	39,991

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
School	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	35%	$7.01	20,319
School	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	54	15	$2,003	50%	95%	$5.12	93,154
School	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	133	15	$132	95%	10%	$0.14	12,244
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	Building SQ.FT.	New	0.02	10	$2	50%	98%	$15.75	63,290
School	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	49	15	$736	25%	94%	$2.07	76,991
School	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$11.32	14,792
School	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.02	10	$0.91	5%	94%	$6.59	20,745
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)	Per Kitchen Exhaust	Existing	399	10	$5,294	73%	85%	$2.36	86,462
School	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,217	18	$6,038	3%	N/A	$0.63	342
School	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,712	18	$6,038	3%	N/A	$0.45	6,476
School	Space Heat Furnace	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.21	10	$0.22	10%	39%	$0.18	14,184
School	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$14.19	37,458
School	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.04	25	$1	75%	15%	$4.53	76,966
School	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.08	25	$2	10%	15%	$2.83	1,903
School	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.04	25	$0.92	35%	35%	$2.34	91,203
School	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.28	25	$2	10%	35%	$0.87	46,005
School	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	232	15	$132	95%	21%	$0.08	21,682
School	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.02	7	$0.18	90%	80%	$2.00	24,021
School	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.02	25	$63	10%	60%	$258.93	2,229
School	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	42	15	$393	25%	94%	$1.30	35,727
School	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$13.30	7,216
School	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.02	10	$0.91	5%	94%	$7.74	10,121
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)	Per Kitchen Exhaust	New	339	10	$5,294	73%	85%	$2.78	41,300
School	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	1,047	18	$5,191	3%	N/A	$0.63	210

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
School	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	1,259	18	$5,191	3%	N/A	$0.53	3,455
School	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$16.68	18,274
School	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	35%	$4.72	7,658
School	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.56	30	$5	50%	95%	$1.09	75,816
School	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	197	15	$132	95%	10%	$0.09	4,713
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	448	10	$8,363	35%	95%	$0.11	0.02
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	448	10	$8,363	35%	95%	$3.33	24,543
School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	Existing	27	10	$261	35%	75%	$1.70	3,102
School	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.26	55%	94%	$17.28	18,171
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	35%	25%	$0.14	0.00
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$42	35%	25%	$3.50	79
School	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	513	10	$2,571	95%	80%	$0.89	35,323
School	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	404	10	$3,659	95%	95%	$1.61	16,511
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	62	25	$805	5%	92%	$0.05	0.04
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	62	25	$805	5%	92%	$1.45	42,447
School	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.97	12	$2	75%	70%	$0.01	0.00
School	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	0.97	12	$2	75%	70%	$0.47	24,563
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	65%	$-0.07	0.00
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	65%	$0.78	4,198
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$5	95%	73%	$0.26	16,898
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$5	95%	73%	$-0.02	0.01
School	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$11	95%	35%	$-0.07	0.02
School	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$11	95%	35%	$0.13	32,407
School	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	358	14	$1,292	75%	N/A	$0.52	56,477
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	6	10	$192	75%	75%	$0.12	0.06
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	6	10	$192	75%	75%	$4.95	68,631

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	93%	$1,005.84	8,706
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	93%	$0.89	0.00
School	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	1,033	13	$3,758	75%	N/A	$0.55	5,834
School	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	23	5	$94	75%	15%	$1.18	40,276
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	447	10	$8,363	35%	95%	$0.11	0.01
School	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	447	10	$8,363	35%	95%	$3.33	13,096
School	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	New	26	10	$261	35%	75%	$1.74	1,623
School	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.26	55%	94%	$17.32	60,005
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	35%	25%	$0.14	0.00
School	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$42	35%	25%	$3.57	41
School	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	502	10	$2,569	95%	80%	$0.91	18,848
School	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	395	10	$3,635	95%	95%	$1.64	8,810
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	62	25	$644	25%	92%	$0.04	0.11
School	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	62	25	$644	25%	92%	$1.16	15,652
School	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	31	15	$2,003	50%	95%	$8.82	56,472
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	65%	$-0.07	0.00
School	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	65%	$0.80	2,196
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$5	95%	73%	$-0.02	0.00
School	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$5	95%	73%	$0.27	8,840
School	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	384	14	$1,840	75%	N/A	$0.70	24,523
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	6	10	$192	75%	75%	$4.96	36,622
School	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	6	10	$192	75%	75%	$0.13	0.03
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	93%	$0.89	0.00
School	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	93%	$1,008.10	4,421

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
School	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	1,109	13	$3,758	75%	N/A	$0.51	53,058
School	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	23	5	$94	75%	15%	$1.18	20,756
University	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	Existing	4,374	10	$0.00	95%	75%	$0.00	21,806
University	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	Existing	83	8	$993	45%	65%	$2.47	170
University	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	Existing	2	12	$1,274	65%	75%	$75.52	17
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	695	12	$382	85%	40%	$0.14	0.00
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	Existing	695	12	$382	85%	40%	$0.09	3,867
University	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	Existing	24,590	10	$2,483	5%	85%	$0.02	731
University	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	Existing	8,837	12	$5,464	25%	90%	$0.10	4,172
University	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	Existing	4,001	12	$2,068	25%	75%	$0.08	21,422
University	Cooking	Broiler	High-Efficiency Broiler (34% Efficient)	Standard Broiler (15% Efficient)	per installation	New	4,374	10	$0.00	95%	75%	$0.00	11,066
University	Cooking	Fryers - Commercial Gas Cooking	Energy Star Commercial Fryer (50% efficient)	Non-Energy Star Fryer (35% efficient)	per installation	New	83	8	$993	45%	65%	$2.47	86
University	Cooking	Griddle	High-Efficiency Griddle (40% Efficient)	Standard Griddle (32% Efficient)	per installation	New	2	12	$1,274	65%	75%	$75.52	9
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	695	12	$382	85%	40%	$0.14	0.00
University	Cooking	High Efficiency Convection Oven	Convection Oven	Standard Oven	per installation	New	695	12	$382	85%	40%	$0.09	1,962
University	Cooking	Oven - Conveyor	High-Efficiency Model (23% Efficient)	Standard Model (15% Efficient)	per installation	New	24,590	10	$2,483	5%	85%	$0.02	371
University	Cooking	Oven - Power Burner	Power Burner Oven - Improved Atmospheric Burner (60% Efficient)	Standard (40%-50% Efficiency)	per installation	New	8,837	12	$5,464	25%	90%	$0.10	2,117
University	Cooking	Steam Cooker	Energy Star Steam Cooker (38% Efficient)	Standard Cooker (30% Efficient)	per installation	New	4,001	12	$2,068	25%	75%	$0.08	10,872
University	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	Existing	3	10	$2	95%	35%	$0.10	16,683
University	Pool Heat	Swimming Pool/Spa Covers	Plastic Or Foam Pool Covers (50-65% Energy Savings)	No Pool Covers	Per pool (22'x44')	New	1	10	$2	95%	35%	$0.30	36,305
University	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	68	15	$736	25%	94%	$1.50	55,667
University	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	20	20	$93	10%	90%	$0.55	57,266
University	Space Heat Boiler	Convert Constant Volume Air System to VAV	Variable Volume Air System	Constant Volume Air System	per building CFM	Existing	0.02	15	$2	15%	67%	$13.81	5,453
University	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.01	15	$0.26	5%	34%	$3.28	3,600
University	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	7	5	$169	75%	80%	$6.79	16,120
University	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	11	5	$122	50%	80%	$3.27	59,663

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
University	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$8.20	40,934
University	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.03	10	$0.91	5%	94%	$4.77	65,059
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)	Per Kitchen Exhaust	Existing	576	10	$5,292	73%	85%	$1.63	75,197
University	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	2,509	20	$8,367	100%	N/A	$0.41	39,299
University	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.01	25	$0.48	75%	85%	$4.40	25,575
University	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.13	25	$1	75%	13%	$1.40	56,297
University	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.09	25	$0.92	35%	35%	$1.05	34,009
University	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.37	25	$2	10%	35%	$0.65	41,842
University	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	149	15	$136	95%	21%	$0.13	7,241
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	Building SQ.FT.	Existing	0.05	10	$2	25%	98%	$6.54	61,249
University	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	6	20	$13	75%	65%	$0.26	22,074
University	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	38	3	$129	90%	45%	$1.54	31,449
University	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.03	25	$63	10%	60%	$187.61	6,167
University	Space Heat Boiler	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	56	15	$393	25%	94%	$0.97	23,383
University	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	20	20	$93	10%	90%	$0.57	26,118
University	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	6	5	$169	75%	80%	$8.20	50,009
University	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$9.90	19,828
University	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.02	10	$0.91	5%	94%	$5.76	33,714
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)	Per Kitchen Exhaust	New	477	10	$5,292	73%	85%	$1.97	42,628
University	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	1,859	20	$7,196	100%	N/A	$0.47	62,149
University	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.01	25	$0.48	75%	85%	$5.31	65,074
University	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.01	25	$0.29	35%	35%	$2.17	19,095
University	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	109	15	$2,003	50%	95%	$2.57	17,924
University	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	123	15	$136	95%	10%	$0.15	15,581

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
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	Building SQ.FT.	New	0.04	10	$2	50%	98%	$7.90	81,693
University	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	Existing	99	15	$736	25%	94%	$1.04	93,822
University	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$5.68	18,784
University	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.04	10	$0.91	5%	94%	$3.30	26,345
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)	Per Kitchen Exhaust	Existing	833	10	$5,292	73%	85%	$1.13	8,457
University	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	2,549	18	$6,321	7%	N/A	$0.32	14,848
University	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	3,584	18	$6,321	7%	N/A	$0.23	28,301
University	Space Heat Furnace	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.42	10	$0.22	10%	39%	$0.09	18,049
University	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.01	25	$0.48	75%	85%	$3.04	50,850
University	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-7 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.20	25	$1	75%	13%	$0.97	3,356
University	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.17	25	$2	10%	15%	$1.42	2,387
University	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-11 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.14	25	$0.92	35%	35%	$0.72	94,368
University	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.52	25	$2	10%	35%	$0.47	54,789
University	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	216	15	$136	95%	21%	$0.09	27,590
University	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.04	7	$0.18	90%	80%	$1.00	94,859
University	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.67 (Average Existing Conditions)	Per Window SQFT	Existing	0.05	25	$63	10%	60%	$129.81	2,867
University	Space Heat Furnace	Automated Ventilation VFD Control (Occupancy Sensors / CO2 Sensors)	Demand Controlled Ventilation (CO2 Sensors)	Constant Ventilation	1 unit per 3,000 sqft	New	84	15	$393	25%	94%	$0.65	45,460
University	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$6.67	9,072
University	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.04	10	$0.91	5%	94%	$3.88	12,724
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)	Per Kitchen Exhaust	New	709	10	$5,292	73%	85%	$1.33	52,551
University	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	2,190	18	$5,434	7%	N/A	$0.32	9,040
University	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	2,635	18	$5,434	7%	N/A	$0.26	14,953
University	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.01	25	$0.48	75%	85%	$3.58	24,560
University	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.02	25	$0.29	35%	35%	$1.46	7,035

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
University	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	1	30	$5	50%	95%	$0.55	96,470
University	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	183	15	$136	95%	10%	$0.10	5,997
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	793	10	$8,367	35%	95%	$1.88	26,491
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	Existing	793	10	$8,367	35%	95%	$0.11	0.00
University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	Existing	27	10	$261	35%	75%	$1.70	1,973
University	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.26	55%	94%	$10.21	28,245
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$41	35%	25%	$0.13	0.00
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$41	35%	25%	$3.45	109
University	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	Existing	512	10	$2,562	95%	80%	$0.89	36,423
University	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	Existing	403	10	$3,661	95%	95%	$1.62	17,025
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	104	25	$805	5%	92%	$0.05	0.01
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	104	25	$805	5%	92%	$0.86	46,066
University	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	70%	$0.01	0.00
University	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	70%	$0.28	26,657
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	65%	$-0.23	0.00
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	Existing	2	5	$5	95%	65%	$0.82	2,551
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$5	95%	73%	$-1.25	0.00
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$5	95%	73%	$0.26	10,751
University	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$11	95%	35%	$-0.72	0.00
University	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$11	95%	35%	$0.13	20,618
University	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	636	14	$1,364	75%	N/A	$0.31	61,209
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	11	10	$192	75%	75%	$0.13	0.02
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	11	10	$192	75%	75%	$2.93	74,075
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	**%	$594.52	10,130
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	**%	$0.90	0.00

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
University	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	1,836	13	$3,956	75%	N/A	$0.33	73,842
University	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	40	5	$94	75%	15%	$0.70	43,710
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	791	10	$8,367	35%	95%	$0.11	0.00
University	Water Heat	Clothes Washer - Ozonating	Ozonating Clothes Washer	Standard Commercial Clothes Washer	Per unit, (average 72.5 gallon	New	791	10	$8,367	35%	95%	$1.88	14,136
University	Water Heat	Clothes Washer Commercial	Energy Star Commercial Clothes Washer MEF=1.73	Standard Commercial Clothes Washer MEF=1.26 (Federal Code)	per installation	New	26	10	$261	35%	75%	$1.74	1,032
University	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.26	55%	94%	$10.23	64,934
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$41	35%	25%	$0.13	0.00
University	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$41	35%	25%	$3.53	57
University	Water Heat	Dishwashing - Commercial - High Temp	High Efficiency Dishwasher	Standard Dishwasher	per installation	New	501	10	$2,572	95%	80%	$0.91	19,436
University	Water Heat	Dishwashing - Commercial - Low Temp	Low-Temp Commercial Dishwasher (Includes Extra Chemmical Cost)	High Temp Commercial Dishwasher	per installation	New	394	10	$3,679	95%	95%	$1.66	9,085
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	104	25	$644	25%	92%	$0.04	0.03
University	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	104	25	$644	25%	92%	$0.69	25,151
University	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	53	15	$2,003	50%	95%	$5.21	61,110
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	65%	$-0.23	0.00
University	Water Heat	Low-Flow Pre-Rinse Spray Valves	0.6 GPM	1.6 GPM (Federal Standard)	Per unit. Ea.	New	2	5	$5	95%	65%	$0.84	1,334
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$5	95%	73%	$-1.25	0.00
University	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$5	95%	73%	$0.27	5,624
University	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	682	14	$1,944	75%	N/A	$0.41	26,551
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	11	10	$192	75%	75%	$0.13	0.01
University	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	11	10	$192	75%	75%	$2.93	39,528
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	**%	$0.90	0.00
University	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	**%	$595.84	5,129
University	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	1,969	13	$3,956	75%	N/A	$0.30	81,902
University	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	40	5	$94	75%	15%	$0.70	22,461
Warehouse	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	Existing	7	20	$93	10%	90%	$1.46	1,284

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Warehouse	Space Heat Boiler	Direct Digital Control System-Installation	DDC Retrofit (Morning Warm-Up Control Logic Included in This Measure)	Pneumatic	Per Building SQ.FT.	Existing	0.00	15	$0.26	5%	93%	$8.78	224
Warehouse	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	Existing	2	5	$169	75%	98%	$18.17	14,455
Warehouse	Space Heat Boiler	Direct Digital Control System-Wireless Performance Monitoring	DDC Retrofit - Wireless Performance Monitoring, Diagnostics And Control	Pnuematic	Number of Points	Existing	4	5	$122	75%	98%	$8.74	11,158
Warehouse	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$21.94	922
Warehouse	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.01	10	$0.91	5%	94%	$12.77	1,487
Warehouse	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	Existing	1,002	20	$9,039	100%	N/A	$1.10	23,035
Warehouse	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$39.70	1,632
Warehouse	Space Heat Boiler	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.01	25	$1	75%	10%	$12.67	2,536
Warehouse	Space Heat Boiler	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-8 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.03	25	$0.92	35%	45%	$3.14	13,798
Warehouse	Space Heat Boiler	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.06	25	$2	10%	35%	$3.51	2,886
Warehouse	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	136	15	$135	95%	24%	$0.14	186
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	Building SQ.FT.	Existing	0.02	10	$2	25%	98%	$17.50	12,832
Warehouse	Space Heat Boiler	Steam Pipe Insulation	R-4	R-0	Linear Foot	Existing	2	20	$13	75%	65%	$0.66	16,197
Warehouse	Space Heat Boiler	Steam Trap Maintenance	Actively stop steam trap leaks	No Maintanence	Per Steam Trap	Existing	14	3	$129	90%	45%	$4.13	16,630
Warehouse	Space Heat Boiler	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.03	25	$63	10%	98%	$231.69	131
Warehouse	Space Heat Boiler	Boiler Economizer	Economizer	No Economizer	Boiler HP - Horse Power	New	7	20	$93	10%	90%	$1.52	383
Warehouse	Space Heat Boiler	Direct Digital Control System-Optimization	Premium-Efficiency EMS System	High-Efficiency EMS System	Number of Points	New	1	5	$169	75%	98%	$33.50	4,785
Warehouse	Space Heat Boiler	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$40.45	305
Warehouse	Space Heat Boiler	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.00	10	$0.91	5%	94%	$23.54	526
Warehouse	Space Heat Boiler	Gas Boiler	90% Thermal Efficiency	80% Thermal Efficiency (State Code)	Per installation	New	564	20	$5,091	100%	N/A	$1.10	10,007
Warehouse	Space Heat Boiler	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$73.20	540
Warehouse	Space Heat Boiler	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	45%	$14.44	514
Warehouse	Space Heat Boiler	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	40	15	$2,002	50%	95%	$6.87	1,830
Warehouse	Space Heat Boiler	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	74	15	$135	95%	12%	$0.25	262
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	Building SQ.FT.	New	0.01	10	$2	50%	98%	$32.27	9,089

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Warehouse	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	Existing	0.00	18	$0.36	45%	45%	$15.18	82,083
Warehouse	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	Existing	0.01	10	$0.91	5%	94%	$8.83	15,120
Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,018	18	$6,829	12%	N/A	$0.86	27,036
Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	Existing	1,432	18	$6,829	12%	N/A	$0.61	11,438
Warehouse	Space Heat Furnace	Infiltration Reduction	Install Caulking And Weatherstripping (ACH 0.65)	Infiltration Conditions (ACH 1.0)	per window sqft	Existing	0.18	10	$0.22	10%	39%	$0.21	23,690
Warehouse	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	Existing	0.00	25	$0.48	75%	85%	$27.47	45,286
Warehouse	Space Heat Furnace	Insulation - Ceiling	R-30 + 8 c.i. (WA State Code)	R-8 (Average Existing Conditions)	Ceiling SQ.FT.	Existing	0.02	25	$1	75%	10%	$8.76	96,273
Warehouse	Space Heat Furnace	Insulation - Duct	R-7 (WA State Code)	No Insulation	per surface area of duct insul	Existing	0.06	25	$2	10%	15%	$3.80	10,417
Warehouse	Space Heat Furnace	Insulation - Floor (non-slab)	R-30 (WA State Code)	R-8 (Average Existing Conditions)	Floor SQ.FT.	Existing	0.04	25	$0.92	35%	45%	$2.17	25,784
Warehouse	Space Heat Furnace	Insulation - Wall	R-13 + 7.5 (WA State Code)	R-3 (Average Existing Conditions)	Wall SQ.FT.	Existing	0.15	25	$2	10%	35%	$1.56	60,376
Warehouse	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	Existing	197	15	$135	95%	24%	$0.10	33,160
Warehouse	Space Heat Furnace	Re-Commissioning	Re-Commissioning	Average Existing Conditions	Building SQFT	Existing	0.01	7	$0.18	90%	80%	$2.68	35,416
Warehouse	Space Heat Furnace	Windows-High Efficiency	U-0.40 (WA State Code)	U-0.65 (Average Existing Conditions)	Per Window SQFT	Existing	0.04	25	$63	10%	98%	$160.32	11,742
Warehouse	Space Heat Furnace	Duct Repair And Sealing	Reduction In Duct Losses to 5%	No Repair or Sealing, 15% duct losses	Building SQ.FT.	New	0.00	18	$0.36	45%	45%	$27.25	26,589
Warehouse	Space Heat Furnace	Exhaust Air to Ventilation Air Heat Recovery	Exhaust Air Heat Recovery	No Heat Recovery	Building CFM	New	0.01	10	$0.91	5%	94%	$15.86	37,291
Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 90% (Condensing Furnace)	AFUE=80%	Per installation	New	573	18	$3,844	12%	N/A	$0.86	53,768
Warehouse	Space Heat Furnace	Gas Furnace	AFUE = 94% (Condensing Furnace)	AFUE=80%	Per installation	New	806	18	$3,844	12%	N/A	$0.61	89,449
Warehouse	Space Heat Furnace	Insulation - Ceiling	R-30 + 19 c.i.	R-30 + 8 c.i. (WA State Code)	Ceiling SQ.FT.	New	0.00	25	$0.48	75%	85%	$49.31	47,063
Warehouse	Space Heat Furnace	Insulation - Floor (non-slab)	R-38	R-30 (WA State Code)	Floor SQ.FT.	New	0.00	25	$0.29	35%	45%	$9.73	36,454
Warehouse	Space Heat Furnace	Leak Proof Duct Fittings	Quick connect fittings that do not require mastic or drawbands	Std duct workmanship	per linear feet of duct insula	New	0.27	30	$5	50%	95%	$2.24	65,605
Warehouse	Space Heat Furnace	Programmable Thermostat	Energy Star Programmable Thermostat	Manual Thermostat	per installation	New	110	15	$135	95%	12%	$0.17	18,948
Warehouse	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	Existing	0.00	10	$0.26	55%	94%	$50.82	25,220
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$43	3%	25%	$0.13	0.00
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	Existing	1	12	$43	3%	25%	$3.52	13
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	130	25	$807	5%	92%	$0.04	0.02
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	Existing	130	25	$807	5%	92%	$0.70	9,059

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.00	0.01
Warehouse	Water Heat	Hot Water (SHW) Pipe Insulation	1.0" of Insulation, assuming R-4 (WA State Code)	No Insulation	per linear foot	Existing	1	12	$2	75%	90%	$0.26	6,870
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$0.00	95%	73%	$-0.06	0.00
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	Existing	3	10	$0.00	95%	73%	$0.00	746
Warehouse	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$20	95%	35%	$-0.09	0.00
Warehouse	Water Heat	Low-Flow Showerheads	2.5 GPM (Federal Code)	4.5 GPM	Per unit. Ea.	Existing	15	10	$20	95%	35%	$0.23	1,431
Warehouse	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	Existing	136	14	$239	75%	N/A	$0.26	12,144
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	11	10	$192	75%	95%	$0.17	0.04
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	Existing	11	10	$192	75%	95%	$2.92	18,498
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	49%	$6.57	0.00
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	Existing	0.00	10	$0.87	75%	49%	$27,956.67	103
Warehouse	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	Existing	394	13	$693	75%	N/A	$0.27	73,883
Warehouse	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	Existing	50	5	$91	75%	45%	$0.54	26,246
Warehouse	Water Heat	Demand controlled Circulating Systems	Demand Controlled Circulating Systems (VFD Control by Demand)	Constant Circulation	Per Building SQ.FT.	New	0.00	10	$0.26	55%	94%	$50.94	12,756
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$43	3%	25%	$0.13	0.00
Warehouse	Water Heat	Dishwasher Residential	ENERGY STAR <= 324 kWh/yr, <= 5.8 gal/cycle	Federal Standard <= 355 kWh/yr, <= 6.5 gal/cycle	per installation	New	1	12	$43	3%	25%	$3.60	7
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	129	25	$645	25%	92%	$0.56	24,373
Warehouse	Water Heat	Drainwater Heat Recovery Water Heater	Install (Power-Pipe or GFX) - Heat Recovery Water Heater	No Heat Recovery System	Per DWH. Ea. (40gallons = 1 un	New	129	25	$645	25%	92%	$0.03	0.06
Warehouse	Water Heat	Integrated Space Heating/Water Heating	Integrated System	Separate Boiler And HW Heater	Per 200 kbtu boiler unit	New	16	15	$2,002	50%	95%	$16.98	12,005
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$0.00	95%	73%	$-0.05	0.00
Warehouse	Water Heat	Low-Flow Showerheads	2.0 GPM	2.5 GPM (Federal Code)	Per unit. Ea.	New	3	10	$0.00	95%	73%	$0.00	390
Warehouse	Water Heat	Tankless Water Heater	EF = 0.82	EF = 0.67	Per installation	New	146	14	$337	75%	N/A	$0.33	5,279
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	11	10	$192	75%	95%	$0.17	0.02
Warehouse	Water Heat	Ultrasonic Faucet Control	Install Ultrasonic Motion Faucet Control	No Faucet Control	Per unit. Ea.	New	11	10	$192	75%	95%	$2.93	9,872
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	49%	$6.47	0.00
Warehouse	Water Heat	Water Cooled Refrigeration with Heat Recovery	Heat Recovery from refrigeration system. Applied to Water Heating Electric End use	No heat recovery	Building SQ.FT.	New	0.00	10	$0.87	75%	49%	$28,017.75	52
Warehouse	Water Heat	Water Heater - Condensing	EF = 0.90	EF = 0.67	Per installation	New	423	13	$693	75%	N/A	$0.25	75,969

Segment	End Use	Measure Name	Measure Description	Baseline Description	Unit Description	Construction Vintage	Savings per Unit (Therms)	Measure Life	Incremental Cost per Unit	Percent of Installations Technically Feasible	Percent of Installations Incomplete	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Warehouse	Water Heat	Water Heater Temperature Setback	Thermostat Setback and Replecement (120 Degrees)	No Thermostat Setback (130 Degrees)	Per DWH. Ea. (40gallons = 1 un	New	49	5	$91	75%	45%	$0.55	14,122

Table B.3.6. Industrial Gas Measure Details

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per Therms	Measure Applicability	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Chemical Mfg	Hvac	HVAC Improvements	21%	15	$0.94	100%	$0.13	3,530
Chemical Mfg	Hvac	HVAC O&M	14%	2	$1.11	100%	$0.74	1,869
Chemical Mfg	Indirect Boiler	Boiler Improvements	2%	15	$0.26	100%	$0.04	14,025
Chemical Mfg	Indirect Boiler	Boiler O&M	3%	2	$0.16	100%	$0.11	20,012
Chemical Mfg	Process Heat	Boiler Improvements	21%	15	$0.06	100%	$0.01	52,309
Chemical Mfg	Process Heat	Heat Improvements	10%	15	$0.36	100%	$0.05	20,955
Chemical Mfg	Process Heat	Heat O&M	1%	2	$0.53	100%	$0.36	1,028
Chemical Mfg	Process Heat	Steam Distribution	14%	15	$0.05	100%	$0.01	42,263
Chemical Mfg	Process Other	Other O&M	10%	2	$0.28	100%	$0.19	9,052
Computer Electronic Mfg	Hvac	HVAC Improvements	11%	15	$0.74	100%	$0.10	82,844
Computer Electronic Mfg	Hvac	HVAC O&M	14%	2	$0.38	100%	$0.25	91,322
Computer Electronic Mfg	Indirect Boiler	Boiler Improvements	12%	15	$1.17	100%	$0.16	94,746
Computer Electronic Mfg	Indirect Boiler	Boiler O&M	9%	2	$0.13	100%	$0.09	79,228
Computer Electronic Mfg	Process Heat	Boiler Improvements	4%	15	$1.69	100%	$0.24	4,265
Computer Electronic Mfg	Process Heat	Heat Improvements	24%	15	$0.37	100%	$0.05	33,585
Computer Electronic Mfg	Process Heat	Heat O&M	4%	2	$0.58	100%	$0.39	3,936
Computer Electronic Mfg	Process Heat	Steam Distribution	10%	15	$0.49	100%	$0.07	10,420
Electrical Equipment Mfg	Hvac	HVAC Improvements	10%	15	$0.60	100%	$0.08	16,791
Electrical Equipment Mfg	Hvac	HVAC O&M	5%	2	$0.18	100%	$0.12	6,622
Electrical Equipment Mfg	Indirect Boiler	Boiler Improvements	12%	15	$1.13	100%	$0.16	14,798
Electrical Equipment Mfg	Indirect Boiler	Boiler O&M	13%	2	$0.23	100%	$0.15	18,227
Electrical Equipment Mfg	Process Heat	Boiler Improvements	7%	15	$0.53	100%	$0.07	30,529
Electrical Equipment Mfg	Process Heat	Heat Improvements	17%	15	$0.56	100%	$0.08	66,263
Electrical Equipment Mfg	Process Heat	Heat O&M	3%	2	$0.43	100%	$0.29	8,059
Electrical Equipment Mfg	Process Heat	Steam Distribution	6%	15	$0.34	100%	$0.05	27,898
Fabricated Metal Products	Hvac	HVAC Improvements	15%	15	$1.22	100%	$0.17	75,476
Fabricated Metal Products	Hvac	HVAC O&M	13%	2	$0.69	100%	$0.46	57,765
Fabricated Metal Products	Indirect Boiler	Boiler Improvements	17%	15	$1.57	100%	$0.22	84,001
Fabricated Metal Products	Indirect Boiler	Boiler O&M	12%	2	$0.11	100%	$0.07	65,210
Fabricated Metal Products	Process Heat	Boiler Improvements	6%	15	$0.47	100%	$0.07	36,750
Fabricated Metal Products	Process Heat	Heat Improvements	7%	15	$0.91	100%	$0.13	39,670
Fabricated Metal Products	Process Heat	Heat O&M	4%	2	$0.48	100%	$0.32	67,061
Fabricated Metal Products	Process Heat	Steam Distribution	5%	15	$0.65	100%	$0.09	11,660
Fabricated Metal Products	Process Other	Other O&M	12%	2	$0.49	100%	$0.33	1,903
Food Mfg	Hvac	HVAC Improvements	20%	15	$0.58	100%	$0.08	34,841
Food Mfg	Hvac	HVAC O&M	6%	2	$0.21	100%	$0.14	7,627
Food Mfg	Indirect Boiler	Boiler Improvements	6%	15	$0.82	100%	$0.11	20,632
Food Mfg	Indirect Boiler	Boiler O&M	4%	2	$0.36	100%	$0.24	78,488
Food Mfg	Process Heat	Boiler Improvements	7%	15	$0.32	100%	$0.04	84,730
Food Mfg	Process Heat	Heat Improvements	13%	15	$0.50	100%	$0.07	35,753
Food Mfg	Process Heat	Heat O&M	4%	2	$0.35	100%	$0.23	32,362
Food Mfg	Process Heat	Steam Distribution	5%	15	$0.46	100%	$0.06	57,763
Food Mfg	Process Other	Other O&M	28%	2	$0.14	100%	$0.09	36,324
Industrial Machinery	Hvac	HVAC Improvements	14%	15	$0.82	100%	$0.11	87,685
Industrial Machinery	Hvac	HVAC O&M	15%	2	$0.34	100%	$0.23	62,993
Industrial Machinery	Indirect Boiler	Boiler Improvements	19%	15	$1.03	100%	$0.14	39,427
Industrial Machinery	Indirect Boiler	Boiler O&M	15%	2	$0.17	100%	$0.12	31,488
Industrial Machinery	Process Heat	Boiler Improvements	2%	15	$1.09	100%	$0.15	17,720
Industrial Machinery	Process Heat	Heat Improvements	13%	15	$0.51	100%	$0.07	29,834
Industrial Machinery	Process Heat	Heat O&M	10%	2	$0.57	100%	$0.38	80,887

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per Therms	Measure Applicability	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Industrial Machinery	Process Heat	Steam Distribution	6%	15	$0.36	100%	$0.05	64,966
Miscellaneous Mfg	Hvac	HVAC Improvements	17%	15	$0.70	50%	$0.10	97,136
Miscellaneous Mfg	Hvac	HVAC O&M	20%	2	$0.05	50%	$0.03	126
Miscellaneous Mfg	Indirect Boiler	Boiler Improvements	14%	15	$0.59	50%	$0.08	94,587
Miscellaneous Mfg	Indirect Boiler	Boiler O&M	5%	2	$0.21	50%	$0.14	33,533
Miscellaneous Mfg	Process Heat	Boiler Improvements	4%	15	$1.05	50%	$0.15	32,638
Miscellaneous Mfg	Process Heat	Heat Improvements	8%	15	$0.46	50%	$0.06	63,232
Miscellaneous Mfg	Process Heat	Heat O&M	4%	2	$0.33	50%	$0.22	25,924
Miscellaneous Mfg	Process Heat	Steam Distribution	12%	15	$0.21	50%	$0.03	97,135
Nonmetallic Mineral Products	Hvac	HVAC Improvements	11%	15	$1.16	100%	$0.16	6,926
Nonmetallic Mineral Products	Hvac	HVAC O&M	2%	2	$0.46	100%	$0.31	1,103
Nonmetallic Mineral Products	Indirect Boiler	Boiler O&M	5%	2	$0.07	100%	$0.04	3,598
Nonmetallic Mineral Products	Process Heat	Boiler Improvements	22%	15	$0.20	100%	$0.03	85,785
Nonmetallic Mineral Products	Process Heat	Heat Improvements	13%	15	$0.90	100%	$0.13	26,146
Nonmetallic Mineral Products	Process Heat	Heat O&M	3%	2	$0.30	100%	$0.20	25,887
Nonmetallic Mineral Products	Process Heat	Steam Distribution	5%	15	$0.41	100%	$0.06	47,569
Nonmetallic Mineral Products	Process Other	Other O&M	15%	2	$1.95	100%	$1.30	3,466
Paper Mfg	Hvac	HVAC Improvements	18%	15	$0.66	100%	$0.09	1,978
Paper Mfg	Hvac	HVAC O&M	22%	2	$0.14	100%	$0.09	3,052
Paper Mfg	Indirect Boiler	Boiler Improvements	8%	15	$0.48	100%	$0.07	22,273
Paper Mfg	Indirect Boiler	Boiler O&M	4%	2	$0.12	100%	$0.08	10,890
Paper Mfg	Process Heat	Boiler Improvements	6%	15	$0.48	100%	$0.07	7,680
Paper Mfg	Process Heat	Heat Improvements	10%	15	$0.68	100%	$0.09	11,983
Paper Mfg	Process Heat	Heat O&M	3%	2	$0.24	100%	$0.16	3,200
Paper Mfg	Process Heat	Steam Distribution	4%	15	$0.18	100%	$0.02	4,812
Paper Mfg	Process Other	Other O&M	20%	2	$0.66	100%	$0.44	3,827
Petroleum Coal Products	Indirect Boiler	Boiler Improvements	9%	15	$0.92	100%	$0.13	5,596
Petroleum Coal Products	Indirect Boiler	Boiler O&M	6%	2	$0.17	100%	$0.11	3,926
Petroleum Coal Products	Process Heat	Boiler Improvements	2%	15	$0.77	100%	$0.11	2,152
Petroleum Coal Products	Process Heat	Heat Improvements	5%	15	$0.75	100%	$0.10	5,689
Petroleum Coal Products	Process Heat	Heat O&M	2%	2	$0.19	100%	$0.13	2,521
Petroleum Coal Products	Process Heat	Steam Distribution	3%	15	$0.05	100%	$0.01	3,691
Plastics Rubber Products	Hvac	HVAC Improvements	9%	15	$0.63	100%	$0.09	22,148
Plastics Rubber Products	Hvac	HVAC O&M	12%	2	$31.16	100%	$20.83	27,022
Plastics Rubber Products	Indirect Boiler	Boiler Improvements	12%	15	$0.31	100%	$0.04	69,425
Plastics Rubber Products	Indirect Boiler	Boiler O&M	6%	2	$0.22	100%	$0.15	31,244
Plastics Rubber Products	Process Heat	Boiler Improvements	10%	15	$0.63	100%	$0.09	25,694
Plastics Rubber Products	Process Heat	Heat Improvements	13%	15	$0.63	100%	$0.09	37,851
Plastics Rubber Products	Process Heat	Heat O&M	8%	2	$0.62	100%	$0.42	18,961
Plastics Rubber Products	Process Heat	Steam Distribution	7%	15	$0.16	100%	$0.02	20,901
Plastics Rubber Products	Process Other	Other O&M	17%	2	$0.19	100%	$0.13	9,909
Primary Metal Mfg	Hvac	HVAC Improvements	14%	15	$0.46	100%	$0.06	2,890
Primary Metal Mfg	Indirect Boiler	Boiler Improvements	18%	15	$0.98	100%	$0.14	4,811
Primary Metal Mfg	Indirect Boiler	Boiler O&M	14%	2	$0.15	100%	$0.10	4,255
Primary Metal Mfg	Process Heat	Boiler Improvements	8%	15	$0.43	100%	$0.06	18,600

Segment	End Use	Measure Name	Percent of End Use Consumption Saved	Measure Life	Incremental Cost per Therms	Measure Applicability	Levelized Cost ($ per Therms)	2031 Achievable Technical Potential (Therms)
Primary Metal Mfg	Process Heat	Heat Improvements	8%	15	$0.74	100%	$0.10	18,430
Primary Metal Mfg	Process Heat	Heat O&M	2%	2	$0.49	100%	$0.33	3,326
Primary Metal Mfg	Process Heat	Steam Distribution	4%	15	$0.39	100%	$0.05	10,475
Printing Related Support	Hvac	HVAC Improvements	17%	15	$0.44	100%	$0.06	69,542
Printing Related Support	Hvac	HVAC O&M	31%	2	$0.33	100%	$0.22	1,626
Printing Related Support	Indirect Boiler	Boiler Improvements	12%	15	$1.04	100%	$0.15	31,541
Printing Related Support	Indirect Boiler	Boiler O&M	10%	2	$0.13	100%	$0.09	29,422
Printing Related Support	Process Heat	Boiler Improvements	16%	15	$1.75	100%	$0.24	82,601
Printing Related Support	Process Heat	Heat Improvements	5%	15	$0.44	100%	$0.06	55,013
Printing Related Support	Process Heat	Heat O&M	4%	2	$0.60	100%	$0.40	41,114
Printing Related Support	Process Heat	Steam Distribution	17%	15	$0.36	100%	$0.05	46,085
Transportation Equipment Mfg	Hvac	HVAC Improvements	7%	15	$0.99	100%	$0.14	66,016
Transportation Equipment Mfg	Hvac	HVAC O&M	14%	2	$0.18	100%	$0.12	43,044
Transportation Equipment Mfg	Indirect Boiler	Boiler Improvements	19%	15	$0.99	100%	$0.14	95,191
Transportation Equipment Mfg	Indirect Boiler	Boiler O&M	6%	2	$0.71	100%	$0.47	25,533
Transportation Equipment Mfg	Process Heat	Boiler Improvements	15%	15	$0.25	100%	$0.03	39,237
Transportation Equipment Mfg	Process Heat	Heat Improvements	20%	15	$0.32	100%	$0.04	53,041
Transportation Equipment Mfg	Process Heat	Heat O&M	3%	2	$0.73	100%	$0.49	21,556
Transportation Equipment Mfg	Process Heat	Steam Distribution	5%	15	$8.28	100%	$1.16	32,326
Transportation Equipment Mfg	Process Other	Other O&M	17%	2	$0.42	100%	$0.28	10,935
Wood Product Mfg	Hvac	HVAC Improvements	10%	15	$1.09	100%	$0.15	9,650
Wood Product Mfg	Hvac	HVAC O&M	5%	2	$0.17	100%	$0.12	4,653
Wood Product Mfg	Indirect Boiler	Boiler Improvements	12%	15	$0.48	100%	$0.07	48,124
Wood Product Mfg	Indirect Boiler	Boiler O&M	4%	2	$0.08	100%	$0.05	14,819
Wood Product Mfg	Process Heat	Boiler Improvements	11%	15	$0.34	100%	$0.05	88,752
Wood Product Mfg	Process Heat	Heat Improvements	8%	15	$2.21	100%	$0.31	52,089
Wood Product Mfg	Process Heat	Heat O&M	6%	2	$0.11	100%	$0.07	40,001
Wood Product Mfg	Process Heat	Steam Distribution	1%	15	$0.08	100%	$0.01	11,596
Wood Product Mfg	Process Other	Other O&M	7%	2	$0.16	100%	$0.10	3,548

Appendix B.4: Detailed Results

The following pie charts show how achievable technical potential is distributed by fuel, sector, segment, and end use.

Figure B.4.1 Electric Achievable Technical Potential: Residential by Segment

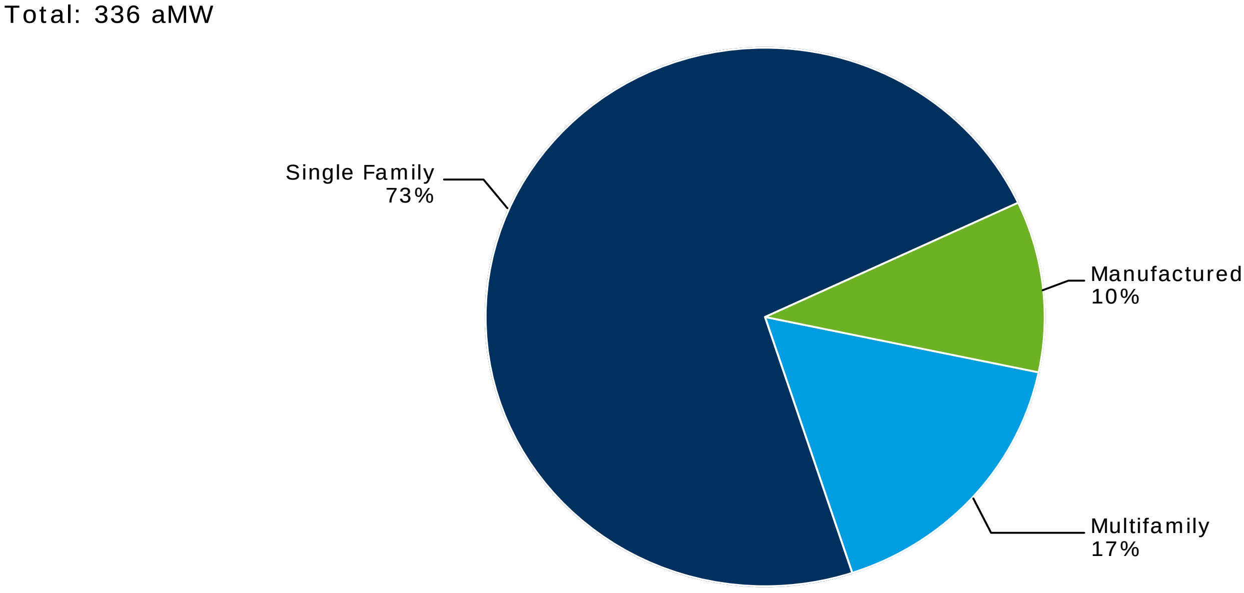


Figure B.4.2 Electric Achievable Technical Potential: Commercial by Segment

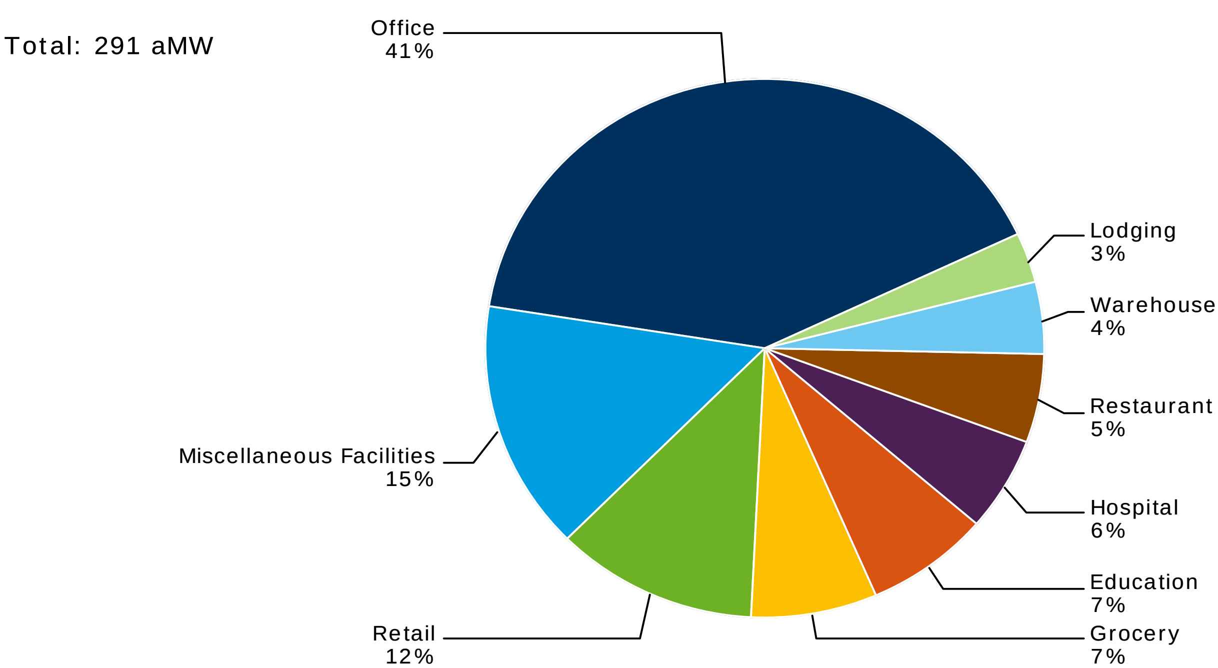


Figure B.4.3 Electric Achievable Technical Potential: Industrial by Segment

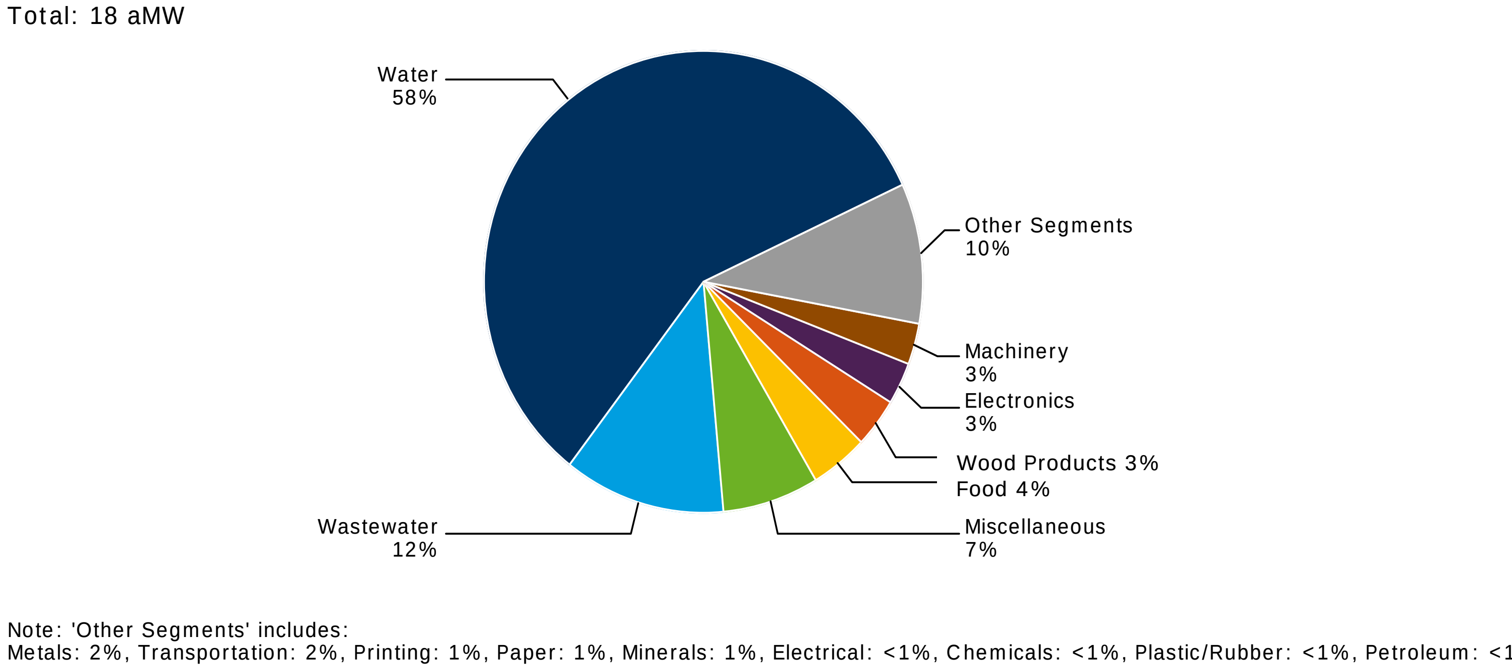


Figure B.4.4 Electric Achievable Technical Potential: Residential by End Use

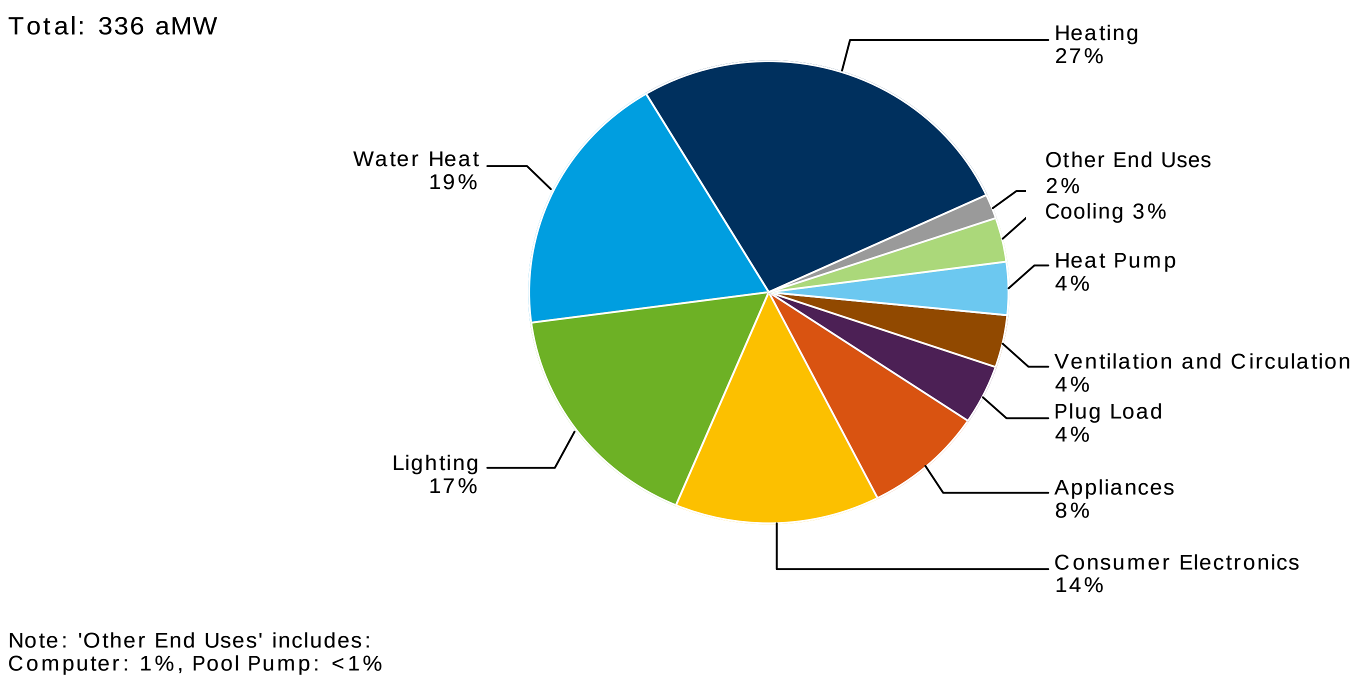


Figure B.4.5 Electric Achievable Technical Potential: Commercial by End Use

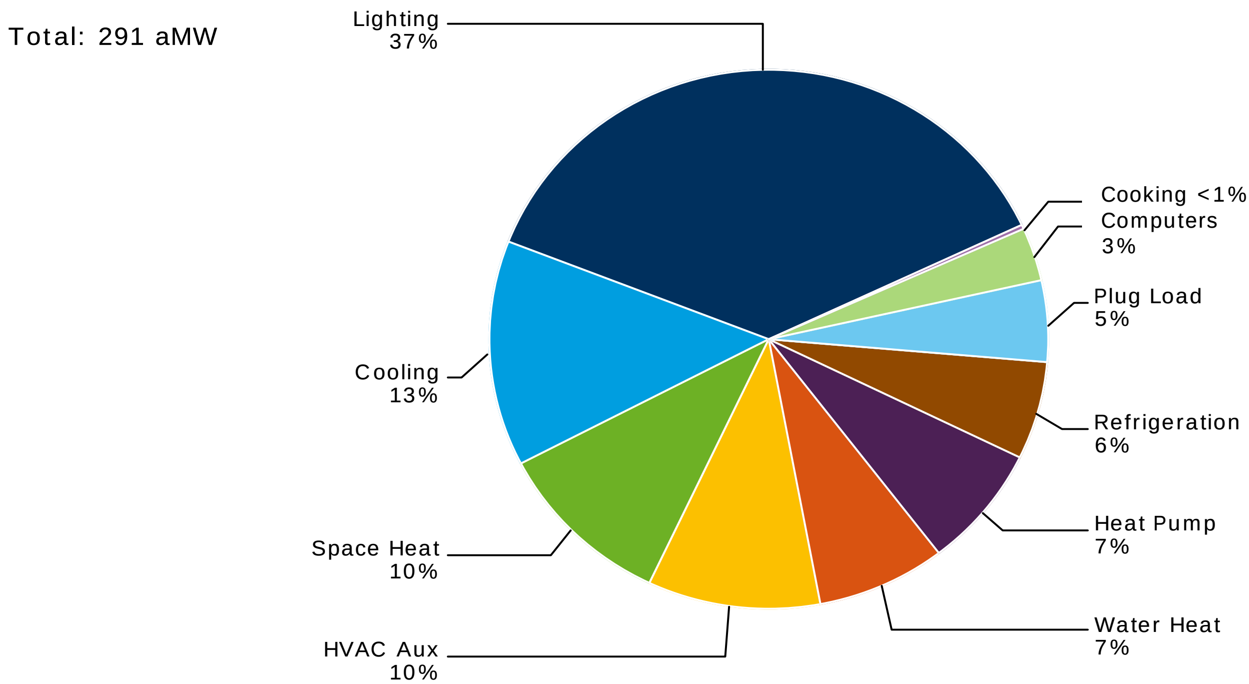


Figure B.4.6 Electric Achievable Technical Potential: Industrial by End Use

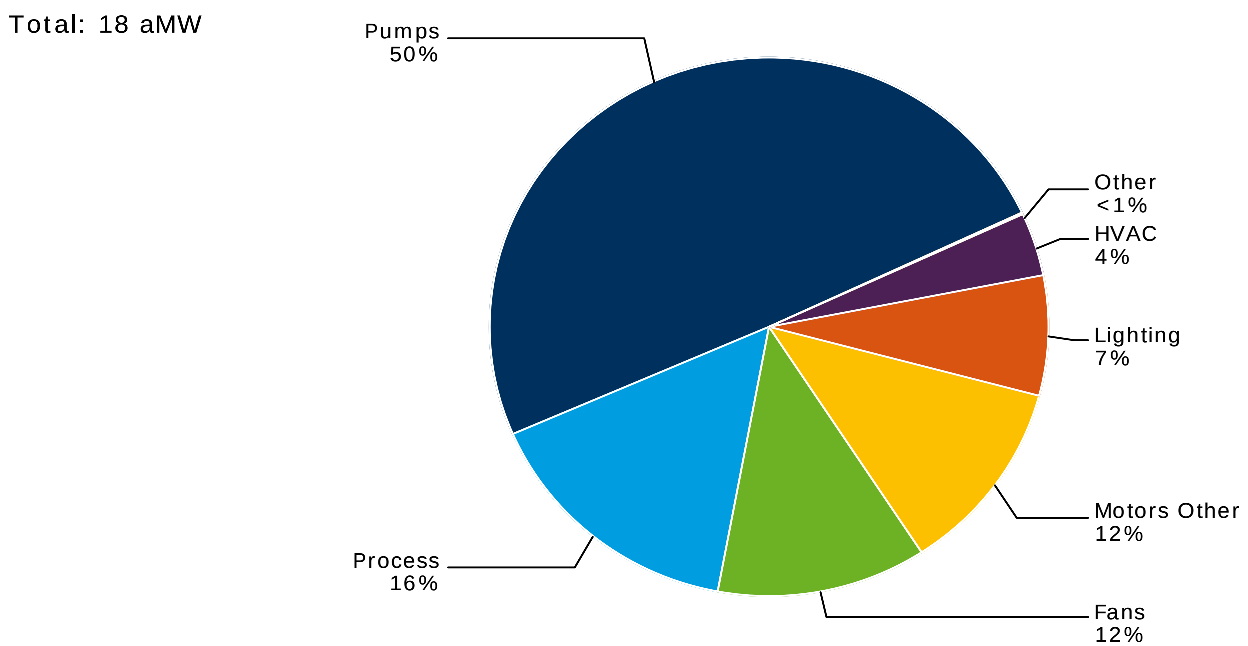


Figure B.4.7 Electric Achievable Technical Potential: Residential Single Family by End Use

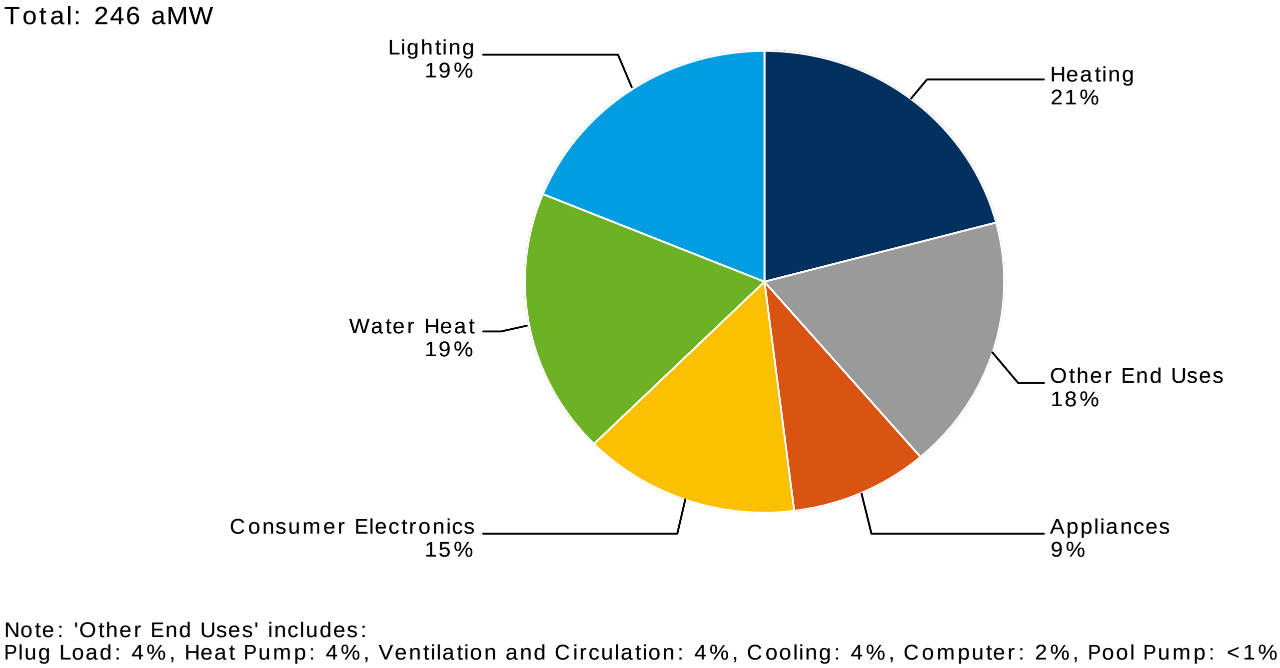


Figure B.4.8 Electric Achievable Technical Potential: Residential Multifamily by End Use

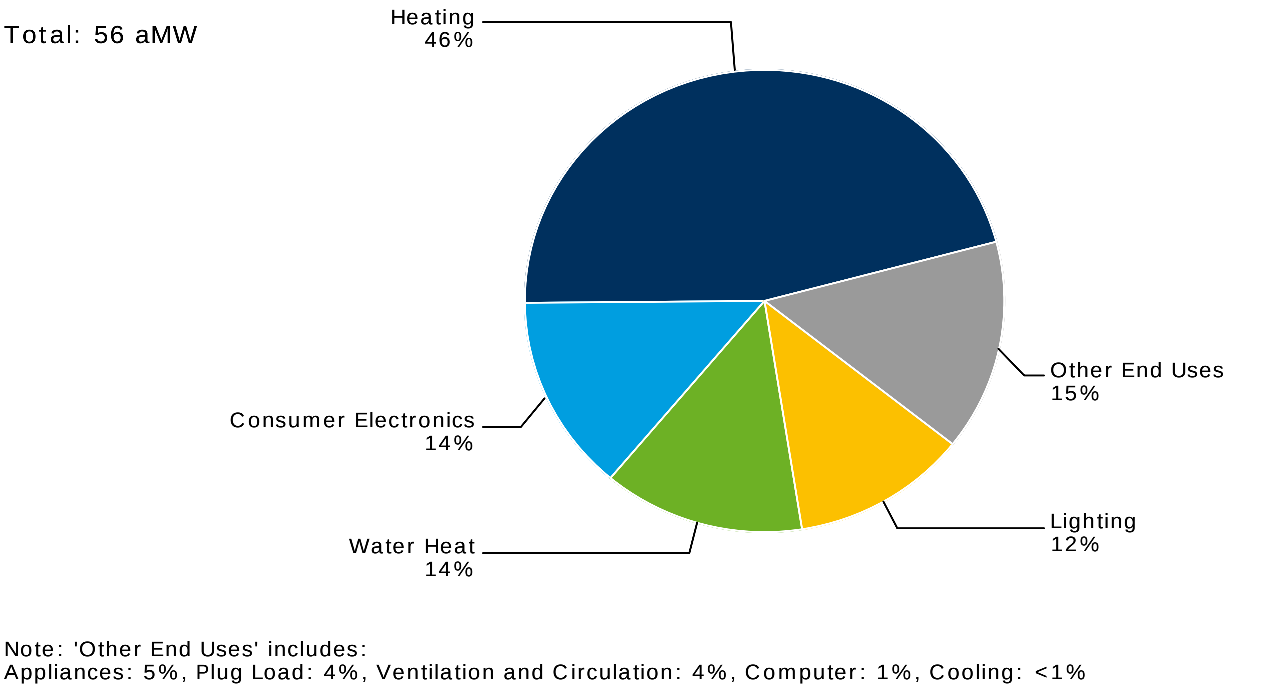


Figure B.4.9 Electric Achievable Technical Potential: Residential Manufactured by End Use

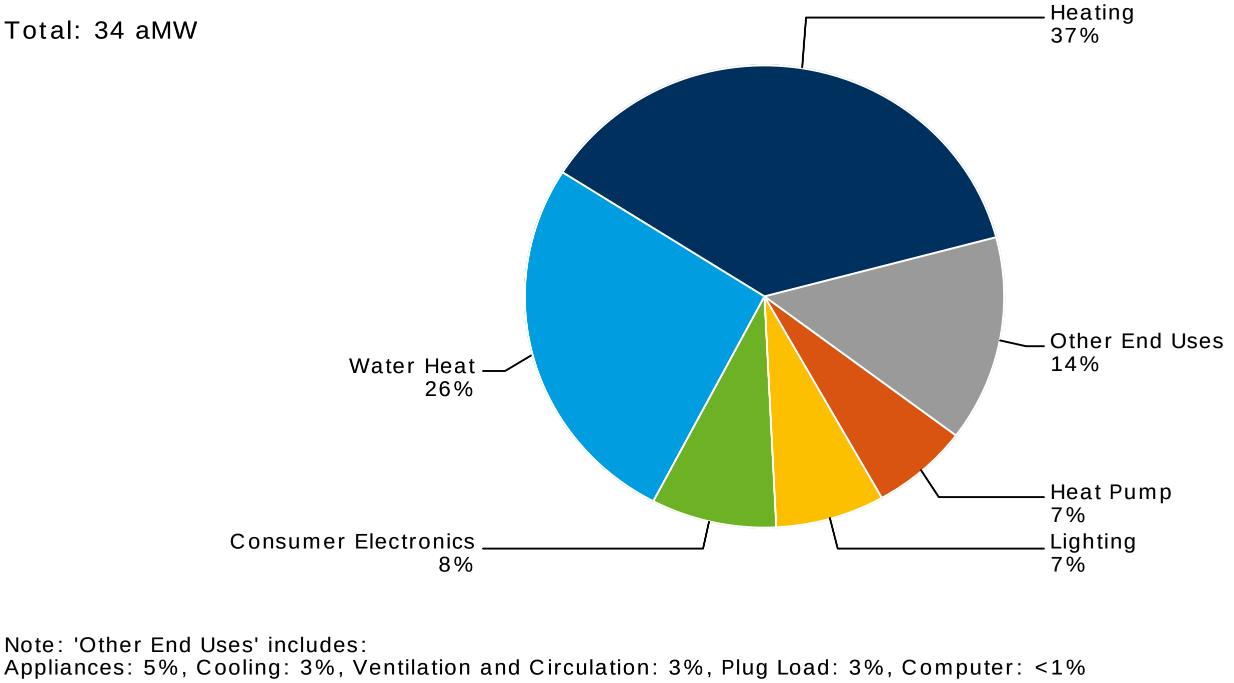


Figure B.4.10 Electric Achievable Technical Potential: Commercial Education by End Use

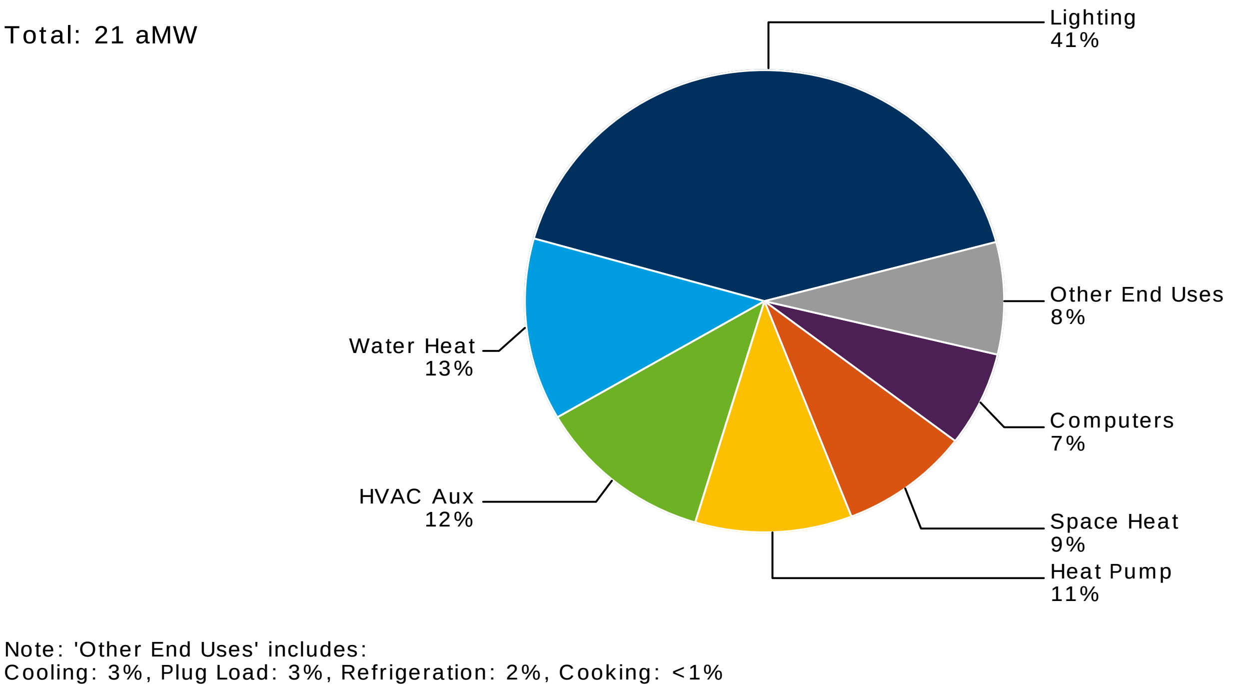
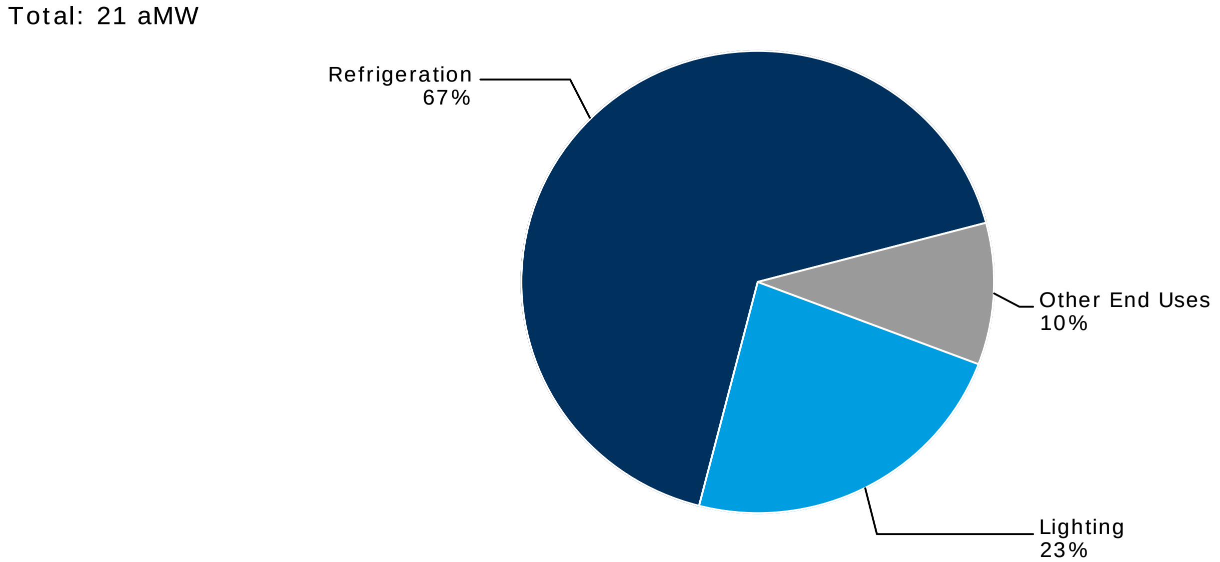
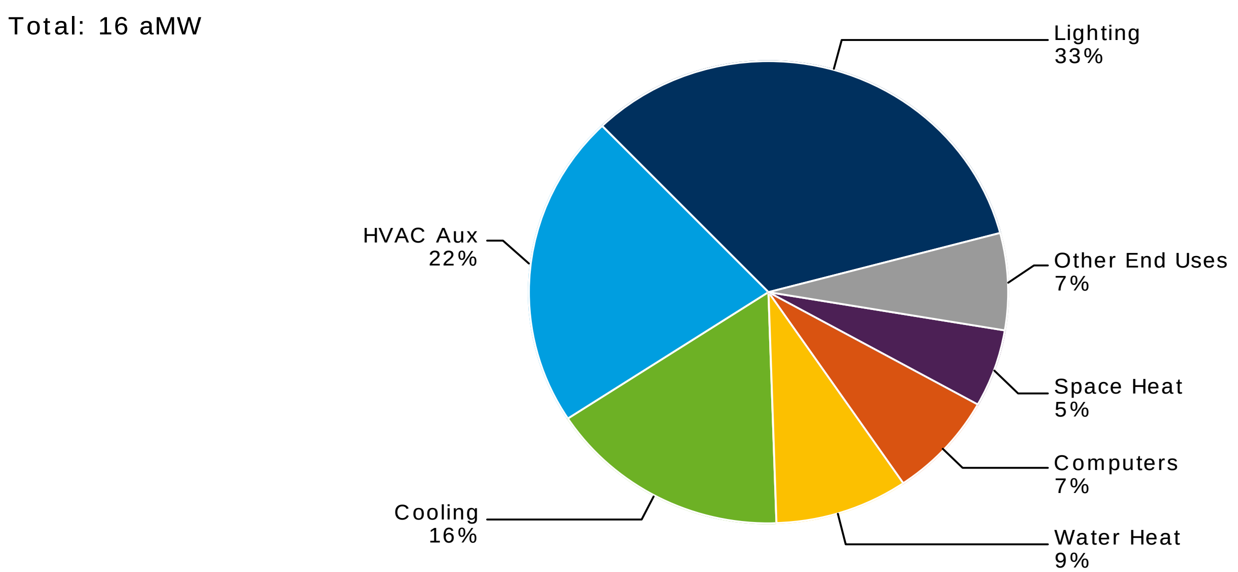


Figure B.4.11 Electric Achievable Technical Potential: Commercial Grocery by End Use



Note: 'Other End Uses' includes:
Cooling: 4%, HVAC Aux: 2%, Heat Pump: 2%, Plug Load: <1%, Space Heat: <1%, Water Heat: <1%, Computers: <1%, Cooking: <1

Figure B.4.12 Electric Achievable Technical Potential: Commercial Hospital by End Use



Note: 'Other End Uses' includes:
Plug Load: 4%, Heat Pump: 2%, Refrigeration: <1%, Cooking: <1%

Figure B.4.13 Electric Achievable Technical Potential: Commercial Lodging by End Use

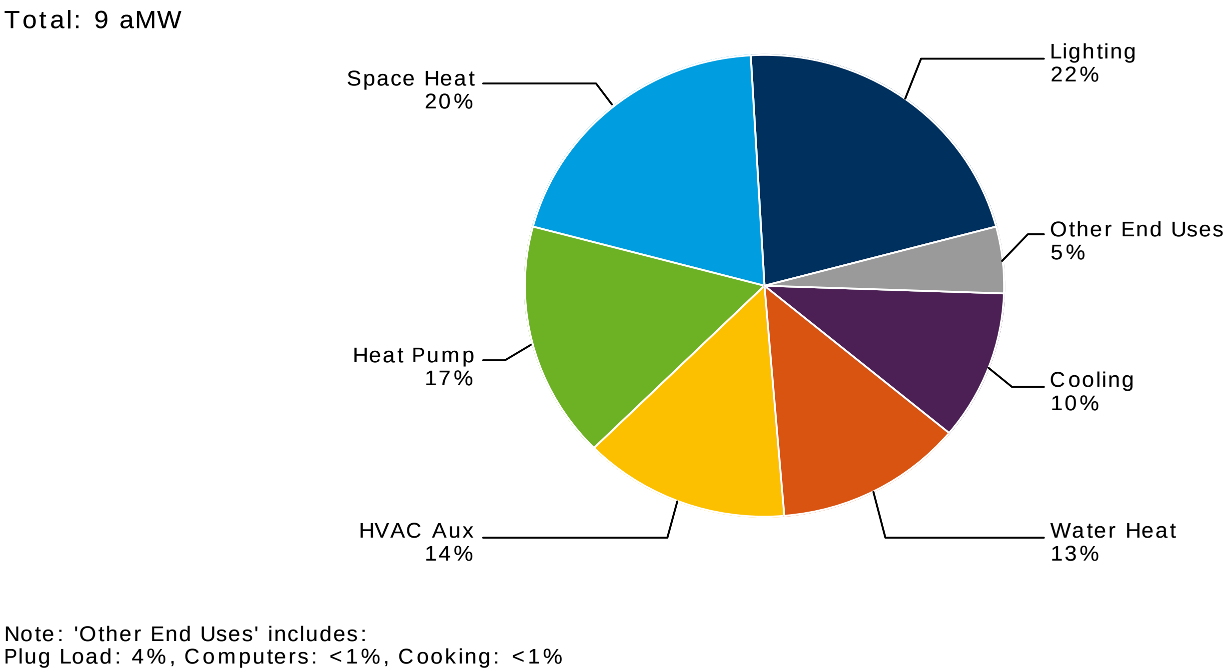


Figure B.4.14 Electric Achievable Technical Potential: Commercial Miscellaneous Facilities by End Use

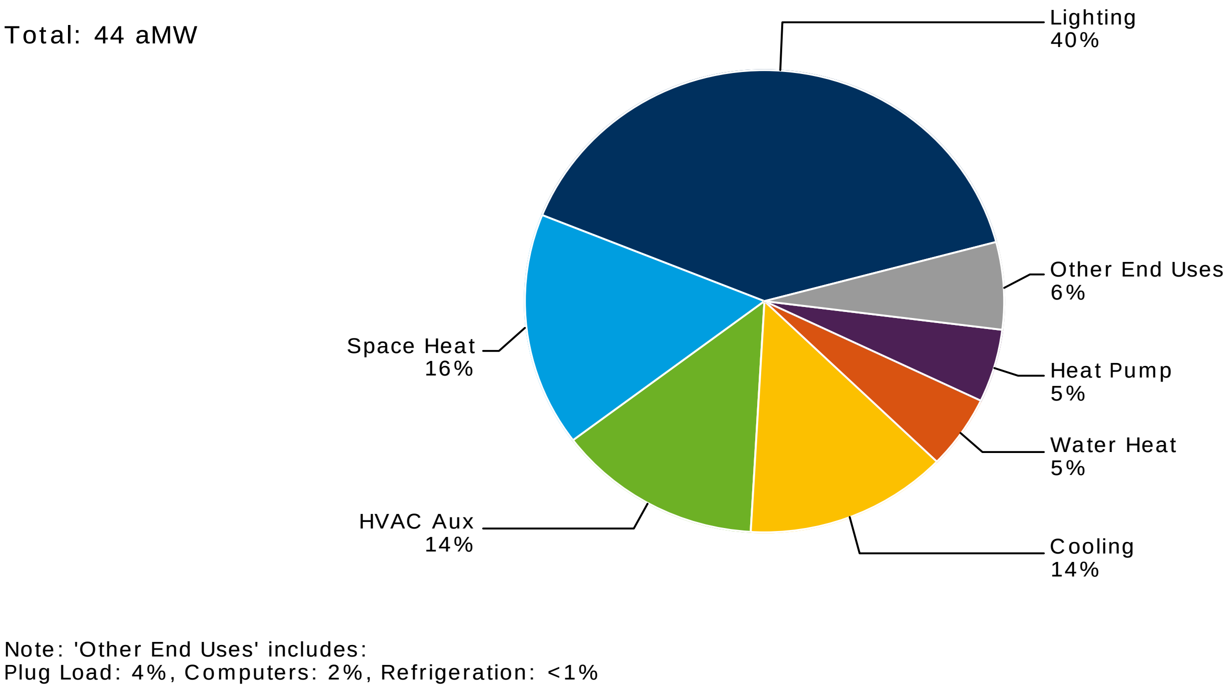


Figure B.4.15 Electric Achievable Technical Potential: Commercial Office by End Use

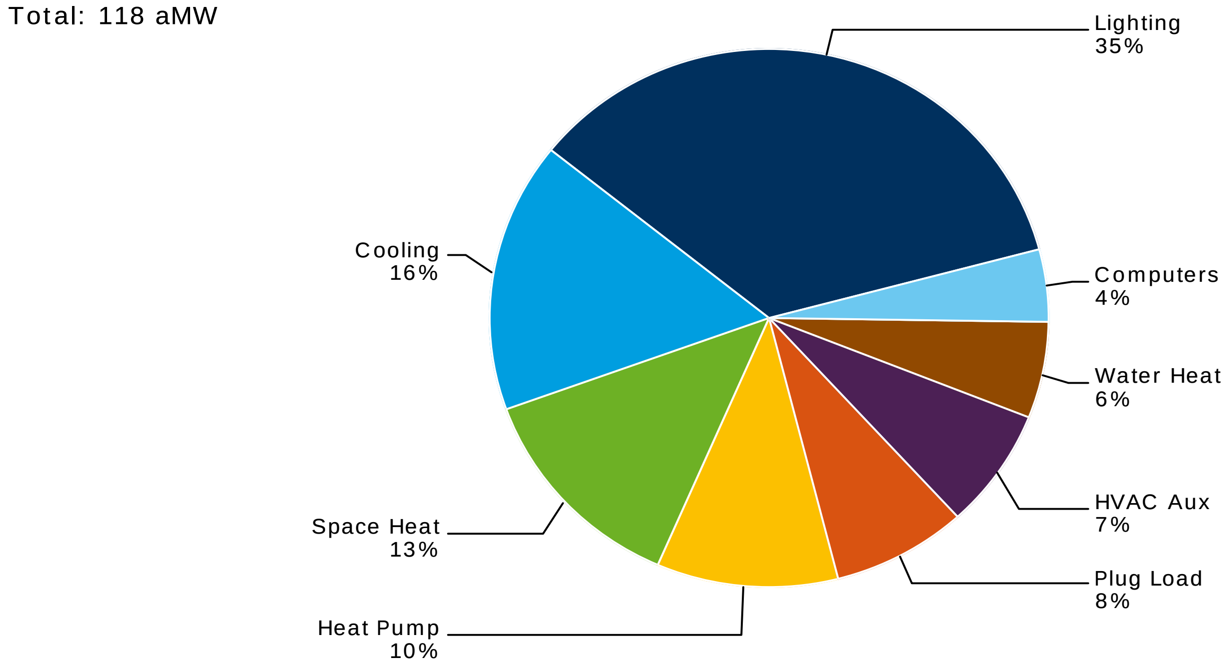
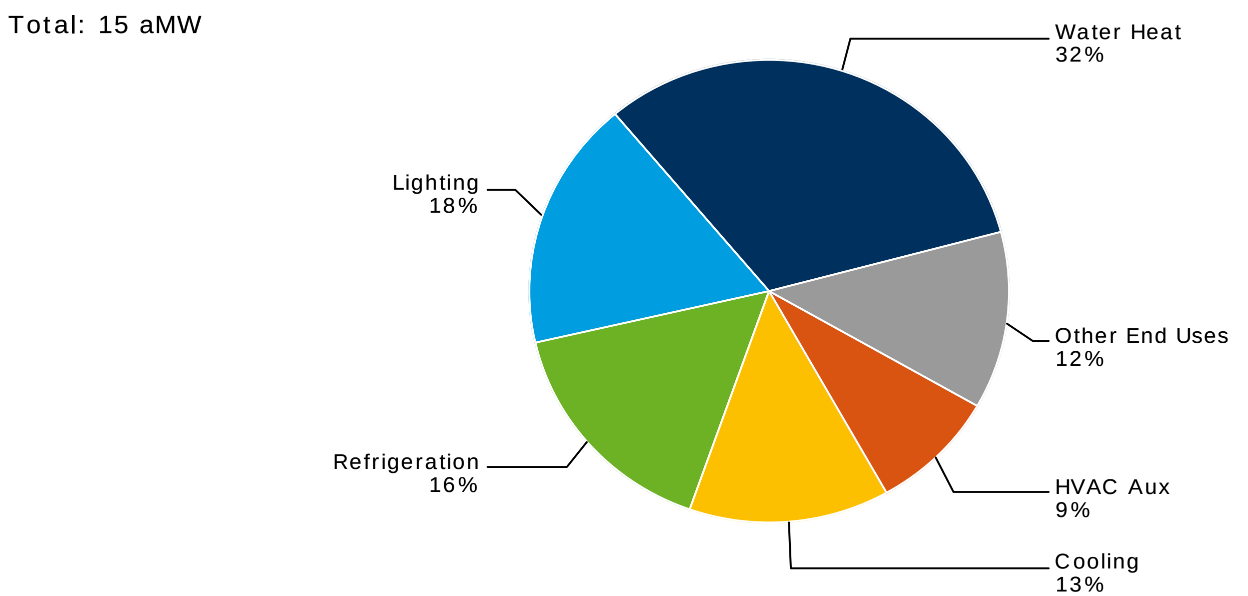


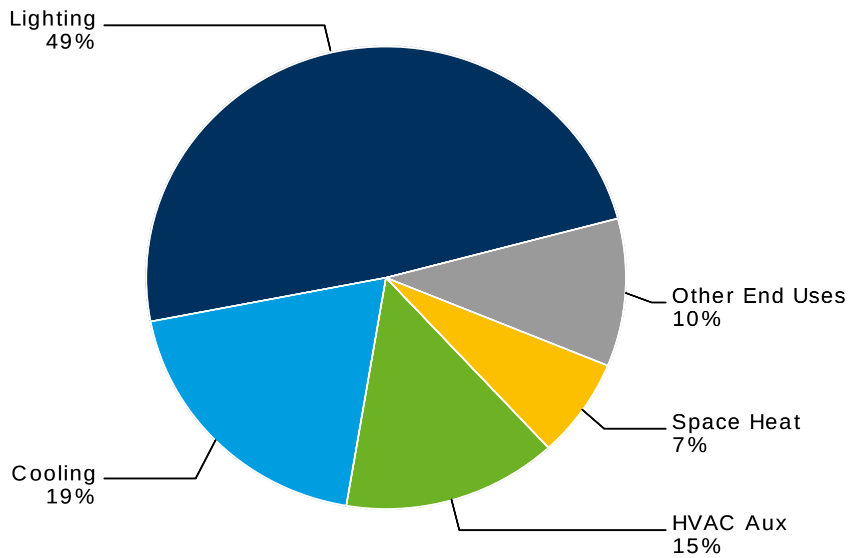
Figure B.4.16 Electric Achievable Technical Potential: Commercial Restaurant by End Use



Note: 'Other End Uses' includes:
Plug Load: 4%, Cooking: 4%, Heat Pump: 3%, Space Heat: <1%, Computers: <1%

Figure B.4.17 Electric Achievable Technical Potential: Commercial Retail by End Use

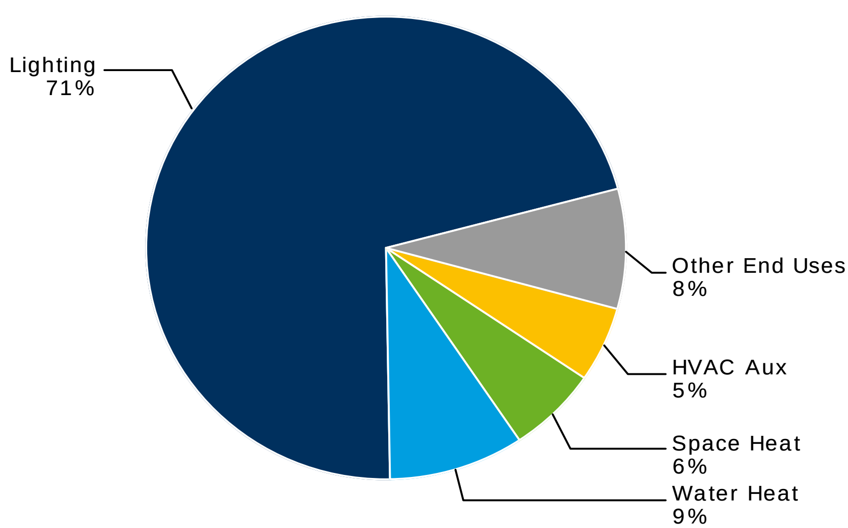
Total: 34 aMW



Note: 'Other End Uses' includes:
Heat Pump: 4%, Water Heat: 4%, Plug Load: 2%, Computers: <1%

Figure B.4.18 Electric Achievable Technical Potential: Commercial Warehouse by End Use

Total: 13 aMW



Note: 'Other End Uses' includes:
Cooling: 2%, Plug Load: 2%, Heat Pump: 2%, Computers: 2%, Refrigeration: <1%

Figure B.4.19 Electric Achievable Technical Potential: Industrial Chemicals by End Use

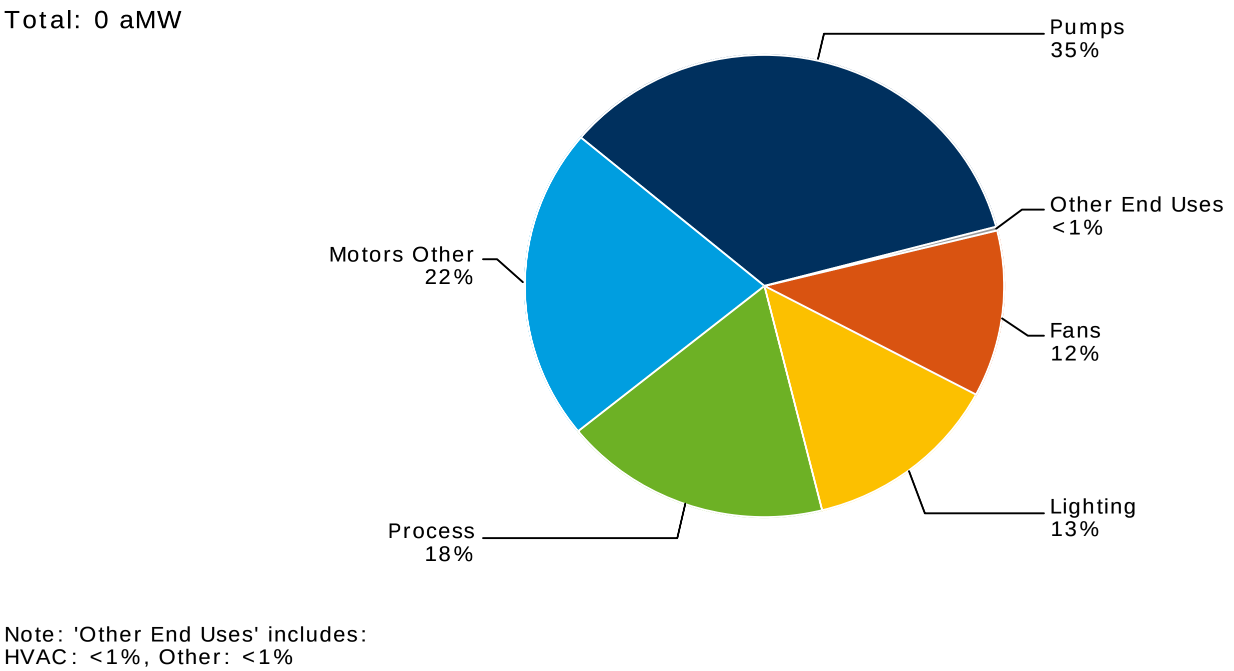


Figure B.4.20 Electric Achievable Technical Potential: Industrial Electrical by End Use

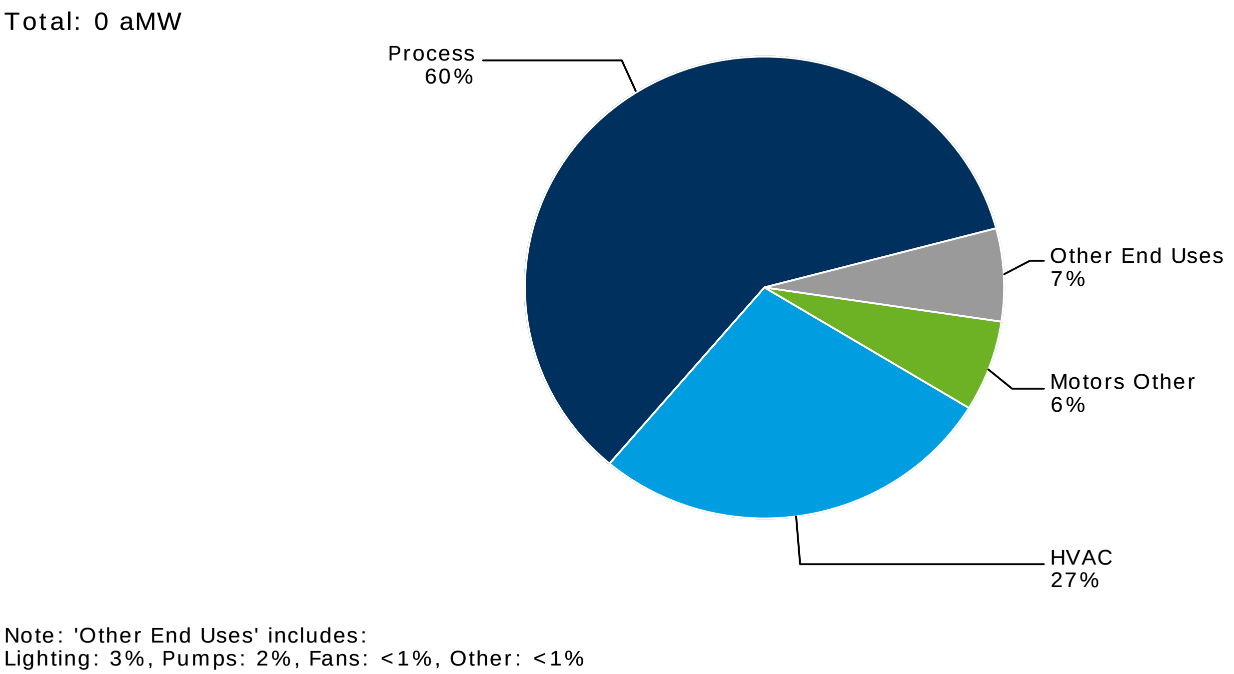


Figure B.4.21 Electric Achievable Technical Potential: Industrial Electronics by End Use

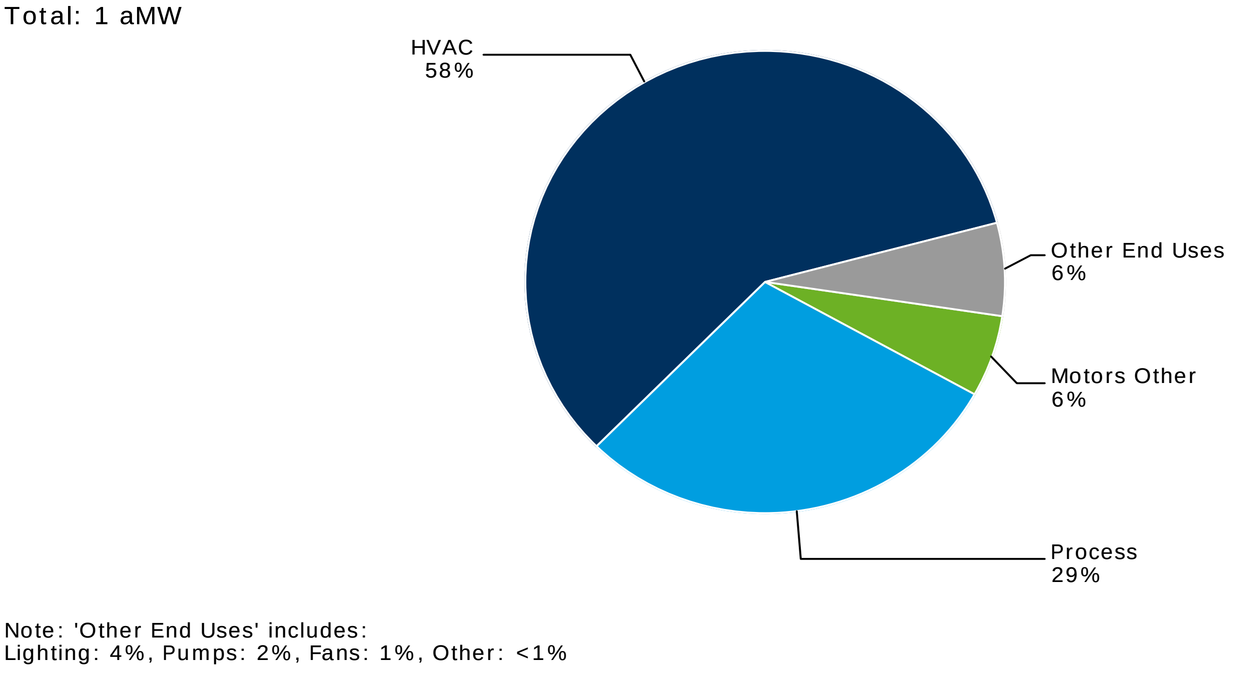


Figure B.4.22 Electric Achievable Technical Potential: Industrial Food by End Use

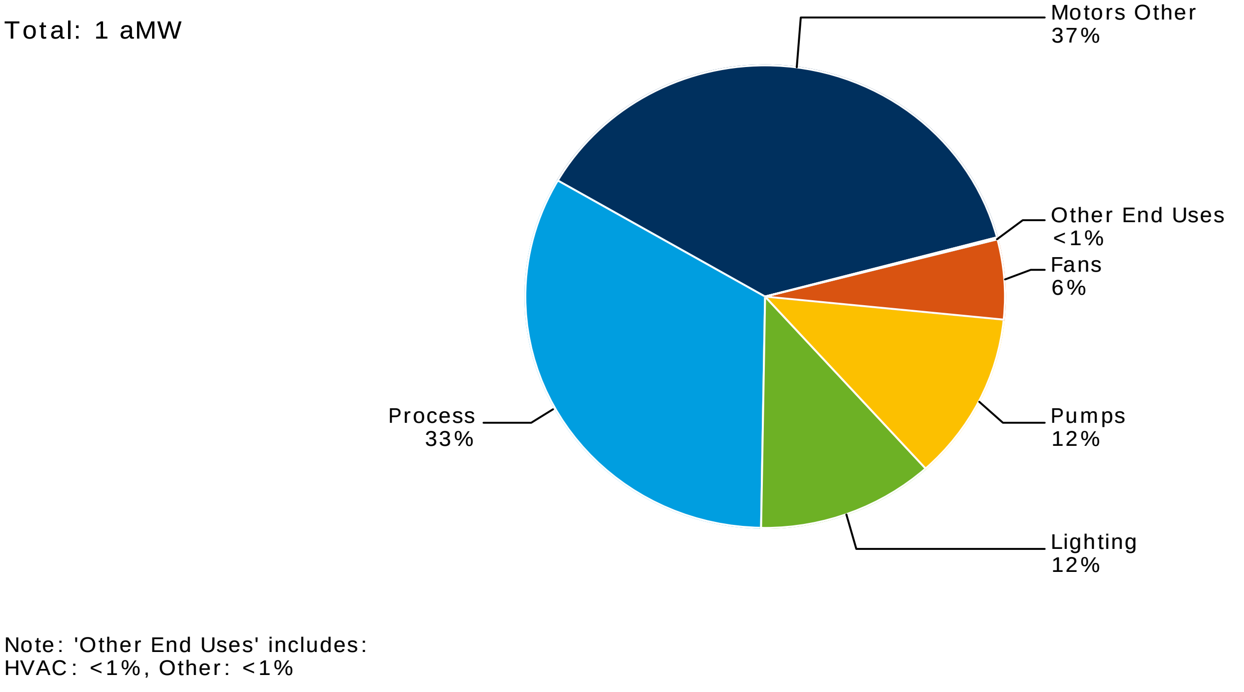
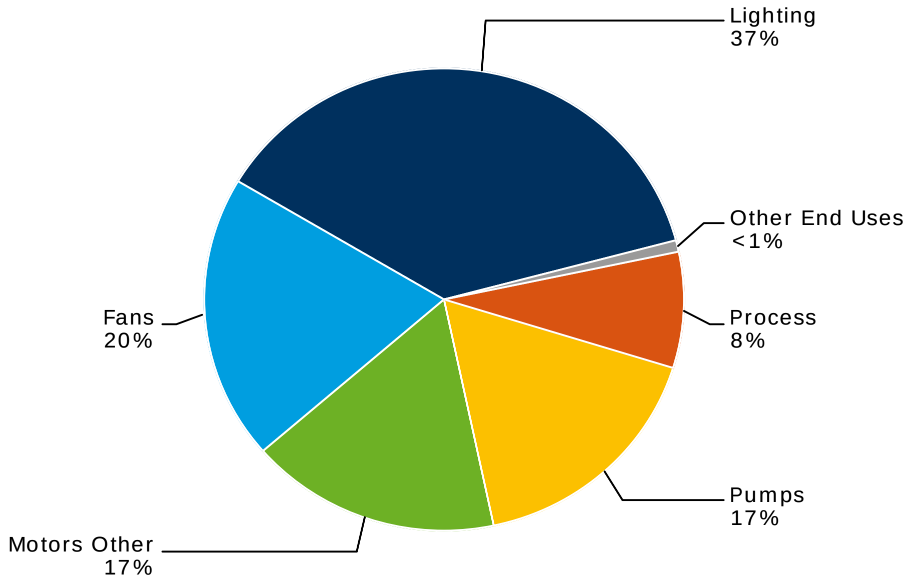


Figure B.4.23 Electric Achievable Technical Potential: Industrial Machinery by End Use

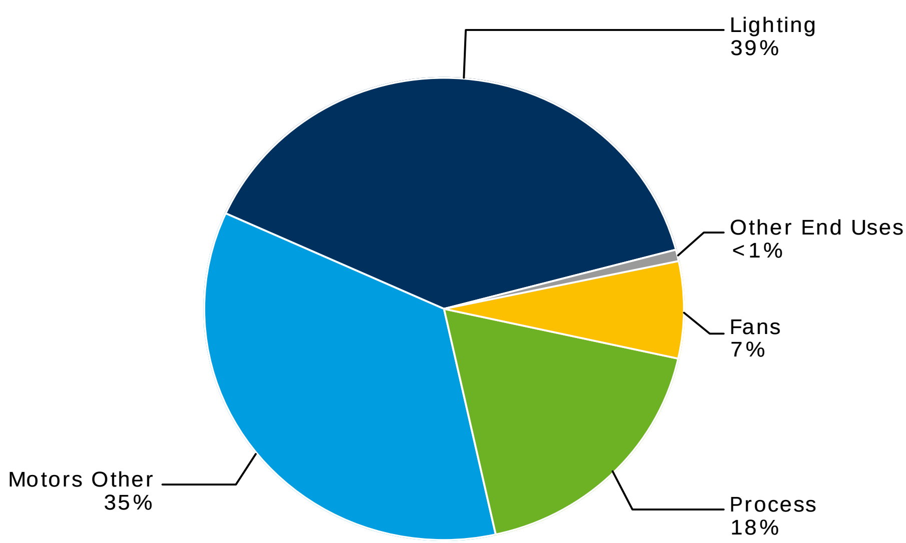
Total: 1 aMW



Note: 'Other End Uses' includes:
HVAC: <1%, Other: <1%

Figure B.4.24 Electric Achievable Technical Potential: Industrial Metals by End Use

Total: 0 aMW



Note: 'Other End Uses' includes:
HVAC: <1%, Pumps: <1%, Other: <1%

Figure B.4.25 Electric Achievable Technical Potential: Industrial Minerals by End Use

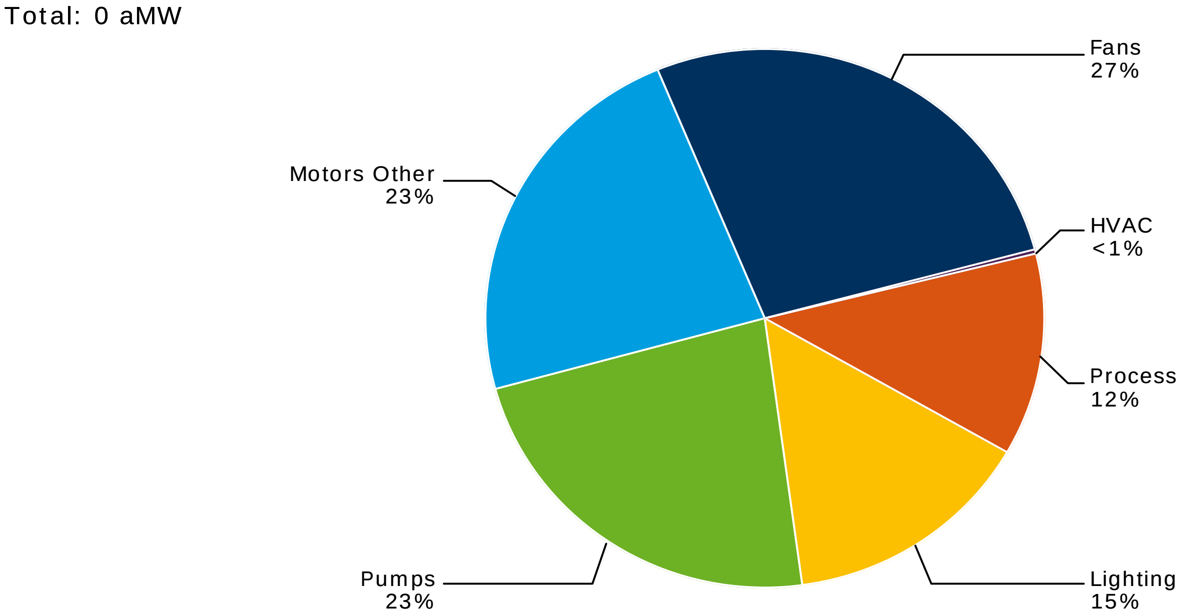


Figure B.4.26 Electric Achievable Technical Potential: Industrial Miscellaneous by End Use

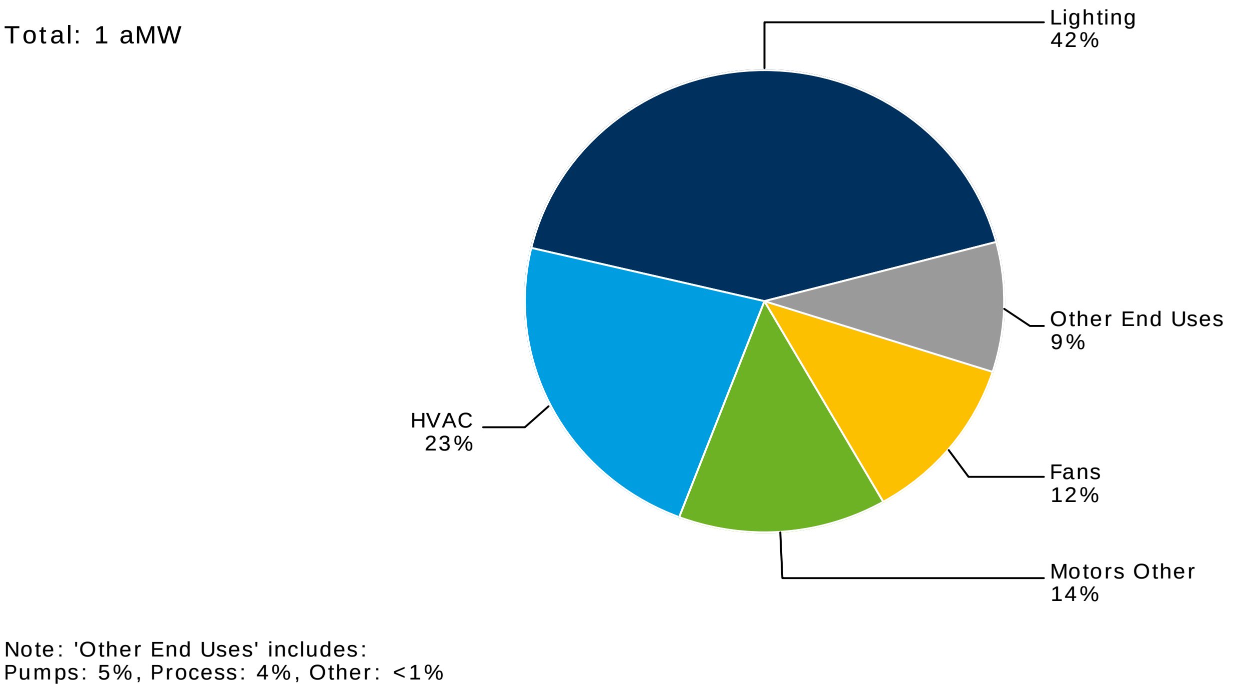


Figure B.4.27 Electric Achievable Technical Potential: Industrial Petroleum by End Use

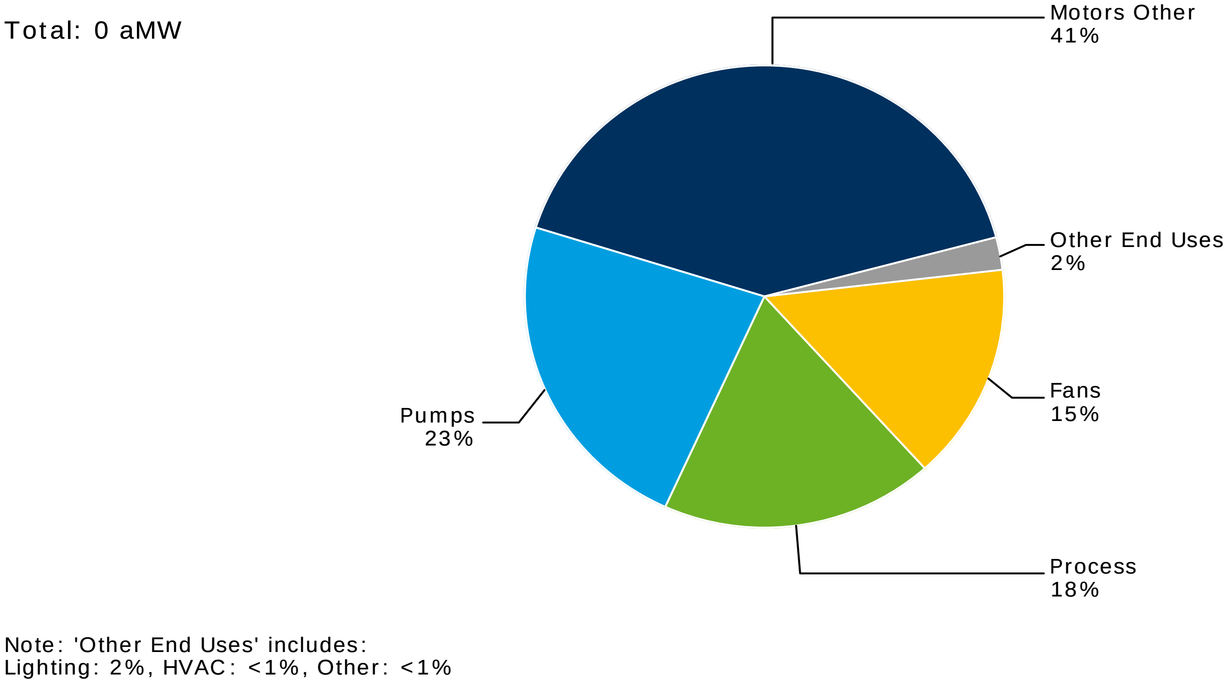


Figure B.4.28 Electric Achievable Technical Potential: Industrial Plastic/Rubber by End Use

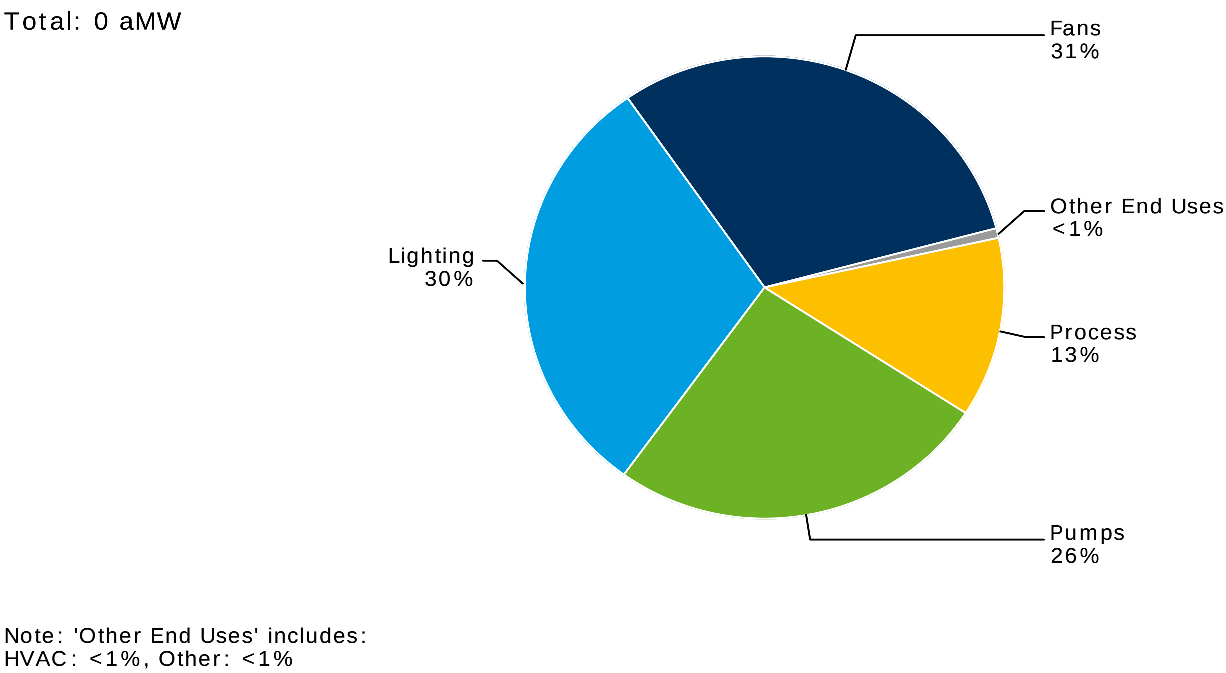


Figure B.4.29 Electric Achievable Technical Potential: Industrial Printing by End Use

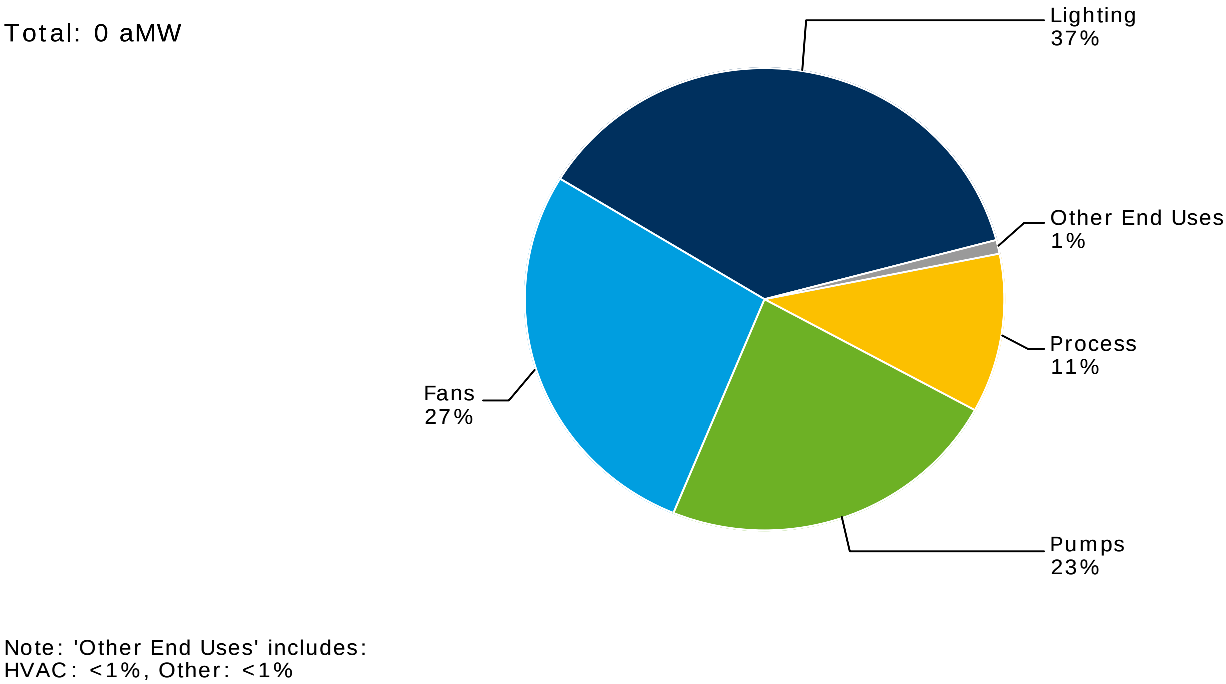


Figure B.4.30 Electric Achievable Technical Potential: Industrial Transportation by End Use

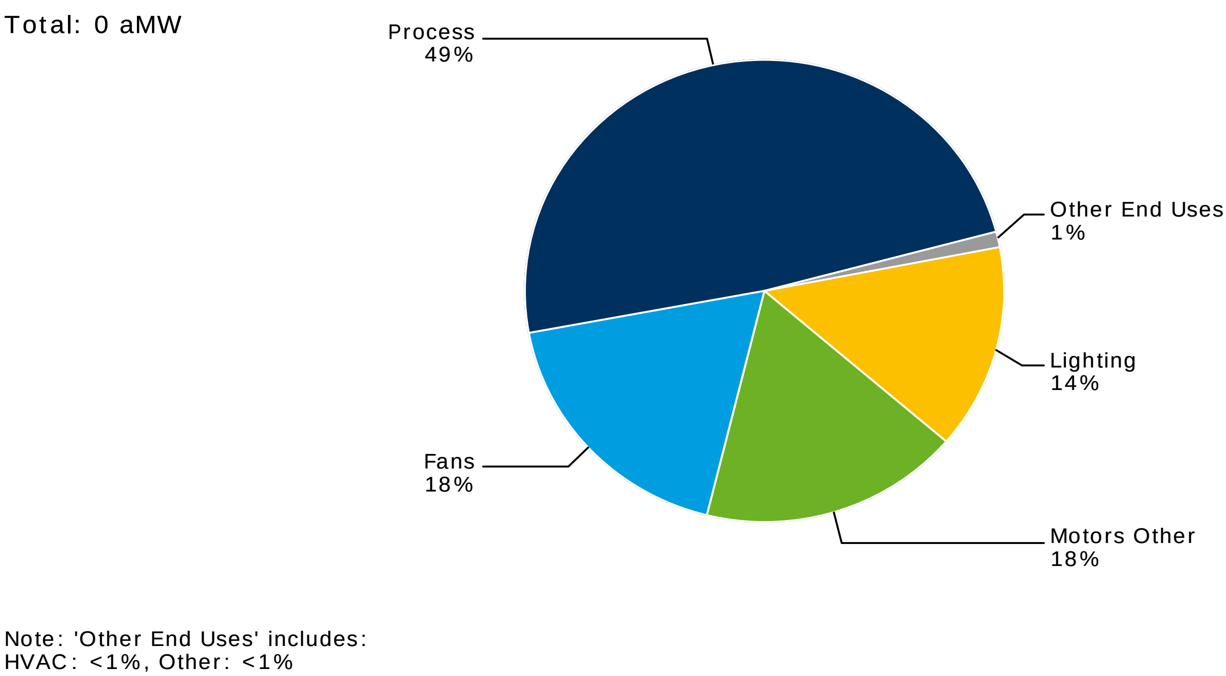
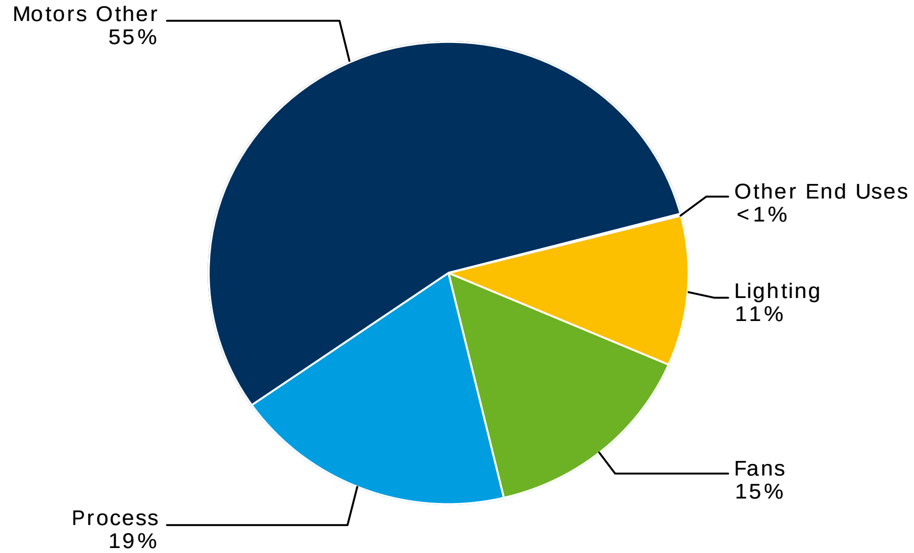


Figure B.4.31 Electric Achievable Technical Potential: Industrial Wood Products by End Use

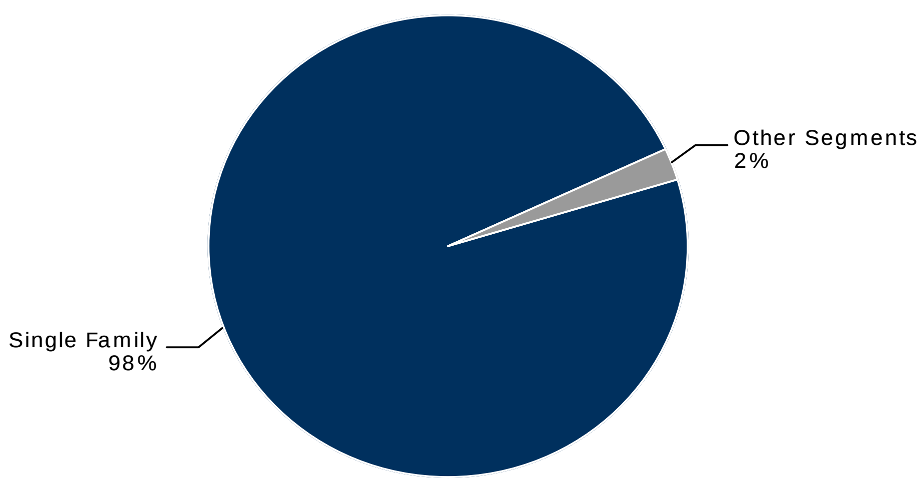
Total: 1 aMW



Note: 'Other End Uses' includes:
HVAC: <1%, Other: <1%

Figure B.4.32 Gas Achievable Technical Potential: Residential by Segment

Total: 183,346,243 Therms



Note: 'Other Segments' includes:
Multifamily: 2%, Manufactured: <1%

Figure B.4.33 Gas Achievable Technical Potential: Commercial by Segment

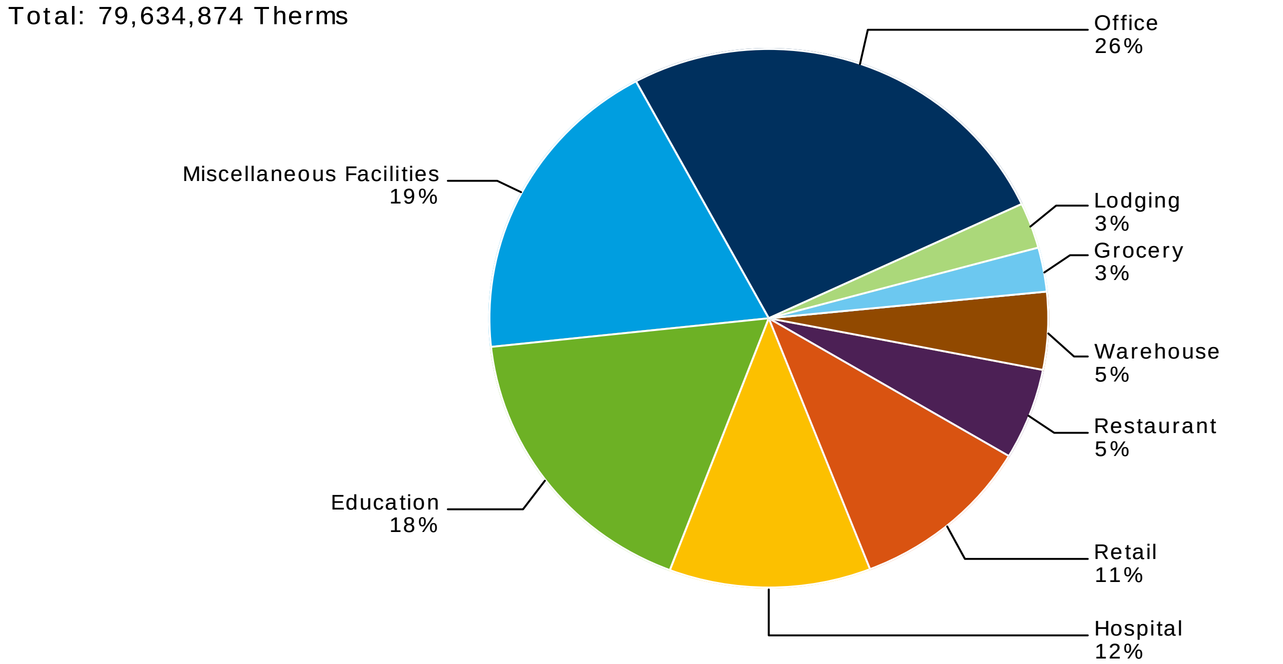
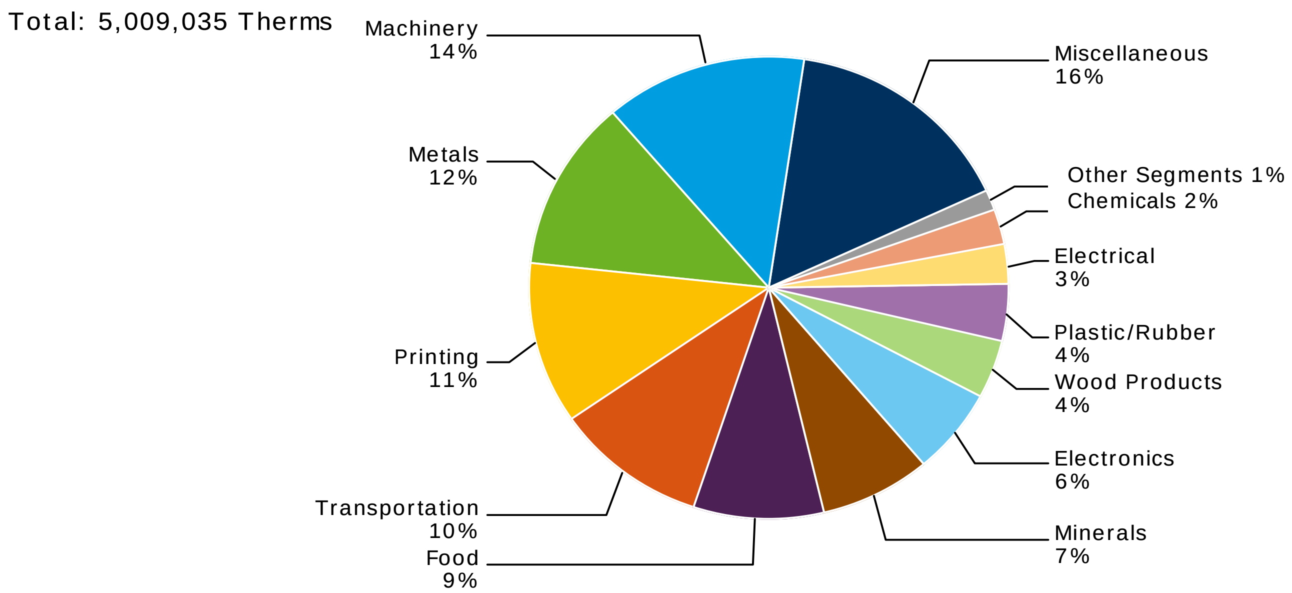


Figure B.4.34 Gas Achievable Technical Potential: Industrial by Segment



Note: 'Other Segments' includes:
Paper: 1%, Petroleum: <1%

Figure B.4.35 Gas Achievable Technical Potential: Residential by End Use

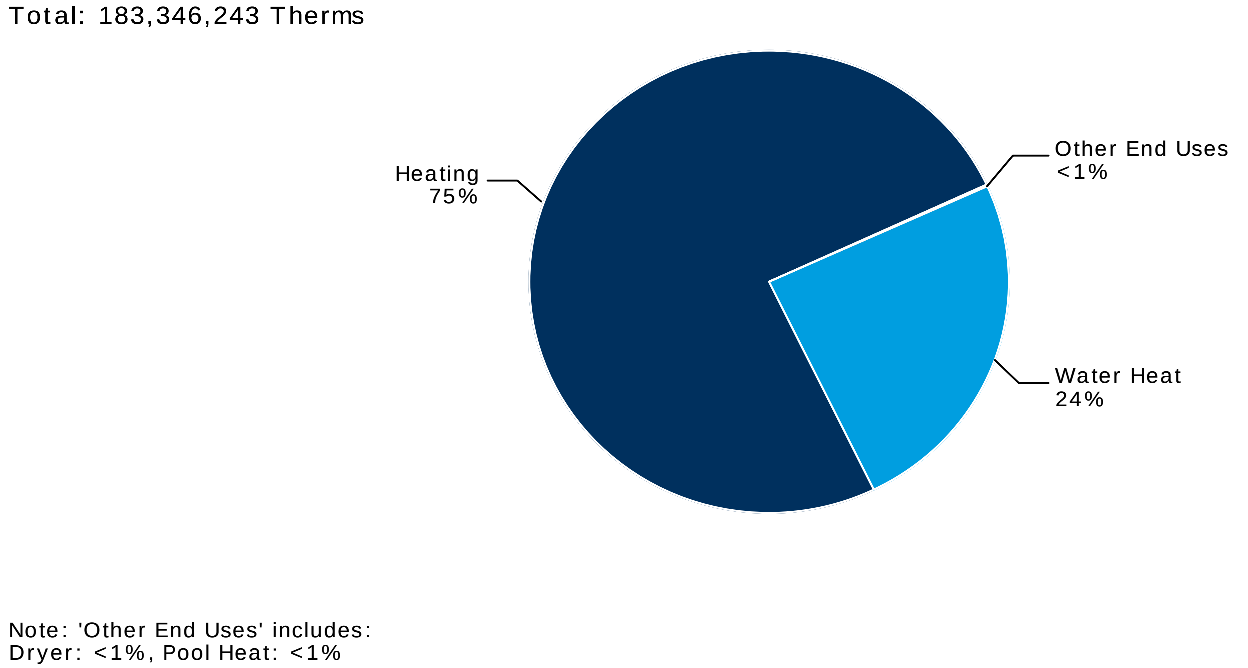


Figure B.4.36 Gas Achievable Technical Potential: Commercial by End Use

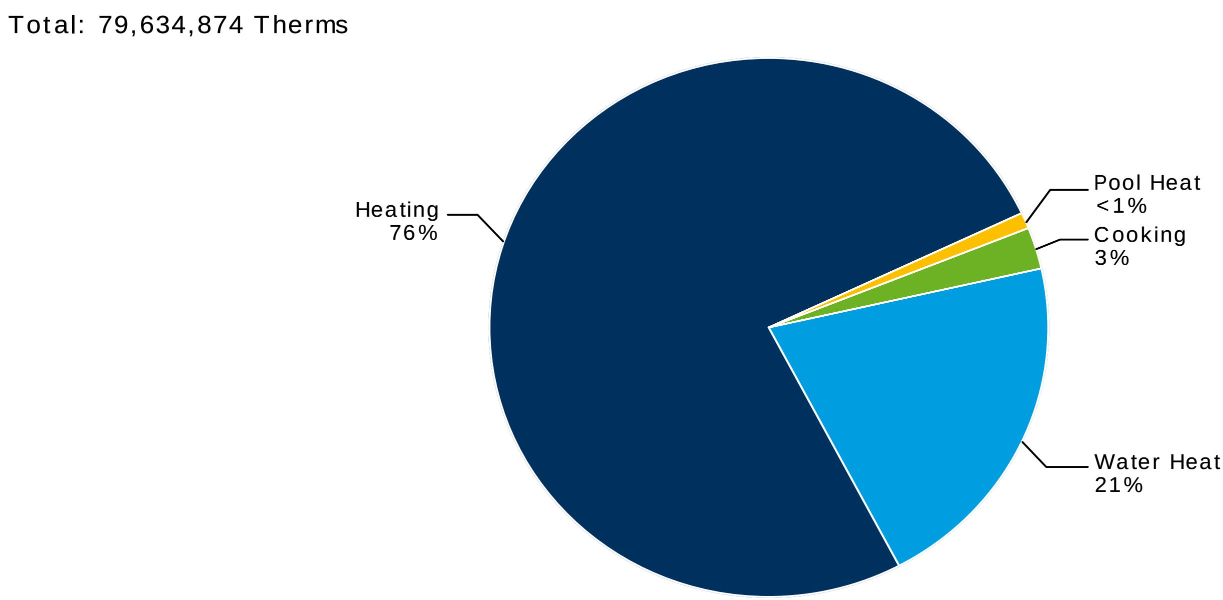


Figure B.4.37 Gas Achievable Technical Potential: Industrial by End Use

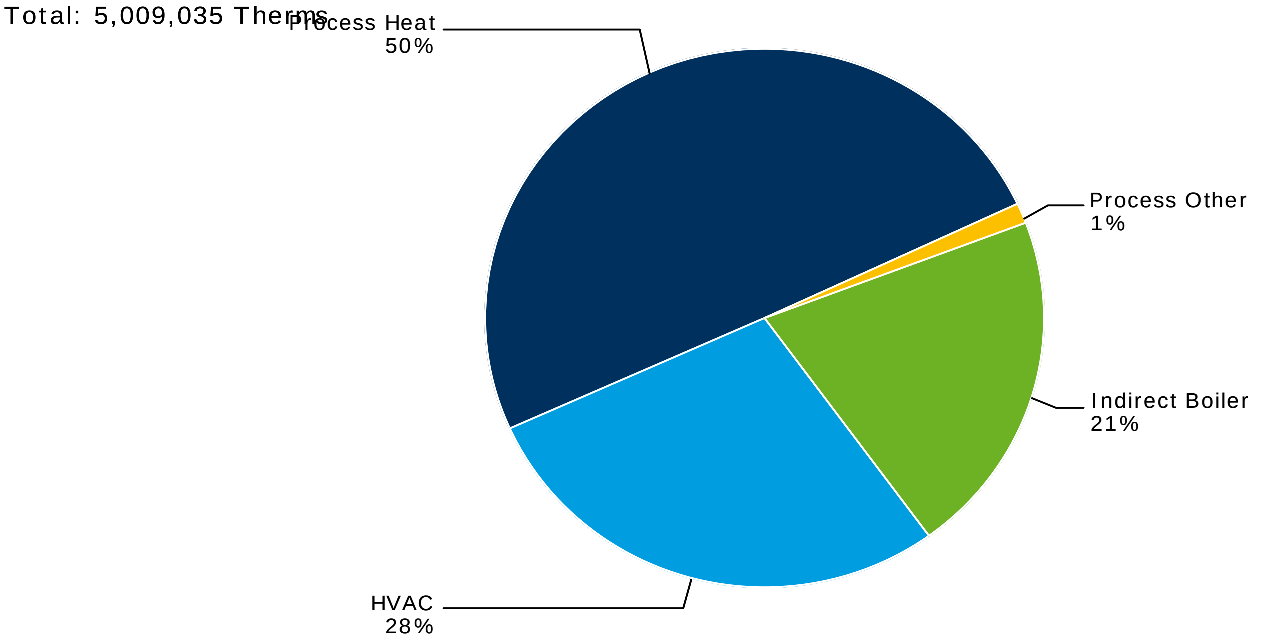


Figure B.4.38 Gas Achievable Technical Potential: Residential Single Family by End Use

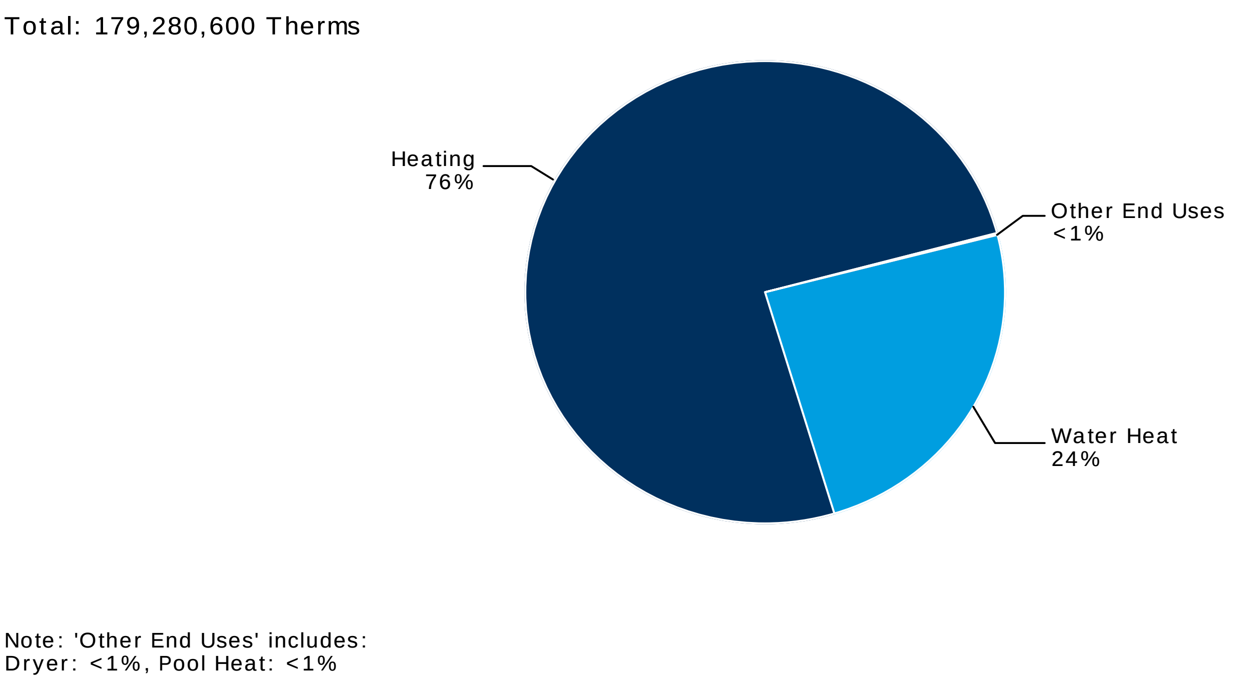


Figure B.4.39 Gas Achievable Technical Potential: Residential Multifamily by End Use

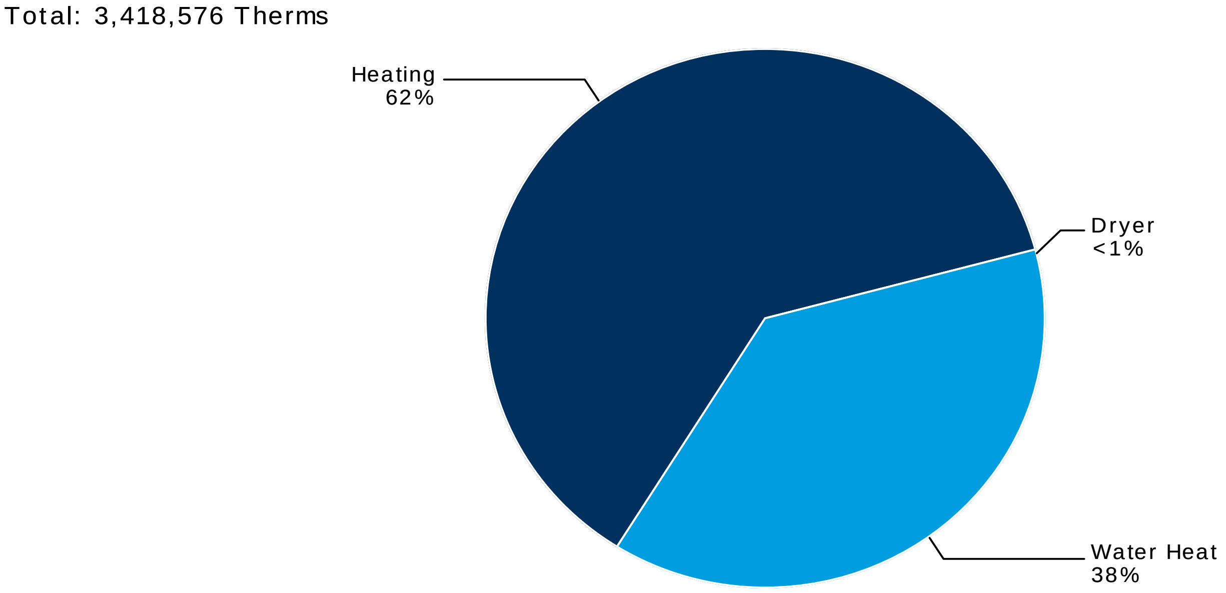


Figure B.4.40 Gas Achievable Technical Potential: Residential Manufactured by End Use

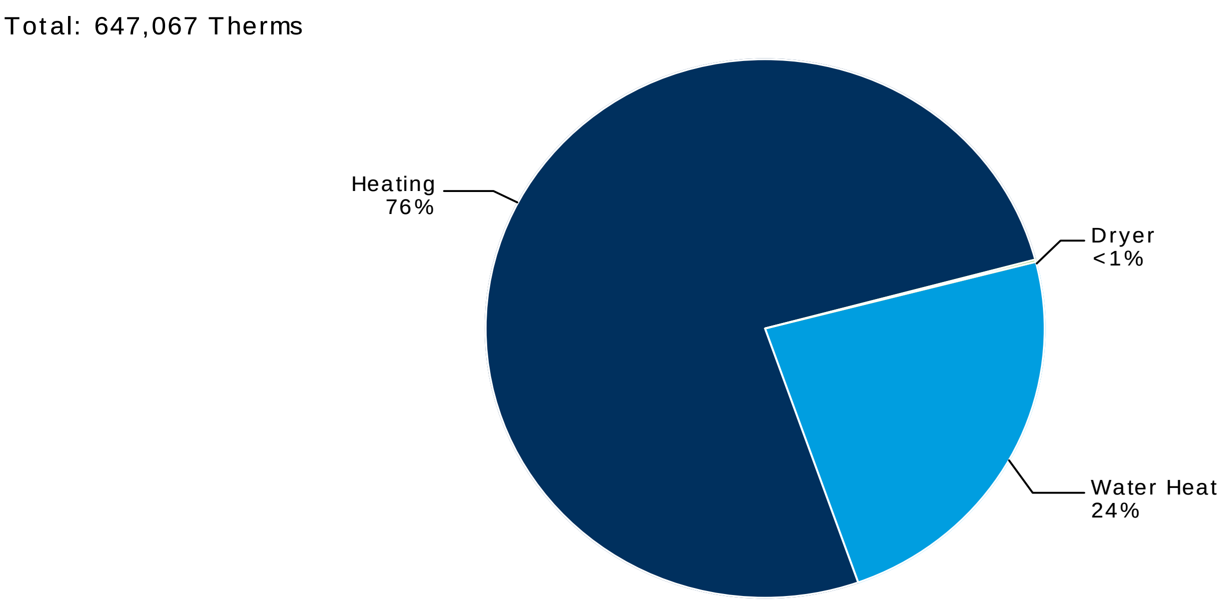


Figure B.4.41 Gas Achievable Technical Potential: Commercial Education by End Use

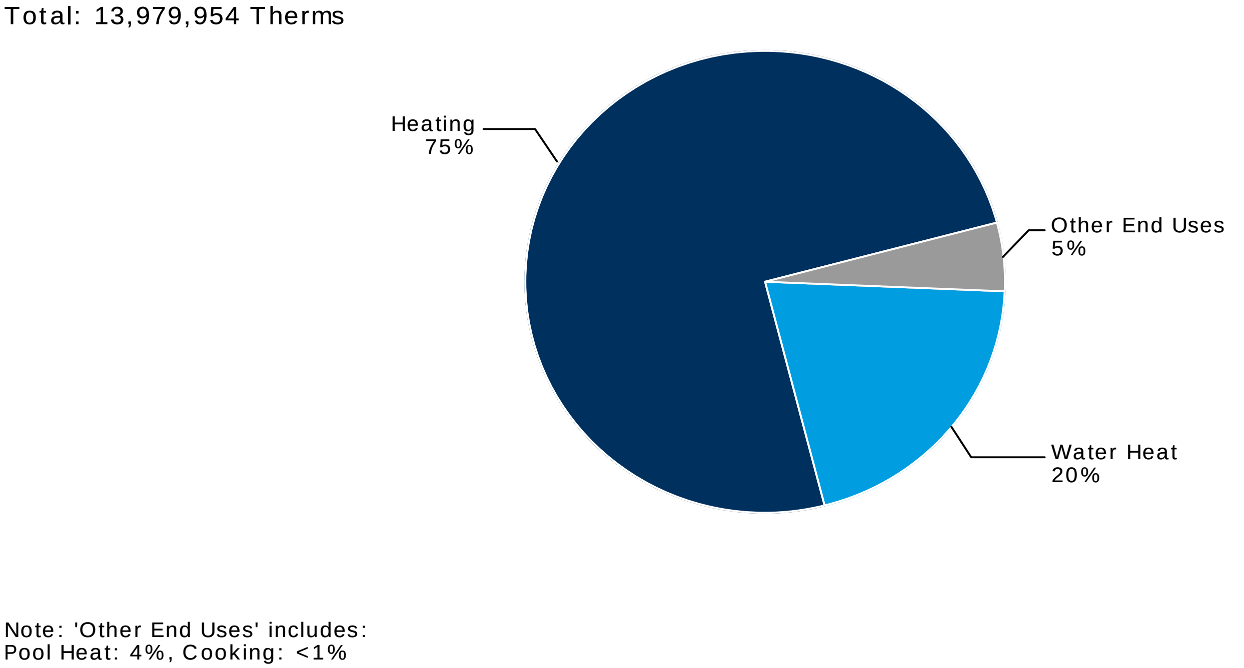


Figure B.4.42 Gas Achievable Technical Potential: Commercial Grocery by End Use

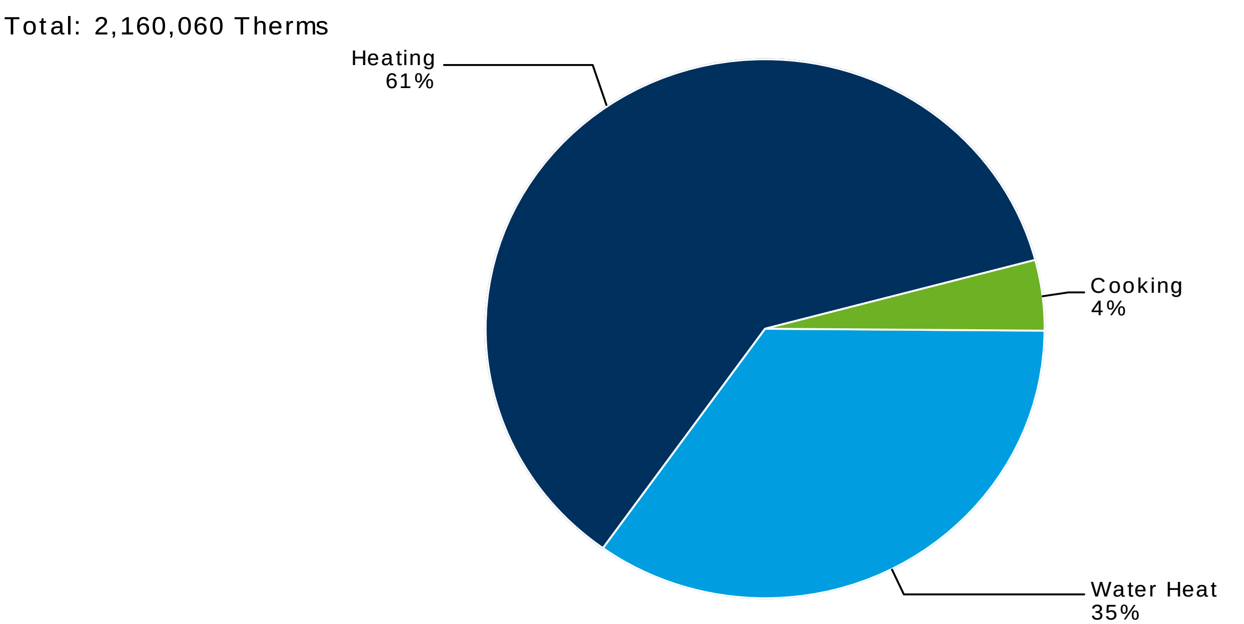


Figure B.4.43 Gas Achievable Technical Potential: Commercial Hospital by End Use

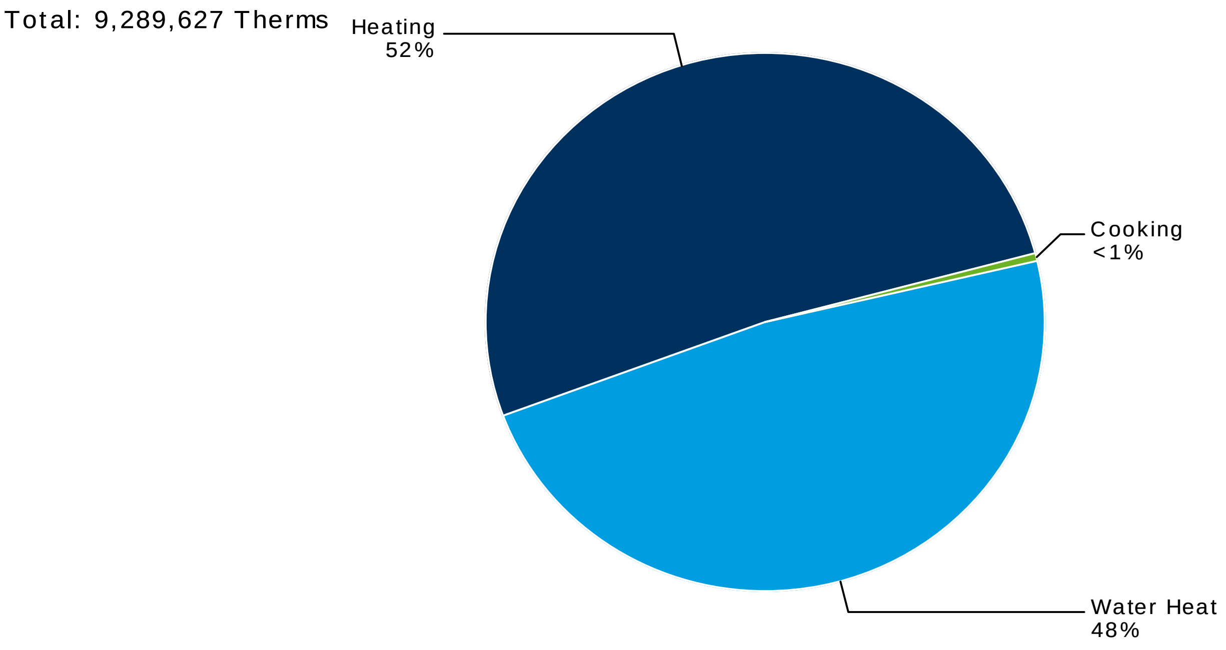


Figure B.4.44 Gas Achievable Technical Potential: Commercial Lodging by End Use

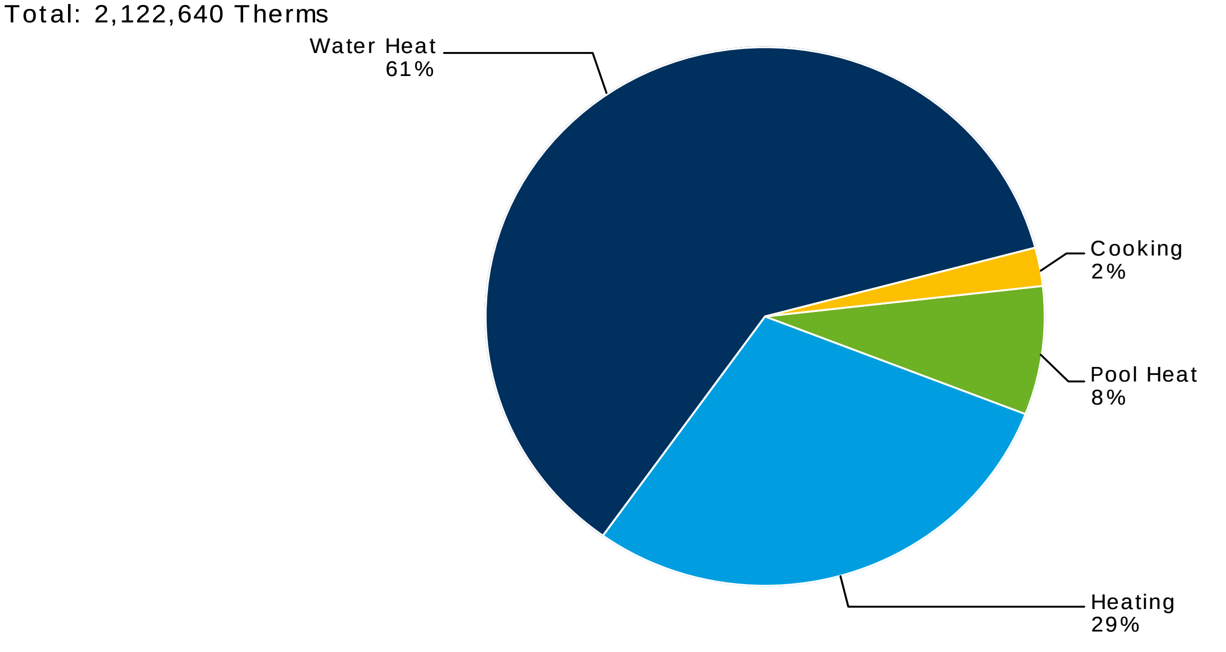


Figure B.4.45 Gas Achievable Technical Potential: Commercial Miscellaneous Facilities by End Use

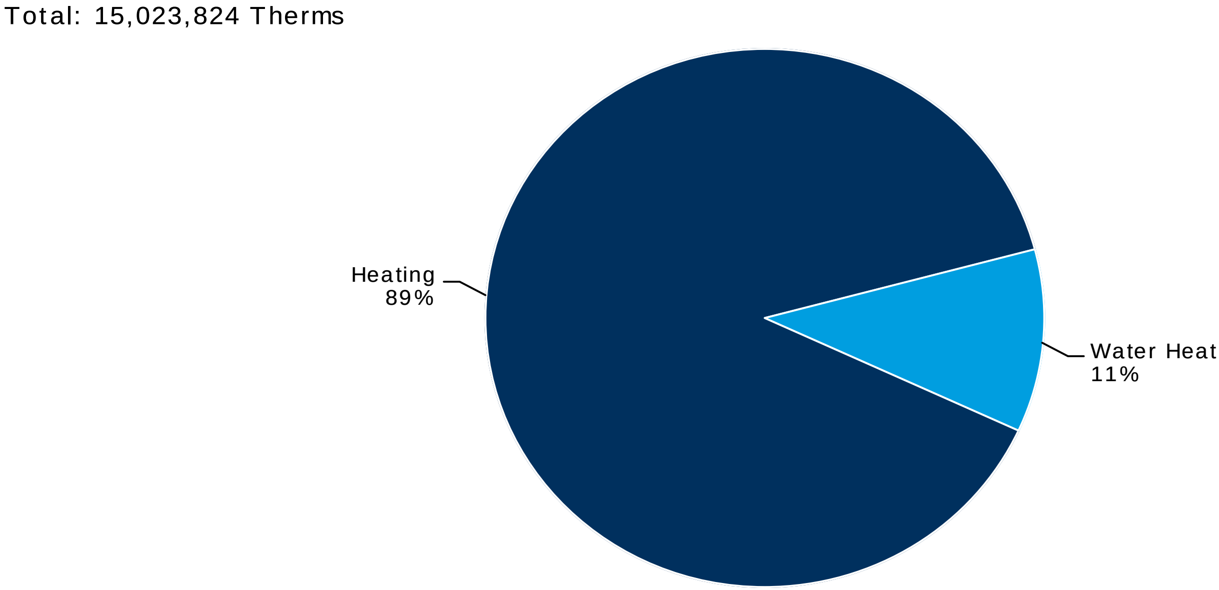


Figure B.4.46 Gas Achievable Technical Potential: Commercial Office by End Use

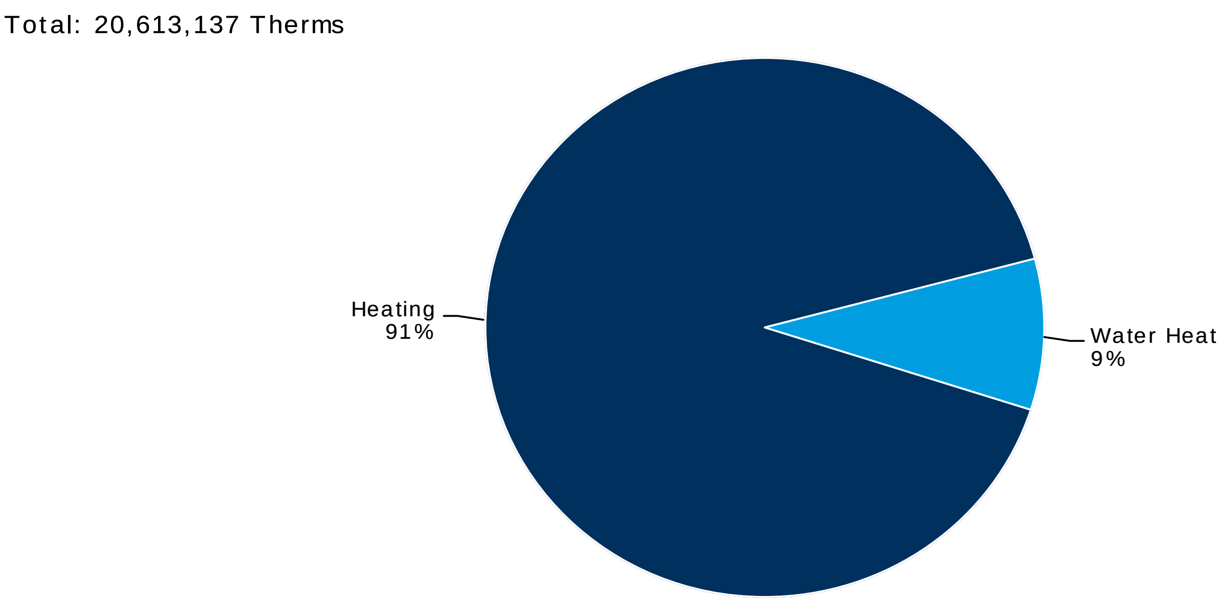


Figure B.4.47 Gas Achievable Technical Potential: Commercial Restaurant by End Use

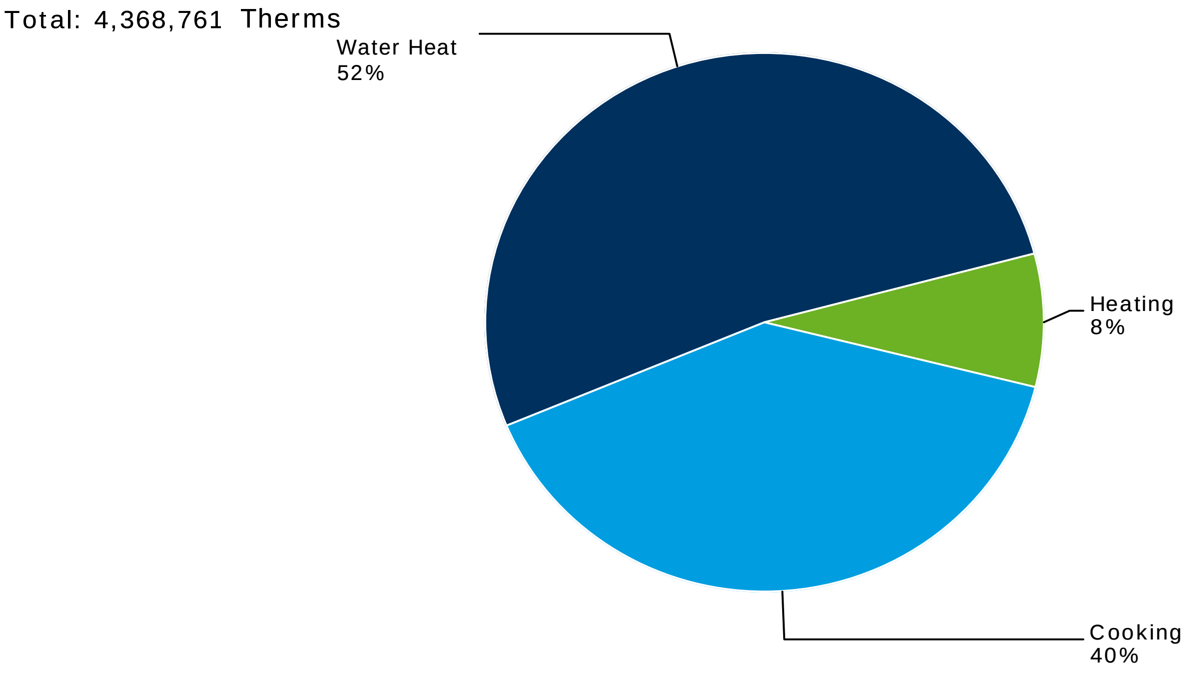


Figure B.4.48 Gas Achievable Technical Potential: Commercial Retail by End Use

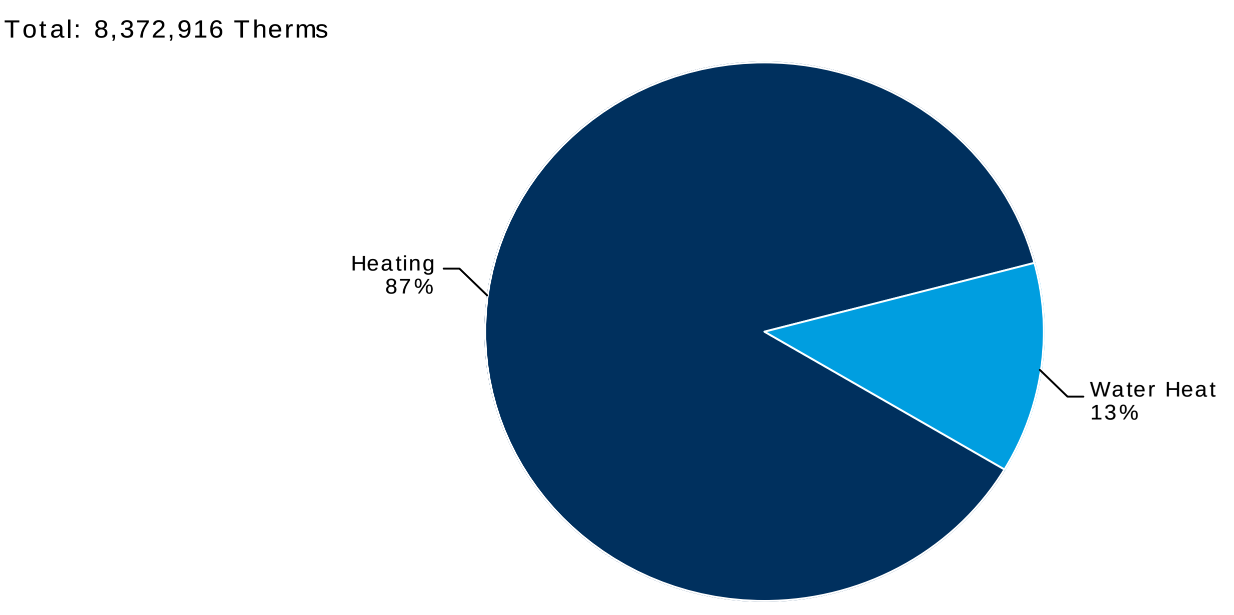


Figure B.4.49 Gas Achievable Technical Potential: Commercial Warehouse by End Use

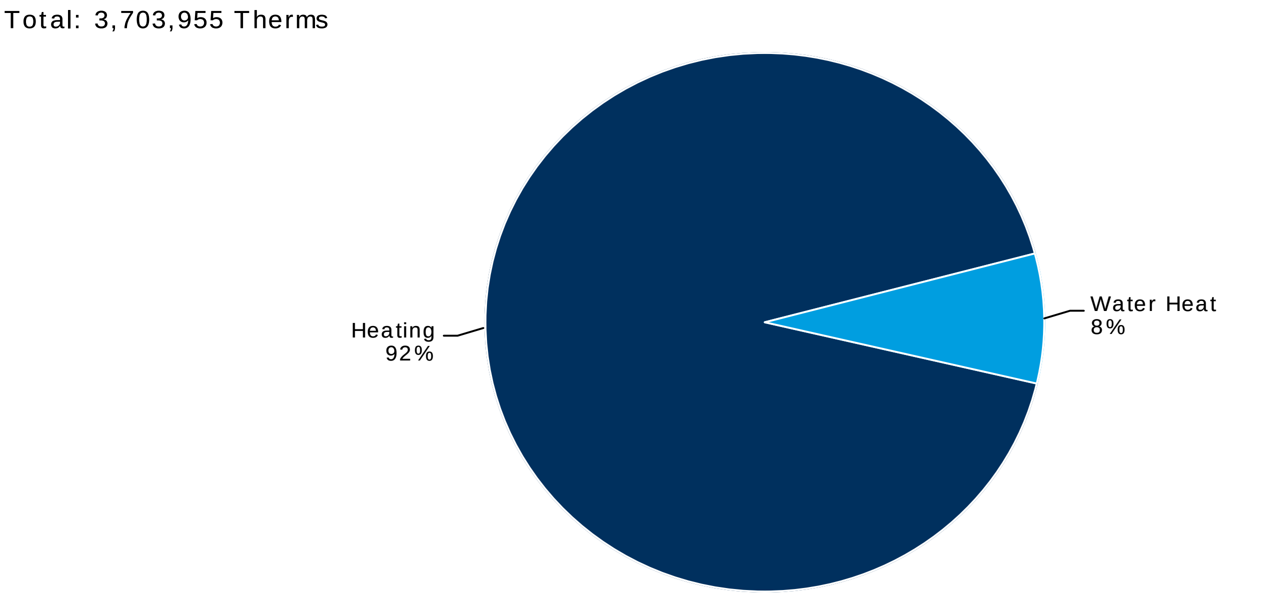


Figure B.4.50 Gas Achievable Technical Potential: Industrial Chemicals by End Use

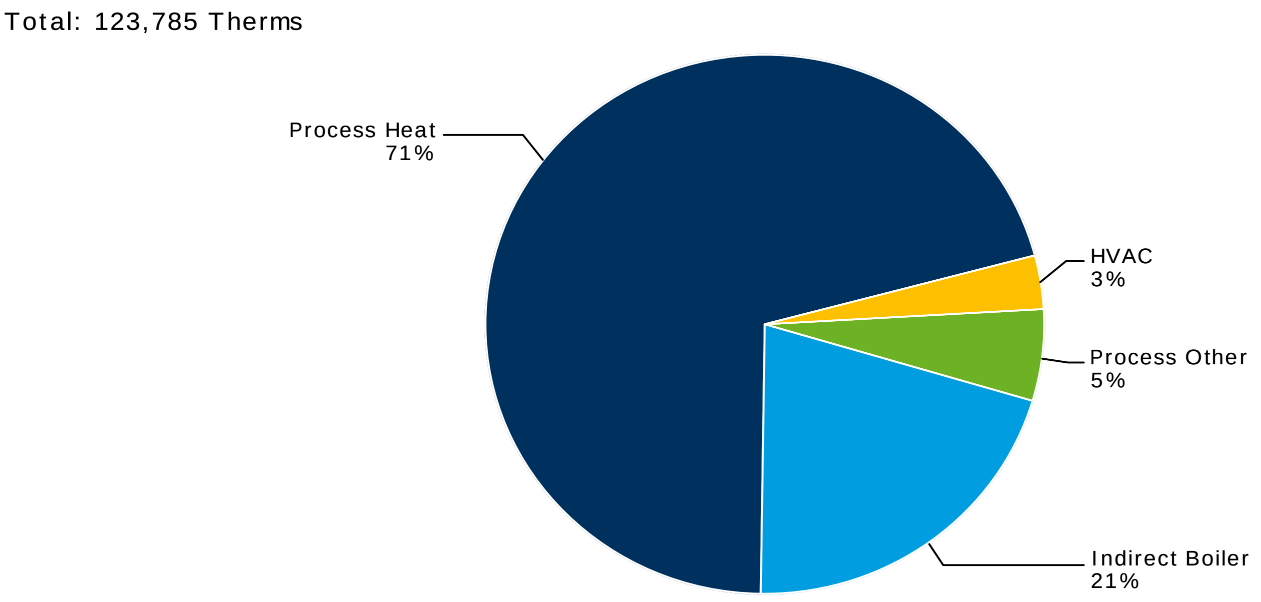


Figure B.4.51 Gas Achievable Technical Potential: Industrial Electrical by End Use

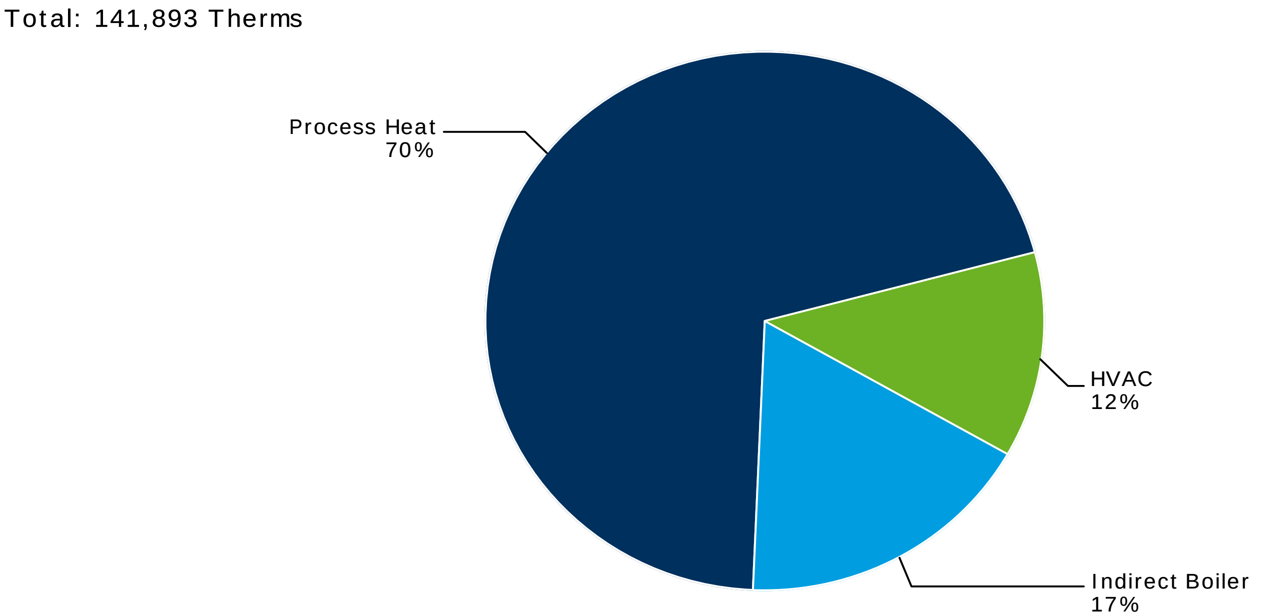


Figure B.4.52 Gas Achievable Technical Potential: Industrial Electronics by End Use

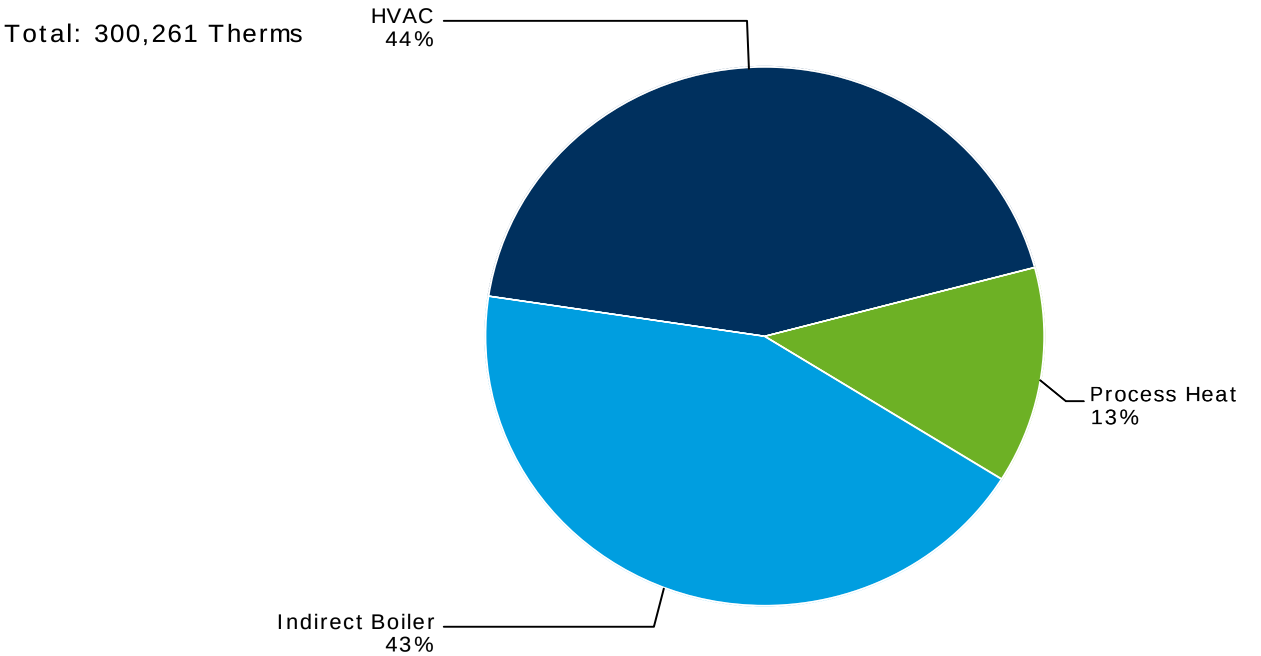


Figure B.4.53 Gas Achievable Technical Potential: Industrial Food by End Use

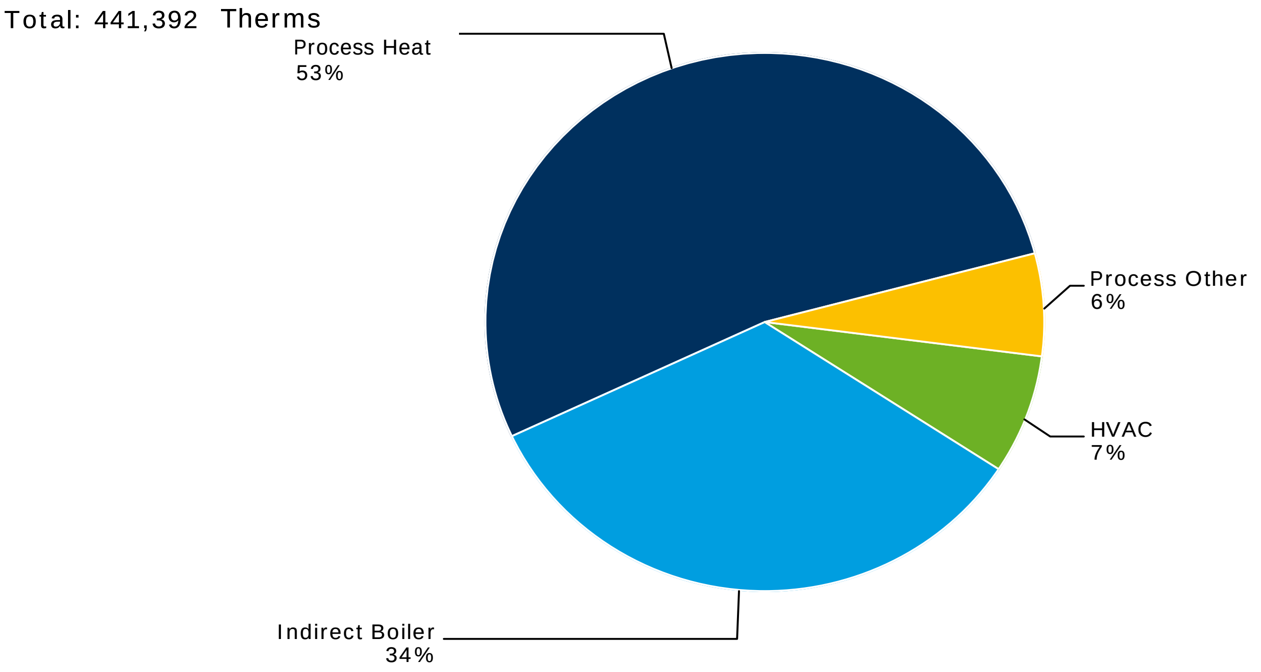


Figure B.4.54 Gas Achievable Technical Potential: Industrial Machinery by End Use

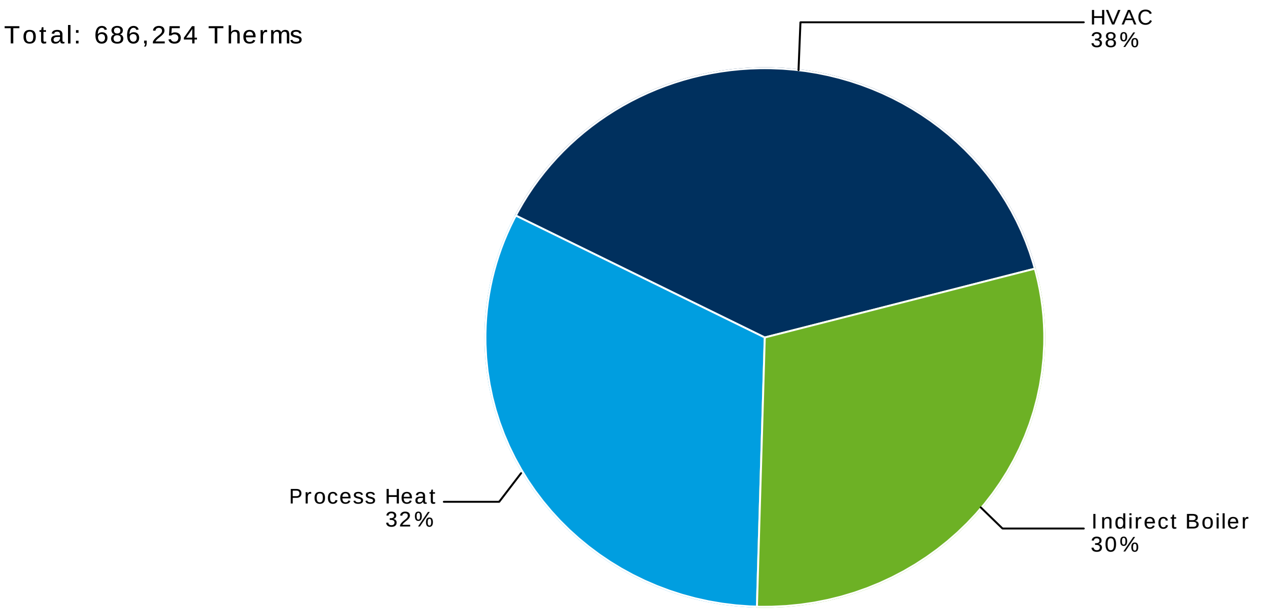


Figure B.4.55 Gas Achievable Technical Potential: Industrial Metals by End Use

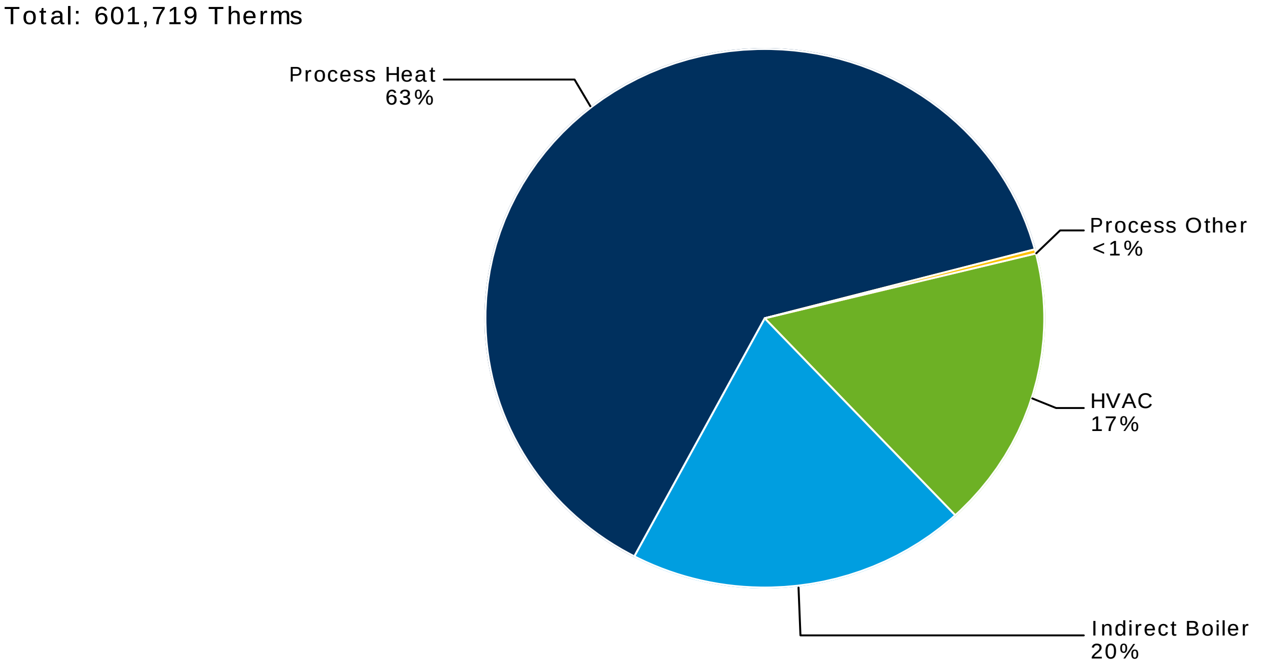


Figure B.4.56 Gas Achievable Technical Potential: Industrial Minerals by End Use

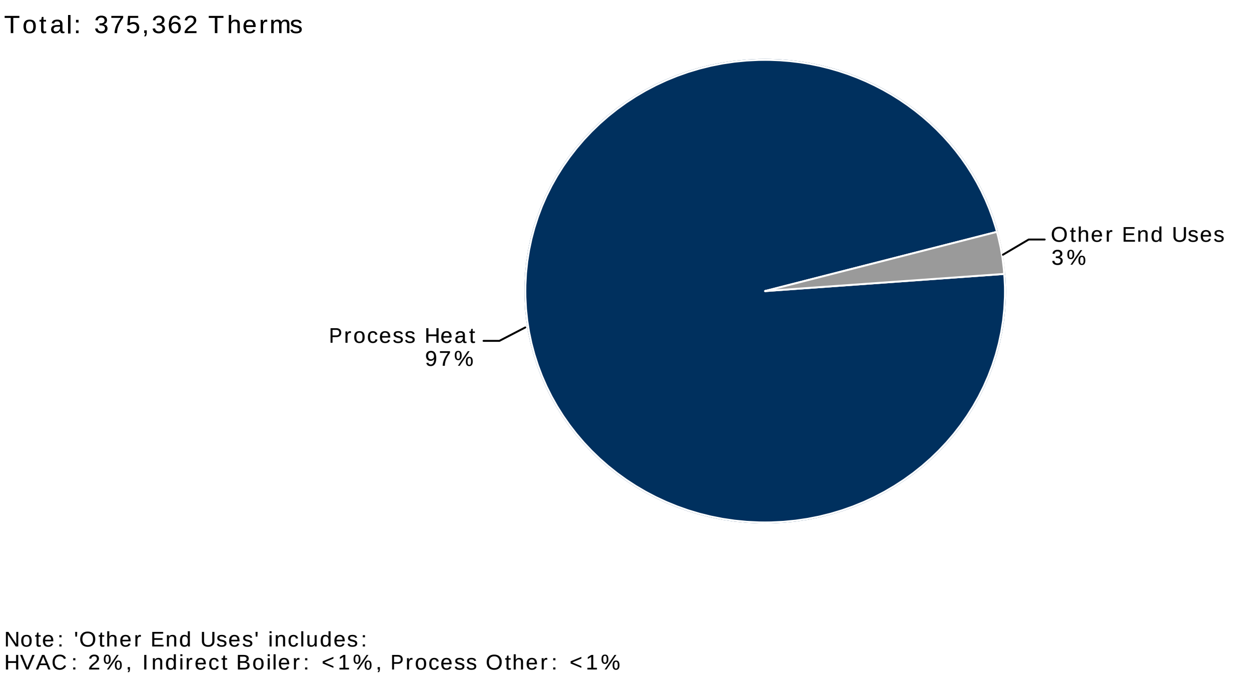


Figure B.4.57 Gas Achievable Technical Potential: Industrial Miscellaneous by End Use

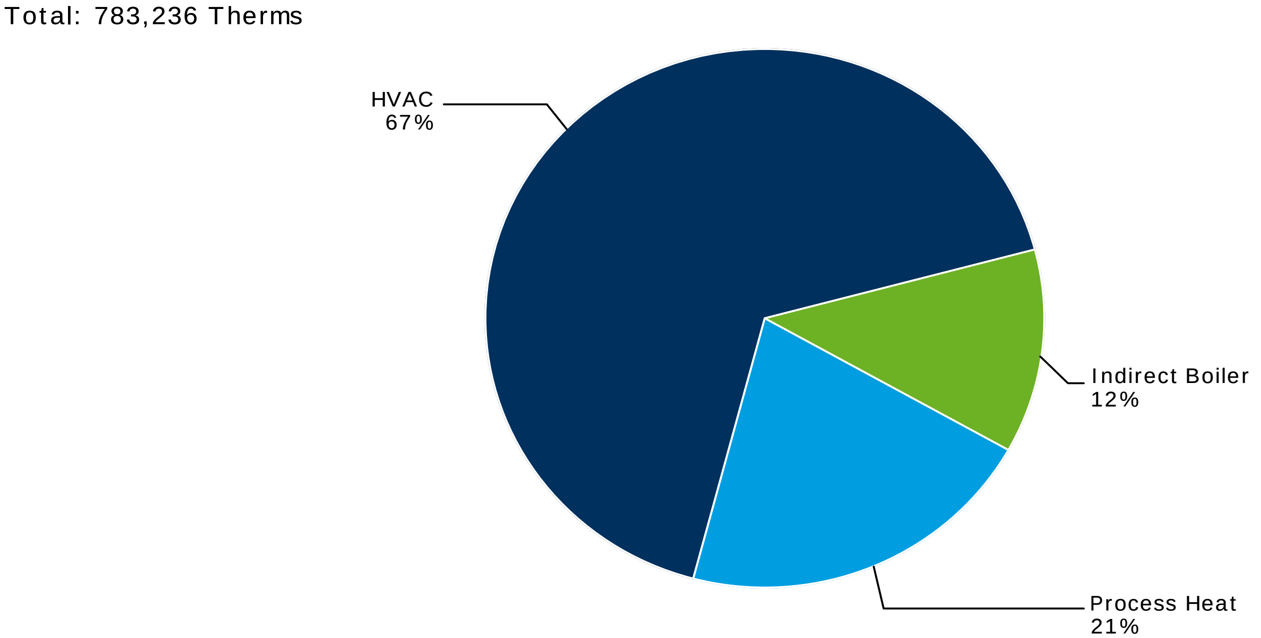


Figure B.4.58 Gas Achievable Technical Potential: Industrial Petroleum by End Use

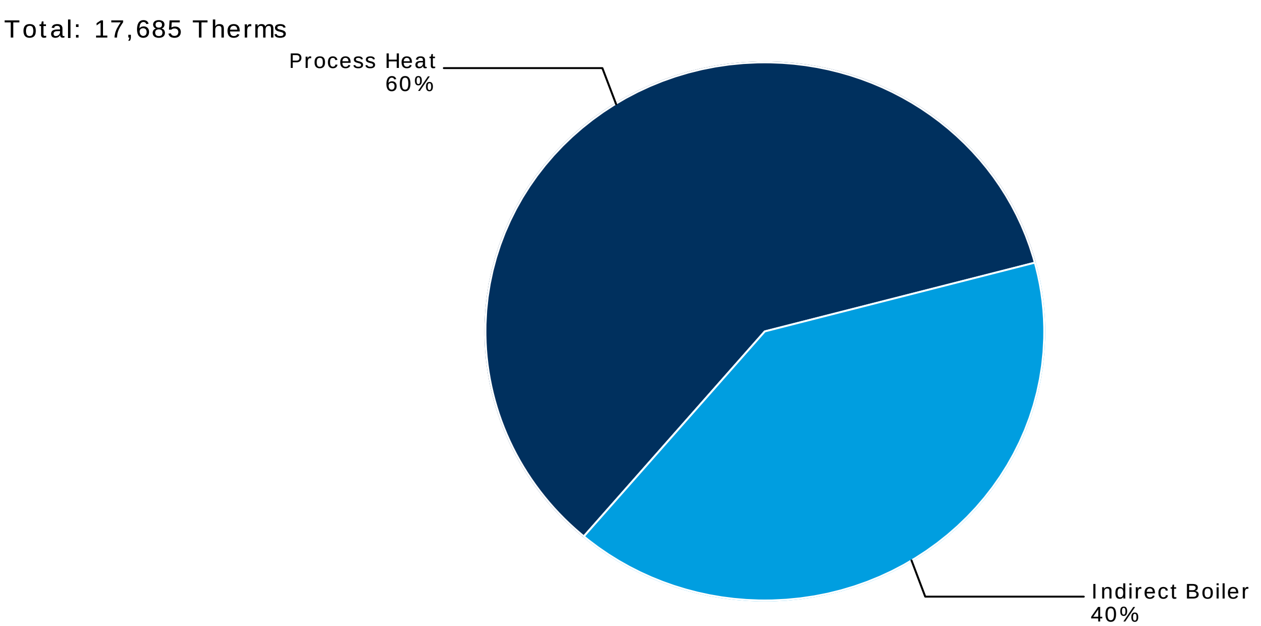


Figure B.4.59 Gas Achievable Technical Potential: Industrial Plastic/Rubber by End Use

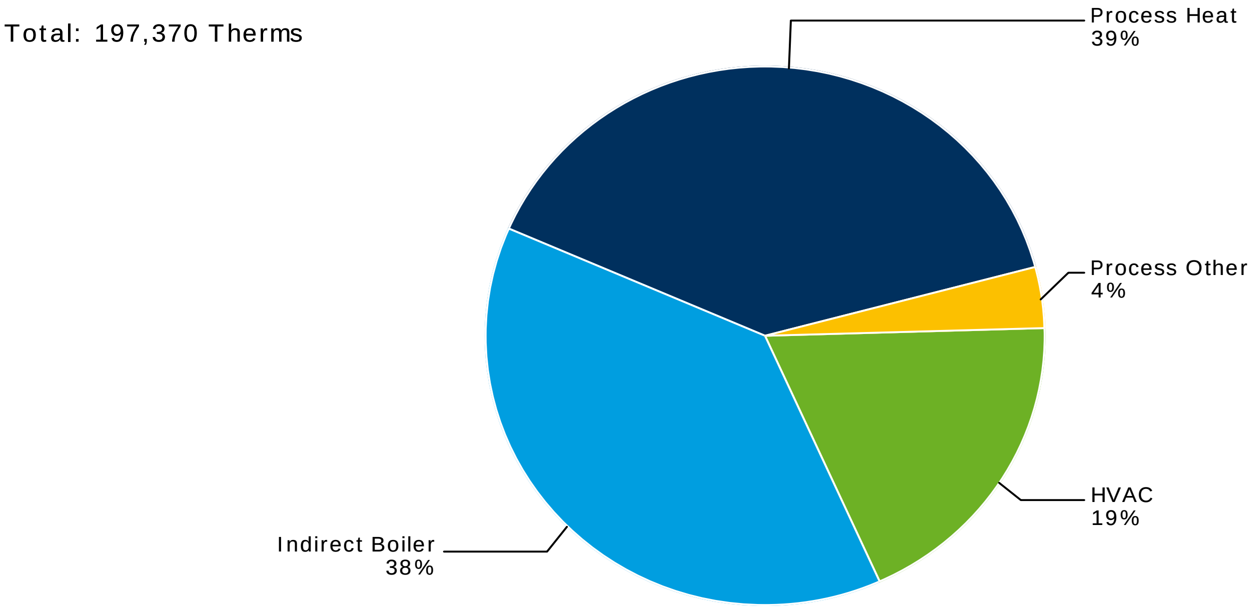


Figure B.4.60 Gas Achievable Technical Potential: Industrial Printing by End Use

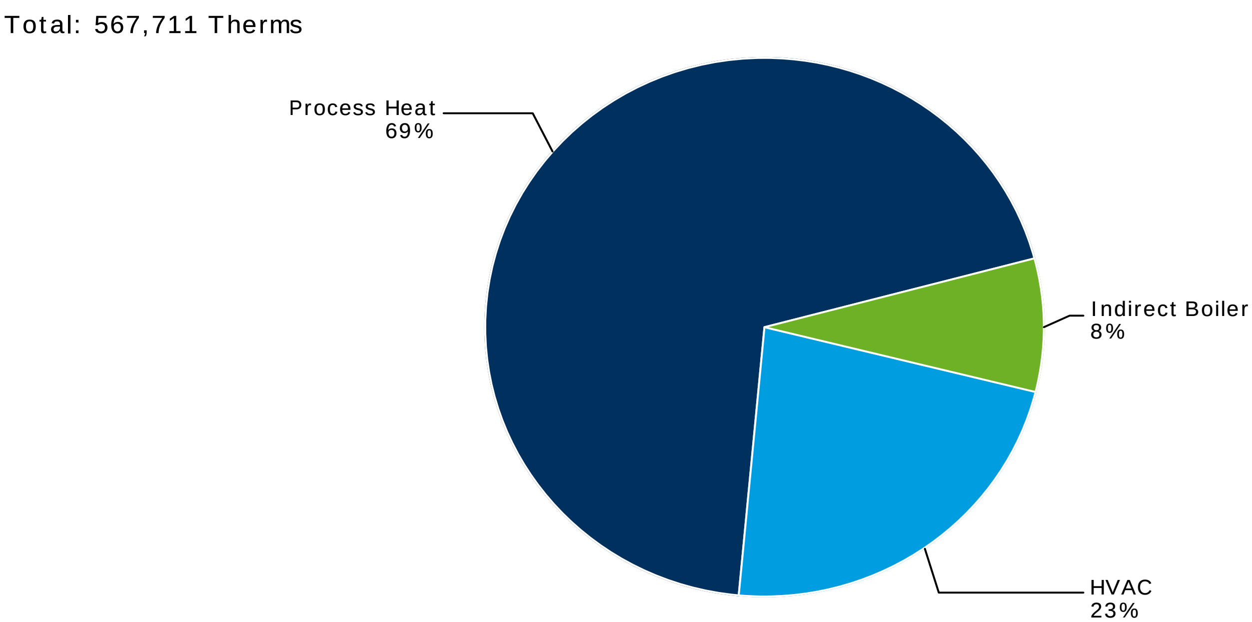


Figure B.4.61 Gas Achievable Technical Potential: Industrial Transportation by End Use

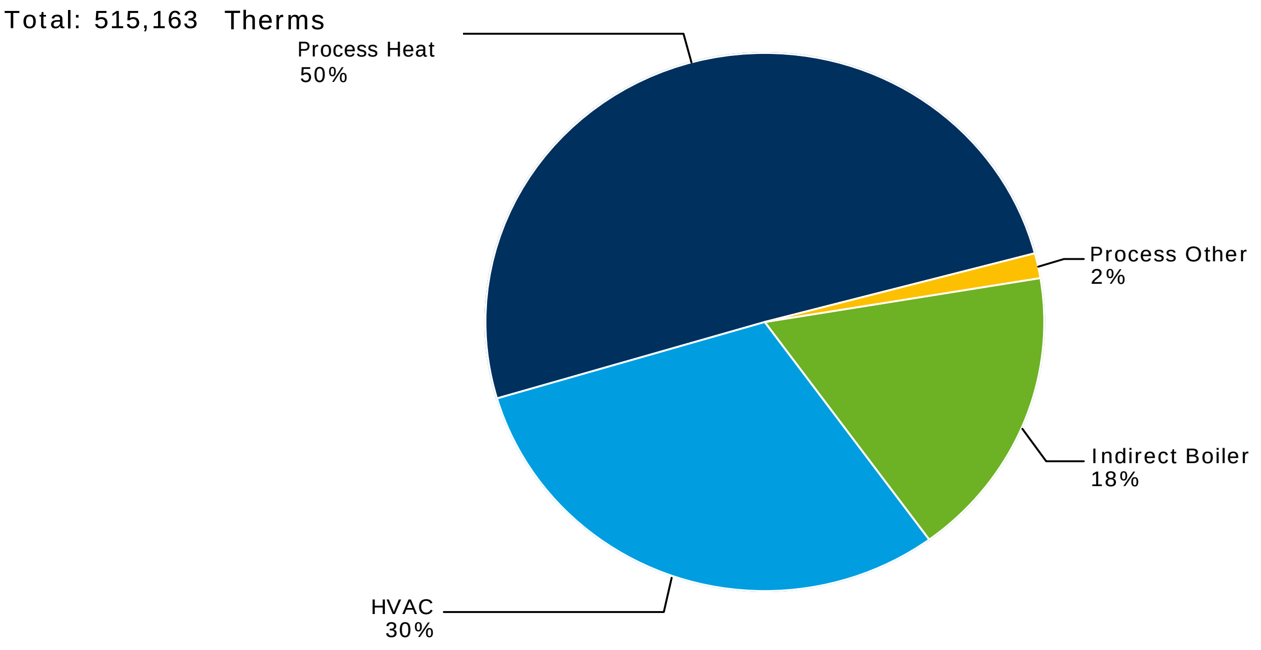
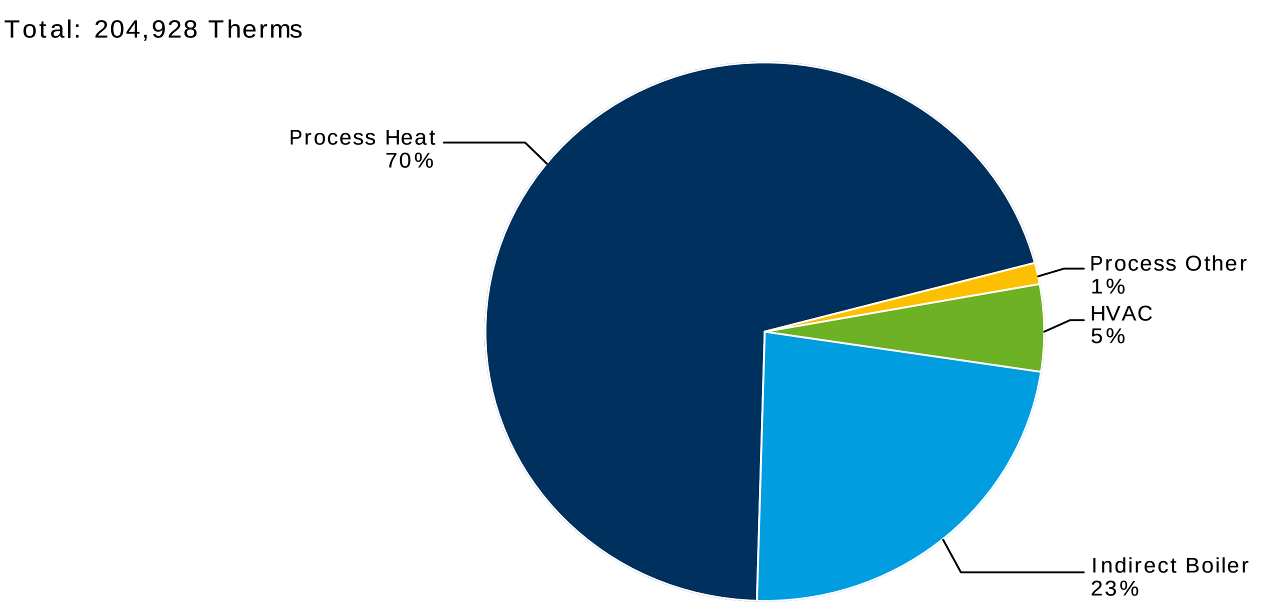


Figure B.4.62 Gas Achievable Technical Potential: Industrial Wood Products by End Use



Appendix C. Technical Supplements: Fuel Conversion

This appendix contains technical details about the fuel conversion potentials.

Table C.1 Economic Assumptions

Assumption	Value
Discount Rate	8.10%
Inflation Rate	2.50%
Electric T&D Savings	0.00%
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	$3,406
NPV Avoided Generation ($/kW)	$0.00
therms/kWh Conversion Factor	0.0341
Zone Heating Adoption Percentage	5%
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
Levelized Gas Avoided Cost (Dth)	$9.53

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 tariff information

UECs for space/water heating: EndUse Forecaster Model
All calculations done for kWh/therms at GENERATION

Table C.2 Piping and Labor Costs

End Use	Costs
Space Heating, Ducted	$700
Space Heating, Baseboard	$500
Clothes Drying	$200
Cooking	$200
Water Heating	$200
Space Heating	$700

Table C.3 Total Customers

Cutstomer Type	New	Existing
Single Family	NA	883,839
Commercial	107,443	172,072
Multifamily	200,715	NA

Table C.4 Distribution of Single-Family Home Size

Home Size	% of Homes
SFam - 1800 sq ft	50%
SFam - 2100 sq ft	10%
SFam - 2400 sq ft	40%

Table C.5 Fuel Conversion Measure Assumptions

Fuel Conversion Measure Assumptions

Sector	Segment	End Use	Construction Type	Discretionary / Lost Opportunity	Measure Name	Measure Description	Baseline Description	Measure Life	Unit Definition	Avg # of Units	EEM Per Unit Cost ($)	Baseline Measure Per Unit Cost ($)	Incremental Per Unit Cost ($)	Per Unit Site Savings (kWh)	Coincidence Factor	Annual Incremental Gas Costs
Residential	SFam - 2100 sq ft	Space Heating: Ducted	Existing	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 5,526.00	$ 875.42	$ 4,650.58	9287	0.000234	$ 563.51
Residential	SFam - 2400 sq ft	Space Heating: Ducted	Existing	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 5,526.00	$ 875.42	$ 4,650.58	10614	0.000234	$ 644.01
Residential	SFam - 2100 sq ft	Clothes Drying	Existing	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 679.00	$ 636.52	$ 42.48	738	0.000163	$ 30.68
Residential	SFam - 2100 sq ft	Cooking	Existing	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	121	0.000423	$ 14.22
Residential	SFam - 2100 sq ft	Water Heating	Existing	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,471.00	$ 654.26	$ 816.74	3500	0.000183	$ 154.41
Residential	SFam - 2100 sq ft	Water Heating	Existing	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	3500	0.000183	$ 203.09
Residential	SFam - 2400 sq ft	Clothes Drying	Existing	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 679.00	$ 636.52	$ 42.48	738	0.000163	$ 30.68
Residential	SFam - 2400 sq ft	Cooking	Existing	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	121	0.000423	$ 14.22
Residential	SFam - 2400 sq ft	Water Heating	Existing	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,471.00	$ 654.26	$ 816.74	3500	0.000183	$ 154.41
Residential	SFam - 2400 sq ft	Water Heating	Existing	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	3500	0.000183	$ 203.09
Commercial	Commercial	Space Heating: Ducted	Existing	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 8,147.92	$ 1,974.10	$ 6,173.82	8552	0.000234	$ 667.39
Commercial	Commercial	Water Heating	Existing	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 3,866.82	$ 1,957.73	$ 1,909.09	14247	0.000183	$ 1,034.51
Commercial	Commercial	Water Heating	Existing	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 3,357.84	$ 1,957.73	$ 1,400.10	14247	0.000183	$ 1,174.81
Commercial	Commercial	Water Heating	New	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 3,866.82	$ 1,957.73	$ 1,909.09	14074	0.000183	$ 1,109.78
Commercial	Commercial	Water Heating	New	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 3,124.85	$ 1,957.73	$ 1,167.12	14074	0.000183	$ 1,260.27
Commercial	Commercial	Space Heating	New	Discretionary	Warm-Up Heat	Gas warm up heat	Electric Furnace	30	Per installation	1	$ 17,032.37	$ 9,424.58	$ 7,607.79	22055	0.000234	$ 1,024.78
Commercial	Commercial	Space Heating	New	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 2,996.11	$ 1,974.10	$ 1,022.01	2115	0.000234	$ 379.61
Residential	MFam Mid Rise: Renter	Space Heating: Ducted	New	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 2,120.00	$ 875.42	$ 1,244.58	3361	0.000234	$ 284.95
Residential	MFam Mid Rise: Renter	Space Heating: Baseboard	New	Discretionary	Furnace	90% Furnace	Baseboard Heating	30	Per installation	1	$ 1,920.00	$ 164.87	$ 1,755.13	2588	0.000234	$ 284.95
Residential	MFam Mid Rise: Renter	Clothes Drying	New	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 679.00	$ 636.52	$ 42.48	578	0.000163	$ 30.68
Residential	MFam Mid Rise: Renter	Cooking	New	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	157	0.000423	$ 14.22
Residential	MFam Mid Rise: Renter	Water Heating	New	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,267.00	$ 654.26	$ 612.74	1696	0.000183	$ 111.02
Residential	MFam Mid Rise: Renter	Water Heating	New	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	1696	0.000183	$ 146.02
Residential	MFam Low Rise: Renter	Space Heating: Ducted	New	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 2,120.00	$ 875.42	$ 1,244.58	3361	0.000234	$ 284.95
Residential	MFam Low Rise: Renter	Space Heating: Baseboard	New	Discretionary	Furnace	90% Furnace	Baseboard Heating	30	Per installation	1	$ 1,920.00	$ 164.87	$ 1,755.13	2588	0.000234	$ 284.95
Residential	MFam Low Rise: Renter	Clothes Drying	New	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 679.00	$ 636.52	$ 42.48	578	0.000163	$ 30.68
Residential	MFam Low Rise: Renter	Cooking	New	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	157	0.000423	$ 14.22
Residential	MFam Low Rise: Renter	Water Heating	New	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,267.00	$ 654.26	$ 612.74	1696	0.000183	$ 111.02
Residential	MFam Low Rise: Renter	Water Heating	New	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	1696	0.000183	$ 146.02
Residential	MFam Mid Rise: Owner	Space Heating: Ducted	New	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 2,120.00	$ 875.42	$ 1,244.58	3361	0.000234	$ 284.95
Residential	MFam Mid Rise: Owner	Space Heating: Baseboard	New	Discretionary	Furnace	90% Furnace	Baseboard Heating	30	Per installation	1	$ 1,920.00	$ 164.87	$ 1,755.13	2588	0.000234	$ 284.95
Residential	MFam Mid Rise: Owner	Clothes Drying	New	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 679.00	$ 636.52	$ 42.48	578	0.000163	$ 30.68
Residential	MFam Mid Rise: Owner	Cooking	New	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	157	0.000423	$ 14.22
Residential	MFam Mid Rise: Owner	Water Heating	New	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,267.00	$ 654.26	$ 612.74	1696	0.000183	$ 111.02
Residential	MFam Mid Rise: Owner	Water Heating	New	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	1696	0.000183	$ 146.02
Residential	MFam Low Rise: Owner	Space Heating: Ducted	New	Discretionary	Furnace	90% Furnace	Electric Furnace	30	Per installation	1	$ 2,120.00	$ 875.42	$ 1,244.58	3361	0.000234	$ 284.95
Residential	MFam Low Rise: Owner	Space Heating: Baseboard	New	Discretionary	Furnace	90% Furnace	Baseboard Heating	30	Per installation	1	$ 1,920.00	$ 164.87	$ 1,755.13	2588	0.000234	$ 284.95
Residential	MFam Low Rise: Owner	Clothes Drying	New	Discretionary	Dryer	Moisture Sensor Dryer	Electric dryer w/ moisture sens, 7.0cuft	30	Per installation	1	$ 941.00	$ 636.52	$ 304.48	578	0.000163	$ 30.68
Residential	MFam Low Rise: Owner	Cooking	New	Discretionary	Over	Convection Cooking	Convection Electric range, 30"	30	Per installation	1	$ 849.00	$ 759.62	$ 89.38	157	0.000423	$ 14.22
Residential	MFam Low Rise: Owner	Water Heating	New	Discretionary	Water Heater	Tankless WH	Electric Water Heater, 50 gal.	30	Per installation	1	$ 1,267.00	$ 654.26	$ 612.74	1696	0.000183	$ 111.02
Residential	MFam Low Rise: Owner	Water Heating	New	Discretionary	Water Heater	WH (>67% EF)	Electric Water Heater, 50 gal.	30	Per installation	1	$ 943.10	$ 654.26	$ 288.84	1696	0.000183	$ 146.02

Figure C.1 Customers Available for Fuel Conversion