AVISTA ELECTRIC CONSERVATION POTENTIAL ASSESSMENT STUDY

Final Report — Electricity Potentials

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EXECUTIVE SUMMARY

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side management (DSM) resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012–2032. This report provides results of the electricity energy efficiency potential study only, and subsequent documents will address natural gas and DR potential.

Study Objectives

The study objectives included:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
  - Impacts of existing Avista DSM programs
  - Avista's load forecasts and load shapes
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
  - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and stacking EE resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

Study Approach

To execute this project, Global took the following steps, which are also shown in Figure ES-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.

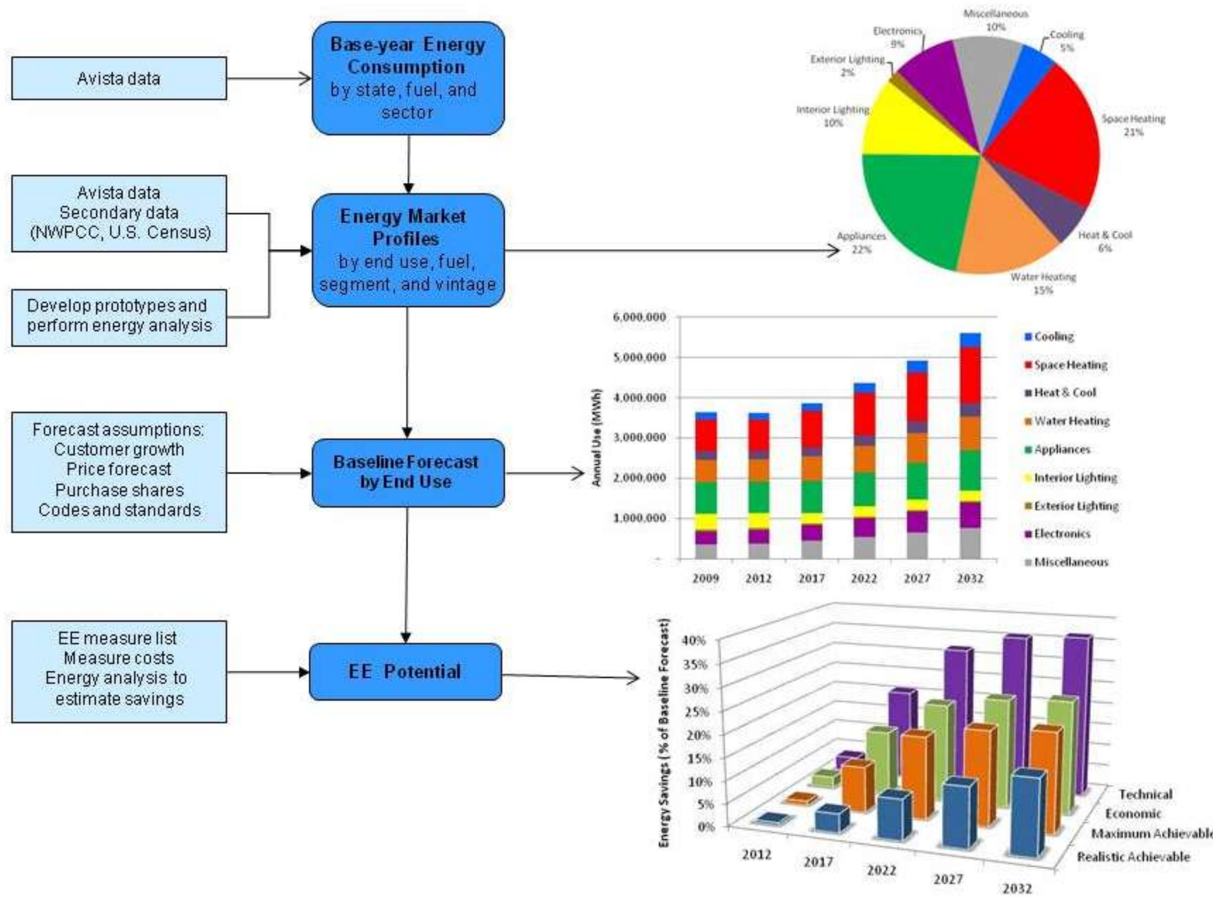
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.

3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.

4. Estimated three levels of energy-efficiency potential, *Technical, Economic,* and *Achievable*.

The steps are described in further detail in Chapter 2.

Figure ES-1 Analysis Approach Overview



The study segmented Avista customers by state and rate class (Residential, Commercial & Industrial (C&I) General Service, C&I Large General Service, Extra Large Commercial, and Extra Large Industrial). In addition, the residential class was segmented by housing type and income (single family, multi-family, mobile home, and low income). The low-income threshold for purposes of this study was defined as 200% of the Federal poverty level. For the pumping rate classes, representing 2% of load, the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator was used to determine future EE potential. Within each segment, energy use was characterized by end-use (e.g., space heating, cooling, lighting, water heat, motors, etc.) and by technology (e.g., heat pump, resistance heating, furnace for space heating). This market characterization is detailed in Chapter 3.

The baseline forecast is the "business as usual" metric, without new utility DSM programs, against which energy savings from energy efficiency measures are compared. The baseline forecast includes the projected impacts of known codes and standards, as of 2010 when the study was conducted. These include the Energy Independence and Security Act (EISA), which mandates higher efficacies for lighting technologies starting in 2012, and a series of recent appliance standards agreed upon in 2010. These recent codes and standards have direct bearing on the amount of utility program potential over and above the effects of codes and standards and naturally occurring conservation. This process incorporates the changes in market conditions such as customer and market growth, income growth, Avista's retail rates forecast, trends in end-use and technology saturations, equipment purchase decisions, consumer price elasticity, and income and persons per household. The baseline forecast enables understanding customer potential estimates in the context of total energy use in the future.

For each customer sector, a robust list of electrical energy efficiency measures was compiled, drawing upon the Sixth Power Plan database, the Regional Technical Forum (RTF), and other measures considered applicable to Avista. This list of energy efficiency equipment and measures included 2,808 equipment options and 1,524 measure options and represented a wide variety of major types of end-use equipment, as well as devices and actions to reduce energy consumption. Considered against current avoided costs, many of these measures do not pass the economic screens, but may ultimately be part of Avista's energy efficiency program portfolio during this 20-year planning horizon. Measure cost, savings, estimated useful life, and other performance factors were characterized for the list of measures. Cost-effectiveness screening was performed, using the total resource cost (TRC) test, for each measure and each year of the study to develop economic potential. The measure analysis is discussed in Chapter 5.

Market Characterization and Baseline Forecast

During 2009, Avista served 354,615 residential, commercial, industrial, and pumping customers with a combined electricity use of approximately 8,862 GWh.

Residential Sector

The total number of 2009 residential customers was 200,134 in Washington and 99,579 in Idaho. Table ES-1 shows their distribution by housing type and income level. The limited income category, which is composed of single-family, multi-family, and mobile homes, represents households with income below $35,000 annually.

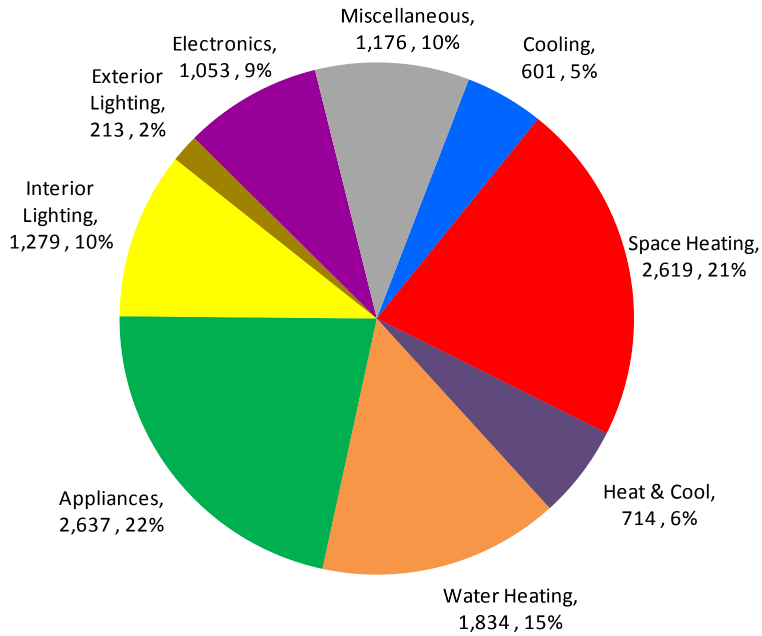
Table ES-1 Residential Electricity Usage and Intensity by Segment and State, 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

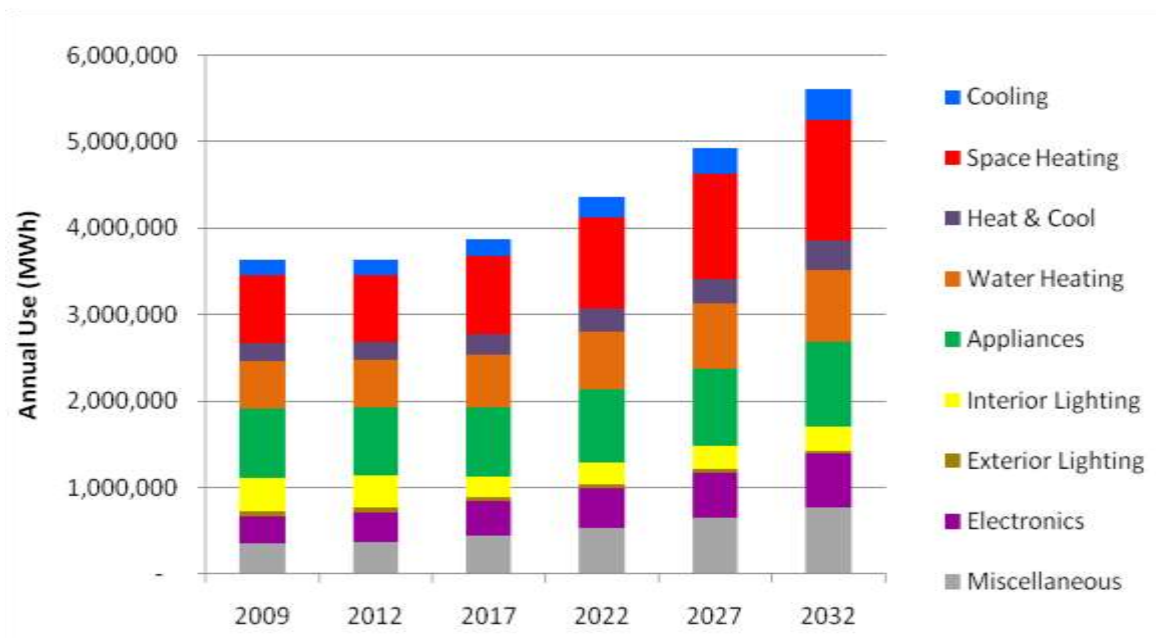
For each residential segment, a snapshot of electricity use by end use and technology was developed. Figure ES-2 presents the end-use breakout by household for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure ES-2 Residential Electricity Use by End Use per Household, 2009 (kWh and %)



The residential baseline forecast incorporates the effects of future customer growth, trends in appliance ownership, building codes, federal appliance standards and customer usage response to changes in electricity prices and household income. As such, it includes naturally-occurring energy efficiency. Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This reflects projected growth in the number of households, home size, and income levels, as well as relatively low electricity prices. Figure ES-3 shows the residential baseline forecast by end use.

Figure ES-3 Residential Baseline Forecast by End Use



Commercial & Industrial Sector

Table ES-2 and Table ES-3 present the segmentation of C&I customers in Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we treated them as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building.

Table ES-2 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table ES-3 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

Figure ES-4 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure ES-4 Commercial and Industrial Electricity Consumption by End Use, 2009

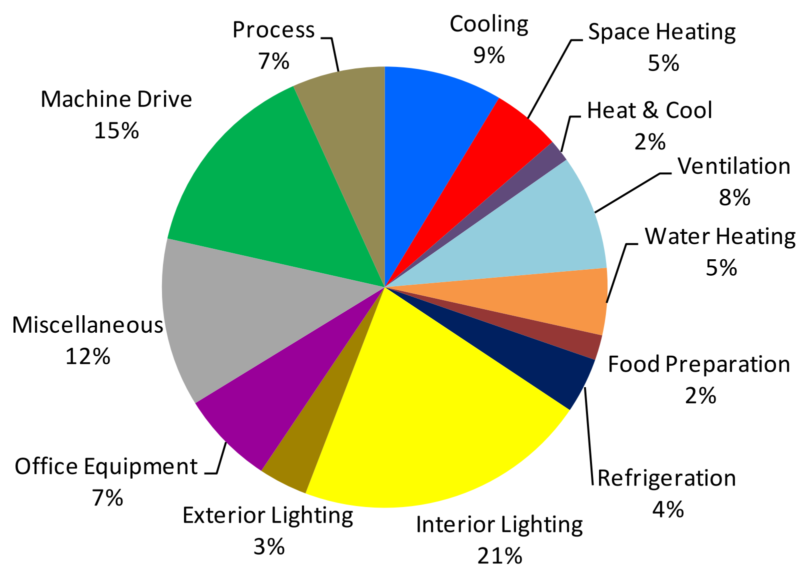
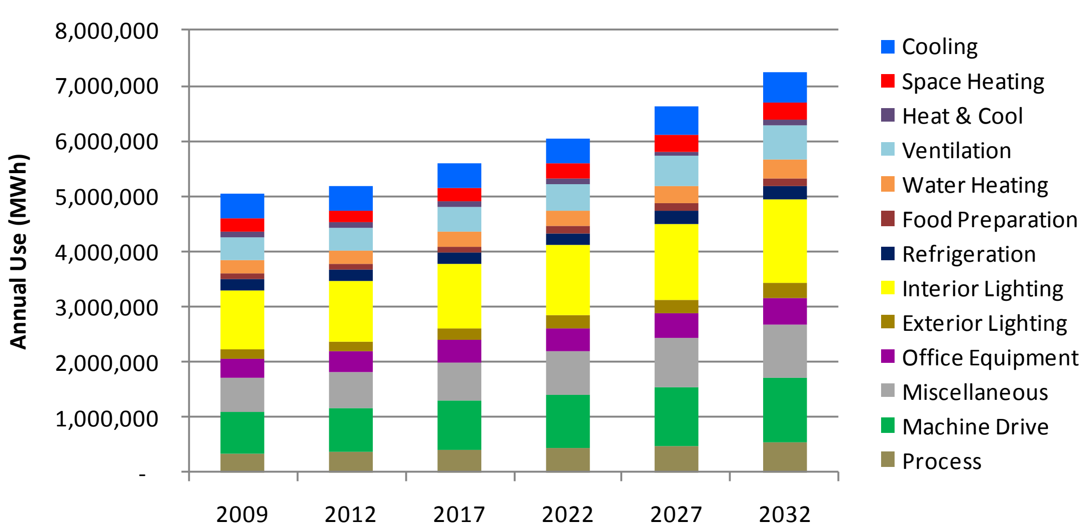


Figure ES-5 presents the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the EISA lighting standard.

Figure ES-5 C&I Baseline Electricity Forecast by End Use



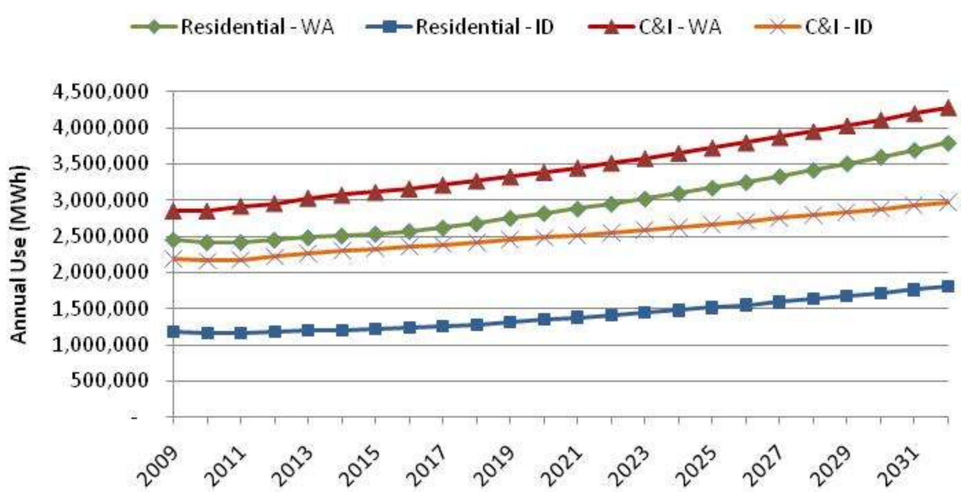
System-wide Baseline Forecast Summary

Table ES-4 and Figure ES-6 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table ES-4 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2022	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,947,427	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,408,812	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,509,816	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,551,291	2,970,324	36.2%	1.3%
Total	**8,667,109**	**8,799,039**	**10,417,347**	**12,851,760**	**48.3%**	**1.7%**

Figure ES-6 Baseline Forecast Summary by Sector and State



The baseline forecast, prior to the consideration of potentials, projects overall growth of 48% in electric consumption. This compounded average annual growth rate of 1.7% during this 20 year period is consistent with Avista's current and previous Integrated Resource Plans. Chapter 4 provides details of the baseline forecast.

Definitions of Potential

In this study, we estimated three types of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction.

Technical potential is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option. Examples of measures that make up technical potential in the residential sector include:

- Ductless mini-split air conditioners with variable refrigerant flow
- Ground source (or geothermal) heat pumps
- LED lighting for general service and linear applications

Technical potential also assumes the adoption of every available other measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning.

Economic potential represents the adoption of all ***cost-effective*** energy efficiency measures. As described earlier, LoadMAP performs an economic screen to determine which measures are economically viable. LoadMAP incorporates the result of the screen into the purchase shares to reflect the most efficient measure that passes the screen. For our analysis, we apply the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost, including the administrative costs associated with any energy-efficiency program.

Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, customer preferences and likely behavior, and budget constraints. It uses a set of market acceptance rate factors (MARs) and program implementation factors (PIFs) to take into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. For example, it considers that other goals such as low rates and customer equity influence the development of final program designs and savings targets. It also considers customer incentive levels that are in line with typical industry practice, defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The achievable potential also takes into account recent utility experience and reported savings from past and present programs. For this study, we developed MARs and PIFs based on the ramp rate curves used in the Sixth Power Plan.[1] These factors were then applied to this study's estimates of economic potential to estimate achievable potential.

Potential Savings from Electric Energy Efficiency

Achievable potential across all sectors is 49,804 MWh (5.7 aMW) in 2012 and increases to a cumulative value of 2,154,328 MWh (245.9 aMW) by 2032. These savings represents 0.6% of the baseline forecast in 2012 and 16.8% in 2032. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and

[1] The Sixth Power Plan Conservation Supply Curve workbooks are available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm, with separate workbooks for specific sectors and end uses.

economic potential savings are 26.3% of the baseline, or roughly 70% of technical potential savings. Achievable potential savings are nearly two-thirds of the economic potential savings.

Figure ES-7 displays the energy use forecast for the three potential levels versus the baseline forecast. Figure ES-8 summarizes the energy-efficiency savings for the three potential levels relative to the baseline forecast for selected years. Table ES-5 presents the energy consumption and peak demand for the potential levels across sectors.

Figure ES-7 Energy Efficiency Potential Forecasts, All Sectors

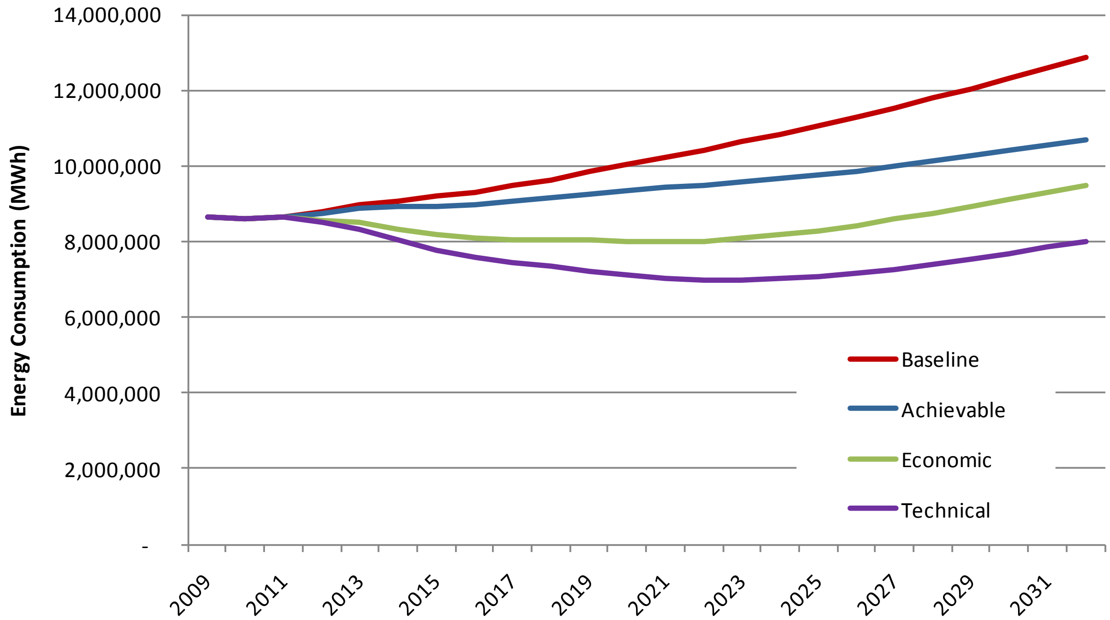


Figure ES-8 Summary of Energy Efficiency Potential Savings, All Sectors

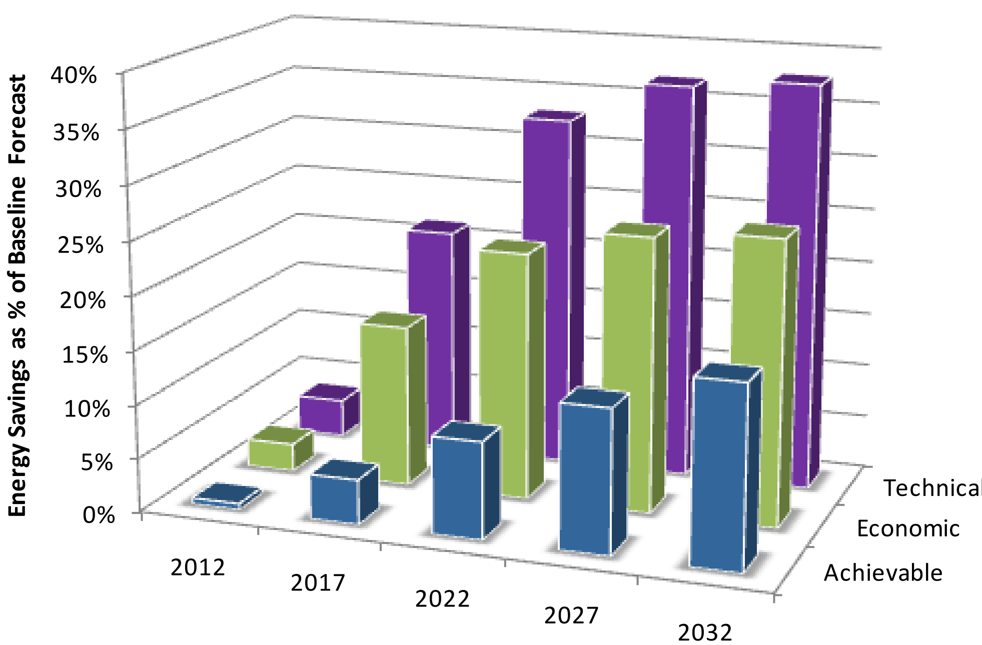


Table ES-5 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand(MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					
Achievable	49,804	395,397	940,578	1,538,868	2,154,328
Economic	229,657	1,426,454	2,398,355	2,942,457	3,386,190
Technical	311,274	2,022,115	3,435,475	4,255,664	4,853,304
Cumulative Energy Savings (% of Baseline)					
Achievable	0.6%	4.2%	9.0%	13.3%	16.8%
Economic	2.6%	15.1%	23.0%	25.5%	26.3%
Technical	3.5%	21.4%	33.0%	36.9%	37.8%
Peak Savings (MW)					
Achievable	14	80	182	307	431
Economic	55	278	474	582	659
Technical	71	398	669	829	944
Peak Savings (% of Baseline)					
Achievable	0.8%	4.3%	8.7%	13.3%	16.8%
Economic	3.1%	14.8%	22.8%	25.2%	25.7%
Technical	4.0%	21.2%	32.2%	35.9%	36.8%

Table ES-6 and Figure ES-9 summarize cumulative achievable potential by sector. Initially, the residential sector accounts for about 55% of the savings, but over time, the C&I sector becomes the source of about two-thirds of the savings.

Table ES-6 Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,067	86,316	234,163	433,646	637,443
Residential, ID	8,583	41,586	97,676	173,001	258,780
C&I, WA	15,732	173,410	378,252	575,336	774,620
C&I, ID	8,422	94,084	230,487	356,884	483,484
Total	**49,804**	**395,397**	**940,578**	**1,538,868**	**2,154,328**

Figure ES-9 Achievable Cumulative Potential by Sector

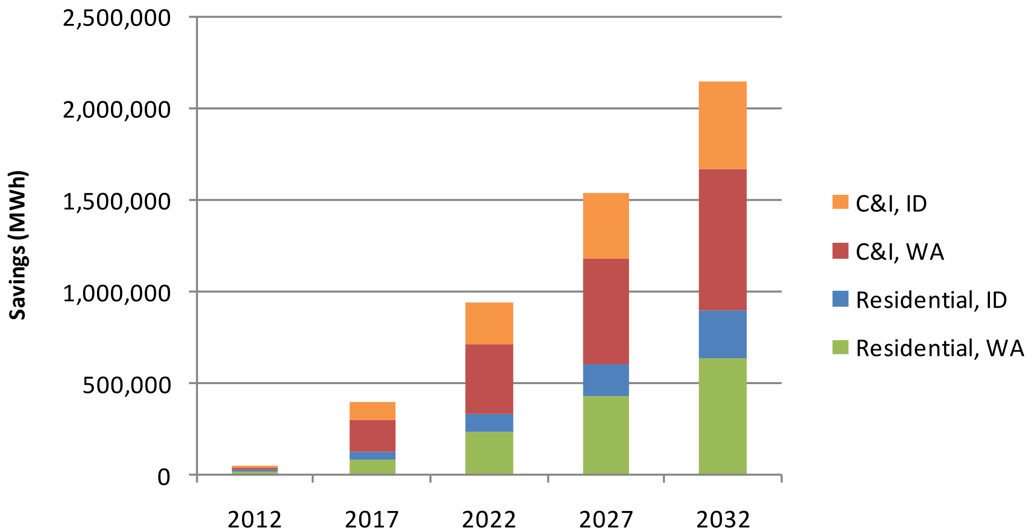


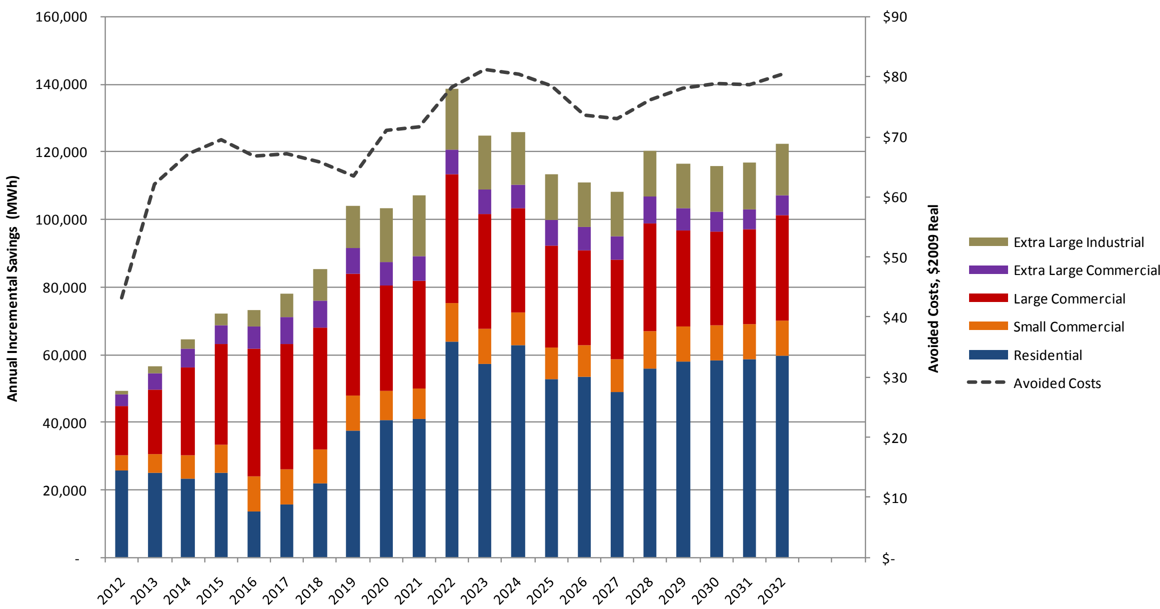
Table ES-7 shows the incremental annual potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential DSM programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table ES-7 Incremental Annual Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,067	16,617	15,532	16,987
Residential, ID	8,583	8,284	7,651	8,115
C&I, WA	15,732	21,164	26,867	30,388
C&I, ID	8,422	10,733	14,540	16,952
Total	**49,804**	**56,794**	**64,590**	**72,443**

Figure ES-10 illustrates how the annual incremental achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure ES-10 Incremental Annual Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

Residential Sector Potential

Achievable potential savings for the residential sector in both states is 25,650 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 896,223 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Table ES-8 presents estimates for energy and peak demand under the three types of potential.

In terms of how residential potential is divided among the various end uses, we note the following:

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative achievable potential.
- ***Space Heating*** offers the second-highest cumulative achievable potential over the study, again due to the potential for conversion to natural gas, but also due to shell measures, controls, and advanced new construction designs.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant

economic and achievable lighting potential due to conversion from advanced incandescents to CFLs.

- ***Appliances*** rank sixth based on technical potential, but fourth in terms of achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2032 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Table ES-8 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand(MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Achievable	25,650	127,902	331,839	606,647	896,223
Economic	89,536	516,557	954,743	1,193,149	1,372,852
Technical	135,708	856,938	1,468,041	1,830,901	2,113,776
Cumulative Energy Savings (% of Baseline)					
Achievable	0.7%	3.3%	7.6%	12.3%	16.0%
Economic	2.5%	13.3%	21.9%	24.3%	24.5%
Technical	3.7%	22.1%	33.7%	37.2%	37.7%
Peak Savings (MW)					
Achievable	10	40	98	180	262
Economic	33	148	281	351	396
Technical	45	233	407	505	580
Peak Savings (% of Baseline)					
Achievable	1.0%	3.9%	8.5%	14.0%	18.1%
Economic	3.3%	14.4%	24.4%	27.2%	27.3%
Technical	4.5%	22.7%	35.4%	39.2%	40.0%

Commercial and Industrial Sector Potential

Achievable potential savings for the C&I sector in both states is 24,154 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,104 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Table ES-9 presents estimates for the sector's energy and peak demand under the three types of potential.

Table ES-9 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Baseline Peak Demand(MW)	788	854	929	1,018	1,117
Cumulative Energy Savings (MWh)					
Achievable	24,154	267,494	608,739	932,221	1,258,104
Economic	140,121	909,897	1,443,612	1,749,309	2,013,338
Technical	175,565	1,165,177	1,967,434	2,424,763	2,739,528
Cumulative Energy Savings (% of Baseline)					
Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.8%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Achievable	4	40	84	127	169
Economic	22	130	193	231	263
Technical	27	165	262	324	364
Peak Savings (% of Baseline)					
Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.8%	32.5%	36.6%	37.8%

In terms of how potential is divided among the various end uses, we note the following:

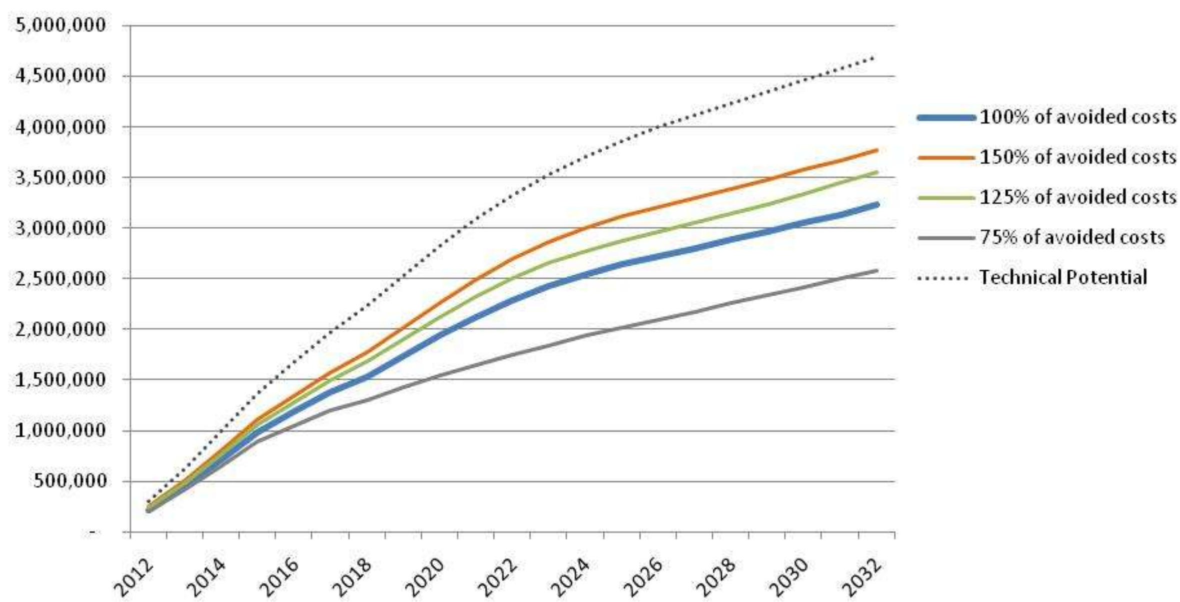
- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study's avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.
- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.

- ***Machine drive*** ranks fourth in achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer's Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- Savings from ***commercial refrigeration, food preparation, and water heating*** are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

Sensitivity of Potential to Avoided Costs

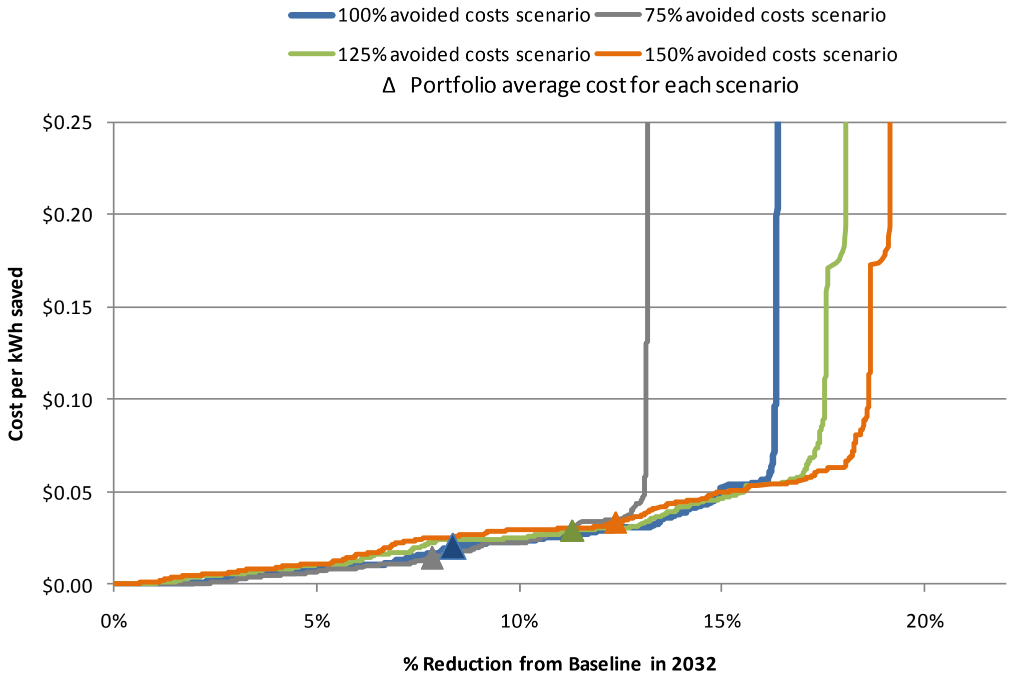
Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure ES -11 shows how achievable potential varies under the four scenarios. The base case achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively. While the changes are significant, the relationship between avoided cost and achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of DSM becomes increasingly expensive.

Figure ES -11 Energy Savings, Achievable Potential Case by Avoided Costs Scenario (MWh)



The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure ES -12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15% savings in 2032 at costs below $0.05/kWh.

Figure ES -12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



Sensitivity of Potential to Customer and Economic Growth

This conservation potential assessment shows that DSM offsets roughly 50% of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that DSM can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, the project team evaluated scenarios with lower customer and economic growth, as indicated in Table ES-10.

Table ES-10 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Household size	~ 1% per year growth	Capped at 110% of existing household size	Capped at 110% of existing household size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table ES -11 shows that as economic and customer growth decreases, the ability of DSM to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table ES -11 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

Pumping Potential

As displayed in Table ES -12, pumping accounts represent 2.2% of Avista's total electricity sales and 0.8% of peak demand. Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table ES -12 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets through 2019, based on 2007 sales. We trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results provided in Table ES -13 and Table ES -14.

Table ES -13 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table ES -14 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	**2,257**	**14,375**	**27,217**

Report Organization

The body of the report is organized as follows:

- Chapter 1, Introduction
- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER | 1

INTRODUCTION

1.1 BACKGROUND

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side management (DSM) resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012-2032. Although the final report will address electricity and natural gas, this interim report provides results of the electricity potential study only.

1.2 OBJECTIVES

Key objectives for the study include:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
    - Impacts of existing Avista DSM programs
    - Avista's load forecasts and load shapes
    - Impacts of codes and standards
    - Technology developments and innovation
    - The economy and energy prices
    - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and DR and stacking EE and DR resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

1.3 REPORT ORGANIZATION

The remainder of this report presents the results of the electricity conservation potential assessment for Avista's Washington and Oregon service territory. In most cases, results for Avista's overall electric system are presented in the body of the report, and Washington- and Oregon-specific results are presented in Appendices A and B respectively. The report is organized as follows:

- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

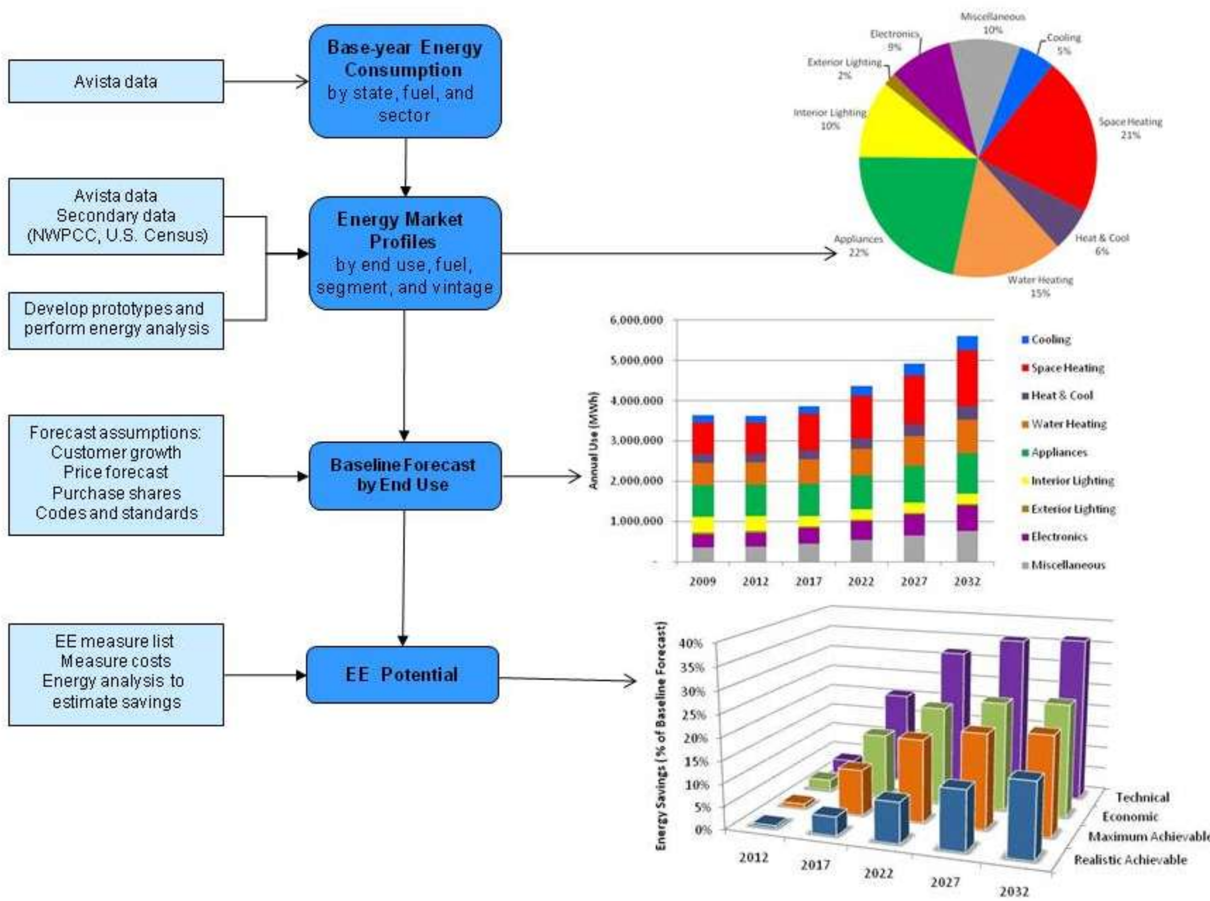
STUDY APPROACH FOR ENERGY EFFICIENCY ANALYSIS

To execute this project, Global took the following steps, which are also shown in Figure 2-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.
3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.
4. Estimated four levels of energy-efficiency potential, *Technical, Economic,* and *Achievable*.

The steps are described in further detail throughout the remainder of this section.

Figure 2-1 Analysis Approach Overview



2.1 MARKET ASSESSMENT AND MARKET PROFILES

It is absolutely critical to develop a good understanding of where Avista is today in terms of energy use and customer behavior before developing projections of potential EE savings. The purpose of the market assessment is to develop market profiles that describe current electricity use in terms of sector, customer segment, and end use. The base year for this study is 2009, the most recent year for which complete billing data was available at the start of the study.

We began the market assessment by defining the market segments (building types, end uses and other dimensions) that are relevant in the Avista service territory. The segmentation scheme employed for this project, as presented in Table 2-1, is based on Avista rate schedules. For the pumping rate classes, we determined to use the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator to determine future EE potential.

Table 2-1 Segmentation Framework for Electricity

Market Dimension	Segmentation Design	Dimension Examples
Dimension 1	Geographic Region	Washington, Idaho
Dimension 2	Sector / Rate Class	Residential — Rate Class 001 C&I General Service — Rate Class 011, 012 C&I Large General Service — Rate Classes 021, 022 Comm. Extra Large General Service — Rate Class 025 Ind. Extra Large General Service — Rate Classes 025, 025P Pumping — Rate Classes 030, 031, 032
Dimension 3	Building Type	Residential: single-family, multi-family, mobile home, limited income No further segmentation of C&I and pumping, except for XLarge General Service, which was divided into commercial and industrial segments
Dimension 4	Vintage	Existing and new construction (as appropriate for residential and commercial sectors)
Dimension 5	End Uses	Cooling, lighting, water heat, motors, etc. (as appropriate by sector)
Dimension 6	Appliances/End Uses and Technologies	Cooling, lighting, water heat, motors, etc. (as appropriate by sector); Technologies such as types of lamps, chillers, color TVs, etc.
Dimension 7	Equipment Efficiency Levels	Old, Standard (minimum standard), Maximum Efficiency

With the segmentation scheme defined, we set out to populate the market profiles. The first step was to identify the electricity sales in the base year for each segment using Avista's 2009 historical customer billing data by rate class. In order to further divide the residential sector, we relied upon regional demographic and economic data from secondary sources (see below).

Then, we developed the data for the remaining market profile elements, which include market size, annual electricity use, electric appliance and equipment saturations, technology shares, and end-use consumption estimates (unit energy consumption or UEC for residential customers and energy use index or EUI for C&I customers). We calibrated the elements of the market profile for each segment to match the segment and sector-level sales we developed in the previous step. We developed market profiles for the entire existing market, as well as new construction in each segment.

While this study did not involve any primary market research, a wealth of primary data is available for the Pacific Northwest region from NEEA and a recent customer saturation survey from Inland Power and Light, a neighboring utility. In addition, data were available from a residential survey conducted as part of Inland Power's December 2009 CPA. We used these sources together with other secondary data, including the Energy Information Agency's Residential Energy Consumption Survey (RECS), the Annual Energy Outlook (AEO), the California's Residential Appliance Saturation Survey (RASS), and the California Commercial End Use Survey (CEUS), to develop the market profiles.

In addition to information about annual electricity use, we also needed estimates of peak demand by segment and end use in order to calculate peak-demand savings from EE measures. We developed a set of peak factors, factors that represent the fraction of annual energy use that occurs during the peak hour, and apply them to annual electricity use to calculate peak demand by end use. Peak factors for this study were developed for each sector, customer segment and end use using Global's EnergyShape™ database and information from Avista regarding its load shapes and peak demand.[2]

Table 2-2 summarizes the data required for the market profiles. This information is required for each segment within each sector, as well as for new construction and existing dwellings/buildings. Additional details regarding sources appear in Appendix E.

Table 2-2 Data Needs for the Market Profiles

Model Inputs	Description	Key Sources
Base-year data		
Market size	Base-year residential dwellings and C&I floor space	Avista billing data, NEEA Reports
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology; Percentage of C&I floor space with equipment/technology	NEAA reports, Inland Power & Light residential saturation survey, RECS, and other secondary data
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwelling that have the technology; EUI: Annual electricity use per square foot for a technology in floor space that has the technology	NEAA reports, RASS, CEUS, engineering analysis, prototype simulations, engineering analysis
Appliance/equipment vintage distribution	Age distribution for each technology	NEEA reports, RASS, CEUS, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Prototype simulations, engineering analysis, appliance/equipment standards, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Peak factors	Share of technology energy use that occurs during the peak hour	Avista data; Global's EnergyShape database

The quality of data inputs is critical. To ensure the best results, we pursued the following course during the data-development process.

[2] The peak factors were used to compute peak demand savings only and they were not used to develop a stand-alone peak-demand forecast.

1. Used NEEA reports, the Inland Power & Light survey of its residential customers, and RECS to provide information about market size for customer segments, appliance and equipment saturations, appliance and equipment characteristics, UECs, building characteristics, customer behavior, operating characteristics, and energy-efficiency actions already taken.
2. Incorporated secondary data sources to supplement and corroborate the research in items 1 and 2 above.
3. Compared and cross-checked with data obtained as part of other northwest utility studies, the EPRI National Potential Study, and other regional sources.
4. Ensured calibration to control totals such as total usage values by segment, available through the billing data.
5. Worked with the Avista staff and the extended project team to vet the data against their knowledge and experience.

The market assessment, market segmentation, and resulting market profiles are presented in Chapter 3.

2.2 BASELINE FORECAST

The next step of the energy efficiency potential study was to develop the baseline forecast which is the metric against which savings from energy-efficiency measures are compared. The baseline case forecasts annual electricity use and peak demand by customer segment and end use under a "business as usual" (without new utility programs) scenario for the 20-year planning horizon starting in 2012. This process is crucial as it allows for projections to be determined in the absence of future DSM programs. This puts the changes in market conditions and customer potentials estimates in context of total energy use in the future and also allows us to project where the energy-efficiency savings will come from. The end-use forecast also includes the expected impacts of codes and standards, which affect what is possible through utility programs. Given the recent extensive attention to energy efficiency at the national level through Smart Grid and American Reinvestment and Recovery Act (ARRA) stimulus efforts and promulgated through the implementation of more stringent codes and standards both nationally and in local jurisdictions, we have taken steps in our modeling framework to capture the effects of market influences in our baseline forecast assessments. This is an important issue for this study, as the adoption of future codes and standards will have a direct bearing on how much utility program EE potential there can be over and above the effects of those efforts. This study includes standards in effect as of late 2010, which were not taken into account during the development of the Sixth Plan.

Inputs to the baseline forecast include:

- Current economic growth forecasts
- New construction forecasts
- Appliance and equipment standards
- Existing and approved changes to building codes and standards
- Forecasted changes in fuel share and equipment saturation
- The (future) effects of utility programs offered prior to 2010
- Avista's electricity price and sales forecasts

2.2.1 Modeling Approach

We used the Load Management Analysis and Planning tool (LoadMAP^{TM}) to develop the baseline forecast, as well as forecasts of energy-efficiency potential. Global developed LoadMAP in 2007 and has used it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies. Built in Excel, the LoadMAP framework is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction, replacement upon failure, early replacement, and non-owner acquisition separately.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting equipment is distinct from refrigerators and freezers.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles we describe above, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use and technology for existing and new buildings. It provides forecasts of total energy use and energy-efficiency savings associated with the three types of potential: technical, economic, and achievable. It also provides forecasts of peak-demand savings for each type of potential.[3]

Table 2-3 summarizes the LoadMAP model inputs required for the baseline forecast. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

[3] The model computes a peak-demand forecast for each type of potential for each end use as an intermediate calculation. Peak-demand savings are calculated as the difference between the peak-demand value in the potential forecast (e.g., technical potential) and the peak-demand value in the baseline forecast.

Table 2-3 Data Needs for the Baseline Forecast and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Avista 2009 IRP, Sixth Power Plan, Regional census data
Equipment purchase shares for baseline forecast	For each equipment/technology, purchase shares for each efficiency level; specified separately for equipment replacement (replace-on-burnout), non-owner acquisition, and new construction	Shipments data, AEO forecast assumptions, appliance/efficiency standards analysis
Electricity prices	Forecast of average electricity prices	Avista price forecast data
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models; Avista forecasting data

We present the results of the baseline forecast development in Chapter 4. As with the development of the market profiles, we reviewed the baseline forecast results with the Avista staff.

2.3 ENERGY EFFICIENCY MEASURES ANALYSIS

The framework for assessing savings, costs, and other attributes of energy-efficiency measures involves identifying the list of measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit/early replacement of equipment, improvements to the building envelope and other actions resulting in improved energy efficiency, and the application of controls to optimize energy use.

We compiled a robust listing of energy efficiency measures for each customer sector, drawing upon a variety of secondary sources:

- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER). The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.
- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S. This is analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). In 2009, Global conducted an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions (including the Pacific region that includes California).

Based on this compilation of information, Global assembled a broad and inclusive universal list of EE measures, covering all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, many of these measures would not pass the economic screens, but may ultimately be part of Avista's EE program portfolios.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For energy-saving measures not already specified in the databases above, we used Global's Building Energy Simulation Tool (BEST), a derivative of the DOE 2.2 building simulation model, to estimate measure savings. We used building prototypes for the Northwest region to estimate energy savings.

For each measure we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic potential.

We provide further descriptions of EE measures analysis and the economic screening process in Chapter 5.

2.4 ASSESSMENT OF ENERGY-EFFICIENCY POTENTIAL

A key objective of this study is to estimate the potential for energy savings through energy efficiency activities in the Avista electric service territory. The potential impact of EE activities is the cumulative total of all energy-related projects.

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[4] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. Specifically, three types of potentials were developed as part of this study:

- ***Technical potential*** is calculated by applying the most efficient option commercially available to each purchase decision, regardless of cost. It is a theoretical case that provides the broadest and highest definition of savings potential since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced by the most efficient feasible type. Technical potential does not take into account the cost-effectiveness of the measures. Further, technical potential is specifically defined as "phase-in technical potential," which assumes that only the portion of the current stock of equipment that has reached the end of its useful life and is due for turnover is changed out by the most efficient measures available (i.e., replacement). Non-equipment measures, such as controls and other devices (e.g., programmable thermostats) are not adopted all at once but are phased-in over time, just like the equipment measures. Lighting retrofits, which are in effect early replacements of existing lighting systems, are considered a non-equipment measure.
- ***Economic potential*** results from the purchase of the most efficient *cost-effective* option available for a given equipment or non-equipment measure. Cost effectiveness is determined by applying an economic test. In this report, the total resource cost (TRC) test[5] was used to assess the cost-effectiveness of individual measures. Measures that passed the economic screen were then represented in the aggregate for economic potential. As with technical potential, economic potential is a phased-in approach. Economic potential is still a hypothetical upper-boundary of savings potential as it represents only measures that are economic but does not yet consider customer acceptance and other factors.
- ***Achievable potential*** refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, customer preferences and likely behavior, and budget constraints. It uses a set of market acceptance rate factors (MARs) and program implementation factors (PIFs) to take into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. For example, it considers that other goals such as low rates and customer equity influence the development of final program

[4] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025:* Developing a Framework for Change. www.epa.gov/eeactionplan.
[5] While there are other tests that can be used to represent the economic potential (e.g., Participant or Utility Cost), the TRC is generally seen as the most appropriate representation of economic potential since it tends to be most representative of the net benefits of energy efficiency to society as a whole. The TRC is used in the economic screen as a proxy for moving forward and representing achievable energy efficiency savings potential for those measures that are most widely cost-effective.

designs and savings targets. It also considers customer incentive levels that are in line with typical industry practice, defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The achievable potential also takes into account recent utility experience and reported savings from past and present programs. For this study, we developed MARs and PIFs based on the ramp rate curves used in the Sixth Power Plan.[6] These factors were then applied to this study's estimates of economic potential to estimate achievable potential.

2.4.1 Modeling Approach

We used LoadMAP to develop the estimates of technical, economic, achievable. LoadMAP calculates results in terms of annual energy saved (kWh) and peak demand reduction (MW) for each level of potential by market segment, end use, and measure type. Figure 2-2 illustrates the LoadMAP process for developing both the baseline forecast the potentials forecasts.

For the ***technical potential***, LoadMAP "chooses" the most efficient option for each purchase decision involving major end-use equipment (refrigerators, air conditioners) during the forecast period. It also phases in all non-equipment measures during the forecast period.

For the ***economic potential***, LoadMAP applies the TRC, which tests each measure in terms of its lifetime benefits (i.e., energy savings multiplied by the avoided cost) relative to the initial capital cost required to install the measure. If the benefit/cost ratio is greater than or equal to 1.0, then the measure passes the screen and it is included in the calculation of economic potential. If the B/C ratio is less than 1.0, the measure is screened out of economic potential. To allow for the changing characteristics of individual, new measures, we perform the economic screen during each year of the forecast period. Therefore, a measure than may not pass the screen in 2010 may pass in some future year. If more than one efficiency option passes the economic screen, for example if SEER 15 and SEER 16 both pass, then the most efficient option, SEER 16, is included in the calculation of economic potential.

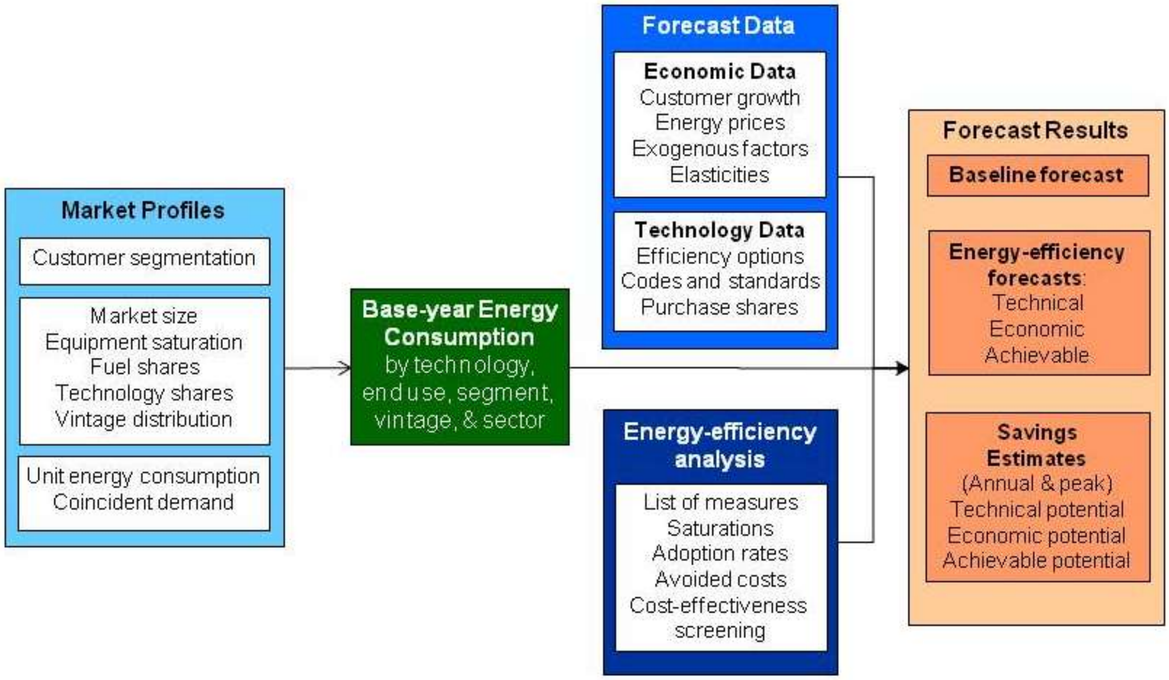
Economic potential still does not take into account the acceptance of those measures by customers, so it is still a hypothetical upper-boundary of EE potential. But again, this exercise is important as it provides useful insights as to how much potential is economic and oftentimes can be compared with other studies of economic potential.

To develop estimates for ***achievable potential***, we specify market adoption rates and program implementation factors for each measure as described above. For this study, we based these factors on the Sixth Power Plan's conservation curve ramp rates, and the past experience at Avista and at other utility EE programs. We also tapped into our recently completed market research for two EE potential studies in which we assessed customer acceptance rates taking into account some degree of financial intervention on the part of the utility to bring down customer paybacks to a level that motivates their participation in various EE programs. While there is a significant degree of uncertainty associated with these adoption rates, we believe that the approach is reasonable and is bounded by the experience gained from other utility EE efforts. Because the adoption rates are model inputs, they can be modified as new information becomes available.

The LoadMAP model provides a forecast of annual electricity use and peak demand under the four types of potential. The energy and peak-demand savings from energy efficiency measures are calculated as the difference between the values for the baseline forecast and the potential forecast.

[6] The Sixth Power Plan Conservation Supply Curve workbooks are available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm, with separate workbooks for specific sectors and end uses.

Figure 2-2 LoadMAP Baseline and Potential Modeling



Results of the potentials assessment are presented in Chapter 6.

MARKET ASSESSMENT AND MARKET PROFILES

Avista Utilities, headquartered in Spokane, Washington is an investor-owned utility with annual revenues of more than $1.3 billion. Avista provides electric and natural gas service to about 481,000 customers in a service territory of more than 30,000 square miles. Avista uses a mix of hydro, natural gas, coal and biomass generation delivered over 2,100 miles of transmission line, 17,000 miles of distribution line, and 6,100 miles of natural gas distribution mains. Avista currently operates a portfolio of electric and natural gas demand-side management (DSM) programs in Washington, Idaho, and Oregon for residential, low-income, and non-residential customers that is funded by a non-bypassable systems benefits charge.

The base year for this study is 2009, the most recent year for which complete billing data available at the beginning of the study. Table 3-1 and Table 3-2 show the breakdown, for Washington and Idaho respectively, of 2009 electricity sales among the major sectors and rate classes, drawn from billing data provided by Avista. Peak demand data was taken from the 2009 System Load Research Project report.[7] Figure 3-1and Figure 3-2 show similar data, but with the Extra Large General Service customers (rate class 025) further divided into commercial and industrial. In Figure 3-1 Electricity Sales by Rate Class, Washington 2009

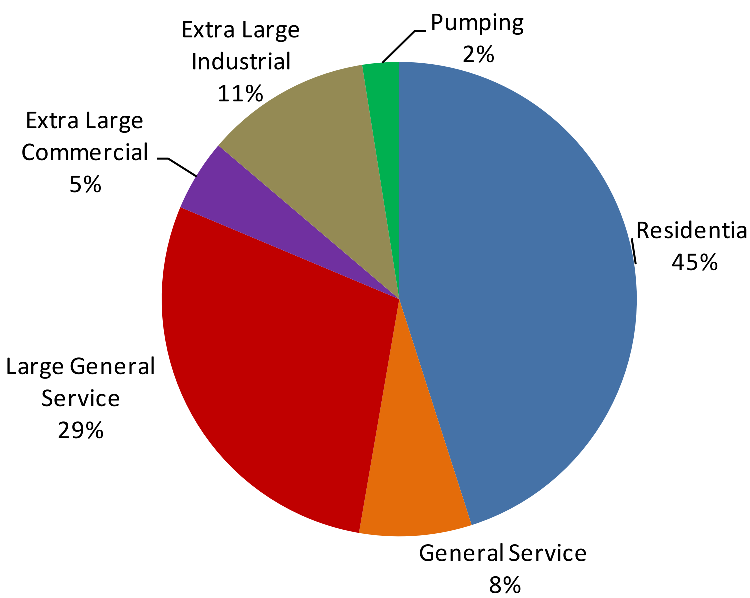


Figure 3-2 for Idaho, Extra Large General Service also includes Potlatch, rate class 25P.

Table 3-1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	200,134	2,451,687	710

[7] Avista Corp. *System Load Research Project* report, March 2010, prepared by KEMA.

General Service	011, 012	27,142	415,935	64
Large General Service	021, 022	3,352	1,556,929	232
Extra Large General Service	025	22	879,233	134
Pumping	031, 032	2,361	135,999	10
Total		**233,011**	**5,439,850**	**1,150**

Table 3-2 Electricity Use and Peak Demand by Rate Class, Idaho 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	99,580	1,182,368	283
General Service	011, 012	19,245	322,570	61
Large General Service	021, 022	1,456	699,953	115
Extra Large General Service	025, 025P	10	266,044	40
Extra Large GS Potlatch	025P	1	892	101
Pumping	031, 032	1,312	58,885	4
Total		**121,604**	**3,422,111**	**603**

Figure 3-1 Electricity Sales by Rate Class, Washington 2009

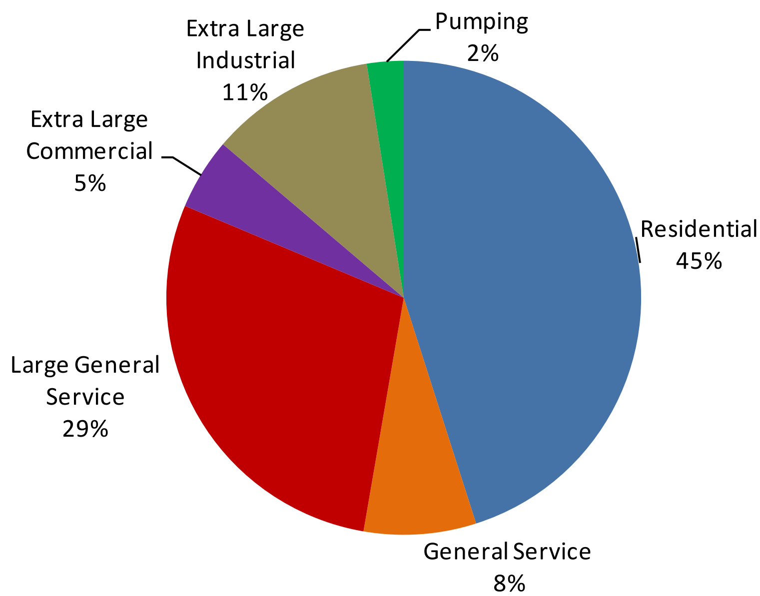
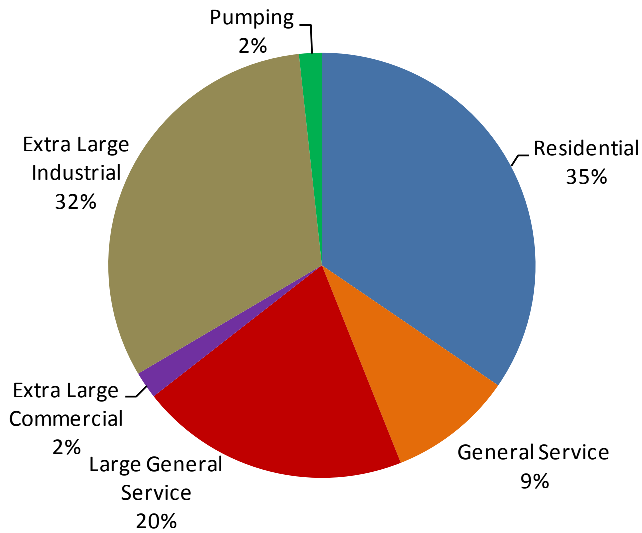


Figure 3-2 Electricity Sales by Rate Class, Idaho 2009



For this study, the project team decided not to explicitly model the EE potential for pumping customers but instead to use the Northwest Power and Conservation Council (NPCC) standard calculator to estimate EE potential. Results of that calculation appear in Chapter 6.

Below we discuss the market characterization and development of market profiles for the Residential and C&I sectors.

3.1 RESIDENTIAL SECTOR

This section characterizes the residential market at a high level, and then provides a profile of how customers in each residential segment use electricity by end use.

3.1.1 Market Characterization

The total number of residential customers was 200,134 in Washington and 99,579 in Idaho, based on the average number of rate class 001 monthly customers for 2009 provided by Avista.[8] We segmented these customers into four groups based on housing type and level of income: single family, multi family, mobile home, and limited income. The single family segment includes single-family detached homes, townhouses, and duplexes or row houses. The multi family segment includes apartments or condos in buildings with more than two units. The limited income segment is composed of all three housing types: single-family homes, multi-family homes, and mobile homes.

Because Avista does not maintain information on housing type or income level, we relied on a variety of survey and demographic sources for segmenting the residential market, including the U.S. Census American Community Survey 2006-2008, a 2009 Inland Power customer survey, and other sources (see Appendix E). Avista defines the limited-income category as those customers with annual income less than or equal to two times the poverty level. For an average household size of 2.5 persons, two times the poverty level is $32,880. For the purpose of our analysis, we used a slightly higher income level cutoff of $35,000 to define this segment, which allowed us to take advantage of the data sources listed above.

The resulting residential customer allocation by segment appears in Table 3-3 and in Note: Minor difference with Idaho residential customer total 99,580 Table 3-2 due to calibration.

Figure 3-3.

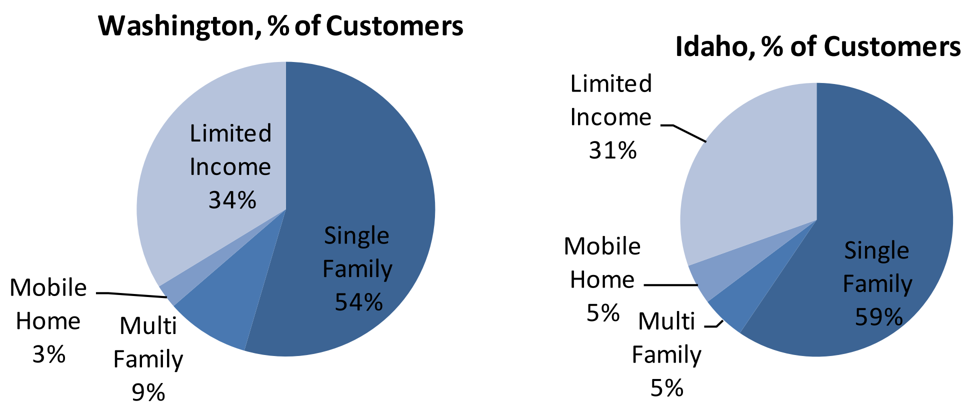
[8] Rate classes 12 and 22, although they include homes, are included with rates classes 11 and 21 respectively, which corresponds with how customer classes were combined for Avista's *System Load Research Project* report.

Table 3-3 Residential Sector Allocation by Segments

	Washington		Idaho	
Segment	**Allocation of Customers**	**% of Total**	**Allocation of Customers**	**% of Total**
Single Family	109,134	54%	59,205	59%
Multi Family	18,219	9%	5,237	5%
Mobile Home	5,248	3%	4,774	5%
Limited Income	67,533	34%	30,363	31%
Total	**200,134**	100%	**99,579**	**100%**

Note: Minor difference with Idaho residential customer total 99,580 Table 3-2 due to calibration.

Figure 3-3 Residential Sector Allocation by Segments, Percentage of Customers



Next, to determine the residential whole building energy intensity (kWh/household) by segment, we drew upon data from the Energy Information Agency, a NEEA residential billing analysis report, and the Inland Power & Light 2009 Conservation Potential Assessment. Based on these sources, we developed the segment level energy intensities shown in Table 3-4. The selected energy intensity values multiplied by the number of households equal the annual sales for each segment. These values sum to the total annual energy use for the residential sector in each state. Figure 3-4 presents the resulting energy sales by segment. The single-family segment used just over half the total residential sector electricity in 2009.

Table 3-4 Residential Electricity Usage and Intensity by Segment and State, 2009

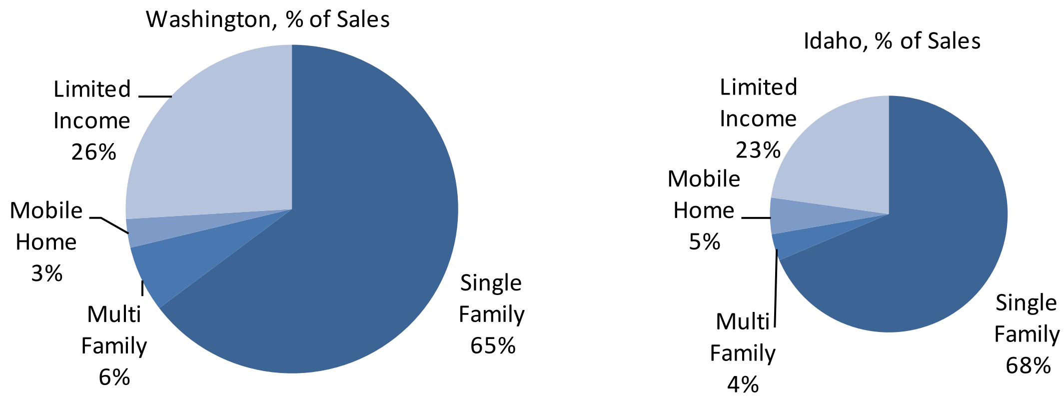
Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales

Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

Note: Minor differences with totals in Table 3-1 and Table 3-2 due to calibration.

Figure 3-4 Residential Electricity Use by Customer Segment, Percentage of Sales 2009



3.1.2 Residential Market Profiles

As we describe in the previous chapter, the market profiles provide the foundation upon which we develop the baseline forecast. For each segment, we created a market profile, which includes the following elements:

- ***Market size*** represents the number of customers in the segment
- ***Saturations*** embody the fraction of homes with the electric technologies. (e.g., homes with electric space heating). We developed these using a combination of survey data from sources including Inland Power & Light, NEEA, and Puget Sound Energy (PSE). The results were cross-checked and validated against various other secondary sources.
- ***UEC (unit energy consumption)*** describes the amount of electricity consumed in 2009 by a specific technology in homes that have the technology (in kWh/household). As above, we used data from Inland Power & Light, NEEA, and PSE. We also used data from various utility potential studies that Global has recently completed. As needed, some minor adjustments were made to calibrate to whole-building intensities.
- ***Intensity*** represents the average use for the technology across all homes in 2009. It is computed as the product of the saturation and the UEC and is defined as kWh/household.
- ***Usage*** is the annual electricity use by a technology/end use in the segment. It is the product of the number of households and intensity and is quantified in GWh.

Table 3-5 presents the average existing home market profile for the entire Avista residential sector. The table shows data captured directly from LoadMAP. Values in red are inputs to LoadMAP. The existing-home profile represents all the housing stock in the Avista service area in 2009. Market profiles for each of the residential segments in Washington and Idaho respectively appear in Appendix A and B.

Figure 3-5 presents the end-use breakout for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other “plug” loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure 3-5 Residential Electricity Use by End Use per Household, 2009 (kWh and %)

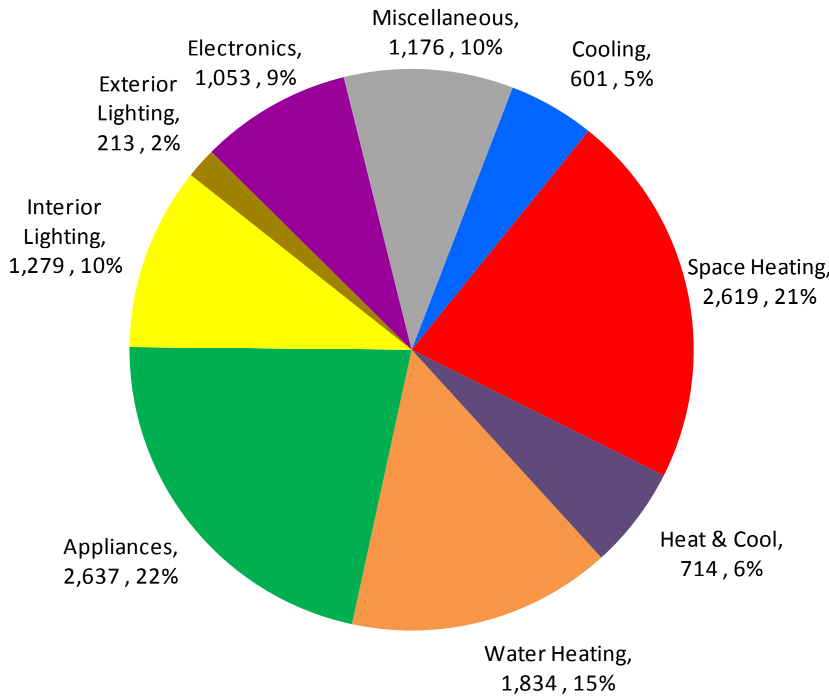


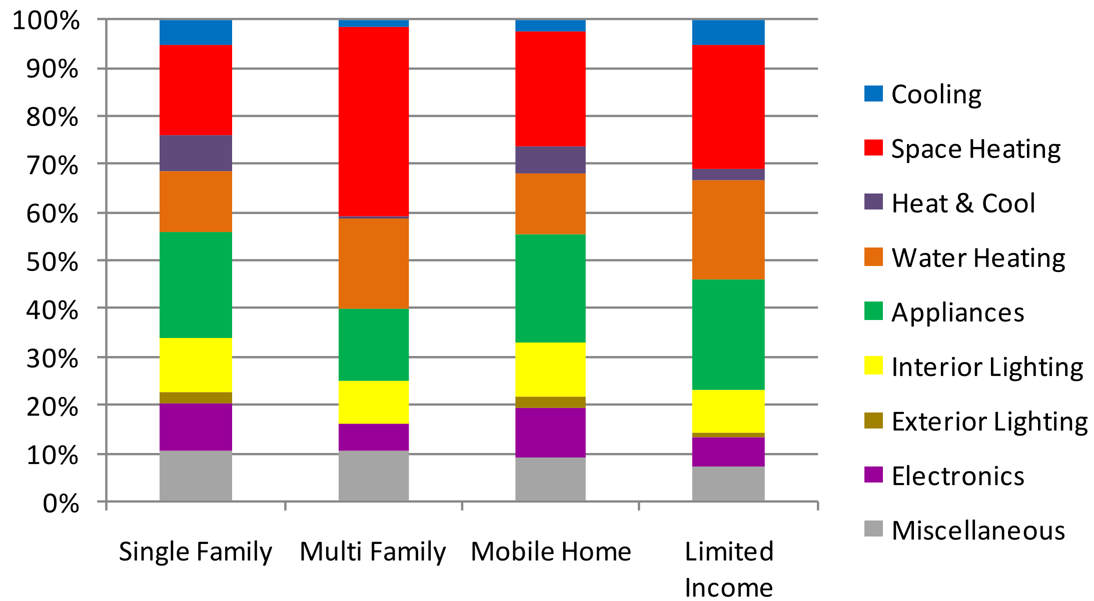
Table 3-5 Average Residential Sector Market Profile

Average Market Profile - Residential Sector

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	29%	1,613	470	141
Cooling	Room AC	20%	643	131	39
Combined Heating/Cooling	Air Source Heat Pump	14%	5,051	699	209
Combined Heating/Cooling	Geothermal Heat Pump	0%	3,715	15	4
Space Heating	Electric Resistance	18%	6,114	1,119	335
Space Heating	Electric Furnace	22%	6,779	1,492	447
Space Heating	Supplemental	9%	83	8	2
Water Heating	Water Heater	66%	2,796	1,834	550
Interior Lighting	Screw-in	100%	1,144	1,144	343
Interior Lighting	Linear Fluorescent	66%	121	80	24
Interior Lighting	Pin-based	92%	59	55	16
Exterior Lighting	Screw-in	70%	301	211	63
Exterior Lighting	High Intensity/Flood	2%	116	2	1
Appliances	Clothes Washer	84%	105	88	26
Appliances	Clothes Dryer	80%	621	498	149
Appliances	Dishwasher	86%	185	160	48
Appliances	Refrigerator	100%	746	746	224
Appliances	Freezer	62%	760	474	142
Appliances	Second Refrigerator	35%	787	277	83
Appliances	Stove	86%	299	257	77
Appliances	Microwave	95%	144	137	41
Electronics	Personal Computers	121%	263	317	95
Electronics	TVs	222%	311	688	206
Electronics	Devices and Gadgets	100%	48	48	14
Miscellaneous	Pool Pump	10%	1,328	130	39
Miscellaneous	Furnace Fan	26%	404	107	32
Miscellaneous	Miscellaneous	100%	940	940	282
Total				**12,125**	**3,634**

Figure 3-6 presents the end-use shares of total electricity use for each housing type. Space heating is the largest single use in all housing types except single family homes where it is lower relative to other uses. Appliances are the largest energy consumer in the single family segment and are a significant energy use in the other segments as well.

Figure 3-6 End-Use Shares of Total Electricity Use by Housing Type, 2009



3.2 COMMERCIAL AND INDUSTRIAL SECTORS

The approach we used for the C&I sectors is analogous to the residential sector. It begins with segmentation, then defines market size and annual electricity use, and concludes with market profiles.

3.2.1 C&I Market Characterization

We developed the non-residential energy use by segment using Avista 2009 billing data by rate class. Table 3-6 and Table 3-7 present the results for the market characterization for Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we chose to model these as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building. When developing the market profiles, as further described below, we began with these assumed prototypical building types, but adjusted them to account for the diversity in each segment. For the Extra Large General Service rate class 025, we divided customers into separate commercial and industrial segments and included the Potlatch facility, Idaho rate class 025P, with the other Idaho Extra Large industrial customers. This grouping enabled better modeling of the industrial customers.

We then used data from NEEA, the California Commercial End Use Study (CEUS), and other recently completed studies to develop estimates of floor space and annual intensities (in kWh/square foot) for each segment. Because of the heterogeneous nature of the C&I sectors and the wide variation in customer size (compared to residential homes), floor space is used as the unit of measure to quantify energy use and equipment inventories on a per-square-foot basis. Note that we are not concerned with absolute square footage, as the purpose of this study is not to estimate C&I floor space, but with the relative size of each segment and its growth over time.

Table 3-6 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table 3-7 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

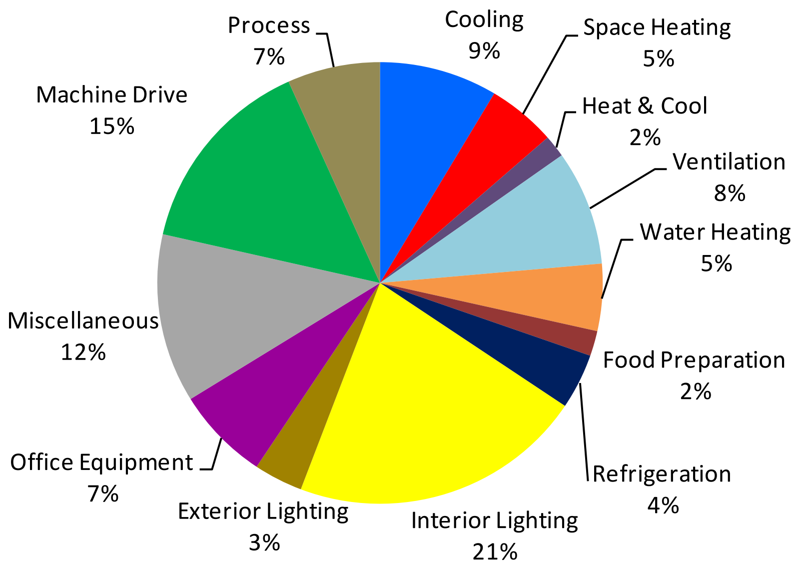
3.2.2 C&I Market Profiles

For the C&I sector, the approach we used to develop market profiles is similar to what we described above for residential.

- ***Saturations*** are the percentage of floor space with each electric end use. For space heating, cooling and water heating, this embodies the electric fuel share. For space heating and cooling, it also embodies the fraction of conditioned space. The saturation values for each end use are from NEEA reports, supplemented with other secondary sources to develop the technology-level saturations. For the industrial segments, we drew upon U.S. Industrial Electric Motor Systems Market Opportunities Assessment from the US Department of Energy (US DOE) and the EIA Annual Energy Outlook.
- ***EUIs (end-use indices)*** represent the amount of electricity used per square foot of floor space in buildings where the equipment is present. Data from NEEA. US DOE, EIA, and other secondary sources provided EUIs by end use. We developed the technology-level EUIs using our engineering model BEST and other secondary sources. Finally, we adjusted the EUIs to calibrate to Avista's overall building type intensity.
- ***Intensity*** is the average use across all floor space (computed as the product of saturation and EUI). For the industrial sector, we calibrate
- ***Annual use*** is the total consumption in 2009 for each end use (computed as the product of the intensity and the floor space for the segment.

Figure 3-7 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure 3-7 Commercial and Industrial Electricity Consumption by End Use, 2009



This information is further detailed in Figure 3-8, which shows the end-use breakdown for the composite of the three commercial segments — Small/Medium, Large, and Extra Large — and Figure 3-9, which shows similar information for the Extra Large Industrial segment.

Observations include the following:

- Commercial buildings
  - Lighting is the largest single energy use across all of the commercial buildings, accounting for 29% of energy use.
  - Space conditioning, including heating, cooling, and ventilation, is close behind with 27% of energy use.
  - Miscellaneous and office equipment are the next largest energy uses.
  - Water heating, refrigeration, and food preparation are only a small portion of energy use in the commercial sector overall, though they are more significant in specific building types (supermarkets, restaurants, hospitals, lodging).
- Extra Large Industrial facilities
  - Machine drive and process loads dominate in this segment, together accounting for 65% of energy use.
  - HVAC and interior lighting consume 17% and 6% of energy respectively.

Figure 3-8 Commercial End Use Consumption, 2009

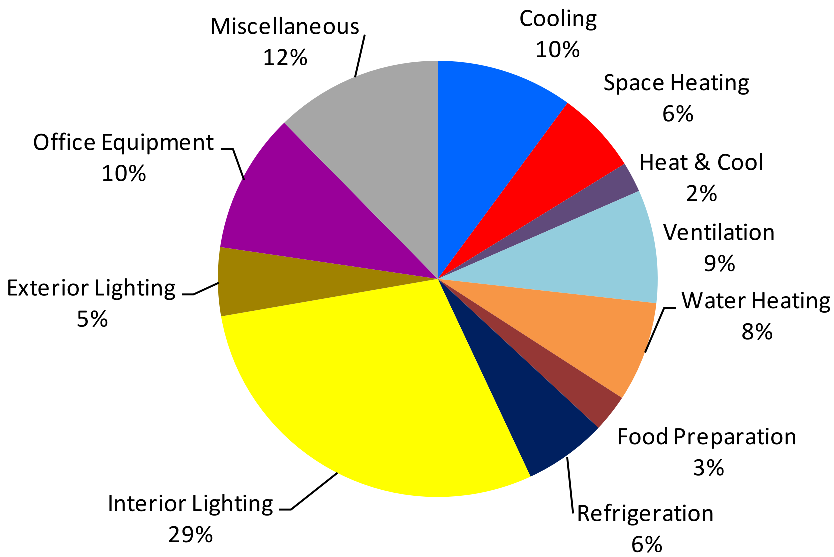


Figure 3-9 Extra Large Industrial End Use Consumption, 2009

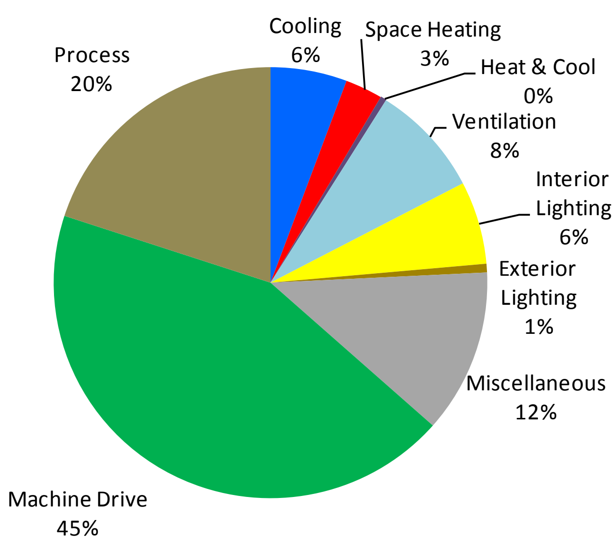


Table 3-8 shows an example commercial average base year market profile, in this case for the Washington Small/Medium Commercial Segment. The table show data captured from LoadMAP, where values shown in red are inputs to the model. The market profiles for each of the Washington and Idaho C&I segments are shown in Appendices A and B respectively.

Table 3-8 Small/Medium Commercial Segment Market Profile, Washington, 2009

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)
Cooling	Central Chiller	13.8%	2.39	0.33	8
Cooling	RTU	63.1%	2.46	1.55	37
Cooling	PTAC	3.3%	2.44	0.08	2
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	5
Space Heating	Electric Resistance	5.9%	6.72	0.39	9
Space Heating	Furnace	17.7%	7.05	1.25	30
Ventilation	Ventilation	76.9%	2.09	1.61	38
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	24
Interior Lighting	HID	100.0%	0.68	0.68	16
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	80
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	4
Exterior Lighting	HID	82.6%	0.76	0.63	15
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	3
Water Heating	Water Heater	63.0%	2.00	1.26	30
Food Preparation	Fryer	25.8%	0.16	0.04	1
Food Preparation	Oven	25.8%	0.98	0.25	6
Food Preparation	Dishwasher	25.8%	0.06	0.01	0
Food Preparation	Hot Food Container	25.8%	0.31	0.08	2
Food Preparation	Food Prep	25.8%	0.01	0.00	0
Refrigeration	Walk in Refrigeration	0.0%	-	-	-
Refrigeration	Glass Door Display	52.4%	0.45	0.23	6
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	6
Refrigeration	Open Display Case	52.4%	0.04	0.02	1
Refrigeration	Vending Machine	52.4%	0.30	0.16	4
Refrigeration	Icemaker	52.4%	0.34	0.18	4
Office Equipment	Desktop Computer	99.9%	0.48	0.48	11
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1
Office Equipment	Server	99.9%	0.36	0.36	9
Office Equipment	Monitor	99.9%	0.25	0.25	6
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	6
Office Equipment	POS Terminal	99.9%	0.27	0.27	7
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	12
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	34
Total				**17.50**	**416**

BASELINE FORECAST

Prior to developing estimates of energy-efficiency potential, a baseline end-use forecast was prepared to quantify how electricity is used by end use in the base year and what electricity is likely to be in the future in absence of new utility programs. The baseline forecast serves as the metric against which energy-efficiency potentials — technical, economic, and achievable — are compared.

4.1 RESIDENTIAL SECTOR

4.1.1 Residential Baseline Forecast Drivers

In general, the baseline forecast incorporates assumptions about economic growth, electricity prices, appliance/equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Customer growth: provided by Avista through 2015, and rate of growth assumed constant thereafter
- Forecasts of electricity prices: provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Forecasts of household size: from Census data and the 6th Plan
- Forecast of income: from Washington state data
- Trends in end-use/technology saturations: developed from the AEO
- Equipment purchase decisions: developed from AEO

Table 4-1 presents the assumptions used in the forecast regarding market size growth, household size, median household income, and electricity prices. The market size growth rate was applied equally to each of the four segments.

Table 4-1 Residential Market Size Forecast (number of households)

Driver	2009	2012	2017	2022	2027	2032	Average Growth (%/yr)
Market Size WA (number of households)	200,134	204,530	217,921	232,414	247,871	264,356	1.21%
Market Size ID (number of households)	99,579	102,077	108,592	115,553	122,960	130,842	1.19%
Persons per household	2.50	2.50	2.50	2.50	2.50	2.50	–
Electricity price WA (cents per kWh)	$0.0721	$0.0796	$0.0804	$0.0825	$0.0845	$0.0867	0.80%
Electricity price ID (cents per kWh)	$0.0742	$0.0855	$0.0876	$0.0898	$0.0921	$0.0944	1.05%
Per capita income ($ real, 2000)	$34,506	$35,787	$39,202	$43,623	$48,400	$53,700	1.92%

In addition to forecasts for household size, electricity price, and median household income, the model also requires elasticities for these variables. The elasticities for prices and persons per household are based on the REEPS model developed by the Electric Power Research Institute (EPRI). The income elasticity was provided by Avista. The values are as follows:

- –0.151 for electricity prices
- 0.75 for income for all end uses except for appliances, where we use 0.375
- 0.20 for persons per household

In addition, we implemented the following assumptions for the residential sector[9]:

- In 2006, a Federal standard for central air conditioners and heat pumps went into effect, requiring all newly manufactured air conditioners and heat pumps to meet SEER 13 or better. This standard applies to replace-upon-burnout in existing construction and new construction. In 2016, the standard becomes SEER 14[10].
- In April 2010, DOE released updated water heater standards that go into effect April 16, 2015. The new standard for water heaters with volume at or below 55 gallons requires an energy factor (EF) equal to 0.96 minus 0.0003 times the rated storage volume in gallons.
- DOE is scheduled to make a final ruling on refrigerator and freezer standards on December 31, 2010. We incorporated this anticipated ruling into the forecast and assumed that refrigeration and freezer consumption will decrease by 20% in 2014[11]. This forecast does not include anticipated standards for room air conditioners, clothes washers, clothes dryers and dishwashers because DOE rulings on the standards have not yet been set.
- Residential lighting is affected by the passage of the Energy Independence and Security Act (EISA) in 2007, which mandates higher efficacies for lighting technologies starting in 2012. Several lighting technologies are anticipated to meet this standard when it goes into effect, including compact fluorescent lamps (CFL) and white light-emitting diodes (LED). As a result, the share of incandescent lamps decreases while CFL and LED purchases increase. CFLs dominate over the forecast period, but LEDs account for about 20% of purchases by 2020.
- In November 2008, ENERGY STAR 3.0 for color televisions went into effect. This standard sets the rules for becoming ENERGY STAR qualified. One such criterion is that TVs must not exceed 1 watt of power in standby mode.

4.1.2 Residential Baseline Forecast Results

Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This is slightly higher than the 1.5% annual growth rate in Avista's 2009 IRP for the period 2009 through 2030. Because the IRP forecast includes future DSM activities and LoadMAP's baseline forecast does not, we would generally expect LoadMAP's baseline forecast to be somewhat higher. This increase is also more than double the AEO forecast of 0.8% average growth.

General observations about this forecast include the following:

- Overall, household growth is robust, with a nearly 32% increase between 2009 and 2032. The AEO forecast is somewhat lower, with a 26% increase in the number of households.
- The factors that impact usage — relatively low electricity prices and strong income growth — result in strong residential consumption growth over the forecast period.

[9] These assumptions reflect standards in effect as of late 2010 or scheduled to take effect over the course of the 20-year study period. Because some of these standards were not yet announced when the NWPCC Sixth Plan was developed, this study's baseline incorporates reduced baseline energy usage compared with the Sixth Plan.

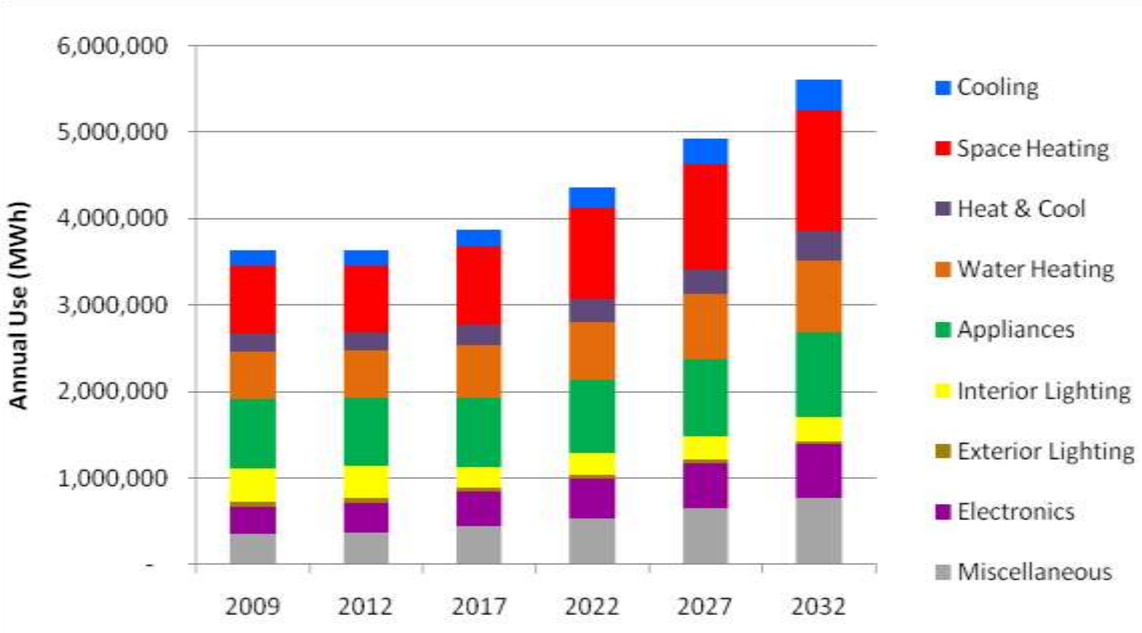
[10] This assumption was included in the 2010 Annual Energy Outlook (AEO) forecast. The SEER 14 standard level used in the AEO forecast was established in a 2009 consensus agreement made between equipment manufacturers and energy efficiency advocacy organizations. DOE is required to publish the final rule on central air conditioners and heat pump standards in 2011.

[11] This level is consistent with the standard recently agreed upon in a joint proposal by home appliance manufacturers and energy efficiency advocates which states that refrigeration and freezer consumption must decrease by 20-30% effective in 2014.

- New homes are larger than existing homes, based on data from the AEO and other studies. However, equipment and appliances are more efficient, so the combined effect is slightly positive.

Figure 4-1 presents the baseline forecast at the end-use level for the residential sector as a whole, in both Washington and Idaho.

Figure 4-1 Residential Baseline Forecast by End Use



End-use specific observations include:

- The drop in all space conditioning loads from 2009 to 2012 is due to the transition from actual weather in 2009 (589 cooling degree days and 6,976 heating degree days) to the normal weather forecast (434 cooling degree days and 6,657 heating degree days) thereafter.
- Cooling grows due to increasing saturation of central air conditioning in new homes and larger home sizes, as well as the addition of central air conditioning to existing homes.
- Space heating, combined heating and cooling, and water heating grow, but at a slightly moderate rate compared to cooling, again due to the growth in households and to larger home sizes.
- Beginning in 2012, the federal lighting standards cause a decline in electricity for interior lighting use of 29% and exterior lighting use by 41% over the forecast period. The AEO 2010 forecast projects a 26% decline in lighting energy use over the same period. The AEO reduction is less than that shown here, again due to increasing home size.
- Appliances decrease, reflecting efficiency gains, particularly in the refrigeration appliances due to standards that offset the small increases in saturations of dishwashers, clothes washers, and clothes dryers.
- Growth in electricity use in electronics is strong and reflects an increase in the saturation of electronics and the trend toward higher-powered computers and larger televisions.
- Growth in miscellaneous use is also substantial. This has been a long-term trend and we incorporate growth assumptions that are consistent with the AEO.

Figure 4-2 presents the forecast of use per household. Most noticeable is that lighting use decreases significantly after 2010, as the lighting standard from EISA comes into effect and as LED lamps begin to gain traction in the later years of the forecast. Appliance use also decreases over the forecast period due to appliance standards. Use in electronics and miscellaneous increase over the forecast period, reflecting the trend that households continue to add various electronics to the home.

Figure 4-2 Residential Baseline Electricity Use per Household by End Use

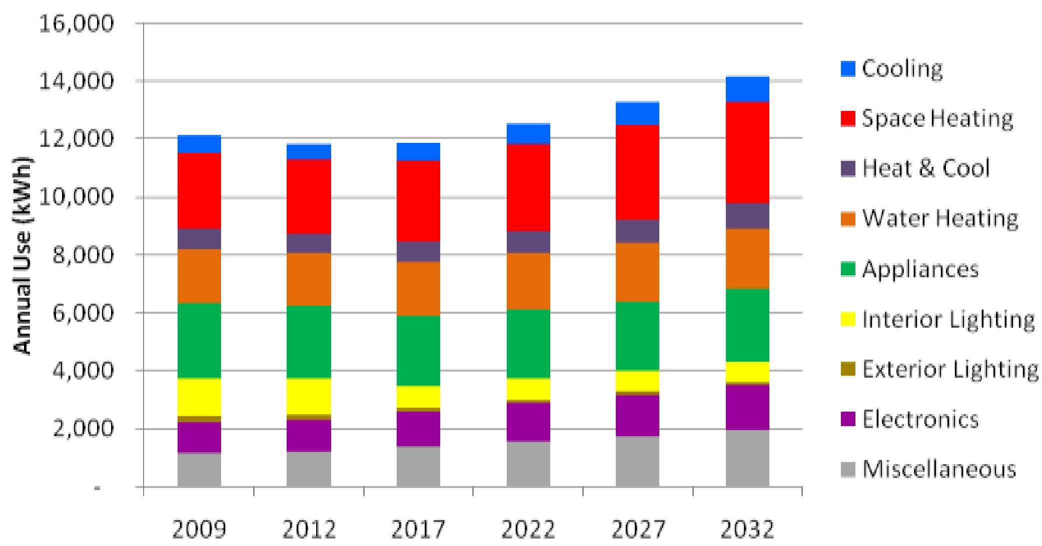


Table 4-2 shows the forecast by end use, while Table 4-3 provides additional detail by technology within each end use. Central AC increases during the forecast as more households add air conditioning. Screw-in lighting decreases as a result of the EISA lighting standard. Over the forecast period there is strong growth in usage from electronics due to the increase in saturation.

Table 4-2 Residential Baseline Forecast Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	180,022	164,865	197,394	239,439	292,044	355,171	97%	3.0%
Space Heating	784,854	783,258	906,261	1,051,822	1,210,093	1,383,665	76%	2.5%
Heat & Cool	213,860	201,410	229,160	258,676	295,177	341,644	60%	2.0%
Water Heating	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Interior Lighting	790,377	776,482	795,594	835,023	894,245	989,025	25%	1.0%
Exterior Lighting	383,305	371,610	246,575	256,864	262,823	271,374	-29%	-1.5%
Appliances	63,864	61,321	41,763	39,795	38,430	37,735	-41%	-2.3%
Electronics	315,599	336,152	394,727	459,538	529,485	616,688	95%	2.9%
Miscellaneous	352,599	374,575	447,870	540,047	648,055	774,496	120%	3.4%
Total	**180,022**	**164,865**	**197,394**	**239,439**	**292,044**	**355,171**	**54%**	**1.9%**

Table 4-3 Residential Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central AC	140,731	130,669	161,085	199,996	249,120	308,429	119%	3.4%
	Room AC	39,291	34,196	36,310	39,443	42,924	46,742	19%	0.8%
Space Heating	Electric Furnace	447,317	447,255	520,409	606,695	700,178	801,899	79%	2.5%
	Electric Resistance	335,280	333,732	383,172	441,947	506,164	577,358	72%	2.4%
	Supplemental	2,257	2,272	2,680	3,180	3,750	4,409	95%	2.9%
Heat & Cool	Air Source Heat Pump	209,371	197,111	224,050	252,476	287,663	332,619	59%	2.0%
	Geothermal Heat Pump	4,489	4,299	5,109	6,200	7,514	9,025	101%	3.0%
Water Heating	Water Heater	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Appliances	Refrigerator	223,654	213,517	204,566	204,184	209,933	231,329	3%	0.1%
	Freezer	141,950	137,910	137,084	136,274	143,528	158,560	12%	0.5%
	Second Refrigerator	83,117	77,296	72,374	70,707	69,137	73,789	-11%	-0.5%
	Clothes Washer	26,332	26,102	27,746	30,875	34,868	39,019	48%	1.7%
	Clothes Dryer	149,267	150,677	163,829	180,582	199,465	221,428	48%	1.7%
	Dishwasher	47,886	48,894	54,242	60,691	68,105	76,321	59%	2.0%
	Stove	77,079	79,792	89,107	99,966	111,884	125,081	62%	2.1%
	Microwave	41,092	42,294	46,647	51,744	57,325	63,498	55%	1.9%
Interior Lighting	Screw-in	342,923	329,329	198,253	200,264	196,856	194,811	-43%	-2.5%
	Linear Fluorescent	24,025	25,171	29,266	34,273	39,944	46,451	93%	2.9%
	Pin-based	16,358	17,110	19,056	22,326	26,023	30,112	84%	2.7%
Exterior Lighting	Screw-in	63,165	60,629	41,255	39,254	37,834	37,069	-41%	-2.3%
	High Intensity/Flood	698	692	508	540	596	666	-5%	-0.2%
Electronics	Personal Computers	94,922	101,516	120,451	143,627	170,677	202,632	113%	3.3%
	TVs	206,326	219,527	256,515	294,816	333,825	384,485	86%	2.7%
	Devices and Gadgets	14,351	15,110	17,761	21,095	24,983	29,572	106%	3.1%
Miscellaneous	Furnace Fan	32,029	33,795	39,817	47,004	54,841	63,046	97%	2.9%
	Pool Pump	38,852	39,438	44,334	51,331	59,964	69,728	79%	2.5%
	Miscellaneous	281,718	301,342	363,719	441,712	533,250	641,722	128%	3.6%
Grand Total		**3,634,086**	**3,626,696**	**3,871,294**	**4,356,240**	**4,918,847**	**5,600,787**	**54%**	**1.9%**

4.2 COMMERCIAL AND INDUSTRIAL SECTOR

4.2.1 C&I Baseline Forecast Drivers

As is the case with the residential sector, the C&I baseline forecast incorporates assumptions about economic growth, electricity prices, equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Floor space growth for Commercial segments derived from Avista customer and load growth projections through 2015 and from Avista IRP projections regarding expansion of existing Extra Large Customer facilities; after 2015 assumed constant growth rate of 2% based on Avista IRP[12]
- Floor space growth for Extra Large Industrial segment derived from Avista customer and load growth projections through 2015; thereafter based on based on employment growth of 2.8% in Washington and 1.4% in Idaho[13]
- Forecasts of electricity prices provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Trends in end-use/technology saturations developed from the AEO
- Equipment purchase decisions developed from AEO[14]

Table 4-4 presents the growth and electricity price assumptions used in the C&I forecast. Market size growth is shown as an indexed value where 2009 equals 1.0

Table 4-4 Commercial Market Size Growth and Electricity Price Forecast

Indexed Market Size 2009 = 1.0	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Small/Med. Comm., WA	1.00	1.04	1.14	1.26	1.39	1.53	1.85%
Large Comm., WA	1.00	1.01	1.10	1.22	1.34	1.48	1.72%
Extra Large Comm., WA	1.00	1.05	1.34	1.48	1.63	1.80	2.57%
Extra Large Industrial, WA	1.00	1.16	1.31	1.51	1.73	1.99	2.99%
Small/Med. Comm., ID	1.00	1.03	1.13	1.25	1.38	1.53	1.84%
Large Comm., ID	1.00	1.03	1.15	1.27	1.40	1.54	1.88%
Extra Large Comm., ID	1.00	1.04	1.25	1.38	1.52	1.68	2.26%
Extra Large Industrial, ID	1.00	1.04	1.13	1.21	1.30	1.39	1.44%

Electricity Price	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Electricity price, WA (cents per kWh)	$0.0700	$0.0698	$0.0703	$0.0727	$0.0752	$0.0778	0.46%
Electricity price, ID (cents per kWh)	$0.0566	$0.0586	$0.0600	$0.0621	$0.0642	$0.0664	0.69%

[12] Avista 2009 IRP, p. 2-10: Commercial usage per customer is forecast to increase for several years due to additional buildings either built or anticipated to be built by existing very large customers, such as Washington State University and Sacred Heart Hospital. Expected additions for very large customers are included in the forecast through 2015, and no additions are included in the forecast after 2015.

[13] Avista 2009 IRP p. 2-6.

[14] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2010), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and trended forward.

4.2.2 C&I Baseline Forecast Results

Figure 4-3 and Table 4-5 present the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Table 4-6 presents the C&I forecast by technology. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the lighting standard.

Figure 4-3 C&I Baseline Electricity Forecast by End Use

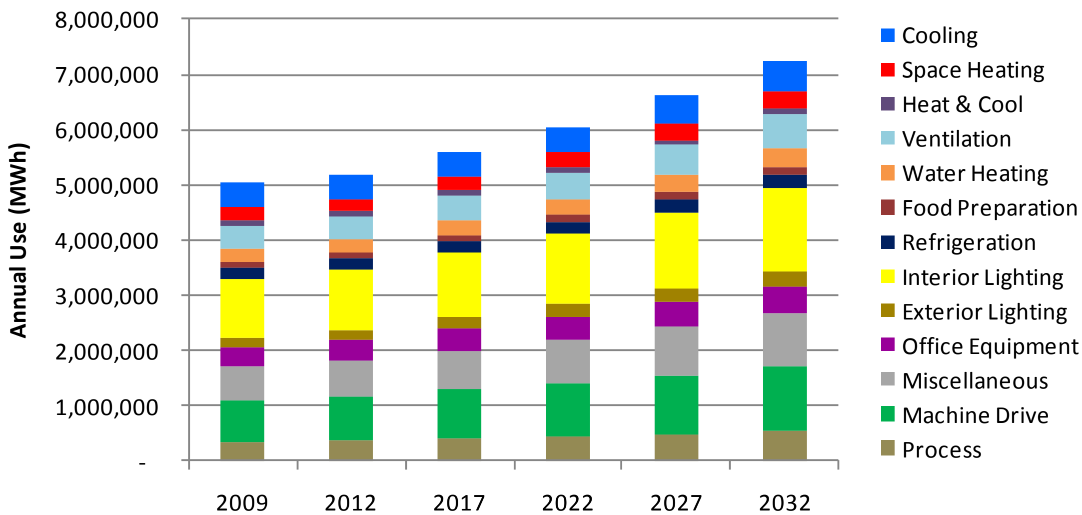


Table 4-5 C&I Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	433,257	429,715	453,330	473,311	504,446	550,621	27.1%	1.04%
Space Heating	250,919	224,970	249,918	273,638	300,093	330,065	31.5%	1.19%
Heat & Cool	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	92,263	94,294	104,419	114,396	125,186	136,992	48.5%	1.72%
Refrigeration	203,660	204,139	213,050	224,372	242,222	264,431	29.8%	1.14%
Interior Lighting	1,079,050	1,106,035	1,175,567	1,274,090	1,388,871	1,513,165	40.2%	1.47%
Exterior Lighting	179,595	183,933	202,023	219,529	239,546	261,703	45.7%	1.64%
Office Equipment	344,351	363,758	387,164	421,052	458,189	498,560	44.8%	1.61%
Miscellaneous	619,607	645,918	714,601	785,490	863,772	950,463	53.4%	1.86%
Machine Drive	740,191	800,303	881,202	966,387	1,061,952	1,169,146	58.0%	1.99%
Process	340,318	367,955	405,497	445,447	489,890	539,389	58.5%	2.00%
Total	**433,257**	**429,715**	**453,330**	**473,311**	**504,446**	**550,621**	**27.1%**	**1.04%**

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central Chiller	161,468	161,651	175,544	184,829	194,228	210,874	30.6%	1.16%
	PTAC	18,631	18,428	18,862	19,691	21,069	23,036	23.6%	0.92%
	RTU	253,158	249,637	258,925	268,791	289,149	316,711	25.1%	0.97%
Space Heating	Electric Resistance	102,223	191,387	212,950	234,235	257,713	283,617	177.5%	4.44%
	Furnace	148,697	33,583	36,969	39,403	42,380	46,447	-68.8%	-5.06%
Heat & Cool	Heat Pump	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	Water Heater	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	Dishwasher	5,561	5,675	6,260	6,889	7,580	8,341	50.0%	1.76%
	Fryer	10,938	11,160	12,267	13,442	14,715	16,107	47.3%	1.68%
	Oven	64,439	65,882	73,158	80,123	87,640	95,864	48.8%	1.73%
	Hot Food Container	10,600	10,838	11,915	13,043	14,260	15,590	47.1%	1.68%
	Food Prep	724	739	818	900	991	1,090	50.5%	1.78%
Refrigeration	Walk in Refrigeration	26,545	26,356	27,877	29,977	32,721	35,993	35.6%	1.32%
	Glass Door Display	29,998	29,887	31,549	33,927	37,032	40,736	35.8%	1.33%
	Solid Door Refrigerator	56,389	55,997	58,578	61,819	66,199	71,682	27.1%	1.04%
	Open Display Case	18,136	18,080	19,502	20,983	22,909	25,201	39.0%	1.43%
	Vending Machine	28,068	28,373	25,594	23,005	23,392	24,849	-11.5%	-0.53%
	Icemaker	44,524	45,447	49,951	54,661	59,969	65,969	48.2%	1.71%
Interior Lighting	HID	175,721	181,398	198,158	215,929	235,578	257,305	46.4%	1.66%
	Linear Fluorescent	686,924	702,882	771,014	840,371	916,893	1,001,311	45.8%	1.64%
	Interior Screw-in	216,406	221,755	206,395	217,790	236,400	254,549	17.6%	0.71%

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh) (continued)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Exterior Lighting	HID	132,407	135,795	150,576	164,140	179,105	195,616	47.7%	1.70%
	Linear Fluorescent	25,393	25,871	28,196	30,732	33,529	36,611	44.2%	1.59%
	Exterior Screw-in	21,795	22,266	23,250	24,657	26,912	29,475	35.2%	1.31%
Office Equipment	Monitor	41,029	53,265	46,532	50,891	55,743	61,060	48.8%	1.73%
	Server	74,853	76,495	84,537	93,022	102,358	112,632	50.5%	1.78%
	Desktop Computer	154,994	158,861	173,772	187,271	201,951	217,747	40.5%	1.48%
	Laptop Computer	13,081	13,425	14,794	15,996	17,306	18,722	43.1%	1.56%
	Printer/copier/fax	39,520	40,314	44,034	48,018	52,383	57,096	44.5%	1.60%
	POS Terminal	20,873	21,398	23,495	25,853	28,448	31,304	50.0%	1.76%
Miscellaneous	Other Miscellaneous	263,934	269,935	298,454	328,409	361,370	397,639	50.7%	1.78%
	Miscellaneous	208,493	225,425	248,425	272,900	300,128	330,453	58.5%	2.00%
	Non-HVAC Motor	147,180	150,558	167,722	184,182	202,275	222,371	51.1%	1.79%
Machine Drive	Less than 5 HP	35,529	38,415	41,579	44,045	47,585	52,286	47.2%	1.68%
	5-24 HP	76,980	83,231	91,723	100,760	110,813	122,010	58.5%	2.00%
	25-99 HP	188,009	203,277	224,017	246,087	270,640	297,986	58.5%	2.00%
	100-249 HP	106,588	115,244	127,002	139,514	153,434	168,937	58.5%	2.00%
	250-499 HP	116,950	126,448	139,349	153,078	168,351	185,361	58.5%	2.00%
	500 and more HP	216,136	233,688	257,531	282,903	311,129	342,566	58.5%	2.00%
Process	Process Cooling/Refrigeration	102,095	110,387	121,649	133,634	146,967	161,817	58.5%	2.00%
	Process Heating	153,143	165,580	182,474	200,451	220,451	242,725	58.5%	2.00%
	Electrochemical Process	85,079	91,989	101,374	111,362	122,473	134,847	58.5%	2.00%
Grand Total		**5,033,023**	**5,172,344**	**5,592,586**	**6,061,107**	**6,618,022**	**7,250,973**	**44.1%**	**1.59%**

4.3 BASELINE FORECAST SUMMARY

Table 4-7 and

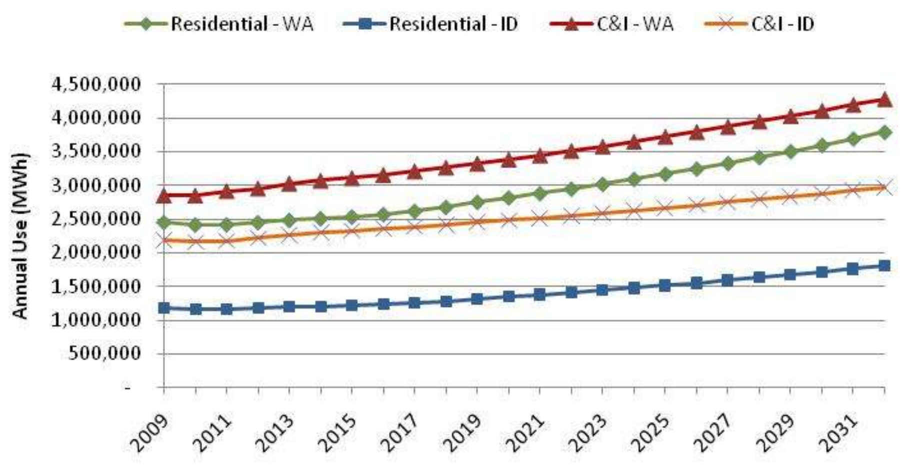
End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	8,667,109	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760	48.3%	1.7%

Figure 4-4 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table 4-7 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	8,667,109	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760	48.3%	1.7%

Figure 4-4 Baseline Forecast Summary by Sector and State



4.3.1 Comparison of Baseline Forecast with Avista 2009 IRP

Table 4-8 compares the Avista 2009 IRP forecast, the LoadMAP baseline forecast for Washington and Idaho combined, and the regional forecast from the Sixth Plan. For the LoadMAP baseline and Avista forecast, the table shows data for the period 2009 through 2030, the last year of the IRP forecast. The Sixth Plan forecast is the medium case scenario for 2010 through 2030.

Table 4-8 Comparison of LoadMAP Baseline, Avista IRP, and Sixth Plan Energy Forecasts (MWh)

	LoadMAP Baseline			Avista IRP[15]			Sixth Plan[16]
Sector	**2009**	**2030**	**Avg. Growth ('09-'30)**	**2009**	**2030**	**Avg. Growth ('09-'30)**	**Avg. Growth ('10-'30)**
Residential	3,634,086	5,314,970	1.8%	3,700,000	5,048,000	1.5%	1.4%
Commercial	3,331,433	4,457,968	1.4%	3,400,000	4,773,000	1.6%	1.6%
Industrial	1,701,589	2,530,353	1.9%	1,900,000	3,029,000	2.2%	0.8%
Total	**8,667,109**	**12,303,291**	**1.7%**	**9,002,009**	**12,852,030**	**1.7%**	**1.4%**

The LoadMAP and IRP forecasts do not match exactly for the base year, likely due to the slightly different ways in which the study team selected rate classes to include and how we grouped them. Also, the IRP was prepared in September 2009, before final results for 2009 were available.

Overall growth in energy usage agrees well between LoadMAP and the IRP, at approximately 1.7% annual average growth. However, Global's forecast for the Residential sector produces greater growth than the IRP's projections, while the opposite is true for Commercial and Industrial sectors. Because the LoadMAP baseline excludes future additional DSM activities, we would generally expect it to be somewhat higher than the IRP forecast, as is the case with the Residential sector. In general, the Sixth Plan forecast, which also excludes additional conservation, is lower than both the LoadMAP and Avista IRP forecasts, with the exception of the Commercial sector, where the Sixth Plan and the Avista IRP agree.

Retail Electricity Prices

Table 4-9 compares retail electricity prices used in the LoadMAP model and those projected in the IRP.

Table 4-9 Comparison of Retail Electricity Prices

	LoadMAP						Avista IRP[17]	
Sector	**2009 ($/kWh)**	**2018 ($/kWh)**	**Avg. Growth ('09-'18)**	**2019 ($/kWh)**	**2032 ($/kWh)**	**Avg. Growth ('19-'32)**	**Avg. Growth ('19-'32)**	**Avg. Growth ('19-'30)**
Res. WA	$0.072	$0.080	1.2%	$0.0818	$0.087	0.5%	10.0%	Inflation
Res. ID	$0.074	$0.088	1.8%	$0.089	$0.094	0.5%	10.0%	Inflation
C&I WA	$0.0700	$0.0703	0.1%	$0.0713	$0.0778	0.7%	10.0%	Inflation
C&I ID	$0.0566	$0.0600	0.6%	$0.0608	$0.0664	0.7%	10.0%	inflation

15 Avista forecast from 2009 IRP, Figure 2.10 and p. 2-12.
16 NPCC Sixth Northwest Conservation and Electric Power Plan, p. C-6, table C-3.
17 Avista 2009 IRP, p. 2-9.

Avista's IRP forecast "is based on retail prices increasing an average of 10 percent annually from 2010 to 2018, followed by increases at the rate of inflation thereafter." However, Avista's most recent load forecast for 2011–2015 shows lower annual rate increases. For this study, Global used the rates from the 2011–2015 load forecast and thereafter, based on data from the AEO, increased rates by 0.50% and 0.68% respectively for residential and C/I customers.

Residential Energy Use per Household

As mentioned above, the LoadMAP residential baseline energy use forecast is higher than the IRP residential forecast. Furthermore, the baseline forecast of energy use per household is notably different, with average growth of 0.6% compared with Avista IRP showing that energy use per household decreases over time.[18]

Long-Term Weather

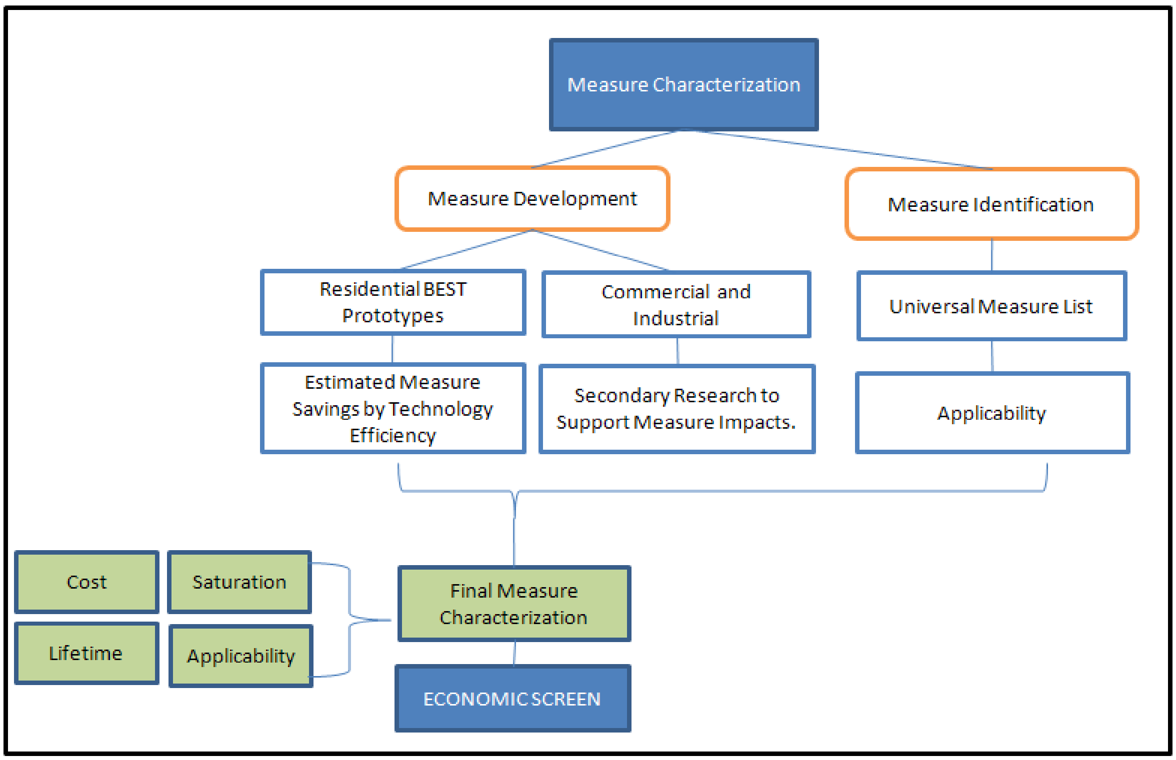
This study used the 30-year normal weather data. In contrast, the IRP mentions warming trends in recent weather. Although the model does not directly account for climate changes, the residential market profiles show an increase in air conditioning saturation over time, which indirectly reflects weather trends.

[18] Avista 2009 IRP Figure 2.9, p. 2-11.

ENERGY-EFFICIENCY MEASURE ANALYSIS

This section describes the framework used to assess the savings, costs, and other attributes of energy-efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, Global assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with the avoided costs, in the economic screen to determine economically feasible measures. Figure 5-1 outlines the framework for measure analysis.

Figure 5-1 Approach for Measure Assessment



5.1 SELECTION OF ENERGY EFFICIENCY MEASURES

The first step of the energy efficiency measure analysis was to identify the list of all relevant energy efficiency measures that should be considered for the Avista CPA. Sources consulted to develop the list for this study included:

- Avista's existing DSM programs
- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER): The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.

- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S., analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). Global's assessment of the national potential for energy efficiency derived for the four DOE regions (including the Pacific region.
- Other recent Global potential studies

Measures can be categorized into one of two types, equipment measures and non-equipment measures, according to the LoadMAP taxonomy:

Equipment measures, or efficient energy-consuming equipment, save energy by providing the same service with a lower energy requirement. An example is the replacement of a standard efficiency refrigerator with an ENERGY STAR model. For equipment measures, many efficiency levels are available for a specific technology that range from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the federal standard SEER 13 unit and spans a broad spectrum of efficiency, with the highest efficiency level represented by a ductless mini-split system with variable refrigerant flow (at SEER levels of 18 or greater).

Non-equipment measures save energy by reducing the need for delivered energy but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set, for example, to run the air conditioner only when people are home. Non-equipment measures fall into one of the following categories:

- Building shell (windows, insulation, roofing material)
- Equipment controls (thermostat, occupancy sensors)
- Equipment maintenance (cleaning filters, changing setpoints)
- Whole-building design (natural ventilation, passive solar lighting)
- Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)
- Displacement measures (ceiling fan instead of central air conditioner)

Non-equipment measures can apply to more than one end use. For example, insulation levels will affect both cooling and space heating energy consumption.

Global prepared a preliminary list of measures for Avista's review and revised the list based on Avista's input.

5.1.1 Residential Measures

Table 5-1 and Table 5-2 show the residential equipment and non-equipment measure options respectively and the segments for which they were modeled. Residential measures are described in Appendix C.

5.1.2 Commercial and Industrial Measures

Table 5-2 Summary of Residential Non-equipment Measures

End Use	Measure	Single Family Existing	Single Family New Construction	Mulfi Family Existing	Multi Family New Construction	Mobile Home Existing	Mobile Home New Construction	Low Income Existing	Low Income New Construction
HVAC	Central AC - Early Replacement	●		●		●	●	●	
	Central AC - Maintenance and Tune-Up	●	●	●	●	●	●	●	●
	Room AC - Removal of Second Unit	●		●		●	●	●	
	Air Source Heat Pump - Maintenance	●	●	●	●	●	●	●	●
	Furnace - Convert to Gas	●	●	●	●	●	●	●	●
	Attic Fan - Installation	●	●					●	●
	Attic Fan - Photovoltaic - Installation	●	●					●	●
	Ceiling Fan - Installation	●	●	●	●	●	●	●	●
	Whole-House Fan - Installation	●	●			●	●	●	●
	Thermostat - Clock/Programmable	●	●	●	●	●	●	●	●
	Insulation - Ceiling / Attic	●	●	●	●	●	●	●	●
	Insulation - Radiant Barrier	●	●	●	●	●	●	●	●
	Insulation - Infiltration Control	●		●		●		●	●
	Insulation - Ducting	●	●	●	●	●	●	●	●
	Repair and Sealing - Ducting	●		●		●		●	
	Insulation - Foundation		●						●
	Insulation - Wall Cavity		●		●		●		●
	Insulation - Wall Sheathing		●		●		●		●
	Doors - Storm and Thermal	●	●	●	●	●	●	●	●
	Windows - Reflective Film	●	●	●	●	●	●	●	●
	Windows - High Efficiency/ENERGY STAR	●	●	●	●	●	●	●	●
	Roofs - High Reflectivity	●	●	●	●	●	●	●	●
	Trees for Shading	●	●	●	●	●	●	●	●
Int. Lighting	Interior Lighting - Occupancy Sensors	●	●	●	●	●	●	●	●
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	●	●	●	●	●	●	●	●
	Exterior Lighting - Photosensor Control	●	●	●	●	●	●	●	●
	Exterior Lighting - Timeclock Installation	●	●	●	●	●	●	●	●
Water Heating	Water Heater - Faucet Aerators	●	●	●	●	●	●	●	●
	Water Heater - Pipe Insulation	●	●	●	●	●	●	●	●
	Water Heater - Low Flow Showerheads	●	●	●	●	●	●	●	●
	Water Heater - Tank Blanket/Insulation	●	●	●	●	●	●	●	●
	Water Heater - Thermostat Setback	●	●	●	●	●	●	●	●
	Water Heater - Timer	●	●	●	●	●	●	●	●
	Water Heater - Hot Water Saver	●	●	●	●	●	●	●	●
	Water Heater - Drainwater Heat Recovery		●		●		●		●
	Water Heater - Convert to Gas	●	●	●	●	●	●	●	●
	Water Heater - Heat Pump Water Heater	●	●	●	●	●	●	●	●
Appliances	Refrigerator - Early Replacement	●		●		●		●	
	Refrigerator - Remove Second Unit	●		●		●		●	
	Freezer - Early Replacement	●		●		●		●	
	Freezer - Remove Second Unit	●		●		●		●	
Electronics	Electronics - Reduce Standby Wattage	●	●	●	●	●	●	●	●
Misc.	Pool - Pump Timer	●	●			●	●	●	●
Multiple End Uses	Home Energy Management System	●	●	●	●	●	●	●	●
	Advanced New Construction Designs		●		●		●		●
	Energy Efficient Manufactured Homes						●		
	ENERGY STAR Homes		●						
	Photovoltaic System	●	●	●	●	●	●	●	●

Table 5-3 and Table 5-4 list the C&I equipment and non-equipment measures, respectively. Measures were modeled for nearly all C&I building types, both new and existing, with only a few exceptions as shown. For all C&I segments, a custom measure category was included to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. In addition, because the Small/Medium Commercial and Large Commercial segments also include some industrial customers, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. C&I Measures are described in Appendix D.

Table 5-1 Summary of Residential Equipment Measures

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Mulfi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Cooling	Central AC	SEER 13	100%	15	2009	2014	●	●	●	●
	Central AC	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Central AC	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Central AC	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Central AC	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Room AC	EER 9.8	100%	10	2009	2032	●	●	●	●
	Room AC	EER 10.8 (ENERGY STAR)	91%	10	2009	2032	●	●	●	●
	Room AC	EER 11	89%	10	2009	2032	●	●	●	●
	Room AC	EER 11.5	85%	10	2009	2032	●	●	●	●
Heat & Cool	Air Source Heat Pump	SEER 13	100%	15	2009	2014	●	●	●	●
	Air Source Heat Pump	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Geothermal Heat Pump	Standard	100%	14	2009	2032	●	●	●	●
	Geothermal Heat Pump	High Efficiency	86%	14	2009	2032	●	●	●	●
Space Heating	Electric Resistance	Electric Resistance	100%	20	2009	2032	●	●	●	●
	Electric Furnace	3400 BTU/KW	100%	15	2009	2032	●	●	●	●
	Supplemental	Supplemental	100%	5	2009	2032	●	●	●	●
Water Heating	Water Heater	Baseline (EF=0.90)	100%	15	2009	2015	●	●	●	●
	Water Heater	High Efficiency (EF=0.95)	95%	15	2009	2032	●	●	●	●
	Water Heater	Geothermal Heat Pump	32%	15	2009	2032	●			
	Water Heater	Solar	25%	15	2009	2032	●	●	●	●
Interior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	81%	5	2015	2020	●	●	●	●
	Screw-in	CFL	22%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	Linear Fluorescent	T12	100%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T8	91%	6	2009	2032	●	●	●	●
	Linear Fluorescent	Super T8	74%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T5	73%	6	2009	2032	●	●	●	●
	Linear Fluorescent	LED	72%	10	2009	2032	●	●	●	●
	Pin-based	Halogen	100%	4	2009	2032	●	●	●	●
	Pin-based	CFL	23%	6	2009	2032	●	●	●	●
	Pin-based	LED	16%	10	2009	2032	●	●	●	●
Exterior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	79%	5	2015	2020	●	●	●	●
	Screw-in	CFL	20%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	High Intensity/Flood	Incandescent	100%	4	2009	2014	●	●	●	●
	High Intensity/Flood	Infrared Halogen	88%	4	2015	2020	●	●	●	●
	High Intensity/Flood	CFL	29%	5	2009	2032	●	●	●	●
	High Intensity/Flood	Metal Halide	27%	5	2009	2032	●	●	●	●
	High Intensity/Flood	High Pressure Sodium	19%	5	2009	2032	●	●	●	●
	High Intensity/Flood	LED	18%	10	2009	2032	●	●	●	●

Table 5-1 Summary of Residential Equipment Measures (continued)

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Mulfi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Appliances	Clothes Washer	Baseline	100%	10	2009	2032	●	●	●	●
	Clothes Washer	ENERGY STAR (MEF > 1.8)	70%	10	2009	2032	●	●	●	●
	Clothes Washer	Horizontal Axis	42%	10	2009	2032	●	●	●	●
	Clothes Dryer	Baseline	100%	13	2009	2032	●	●	●	●
	Clothes Dryer	Moisture Detection	85%	13	2009	2032	●	●	●	●
	Dishwasher	Baseline	100%	9	2009	2032	●	●	●	●
	Dishwasher	ENERGY STAR	85%	9	2009	2010	●	●	●	●
	Dishwasher	ENERGY STAR (2011)	81%	9	2011	2032	●	●	●	●
	Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Freezer	Baseline	100%	11	2009	2013	●	●	●	●
	Freezer	ENERGY STAR	85%	11	2009	2013	●	●	●	●
	Freezer	Baseline (2014)	80%	11	2014	2032	●	●	●	●
	Freezer	ENERGY STAR (2014)	68%	11	2014	2032	●	●	●	●
	Second Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Second Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Second Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Second Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Stove	Baseline	100%	13	2009	2032	●	●	●	●
	Stove	Convection Oven	98%	13	2009	2032	●	●	●	●
	Stove	Induction (High Efficiency)	88%	13	2009	2032	●	●	●	●
	Microwave	Microwave	100%	9	2009	2032	●	●	●	●
Electronics	Personal Computers	Baseline	100%	5	2009	2032	●	●	●	●
	Personal Computers	ENERGY STAR	65%	5	2009	2032	●	●	●	●
	Personal Computers	Climate Savers	50%	5	2009	2032	●	●	●	●
	TVs	Baseline	100%	11	2009	2032	●	●	●	●
	TVs	ENERGY STAR	80%	11	2009	2032	●	●	●	●
	Devices and Gadgets	Devices and Gadgets	100%	5	2009	2032	●	●	●	●
Miscellaneous	Pool Pump	Baseline Pump	100%	15	2009	2032	●		●	●
	Pool Pump	High Efficiency Pump	90%	15	2009	2032	●		●	●
	Pool Pump	Two-Speed Pump	60%	15	2009	2032	●		●	●
	Furnace Fan	Baseline	100%	18	2009	2032	●	●	●	●
	Furnace Fan	Furnace Fan with ECM	75%	18	2009	2032	●	●	●	●
	Miscellaneous	Miscellaneous	100%	5	2009	2032	●	●	●	●

Table 5-2 Summary of Residential Non-equipment Measures

End Use	Measure	Single Family Existing	Single Family New Construction	Multi Family Existing	Multi Family New Construction	Mobile Home Existing	Mobile Home New Construction	Low Income Existing	Low Income New Construction
HVAC	Central AC - Early Replacement	●		●		●	●	●	
	Central AC - Maintenance and Tune-Up	●	●	●	●	●	●	●	●
	Room AC - Removal of Second Unit	●		●		●	●	●	
	Air Source Heat Pump - Maintenance	●	●	●	●	●	●	●	●
	Furnace - Convert to Gas	●	●	●	●	●	●	●	●
	Attic Fan - Installation	●	●					●	●
	Attic Fan - Photovoltaic - Installation	●	●					●	●
	Ceiling Fan - Installation	●	●	●	●	●	●	●	●
	Whole-House Fan - Installation	●	●			●	●	●	●
	Thermostat - Clock/Programmable	●	●	●	●	●	●	●	●
	Insulation - Ceiling / Attic	●	●	●	●	●	●	●	●
	Insulation - Radiant Barrier	●	●	●	●	●	●	●	●
	Insulation - Infiltration Control	●		●		●		●	●
	Insulation - Ducting	●	●	●	●	●	●	●	●
	Repair and Sealing - Ducting	●		●		●		●	
	Insulation - Foundation		●						●
	Insulation - Wall Cavity		●		●		●		●
	Insulation - Wall Sheathing		●		●		●		●
	Doors - Storm and Thermal	●	●	●	●	●	●	●	●
	Windows - Reflective Film	●	●	●	●	●	●	●	●
	Windows - High Efficiency/ENERGY STAR	●	●	●	●	●	●	●	●
	Roofs - High Reflectivity	●	●	●	●	●	●	●	●
	Trees for Shading	●	●	●	●	●	●	●	●
Int. Lighting	Interior Lighting - Occupancy Sensors	●	●	●	●	●	●	●	●
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	●	●	●	●	●	●	●	●
	Exterior Lighting - Photosensor Control	●	●	●	●	●	●	●	●
	Exterior Lighting - Timeclock Installation	●	●	●	●	●	●	●	●
Water Heating	Water Heater - Faucet Aerators	●	●	●	●	●	●	●	●
	Water Heater - Pipe Insulation	●	●	●	●	●	●	●	●
	Water Heater - Low Flow Showerheads	●	●	●	●	●	●	●	●
	Water Heater - Tank Blanket/Insulation	●	●	●	●	●	●	●	●
	Water Heater - Thermostat Setback	●	●	●	●	●	●	●	●
	Water Heater - Timer	●	●	●	●	●	●	●	●
	Water Heater - Hot Water Saver	●	●	●	●	●	●	●	●
	Water Heater - Drainwater Heat Recovery		●		●		●		●
	Water Heater - Convert to Gas	●	●	●	●	●	●	●	●
	Water Heater - Heat Pump Water Heater	●	●	●	●	●	●	●	●
Appliances	Refrigerator - Early Replacement	●		●		●		●	
	Refrigerator - Remove Second Unit	●		●		●		●	
	Freezer - Early Replacement	●		●		●		●	
	Freezer - Remove Second Unit	●		●		●		●	
Electronics	Electronics - Reduce Standby Wattage	●	●	●	●	●	●	●	●
Misc.	Pool - Pump Timer	●	●			●	●	●	●
Multiple End Uses	Home Energy Management System	●	●	●	●	●	●	●	●
	Advanced New Construction Designs		●		●		●		●
	Energy Efficient Manufactured Homes						●		
	ENERGY STAR Homes		●						
	Photovoltaic System	●	●	●	●	●	●	●	●

Table 5-3 Summary of Commercial and Industrial Equipment Measures

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Cooling	Central Chiller	1.5 kW/ton, COP 2.3	●	●		
	Central Chiller	1.3 kW/ton, COP 2.7	●	●		
	Central Chiller	1.26 kW/ton, COP 2.8	●	●		
	Central Chiller	1.0 kW/ton, COP 3.5	●	●		
	Central Chiller	0.97 kW/ton, COP 3.6	●	●		
	Central Chiller	0.75 kw/ton, COP 4.7			●	●
	Central Chiller	0.60 kw/ton, COP 5.9			●	●
	Central Chiller	0.58 kw/ton, COP 6.1			●	●
	Central Chiller	0.55 kw/Ton, COP 6.4			●	●
	Central Chiller	0.51 kw/ton, COP 6.9			●	●
	Central Chiller	0.50 kw/Ton, COP 7.0			●	●
	Central Chiller	0.48 kw/ton, COP 7.3			●	●
	Central Chiller	Variable Refrigerant Flow	●	●	●	●
	RTU	EER 9.2	●	●	●	●
	RTU	EER 10.1	●	●	●	●
	RTU	EER 11.2	●	●	●	●
	RTU	EER 12.0	●	●	●	●
	RTU	Ductless VRF	●	●	●	●
Heat & Cool	PTAC	EER 9.8	●	●	●	●
	PTAC	EER 10.2	●	●	●	●
	PTAC	EER 10.8	●	●	●	●
	PTAC	EER 11	●	●	●	●
	PTAC	EER 11.5	●	●	●	●
	Heat Pump	EER 9.3, COP 3.1	●	●	●	●
	Heat Pump	EER 10.3, COP 3.2	●	●	●	●
	Heat Pump	EER 11.0, COP 3.3	●	●	●	●
	Heat Pump	EER 11.7, COP 3.4	●	●	●	●
	Heat Pump	EER 12, COP 3.4	●	●	●	●
	Heat Pump	Ductless Mini-Split System	●	●	●	●
	Heat Pump	Geothermal*	●	●	●	●
Space Heating	Electric Resistance	Standard	●	●	●	●
	Furnace	Standard	●	●	●	●
Ventilation	Ventilation	Constant Volume	●	●	●	●
	Ventilation	Variable Air Volume	●	●	●	●

*** New construction only**

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Interior Lighting	Interior Screw-in	Incandescents	●	●	●	●
	Interior Screw-in	Infrared Halogen	●	●	●	●
	Interior Screw-in	CFL	●	●	●	●
	Interior Screw-in	LED	●	●	●	●
	HID	Metal Halides	●	●	●	●
	HID	High Pressure Sodium	●	●	●	●
	Linear Fluorescent	T12	●	●	●	●
	Linear Fluorescent	T8	●	●	●	●
	Linear Fluorescent	Super T8	●	●	●	●
	Linear Fluorescent	T5	●	●	●	●
	Linear Fluorescent	LED	●	●	●	●
Exterior Lighting	Exterior Screw-in	Incandescents	●	●	●	●
	Exterior Screw-in	Infrared Halogen	●	●	●	●
	Exterior Screw-in	CFL	●	●	●	●
	Exterior Screw-in	Metal Halides	●	●	●	●
	Exterior Screw-in	LED	●	●	●	●
	HID	Metal Halides	●	●	●	●
	HID	High Pressure Sodium	●	●	●	●
	HID	Low Pressure Sodium	●	●	●	●
	Linear Fluorescent	T12	●	●	●	●
	Linear Fluorescent	T8	●	●	●	●
	Linear Fluorescent	Super T8	●	●	●	●
	Linear Fluorescent	T5	●	●	●	●
	Linear Fluorescent	LED	●	●	●	●
Water Heating	Water Heater	Baseline (EF=0.90)	●	●	●	
	Water Heater	High Efficiency (EF=0.95)	●	●	●	
	Water Heater	Geothermal Heat Pump	●	●	●	
	Water Heater	Solar	●	●	●	
Food Preparation	Fryer	Standard	●	●	●	
	Fryer	Efficient	●	●	●	
	Oven	Standard	●	●	●	
	Oven	Efficient	●	●	●	
	Dishwasher	Standard	●	●	●	
	Dishwasher	Efficient	●	●	●	
	Hot Food Container	Standard	●	●	●	
	Hot Food Container	Efficient	●	●	●	
	Food Prep Misc.	Standard	●	●	●	
	Food Prep Misc.	Efficient	●	●	●	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Refrigeration	Walk in Refrigeration	Standard	•	•	•	
	Walk in Refrigeration	Efficient	•	•	•	
	Glass Door Display	Standard	•	•	•	
	Glass Door Display	Efficient	•	•	•	
	Solid Door Refrigerator	Standard	•	•	•	
	Solid Door Refrigerator	Efficient	•	•	•	
	Open Display Case	Standard	•	•	•	
	Open Display Case	Efficient	•	•	•	
	Vending Machine	Base	•	•	•	
	Vending Machine	Base (2012)	•	•	•	
	Vending Machine	High Efficiency	•	•	•	
	Vending Machine	High Efficiency (2012)	•	•	•	
	Icemaker	Standard	•	•	•	
	Icemaker	Efficient	•	•	•	
Office Equipment	Desktop Computer	Baseline	•	•	•	
	Desktop Computer	ENERGY STAR	•	•	•	
	Desktop Computer	Climate Savers	•	•	•	
	Laptop Computer	Baseline	•	•	•	
	Laptop Computer	ENERGY STAR	•	•	•	
	Laptop Computer	Climate Savers	•	•	•	
	Server	Standard	•	•	•	
	Server	ENERGY STAR	•	•	•	
	Monitor	Standard	•	•	•	
	Monitor	ENERGY STAR	•	•	•	
	Printer/copier/fax	Standard	•	•	•	
	Printer/copier/fax	ENERGY STAR	•	•	•	
	POS Terminal	Standard	•	•	•	
	POS Terminal	ENERGY STAR	•	•	•	
Miscellaneous	Non-HVAC Motor	Standard	•	•	•	
	Non-HVAC Motor	Standard (2015)	•	•	•	
	Non-HVAC Motor	High Efficiency	•	•	•	
	Non-HVAC Motor	High Efficiency (2015)	•	•	•	
	Non-HVAC Motor	Premium	•	•	•	
	Non-HVAC Motor	Premium (2015)	•	•	•	
	Other Miscellaneous	Miscellaneous	•	•	•	•
	Other Miscellaneous	Miscellaneous (2013)	•	•	•	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Machine Drive	Less than 5 HP	Standard				●
	Less than 5 HP	High Efficiency				●
	Less than 5 HP	Standard (2015)				●
	Less than 5 HP	Premium				●
	Less than 5 HP	High Efficiency (2015)				●
	Less than 5 HP	Premium (2015)				●
	5-24 HP	Standard				●
	5-24 HP	High				●
	5-24 HP	Premium				●
	25-99 HP	Standard				●
	25-99 HP	High				●
	25-99 HP	Premium				●
	100-249 HP	Standard				●
	100-249 HP	High				●
	100-249 HP	Premium				●
	250-499 HP	Standard				●
	250-499 HP	High				●
	250-499 HP	Premium				●
	500 and more HP	Standard				●
	500 and more HP	High				●
	500 and more HP	Premium				●
Process	Process Cooling/Refrig.	Standard				●
	Process Cooling/Refrig.	Efficient				●
	Process Heating	Standard				●
	Process Heating	Efficient				●
	Electrochemical Process	Standard				●
	Electrochemical Process	Efficient				●

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
HVAC	RTU - Maintenance	●	●	●	●
	RTU - Evaporative Precooler	●	●		
	Chiller - Chilled Water Reset	●	●	●	●
	Chiller - Chilled Water Variable-Flow System	●	●	●	●
	Chiller - Condenser Water Temprature Reset	●	●	●	●
	Chiller - High Efficiency Cooling Tower Fans	●	●	●	●
	Chiller - Turbocor Compressor	●	●	●	●
	Chiller - VSD	●	●	●	●
	Cooling - Economizer Installation	●	●	●	●
	Heat Pump - Maintenance	●	●	●	●
	Insulation - Ducting	●	●	●	●
	Repair and Sealing - Ducting	●		●	
	Insulation - Ceiling	●	●		
	Insulation - Radiant Barrier	●	●		
	Insulation - Wall Cavity		●		
	Cooking - Exhaust Hoods with Sensor Control	●	●		
	Fans - Energy Efficient Motors	●	●	●	●
	Fans - Variable Speed Control	●	●	●	●
	Pumps - Variable Speed Control	●	●		
	Thermostat - Clock/Programmable	●	●	●	●
	Roofs - High Reflectivity	●	●		
	Roofs - Green		●		
	Windows - High Efficiency	●	●		
	Retrocommissioning - HVAC	●		●	
	Commissioning - HVAC		●		●
	Furnace - Convert to Gas	●	●	●	●
Interior Lighting	Interior Fluorescent - Photocell Controlled T8 Dimming	●	●		
	Interior Fluorescent - Delamp and Install Reflectors	●		●	
	Interior Fluorescent - Bi-Level Fixture w/Occupancy Sen	●	●		
	Interior Fluorescent - High Bay Fixtures	●	●	●	●
	Interior Screw-in - Task Lighting	●	●	●	●
	Central Lighting Controls	●	●	●	●
	Occupancy Sensors	●	●	●	●
	Time Clocks and Timers	●	●	●	●
	LED Exit Lighting	●	●	●	●
	Hotel Guestroom Controls	●	●		
	Retrocommissioning - Lighting	●		●	
	Commissioning - Lighting		●		●
Exterior Lighting	Daylighting Controls	●	●	●	●
	Photovoltaic Installation	●	●	●	●
	Cold Cathode Lighting	●	●	●	●
	Induction Lamps	●	●		

Note: Conversion of electric furnaces to gas was only modeled for Small/Medium Commercial segment.

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures (continued)

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
Water Heating	Faucet Aerators/Low Flow Nozzles	●	●		
	Hot Water Saver	●	●		
	Pipe Insulation	●	●		
	Tank Blanket/Insulation	●	●		
	Thermostat Setback	●	●		
	Convert to Gas	●	●		
	Heat Pump Water Heater	●	●		
Refrigeration	Floating Head Pressure	●	●		
	Insulation - Bare Suction Lines	●	●		
	Demand Defrost	●	●		
	High Efficiency Case Lighting	●	●		
	Evaporator Fan Controls	●	●		
	Anti-Sweat Heater/Auto Door Closer	●	●		
	Door Gasket Replacement	●	●		
	Night Covers	●	●		
	Strip Curtain	●	●		
	Vending Machine - Controller	●	●		
Office Equipment	ENERGY STAR Power Supply	●	●		
Miscellaneous	Laundry - High Efficiency Clothes Washer	●	●		
	Miscellaneous - Energy Star Water Cooler	●	●		
Machine Drive	Motors - Variable Frequency Drive			●	●
	Motors - Magnetic Adjustable Speed Drives			●	●
	Compressed Air - System Controls			●	●
	Compressed Air - System Optimization & Improvements			●	●
	Compressed Air - System Maintenance			●	●
	Compressed Air - Compressor Replacement			●	●
	Fan System - Controls			●	●
	Fan System - Optimization			●	●
	Fan System - Maintenance			●	●
	Pumping System - Controls			●	●
	Pumping System - Optimization			●	●
	Pumping System - Maintenance			●	●
	Pumps - Variable Speed Control	●	●	●	●
Industrial Process	Industrial Process Improvements	●	●		
	Refrigeration - System Controls			●	●
	Refrigeration - System Maintenance			●	●
	Refrigeration - System Optimization			●	●
Multiple End Uses	Energy Management System	●	●	●	●
	Retrocommissioning - Comprehensive	●			
	Advanced New Construction Designs		●		●
	Commissioning - Comprehensive		●		
	Pumps - Variable Speed Control	●	●	●	●
	Custom Measures	●	●	●	●

Note: Conversion of electric water heaters to gas only modeled for Small/Medium Commercial segment.

5.2 MEASURE CHARACTERISTICS

For each measure considered, the Global team developed the following data for input to the LoadMAP model:

Energy Impacts: The energy-savings impacts represent the annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects. This approach takes into account the efficiency of the equipment that is providing that end use. For example, savings due to increased insulation will be greater if heating is provided by electric resistance, and lower if heating is provided by a heat pump. For the residential and commercial sectors, the BEST simulation model was used to determine the savings impacts. The key advantage of utilizing BEST is that interactive effects between HVAC measures and other measures such as lighting and building construction are captured and quantified. In addition, the prototype modeling combines the primary market data with Spokane-specific Typical Meteorological Year (TMY) weather data to derive savings. For the industrial sector, secondary data resources such as the EPRI National Potential Study and DEEM were used to develop assessments of savings at the end-use level.

Peak Demand Impacts: Savings during the peak demand periods are specified for each measure. These impacts relate to the energy savings and depend on each measure's "coincidence" with the system peak. To accurately express the peak impacts of the energy efficiency measures considered, the project used a combined approach of prototype simulation (BEST model) and Global's proprietary end-use load shape database, EnergyShape.

Costs: For equipment measures, the measure characterization includes the full cost of purchasing and installing the equipment on a per-unit or per-square-foot basis for the residential and C&I sectors, respectively. For non-equipment measures in existing buildings, the cost likewise represents the full installed cost. For non-equipment measures in new construction, the approach is slightly different; the costs may be either the full cost of the measure, for example a programmable thermostat, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level, such as upgrading from R13 to R26 insulation. These costs were developed specifically for the Spokane area and drew upon sources including the Sixth Plan databases.

Measure Lifetimes: These estimates were derived from the technical data and secondary data sources that support the measure demand and energy savings analysis. Values were obtained from the Sixth Plan database, DEER database, DEEM, and other secondary sources.

Applicability: This factor is an estimate of the percentage of either dwellings in the residential sector or square feet in the C&I sectors where it is technically feasible for the specific measure to be implemented. These figures are based on secondary data sources such as NEEA reports, California's DEER database, DEEM, and others.

On Market and Off Market Availability: To account for the fact that some equipment will no longer be available for sale due to changes in appliance standards, or that some high-efficiency equipment is expected to enter the market during the study period, the project also developed on market and off market inputs, expressed as years, for the equipment measures.

5.2.1 Measure Cost Data Development

Costs for equipment and non-equipment measures include both material and labor costs associated with the measure's installation. These costs draw upon national construction cost averages.

The following references were used to develop the equipment and measure costs:

- Sixth Northwest Conservation and Electric Power Plan Conservation Supply Curves workbooks
- DEER – California Database for Energy Efficient Resources

- RS Means Facilities Maintenance and Repair Cost Data
- RS Means Mechanical Construction Costs
- RS Means Building Construction Cost Data
- USGBC — LEED New Construction & Major Renovation (2008)
- RS Means Green Buildings Project Planning & Cost Estimating Second Edition (2008)
- Grainger Catalog Volume 398, (2007-2008)

5.2.2 Representative Measure Data Inputs

To provide an example of the measure data, Table 5-5 and Table 5-6 present samples of the detailed data inputs behind equipment and non-equipment measures, respectively, for the case of residential central air conditioning in single-family homes. Table 5-5 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, usage, and cost estimates. These values all contribute to the outcome of the stock accounting model, in which the purchase of an above-standard unit is first analyzed for cost-effectiveness (comparing incremental cost to lifetime benefits) and then, for the levels that pass the screen, incorporated into the new units purchased.

Table 5-5 Sample Equipment Measures for Central Air Conditioning — Single Family Home Segment

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13	15	$3,794	1,619	2009	2014
SEER 14 (ENERGY STAR)	15	$4,072	1,485	2009	2032
SEER 15 (CEE Tier 2)	15	$4,350	1,435	2009	2032
SEER 16 (CEE Tier 3)	15	$4,628	1,393	2009	2032
Ductless Mini-split System	20	$8,193	1,214	2009	2032

Table 5-6 lists the non-equipment measures affecting an existing single-family home's central air conditioning electricity use. These measures are also evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings are calculated for each year of the model and depend on the base year saturation of the measure, the overall applicability of the measure, and the savings as a percentage of the relevant energy end uses. Residential central air conditioning provides energy savings, but no demand savings due to Avista's existing heating season peak. In addition to the Applicability factor, a Feasibility factor is applied to account for the feasibility of installing the measure.

Table 5-6 Sample Non-Equipment Measures – Single Family Homes, Existing

End Use	Measure	Saturation in 2009[19]	Applicability	Feasibility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Cooling	Central AC — Early Replacement	0%	80%	10%	15	$2,895	10.0%	0%
Cooling	Central AC — Maintenance and Tune-Up	41%	100%	100%	4	$125	10.0%	0%
Cooling	Attic Fan — Installation	11%	50%	45%	18	$116	0.7%	0%
Cooling	Attic Fan — Photovoltaic	13%	100%	45%	19	$350	1.4%	0%
Cooling	Ceiling Fan	52%	100%	75%	15	$160	11.0%	0%
Cooling	Whole-House Fan	7%	25%	75%	18	$200	9.0%	0%
Cooling	Insulation — Ducting	15%	100%	75%	18	$500	3.0%	0%
Cooling	Repair and Sealing — Ducting	12%	100%	50%	18	$500	10.0%	0%
Cooling	Doors — Storm and Thermal	38%	100%	75%	11	$320	1.0%	0%
Cooling	Insulation — Infiltration Control	46%	100%	90%	12	$266	3.0%	0%
Cooling	Insulation — Ceiling	68%	90%	80%	20	$594	3.0%	0%
Cooling	Insulation — Radiant Barrier	5%	100%	90%	12	$923	5.0%	0%
Cooling	Roofs — High Reflectivity	5%	100%	10%	15	$1,550	6.1%	0%
Cooling	Windows — Reflective Film	5%	50%	90%	10	$267	7.0%	0%
Cooling	Windows — High Efficiency/ENERGY STAR	83%	100%	90%	25	$7,500	12.0%	0%
Cooling	Thermostat — Clock/Programmable	55%	75%	75%	11	$114	8.0%	0%
Cooling	Home Energy Management System	20%	50%	75%	20	$300	10.0%	0%
Cooling	Photovoltaics	0%	80%	60%	15	$17,000	50.0%	0%
Cooling	Trees for Shading	10%	90%	75%	20	$40	1.1%	0%

5.2.3 Conversion to Natural Gas

Conversion to natural gas (fuel switching) for both space heating and water heating was evaluated as a special case. These options were evaluated as non-equipment measures, though of course, they are in fact equipment changes. Modeling conversion to gas as a non-equipment measure allowed using the applicability and feasibility factors to better account for customers' real ability to implement these technologies.

For conversion of water heaters to natural gas, an applicability factor was developed based on Avista GIS data combined with the market profiles to indicate that approximately 63% of Washington homes and 57% of Idaho homes with electric water heating are within 500 feet of a gas main. The feasibility factor of 80% assumes that other factors, such as inability to accommodate venting, would prevent 20% of customers from making the switch to gas water heating. For heat pump water heaters, we assumed the technology is applicable to the remaining customers (100% – (63% * 80%) = 50% in Washington and 54% using a similar calculation for

[19] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

Idaho). However, the feasibility factor is 50% for single family homes because only about half of these customers have water heating systems with tanks larger than 55 gallons that are suitable for heat pump water heaters. For the other housing types, the feasibility factors were lower due to the still lower saturation of larger than 55 gallon water heating systems. Conversion of electric furnaces to gas was modeled using similar assumptions.

Table 5-7 shows assumptions for water heating non-equipment measures in Washington single-family homes, including the conversion to gas and heat pump measures discussed above.

Table 5-7 Sample Non-Equipment Water Heating Measures – Single Family Homes, Existing, Washington

End Use	Measure	Saturation in 2009[20]	Applicability	Feasibility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Water Heating	Faucet Aerators	53%	100%	90%	25	$24	3.7%	1.9%
Water Heating	Pipe Insulation	17%	100%	38%	13	$180	5.7%	2.9%
Water Heating	Low Flow Showerheads	75%	100%	80%	10	$96	17.1%	8.6%
Water Heating	Tank Blanket/Insulation	17%	100%	75%	10	$15	9.1%	4.6%
Water Heating	Thermostat Setback	17%	100%	75%	5	$40	9.1%	4.6%
Water Heating	Timer	17%	100%	40%	10	$194	8.0%	4.0%
Water Heating	Hot Water Saver	5%	100%	50%	5	$35	8.8%	4.4%
Water Heating	Convert to Gas	0%	63%	80%	15	$3,675	100.0%	100.0%
Water Heating	Heat Pump	0%	50%	50%	15	$1,500	30.0%	15.0%

The equipment measure data tables for all energy efficiency measures assessed in this study are presented in Appendix C for the residential sector and Appendix C for the C&I sectors.

5.3 APPLICATION OF MEASURES FOR TECHNICAL POTENTIAL

Technical potential, as we defined it in Chapter 2, is a theoretical construct that assumes the highest efficiency measures that are technically feasible to install are adopted by customers, regardless of cost or customer preferences. Thus, determining the technical potential is relatively straightforward; LoadMAP uses the energy use associated with the most efficient equipment options for each end use and technology, as well as the energy savings for all defined non-equipment measures that apply to that end use and technology, to calculate energy use at the technical potential level. For example, for residential central air conditioning, as shown in Table 5-5, the most efficient option is a ductless mini-split system. The multiple non-equipment measures shown in Table 5-7 are then applied to the energy used by the ductless mini-split system to further reduce CAC energy use. LoadMAP applies the savings due to the non-equipment measures one-by-one to avoid double counting of savings. The measures are evaluated in order of their B/C ratio, with the measure with the highest B/C ratio applied first. Each time a measure is applied, the baseline energy use for the end use is reduced and the percentage savings for the next measure is applied to the revised (lower) usage.

5.4 APPLICATION OF MEASURES FOR ECONOMIC POTENTIAL

Next, to determine the economic level of efficiency potential, it is necessary to perform an economic screen on each individual measure. The economic screen applied in this study for non-

[20] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

equipment measures is a total resource cost (TRC) test that compares the lifetime benefits (both energy and peak demand) of each applicable measure with installed cost (including material, labor, and administration of a delivery mechanism, such as an energy efficiency program).[21] The lifetime benefits are obtained by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. Global assigns each measure values for savings, costs, and lifetimes as part of our measure characterization process. For economic screening of measures, incentives are not included because they represent a simple transfer from one party to another but have no effect on the overall measure cost.

The lifetime benefits of each energy efficiency measure depend on the forecast of Avista avoided costs. Avista provided projected avoided costs for energy and capacity over the study period. Figure 5-2 shows the avoided energy costs for the residential and C&I segments, which are 2009 real $/MWh and include Avista's adjustments for risk and the 10% Power Act premium. The avoided energy costs differ by segment due to the segments' differing load shapes. Figure 5-2 also shows the avoided capacity costs for Avista's overall system in 2009 real $/kW.

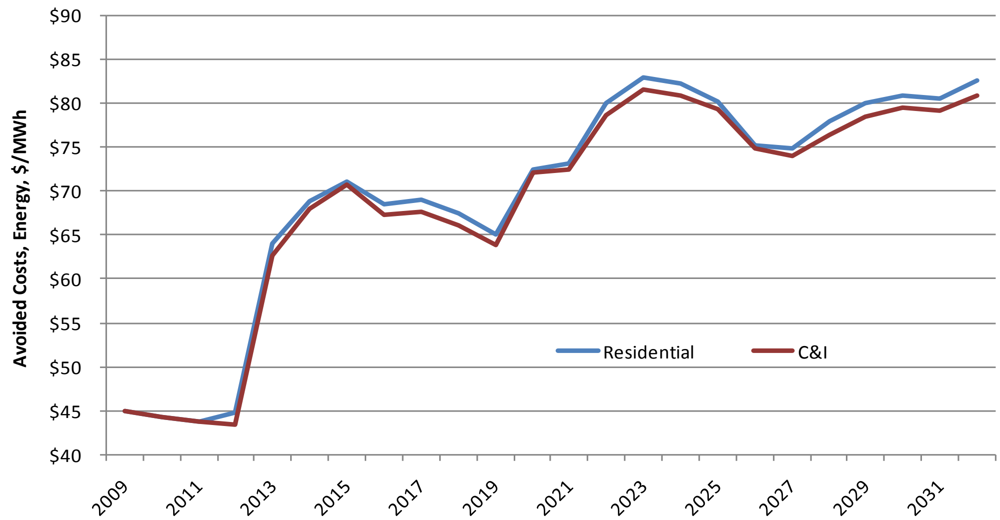
The LoadMAP model performs the economic screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast.

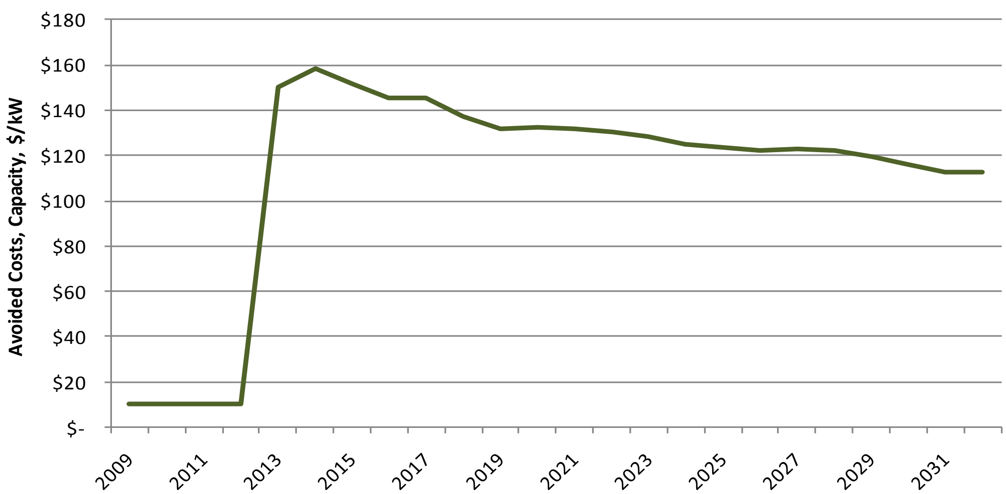
It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen table.

[21] Note that the TRC test is typically the industry standard for evaluating measure-level cost-effectiveness. There are other test perspectives that are often considered in energy efficiency potential studies. The Participant test measures the benefits and costs from the perspective of program participants as a whole. The Ratepayer Impact Measure (RIM) test measures the difference between the change in total revenues paid to a utility and the change in total costs to a utility resulting from the energy efficiency and demand response programs. The Utility Cost (UC) test measures the costs and benefits from the perspective of the utility administering the program. Neither the RIM nor UC tests are typically applied in the context of measure-level economic screens, but rather in the broader context of energy efficiency programs and initiatives put into place to deliver the energy efficiency measures.

Figure 5-2 Avoided Costs for Energy and Capacity





5.4.1 Equipment Measures Economic Screening

For equipment measures, LoadMAP evaluates the cost-effectiveness of each measure option, compared to the efficiency option that immediately precedes it. Continuing with the example of residential central air conditioning, as shown in Table 5-5, the standard efficiency option in 2010 is SEER 13. LoadMAP calculates the lifetime benefits and costs associated with each of the higher efficiency options to select the option with the highest net present value.

Table 5-8 shows the results of the economic screen for CAC for selected years, as well as results for two interior lighting technologies. In 2010, the most cost-effective option is SEER 14, while in 2012, due to rising energy costs, it changes to SEER 15. However, in 2015, due to federal energy efficiency standards, the SEER 13 unit goes off the market and SEER 14 becomes the standard efficiency unit. In 2015 and beyond, the economic screen selects the SEER 14 option because the marginal savings between the standard efficiency SEER 14 unit and the higher-efficiency options are not sufficient to make the higher-efficiency units economical. The table also shows how the economic choice for two of the lighting technology options varies over the study period.

Table 5-8 Economic Screen Results for Selected Residential Equipment Measures

Technology	2012	2017	2022	2027	2032
Central AC	SEER 13	SEER 14	SEER 14	SEER 14	SEER 14
Interior Lighting Screw-in	CFL	CFL	CFL	LED	LED
Interior Lighting Linear Fluorescent	T8	T8	T8	Super T8	Super T8

5.4.2 Non-equipment Measures Economic Screening

For non-equipment measures, LoadMAP evaluates the cost-effectiveness of each measure. The kWh savings are computed as the percent savings from the measure applied to the relevant end-use energy. If the measure passes the screen (has a B/C ratio greater than or equal to 1.0), the measure is included in economic potential. Otherwise, it is screened out for that year.

5.5 TOTAL MEASURES EVALUATED

Table 5-9 summarizes the number of equipment and non-equipment measures evaluated for each sector. In total, the project evaluated 4,332 energy efficiency measures.

Table 5-9 Number of Measures Evaluated

	Residential	C&I	Total Number of Measures
Equipment Measures Evaluated	1,284	608	1,892
Non-Equipment Measures Evaluated	1,524	916	2,440
Total Measures Evaluated	**2,808**	**1,524**	**4,332**

Appendix C shows the results of the economic screening process by segment, vintage, end use and measure for the residential sector. Appendix D shows the equivalent information for the commercial and industrial sectors.

ENERGY EFFICIENCY POTENTIAL RESULTS

This chapter presents the results of the energy-efficiency analysis. Before we provide the overall and sector-level results, we review the three levels of potential developed for this study.

6.1 DEFNITIONS OF POTENTIAL

In this study, we estimated three types of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction.

Technical potential is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option. Examples of measures that make up technical potential in the residential sector include:

- Ductless mini-split air conditioners with variable refrigerant flow
- Ground source (or geothermal) heat pumps
- LED lighting for general service and linear applications

Technical potential also assumes the adoption of every available other measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning.

Economic potential represents the adoption of all ***cost-effective*** energy efficiency measures. As described earlier, LoadMAP performs an economic screen to determine which measures are economically viable. LoadMAP incorporates the result of the screen into the purchase shares to reflect the most efficient measure that passes the screen. For our analysis, we apply the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost, including the administrative costs associated with any energy-efficiency program.

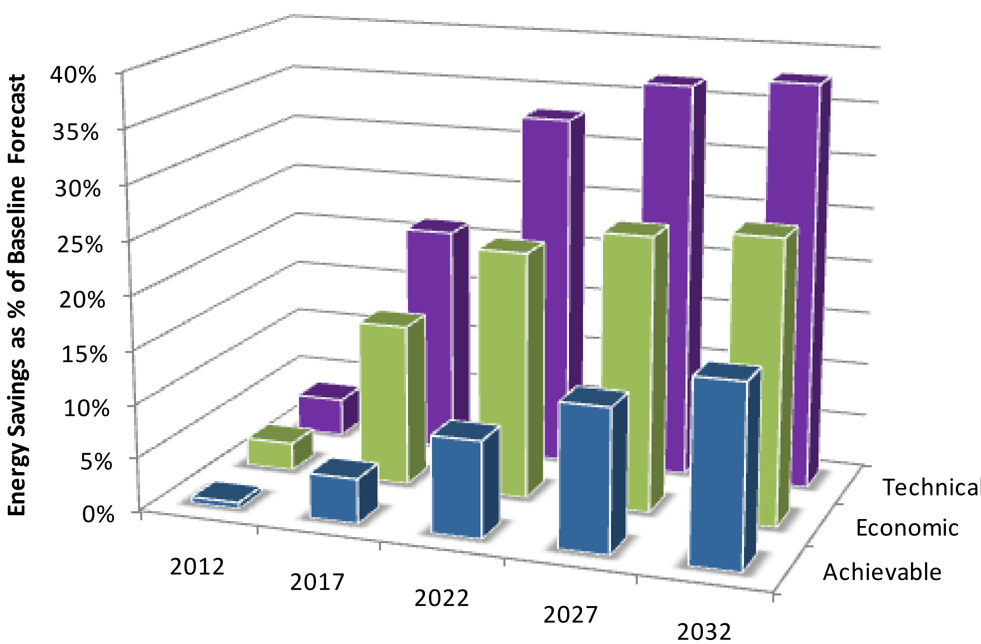
Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, customer preferences and likely behavior, and budget constraints. It uses a set of market acceptance rate factors (MARs) and program implementation factors (PIFs) to take into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. For example, it considers that other goals such as low rates and customer equity influence the development of final program designs and savings targets. It also considers customer incentive levels that are in line with typical industry practice, defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The achievable potential also takes into account recent utility experience and reported savings from past and present programs. For this study, we developed MARs and PIFs based on the ramp rate curves used in the Sixth Power Plan.[22] These factors were then applied to this study's estimates of economic potential to estimate achievable potential.

As with the baseline forecast, we developed the estimates of energy-efficiency potential using the LoadMAP model. We present high-level results in the rest of this chapter for the overall Avista electricity system. Separate results for Washington and Idaho are presented in Appendices A and B.

6.2 OVERALL ENERGY EFFICIENCY POTENTIAL

Achievable potential across all sectors is 49,804 MWh (5.7 aMW) in 2012 and increases to a cumulative value of 2,154,328 MWh (245.9 aMW) by 2032. These savings represents 0.6% of the baseline forecast in 2012 and 16.8% in 2032. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and economic potential savings are 26.3% of the baseline, or roughly 70% of technical potential savings. Achievable potential savings are nearly two-thirds of the economic potential savings.

Figure 6-1 summarizes the energy-efficiency savings for the three potential levels relative to the baseline forecast for selected years. Figure 6-2 displays the energy use forecast for the three potential levels versus the baseline forecast. Figure 6-1 Summary of Energy Efficiency Potential Savings, All Sectors



presents the energy consumption and peak demand for the potential levels across sectors.

[22] The Sixth Power Plan Conservation Supply Curve workbooks are available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm, with separate workbooks for specific sectors and end uses.

Figure 6-1 Summary of Energy Efficiency Potential Savings, All Sectors

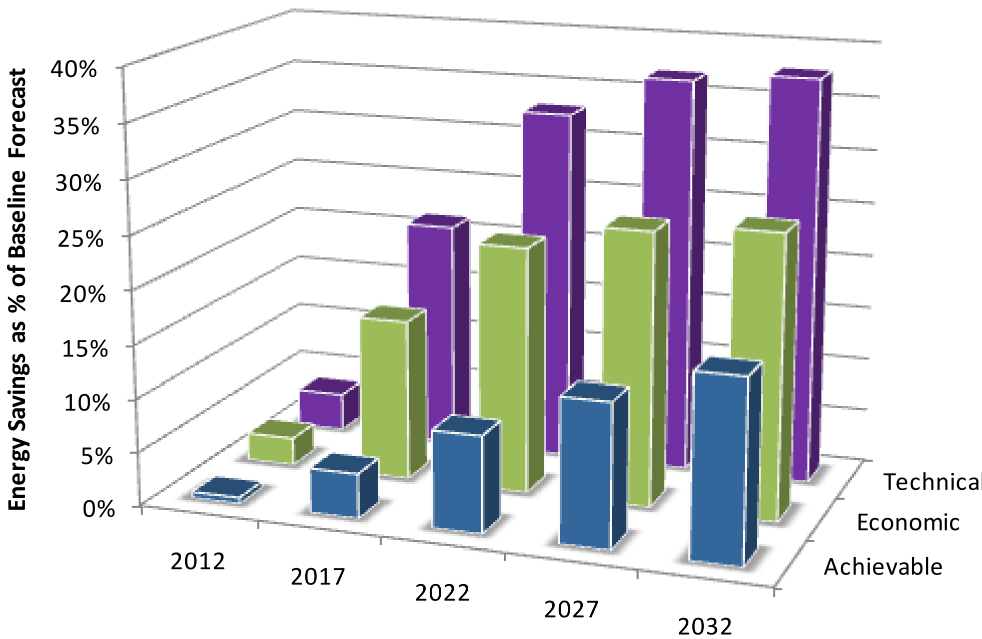


Figure 6-2 Energy Efficiency Potential Forecasts, All Sectors

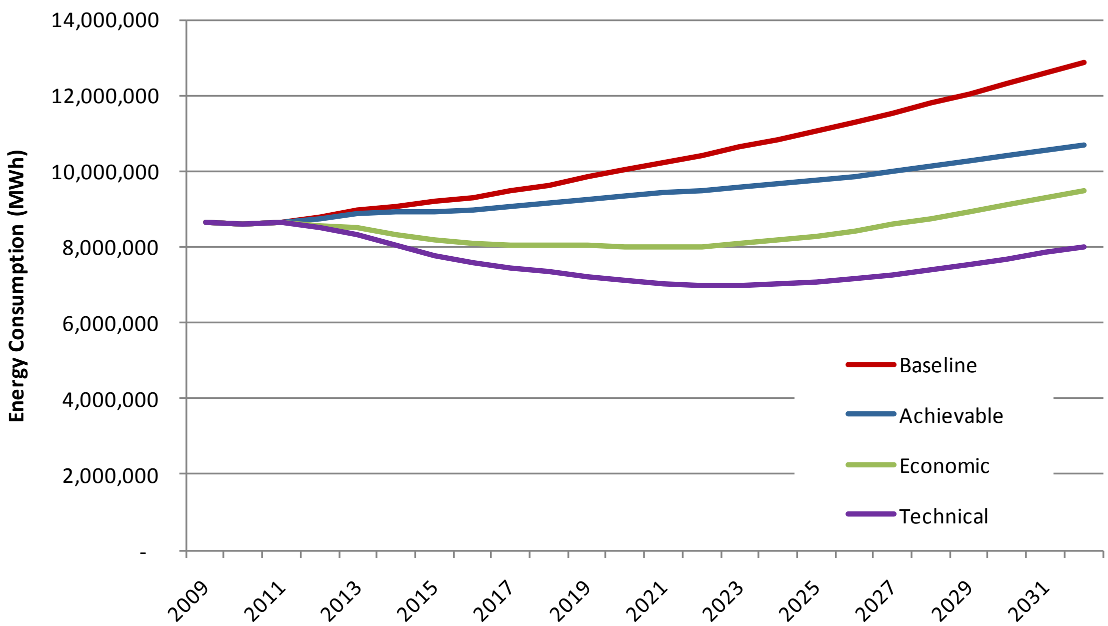


Table 6-1 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand(MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					

Achievable	49,804	395,397	940,578	1,538,868	2,154,328
Economic	229,657	1,426,454	2,398,355	2,942,457	3,386,190
Technical	311,274	2,022,115	3,435,475	4,255,664	4,853,304
Cumulative Energy Savings (% of Baseline)					
Achievable	0.6%	4.2%	9.0%	13.3%	16.8%
Economic	2.6%	15.1%	23.0%	25.5%	26.3%
Technical	3.5%	21.4%	33.0%	36.9%	37.8%
Peak Savings (MW)					
Achievable	14	80	182	307	431
Economic	55	278	474	582	659
Technical	71	398	669	829	944
Peak Savings (% of Baseline)					
Achievable	0.8%	4.3%	8.7%	13.3%	16.8%
Economic	3.1%	14.8%	22.8%	25.2%	25.7%
Technical	4.0%	21.2%	32.2%	35.9%	36.8%

Table 6-2 and Figure 6-3 summarize cumulative achievable potential by sector. Initially, the residential sector accounts for about 55% of the savings, but over time, the C&I sector becomes the source of about two-thirds of the savings.

Table 6-2 Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,067	86,316	234,163	433,646	637,443
Residential, ID	8,583	41,586	97,676	173,001	258,780
C&I, WA	15,732	173,410	378,252	575,336	774,620
C&I, ID	8,422	94,084	230,487	356,884	483,484
Total	**49,804**	**395,397**	**940,578**	**1,538,868**	**2,154,328**

Figure 6-3 Achievable Cumulative Potential by Sector

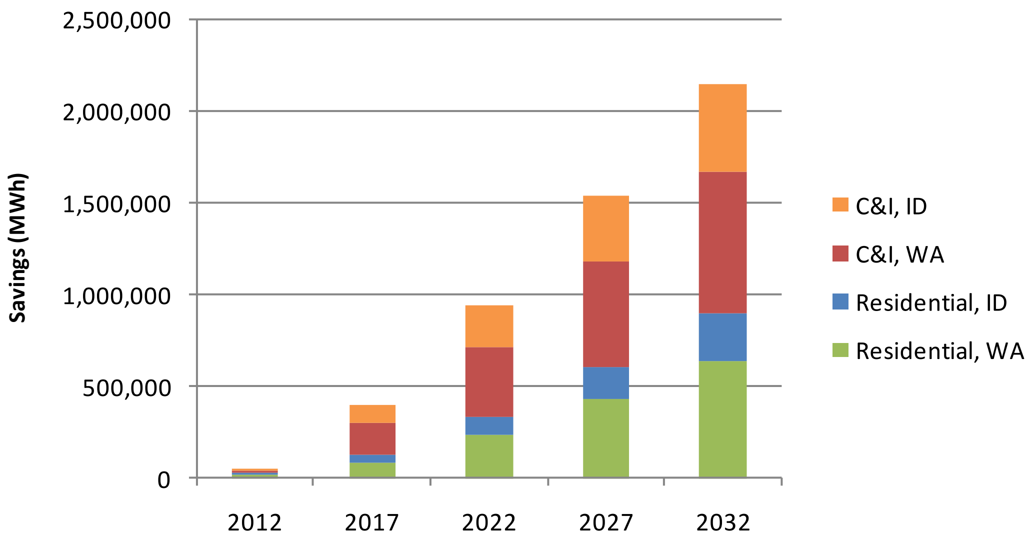


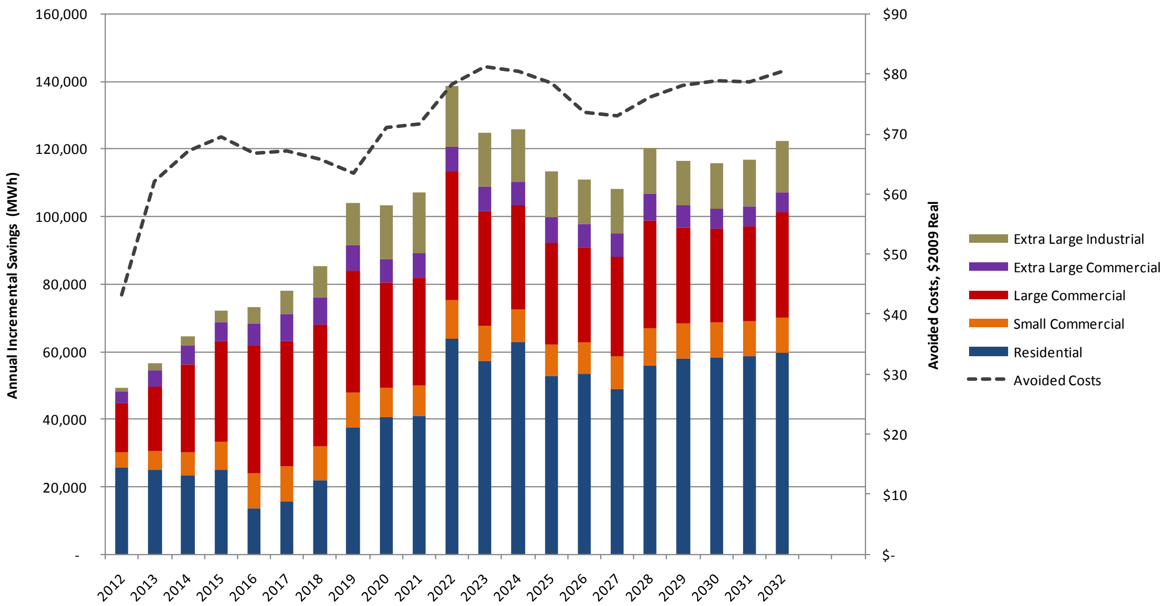
Table 6-3 shows the incremental annual potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential DSM programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table 6-3 Incremental Annual Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,067	16,617	15,532	16,987
Residential, ID	8,583	8,284	7,651	8,115
C&I, WA	15,732	21,164	26,867	30,388
C&I, ID	8,422	10,733	14,540	16,952
Total	**49,804**	**56,794**	**64,590**	**72,443**

In Figure 6-4, we can see how the annual incremental achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure 6-4 Incremental Annual Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

6.3 RESIDENTIAL SECTOR

Achievable potential savings for the residential sector in both states is 25,650 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 896,223 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Figure 6-5 depicts the potential savings estimates graphically. Figure 6-6 shows the energy use forecasts under the three types of potential versus the baseline forecast. Table 6-3 presents estimates for energy and peak demand under the three types of potential.

Figure 6-5 Energy Efficiency Potential Savings, Residential Sector

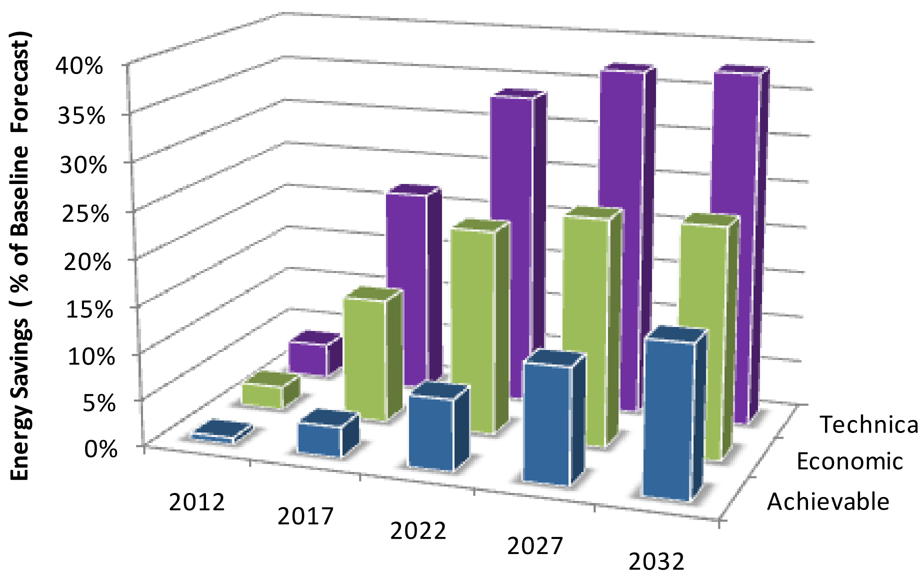


Figure 6-6 Energy Efficiency Potential Forecast, Residential Sector

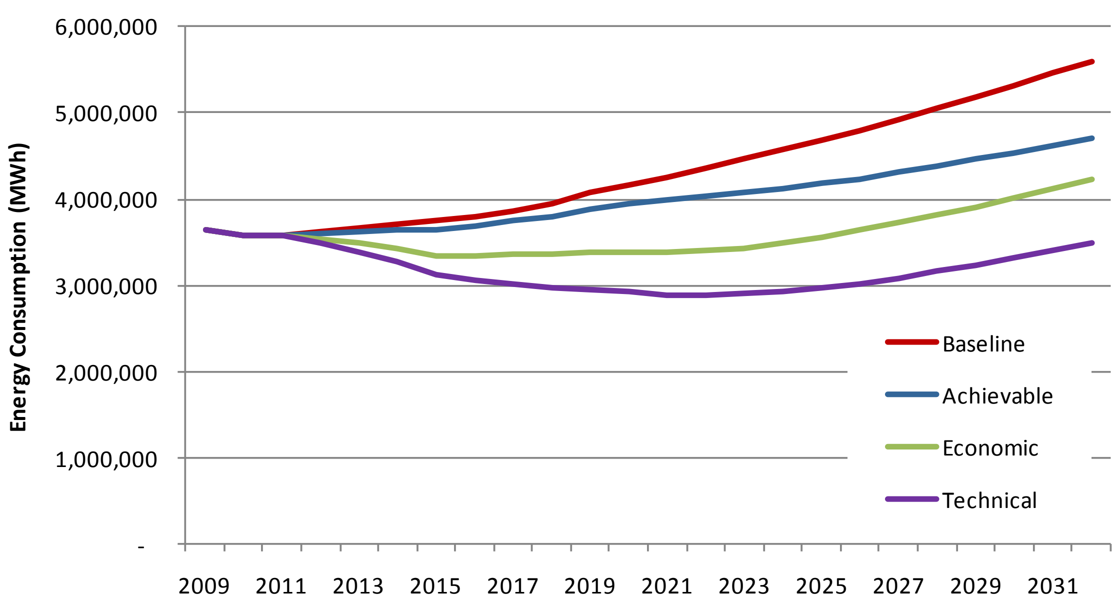


Table 6-4 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand(MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Achievable	25,650	127,902	331,839	606,647	896,223
Economic	89,536	516,557	954,743	1,193,149	1,372,852
Technical	135,708	856,938	1,468,041	1,830,901	2,113,776
Cumulative Energy Savings (% of Baseline)					
Achievable	0.7%	3.3%	7.6%	12.3%	16.0%
Economic	2.5%	13.3%	21.9%	24.3%	24.5%
Technical	3.7%	22.1%	33.7%	37.2%	37.7%
Peak Savings (MW)					
Achievable	10	40	98	180	262
Economic	33	148	281	351	396
Technical	45	233	407	505	580
Peak Savings (% of Baseline)					
Achievable	1.0%	3.9%	8.5%	14.0%	18.1%
Economic	3.3%	14.4%	24.4%	27.2%	27.3%
Technical	4.5%	22.7%	35.4%	39.2%	40.0%

6.3.1 Residential Potential by Market Segment

Table 6-5 shows the baseline forecast and achievable potential energy savings for the four residential segments in selected years. Single-family homes in Washington and Idaho account for 65% and 68% of each state's residential sector total sales during the base year and throughout the forecast. Thus, as one would expect, single-family homes account for the largest share of potential savings. Table 6-6 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-5 Residential Sector, Baseline and Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	2,394,930	2,551,956	2,876,301	3,252,564	3,709,958
Multi Family	203,544	222,114	253,265	288,585	330,209
Mobile Home	126,939	133,923	149,975	168,639	191,313
Limited Income	901,283	963,301	1,076,699	1,209,059	1,369,306
Total	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Cumulative Energy Savings, Achievable Potential (MWh)					
Single Family	18,396	87,681	236,658	429,338	630,872
Multi Family	1,065	5,535	14,153	28,354	42,757
Mobile Home	985	4,268	7,515	13,178	19,854
Limited Income	5,204	30,419	73,512	135,777	202,740
Total	25,650	127,902	331,839	606,647	896,223
% of Total Residential Cumulative Energy Savings					
Single Family	71.7%	68.6%	71.3%	70.8%	70.4%
Multi Family	4.2%	4.3%	4.3%	4.7%	4.8%
Mobile Home	3.8%	3.3%	2.3%	2.2%	2.2%
Limited Income	20.3%	23.8%	22.2%	22.4%	22.6%

Table 6-6 Residential Potential by Housing Type, 2022

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	2,876,301	253,265	149,975	1,076,699	4,356,240
Cumulative Energy Savings (MWh)					
Achievable	236,658	14,153	7,515	73,512	331,839
Economic Potential	667,247	46,320	20,935	220,241	954,743
Technical Potential	950,449	77,463	52,154	387,975	1,468,041
Cumulative Energy Savings % of Baseline					
Achievable	8.2%	5.6%	5.0%	6.8%	7.6%
Economic Potential	23.2%	18.3%	14.0%	20.5%	21.9%
Technical Potential	33.0%	30.6%	34.8%	36.0%	33.7%

6.3.2 Residential Potential by End Use, Technology, and Measure Type

Table 6-7 provides estimates of savings for each end use and type of potential.

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available (see discussion below) and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative achievable potential.
- ***Space Heating*** offers the second-highest cumulative technical potential over the study and its economic potential is slightly higher than water heating, again due to the potential for conversion to natural gas (see discussion below), but also due to shell measures, controls, and advanced new construction designs. Based on achievable savings, space heating also ranks second.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant economic and achievable lighting potential due to conversion from advanced incandescents to CFLs.
- ***Appliances*** rank sixth based on technical potential, but fourth in terms of achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2031 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Table 6-7 Residential Cumulative Savings by End Use and Potential Type (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Achievable	14	2,443	8,588	23,412	44,892
	Economic	364	22,925	41,690	60,482	82,185
	Technical	4,155	63,885	102,963	147,309	200,588
Space Heating	Achievable	73	12,052	76,875	188,252	304,328
	Economic	2,140	123,412	291,676	402,563	480,429
	Technical	4,014	172,368	390,626	528,107	651,071
Heat/Cool	Achievable	12	872	2,353	6,048	15,539
	Economic	447	12,872	15,291	18,697	27,916
	Technical	3,334	27,773	47,801	66,829	76,389
Water Heating	Achievable	414	20,344	102,112	202,933	316,850
	Economic	5,051	102,542	296,130	391,364	461,525
	Technical	26,668	253,789	527,056	668,318	745,452
Appliances	Achievable	1,282	12,411	26,859	42,554	59,056
	Economic	5,548	61,277	80,081	85,195	91,618
	Technical	7,229	78,554	105,335	113,831	120,932
Interior Lighting	Achievable	18,569	52,269	64,439	74,958	71,445
	Economic	55,377	107,842	116,225	106,057	86,182
	Technical	64,748	148,015	146,127	136,520	126,690
Exterior Lighting	Achievable	3,281	10,532	10,777	10,042	8,058
	Economic	9,770	21,965	17,611	13,313	9,494
	Technical	11,200	28,680	24,906	22,638	22,320
Electronics	Achievable	1,780	13,544	32,080	45,568	57,382
	Economic	8,967	45,853	67,702	76,036	87,323
	Technical	12,390	65,526	93,981	106,595	122,734
Miscellaneous	Achievable	225	3,435	7,756	12,880	18,673
	Economic	1,871	17,869	28,336	39,442	46,180
	Technical	1,970	18,348	29,247	40,754	47,600
Total	Achievable	25,650	127,902	331,839	606,647	896,223
	Economic	89,536	516,557	954,743	1,193,149	1,372,852
	Technical	135,708	856,938	1,468,041	1,830,901	2,113,776

Figure 6-7 focuses on achievable potential by end use in selected years. As discussed above, by the end of the study period, water heating and space heating are the largest contributors to achievable potential. In the early years of the study period, lighting maintains its historic role as the largest contributor to residential sector savings, due to remaining opportunities for conversion from incandescent lighting (both today’s standard lamps and the new advanced incandescents) to CFLs. By 2022, however, the percentage of savings due to lighting is projected to drop off as advanced incandescents become the new baseline.

Figure 6-7 Residential Achievable Potential by End Use, Selected Years

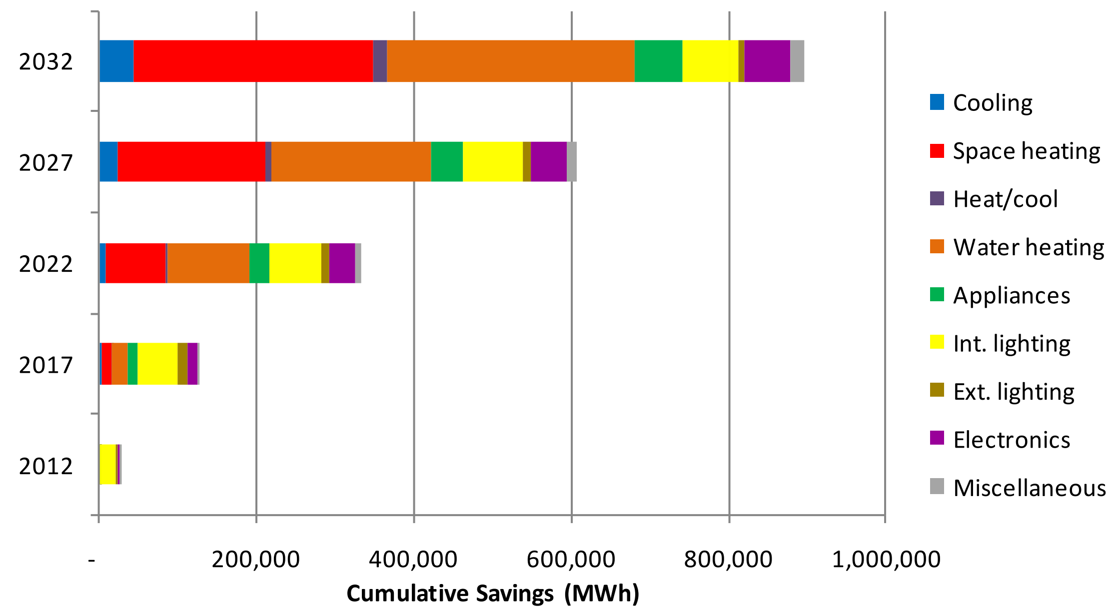


Table 6-8 shows the savings by end use and market segment in 2022. The segments are similar in terms of the savings opportunities by end use, but there are a few notable differences. Single-family homes have more exterior lighting and so have more savings potential for this end use. Similarly, single-family homes have swimming pools and therefore have more potential for savings in pool pumps, which are included in miscellaneous loads. Water heating is a higher proportion of potential savings in multi-family homes, mobile homes, and limited income homes, reflecting the smaller home sizes and thus diminished savings potential for space conditioning and appliances, compared to single family homes.

Table 6-8 Residential Potential by End Use and Market Segment, 2022 (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	4,975	258	129	3,226	8,588
Space heating	59,038	3,972	908	12,957	76,875
Heat/cool	2,138	12	88	114	2,353
Water heating	65,162	6,079	1,132	29,739	102,112
Appliances	19,090	529	950	6,290	26,859
Interior lighting	45,467	2,415	2,203	14,354	64,439
Exterior lighting	8,875	127	480	1,295	10,777
Electronics	25,054	754	1,302	4,970	32,080
Miscellaneous	6,860	6	324	566	7,756
Total	**236,658**	**14,153**	**7,515**	**73,512**	**331,839**

As described in Chapter 5, using our LoadMAP model, we develop separate estimates of potential for for equipment and non-equipment measures.

Table 6-9 presents results for equipment at the technology level, for which Achievable potential is greater than zero.

Table 6-9 Residential Cumulative Achievable Potential by End Use and Equipment Measures, Selected Years (MWh)

End Use	Technology	2012	2017	2022	2027	2032
Cooling	Central AC	-	152	167	237	231
Heat/Cool	Air Source Ht. Pump	-	-	-	-	4,835
Water Heating	Water Heater	140	1,047	1,096	2,130	22,240
Appliances	Clothes Washer	83	1,014	2,552	4,060	5,255
	Clothes Dryer	103	708	1,299	1,761	2,131
	Dishwasher	115	1,074	2,621	4,015	5,316
	Refrigerator	438	1,999	4,064	6,232	8,655
	Freezer	333	1,651	3,592	4,599	5,784
	Second Refrigerator	154	747	1,424	2,223	2,792
	Stove	22	165	371	748	1,105
Interior Lighting	Screw-in	17,292	42,771	48,939	50,750	36,628
	Linear Fluorescent	173	1,906	3,576	5,344	7,579
	Pin-based	1,102	7,398	11,079	16,520	22,761
Exterior Lighting	Screw-in	3,256	10,404	10,606	9,808	7,785
	High Intensity/Flood	25	128	171	233	273
Electronics	Personal Computers	1,148	9,279	15,975	23,461	32,216
	TVs	620	3,260	6,039	7,317	10,003
Miscellaneous	Pool Pump	171	1,581	3,896	7,132	10,581
	Furnace Fan	45	560	1,668	3,411	5,725
Total		**25,220**	**85,845**	**119,135**	**149,983**	**191,895**

Conversion of electric water heaters and electric furnaces to natural gas was modeled as a special case within the measure analysis to allow consideration of feasibility (e.g., homes too far from a natural gas line), as well as to allow the option of a heat pump water heater for homes where conversion to gas is not feasible. Table 6-10 shows the residential sector achievable savings from converting electric furnaces and water heaters to natural gas. Conversion ramps up slowly, but because it completely removes use of electricity from two of the largest ends uses, it accounts for a substantial portion of savings by 2032: For water heating, about one-fourth of the savings from conversion to gas occurs in new construction. For furnaces, the fraction due to new construction is roughly one-third.

Table 6-10 Achievable Savings from Conversion to Natural Gas (MWh)

	2012	2017	2022	2027	2032
Water heater —convert to gas Achievable potential (MWh)	46	4,967	69,406	146,834	215,691
Water heater –convert to gas (% of Res. Achievable potential)	0.2%	3.9%	20.9%	24.2%	24.1%
Furnace — convert to gas Achievable potential (MWh)	10	2,488	45,453	107,376	170,970
Furnace — convert to gas (% of Res. Achievable potential)	0%	1.9%	13.7%	17.7%	19.1%

Table 6-11 presents savings results for non-equipment measures for which Achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that because a measure such as insulation provides both space cooling and space heating savings, Table 6-11 does not break down savings by end use.

Table 6-11 Residential Achievable Savings for Non-equipment Measures (MWh)

Measure	2012	2017	2022	2027	2032
Water Heater - Convert to Gas	46	4,967	69,406	146,834	215,691
Furnace - Convert to Gas	10	2,488	45,453	107,376	170,970
Advanced New Construction Designs	1	180	4,206	16,530	34,695
Repair and Sealing - Ducting	20	2,713	7,763	19,896	31,001
Insulation - Infiltration Control	20	2,731	7,696	19,455	30,081
Water Heater - Thermostat Setback	142	8,150	13,721	20,321	27,414
Home Energy Management System	7	1,175	4,146	10,930	21,118
Water Heater - Hot Water Saver	6	426	5,447	12,453	19,430
Freezer - Remove Second Unit	22	3,246	6,959	12,252	18,178
Electronics - Reduce Standby Wattage	13	1,004	10,066	14,790	15,163
Thermostat - Clock/Programmable	21	2,859	7,907	13,130	14,243
Insulation - Foundation	1	438	1,979	6,304	12,017
Air Source Heat Pump - Maintenance	12	872	2,353	6,048	10,704
Refrigerator - Remove Second Unit	13	1,807	3,977	6,664	9,841
Water Heater - Faucet Aerators	12	978	2,341	5,103	8,462
Insulation - Ducting	1	195	1,024	4,243	8,090
Insulation - Wall Cavity	1	276	1,234	3,904	7,416
Water Heater - Tank Blanket/Insulation	49	2,596	4,051	5,626	7,363
Ceiling Fan - Installation	0	87	743	3,330	6,054
Room AC - Removal of Second Unit	6	919	2,280	3,947	5,869
Water Heater - Heat Pump	-	23	793	2,646	5,703
Water Heater - Timer	8	1,165	2,477	3,561	4,950
Insulation - Ceiling	2	400	1,201	2,978	4,815
Water Heater - Low Flow Showerheads	9	887	1,762	2,604	3,555
Central AC - Maintenance and Tune-Up	-	-	-	-	2,898
Pool - Pump Timer	8	1,294	2,192	2,337	2,368
Insulation - Wall Sheathing	0	50	230	757	2,342
Water Heater - Pipe Insulation	2	106	1,018	1,655	2,040
Whole-House Fan - Installation	0	27	278	991	1,856
Total	**430**	**42,057**	**212,703**	**456,664**	**704,329**

Looking at both the equipment (

Table 6-9) and non-equipment measure results (Table 6-11), we see that initially nearly all of the savings come from the equipment measures, particularly lighting, but over time an increasing proportion of the savings come from conversion of water heating and space heating to natural gas. At the study mid-point in 2022, the four measures with the greatest achievable poential are:

- Water heater conversion to gas (69,406 MWh)
- Replacement of interior screw in lamps (48,939 MWh)
- Furnace conversion to gas (45,453 MWh)
- Replacement of personal computers with ENERGY STAR units (15,975 MWh)

These four measures provide achievable potential of 179,773 MWh in 2022, which is approximately 54% of the total 2022 potential for the residential sector.

6.4 COMMERCIAL AND INDUSTRIAL SECTOR POTENTIAL

Achievable potential savings for the C&I sector in both states is 24,154 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,104 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Figure 6-8 depicts the potential savings estimates graphically. Figure 6-9 shows the energy use forecasts under the three types of potential versus the baseline forecast. Table 6-12 presents estimates for the sector's energy and peak demand under the three types of potential.

Figure 6-8 Energy Efficiency Potential Savings, Commercial and Industrial Sector

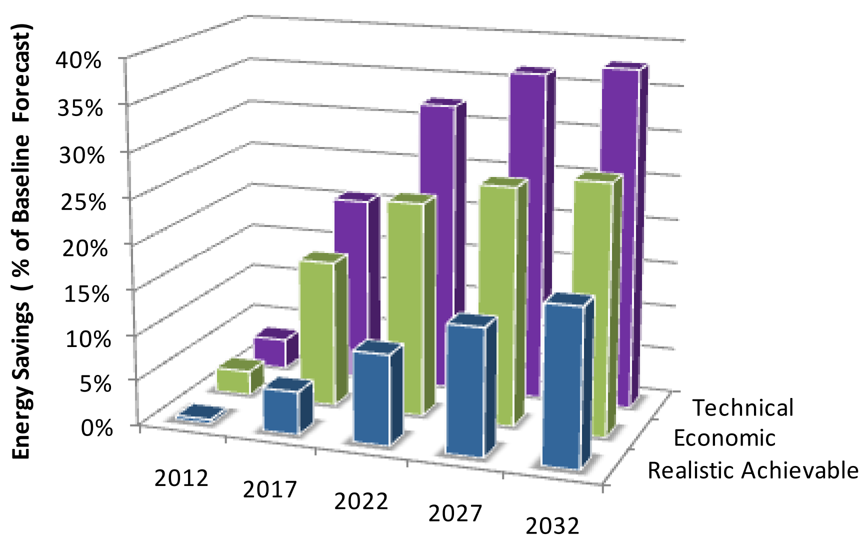


Figure 6-9 Energy Efficiency Potential Forecast, Commercial and Industrial Sector

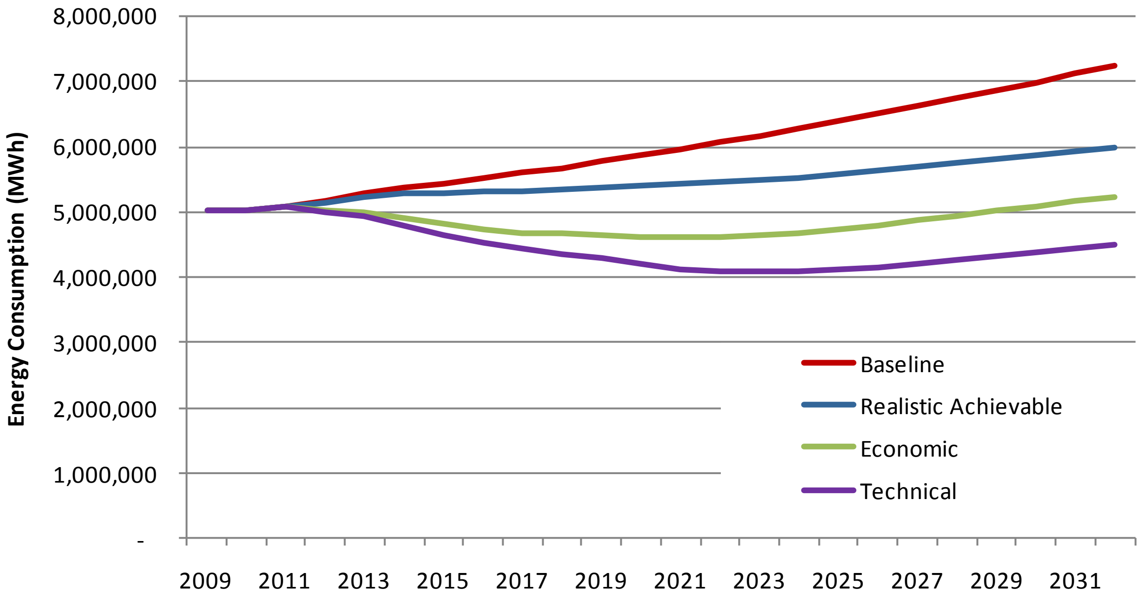


Table 6-12 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Baseline Peak Demand(MW)	788	854	929	1,018	1,117
Cumulative Energy Savings (MWh)					
Achievable	24,154	267,494	608,739	932,221	1,258,104
Economic	140,121	909,897	1,443,612	1,749,309	2,013,338
Technical	175,565	1,165,177	1,967,434	2,424,763	2,739,528
Cumulative Energy Savings (% of Baseline)					
Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.8%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Achievable	4	40	84	127	169
Economic	22	130	193	231	263
Technical	27	165	262	324	364
Peak Savings (% of Baseline)					
Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.8%	32.5%	36.6%	37.8%

6.4.1 Commercial Potential by Market Segment and State

Table 6-13 shows the baseline forecast and achievable potential energy savings for the four C&I segments. Large Commercial customers account for the largest portion of the baseline forecast and thus also have the largest achievable potential. In 2012 the Large Commercial segment's achievable potential is 14,754 MWh or 61.1% of C&I total achievable potential. By 2032 its share of C&I potential has dropped slightly to 50.8%. In contrast, the Extra Large Industrial customers increase their role in savings over the study period, beginning with only 1,673 MWh of achievable potential or 6.9% of total C&I potential in 2012, but growing by 2032 to cumulative achievable savings of 285,178 MWh or 22.7% of the C&I sector savings. Table 6-14 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-13 C&I Sector, Baseline and Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	730,499	772,442	832,324	906,807	992,374
Large Commercial	2,266,380	2,403,446	2,592,110	2,822,788	3,088,354
Extra Large Commercial	347,860	421,489	457,725	497,943	541,389
Extra Large Industrial	1,827,605	1,995,209	2,178,948	2,390,485	2,628,857
Total	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings, Achievable Potential (MWh)					
Small/Med. Commercial	4,511	46,334	96,231	144,827	197,622
Large Commercial	14,754	164,668	338,450	491,020	638,562
Extra Large Commercial	3,216	33,198	69,605	105,163	136,743
Extra Large Industrial	1,673	23,294	104,453	191,210	285,178
Total	24,154	267,494	608,739	932,221	1,258,104
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	18.7%	17.3%	15.8%	15.5%	15.7%
Large Commercial	61.1%	61.6%	55.6%	52.7%	50.8%
Extra Large Commercial	13.3%	12.4%	11.4%	11.3%	10.9%
Extra Large Industrial	6.9%	8.7%	17.2%	20.5%	22.7%

Table 6-14 C&I Potential by Segment, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	832,324	2,592,110	457,725	2,178,948	6,061,107
Cumulative Energy Savings (MWh)					
Achievable	96,231	338,450	69,605	104,453	608,739
Economic Potential	193,950	646,644	144,275	458,743	1,443,612
Technical Potential	308,119	951,283	184,560	523,472	1,967,434
Cumulative Energy Savings % of Baseline					
Achievable	12%	13%	15%	5%	10%
Economic Potential	23%	25%	32%	21%	24%
Technical Potential	37%	37%	40%	24%	32%

6.4.2 C&I Potential by End Use, Technology, and Measure Type

Table 6-15 presents the C&I sector savings by end use and potential type. Recall that the Small/Medium Commercial and Large Commercial Segments include a small percentage of industrial-type customers. Hence, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. In addition, the miscellaneous category includes non-HVAC motors to capture motor use within small industrial facilities. For all C&I customers, a custom measure category was included to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. In terms of how potential is divided among the various end uses, we note the following:

- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study's avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.
- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.
- ***Machine drive*** ranks fourth in achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer's Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- Savings from commercial refrigeration, food preparation, and water heating are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

Table 6-15 C&I Cumulative Savings by End Use and Potential Type (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Achievable	205	14,595	50,416	82,103	119,700
	Economic	2,848	51,234	108,395	146,209	191,484
	Technical	7,425	96,886	200,488	252,951	302,301
Space Heating	Achievable	15	2,144	11,476	22,238	36,935
	Economic	287	11,263	31,407	45,948	66,715
	Technical	512	17,737	51,975	71,644	94,897
Heat/Cool	Achievable	47	3,765	6,874	8,352	10,413
	Economic	541	8,928	11,319	13,415	15,092
	Technical	743	10,317	13,864	16,814	18,949
Ventilation	Achievable	457	7,102	35,467	69,845	117,020
	Economic	7,544	56,221	144,530	201,459	237,313
	Technical	10,719	82,071	220,464	294,789	323,008
Water Heating		205	6,315	13,969	20,663	27,581
		1,907	19,044	27,780	34,762	36,791
		12,461	93,375	174,865	249,648	274,495
Food Preparation	Achievable	213	2,665	7,608	14,695	22,009
	Economic	2,824	17,789	32,528	39,188	42,755
	Technical	3,215	19,520	35,976	43,195	47,322
Refrigeration	Achievable	185	1,877	6,192	11,901	17,567
	Economic	2,768	13,518	25,844	33,360	37,422
	Technical	3,273	17,982	40,008	51,933	58,855
Interior Lighting	Achievable	17,619	166,503	328,877	477,040	598,564
	Economic	78,200	461,679	609,517	700,595	803,195
	Technical	85,734	504,965	681,379	784,870	892,840
Exterior Lighting	Achievable	1,634	23,519	46,019	57,477	68,467
	Economic	7,096	67,172	78,193	81,864	86,650
	Technical	7,893	73,413	87,263	98,652	110,984
Office Equipment	Achievable	2,642	27,112	44,602	58,637	73,152
	Economic	19,053	86,895	91,341	95,389	99,348
	Technical	25,452	119,267	126,773	134,377	142,248
Machine Drive	Achievable	581	9,104	42,030	72,656	101,018
	Economic	6,560	57,477	158,387	196,285	214,864
	Technical	6,994	67,404	204,459	258,683	286,647
Process	Achievable	345	2,590	14,014	33,699	60,759
	Economic	10,390	57,275	120,473	154,151	172,559
	Technical	10,390	57,275	120,473	154,151	172,559
Miscellaneous	Achievable	7	204	1,194	2,914	4,921
	Economic	103	1,403	3,897	6,684	9,150
	Technical	753	4,964	9,446	13,056	14,423
Total	Achievable	24,154	267,494	608,739	932,221	1,258,104
	Economic	140,121	909,897	1,443,612	1,749,309	2,013,338
	Technical	175,565	1,165,177	1,967,434	2,424,763	2,739,528

Figure 6-10 focuses on achievable potential by end use in selected years. Interior lighting remains the largest source of potential in the C&I sector throughout the study. Cooling, ventilation, and machine drive are the next largest contributors as discussed above.

Figure 6-10 C&I Achievable Potential by End Use, Selected Years

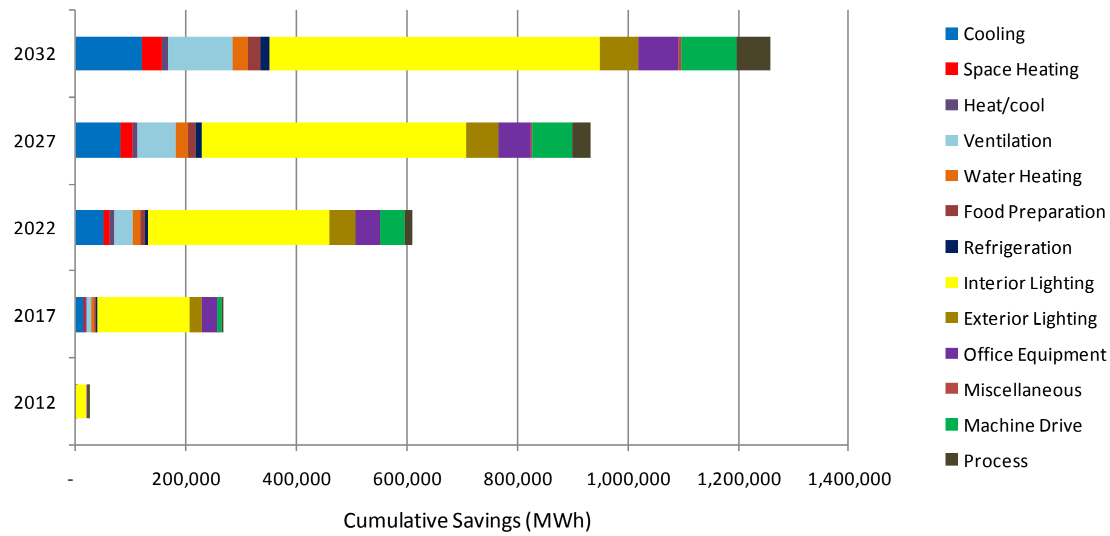


Table 6-16 shows the savings by end use and C&I market segment in 2022. As one would expect, the Extra Large Industrial segment differs significantly from the other segments. Machine drive and process improvements constitute 40% and 13% of achievable potential for this segment. Note that the three commercial building segments, which are based on Avista's rate structure, do include a small percentage of industrial businesses. For these customers, the miscellaneous savings end-use includes non-HVAC motors.

Table 6-16 C&I Achievable Potential by End Use and Market Segment, 2022 (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	3,823	26,225	5,151	15,217	50,416
Space Heating	778	6,727	1,521	2,450	11,476
Combined Heating/Cooling	572	5,264	583	455	6,874
Ventilation	8,757	5,663	5,627	15,420	35,467
Water Heating	2,190	5,825	5,954	-	13,969
Food Preparation	1,238	5,563	807	-	7,608
Refrigeration	1,313	4,383	496	-	6,192
Interior Lighting	58,481	218,078	38,555	13,764	328,877
Exterior Lighting	10,719	27,639	6,557	1,103	46,019
Office Equipment	8,011	32,404	4,187	-	44,602
Machine Drive	-	-	-	42,030	42,030
Process	-	-	-	14,014	14,014
Miscellaneous	349	678	168	-	1,194
Total	**96,231**	**338,450**	**69,605**	**104,453**	**608,739**

Table 6-17 presents Achievable potential savings for equipment measures for which Achievable potential is greater than zero. These results provide additional detail at the technology level. For example, within interior lighting, screw-in lamps initial provide the greatest share of savings, but the EISA standards move the baseline in that category to a higher efficiency level. Consequently, in the long run, fluorescent lamps offer the greatest savings potential.

Table 6-17 C&I Cumulative Achievable Potential by End Use and Equipment Measures, (MWh)

End Use	Technology	2012	2017	2022	2027	2032
Cooling	Central Chiller	81	855	3,288	7,640	12,774
	PTAC	6	6	6	2	0
Heat/Cool	Heat Pump	21	391	1,172	2,139	3,850
Ventilation	Ventilation	140	1,047	1,096	2,130	22,240
Water Heater	Water Heater	174	2,019	4,463	9,754	15,944
Food Preparation	Fryer	13	147	392	744	1,132
	Hot Food Container	13	275	763	1,471	2,260
	Oven	187	2,203	5,881	11,348	17,450
Refrigeration	Glass Door Display	32	434	1,248	2,495	4,202
	Icemaker	25	324	961	1,726	2,635
	Solid Door	43	497	1,331	2,508	3,961
	Vending Machine	83	455	1,111	2,018	2,985
	Walk in Refrigeration	2	26	63	120	216
Interior Lighting	Interior Screw-in	10,283	66,690	101,556	136,813	154,664
	HID	2,837	25,587	50,762	71,627	88,457
	Linear Fluorescent	4,319	53,111	104,450	152,199	187,071
Exterior Lighting	Screw-in	230	3,155	5,265	4,315	2,190
	HID	1,267	16,135	31,807	40,493	49,968
	Linear Fluorescent	124	2,230	3,784	4,933	6,221
Office Equipment	Desktop Computer	1,546	14,363	22,986	30,157	37,223
	Laptop Computer	111	1,031	1,649	2,098	2,470
	Monitor	317	1,139	1,970	2,665	3,315
	POS Terminal	37	514	939	1,341	1,798
	Printer/copier/fax	110	1,626	2,988	4,067	5,099
	Server	511	7,235	11,670	15,760	20,650
Machine Drive	Less than 5 HP	34	236	663	1,128	1,726
	5-24 HP	73	532	1,536	2,635	4,034
	25-99 HP	183	1,325	3,825	6,562	10,044
	100-249 HP	51	373	1,077	1,848	2,828
	250-499 HP	55	397	1,145	1,964	3,006
	500 and more HP	103	748	2,160	3,705	5,671
Process	Electrochem. Process	49	358	1,869	4,501	8,226
	Process	65	479	2,500	6,018	10,999
	Process Heating	231	1,707	8,907	21,445	39,192
Miscellaneous	Non-HVAC Motor	6	95	520	1,637	3,243
Total		**23,654**	**212,346**	**405,630**	**602,461**	**792,199**

Table 6-18 presents savings results for non-equipment measures for which Achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that, because a measure such as insulation provides both space cooling and space heating savings, Table 6-11does not break down savings by end use.

Table 6-18 C&I Cumulative Achievable Savings for Non-equipment Measures (MWh)

Measure	2012	2017	2022	2027	2032
Energy Management System	39	2,372	25,108	44,449	61,576
Advanced New Construction Designs	1	106	1,626	13,280	49,533
Retrocommissioning - Lighting	57	11,775	21,760	27,611	33,491
Interior Fluorescent - High Bay Fixtures	21	1,262	13,307	23,921	32,442
Custom Measures	4	829	11,321	22,556	25,199
Retrocommissioning - Comprehensive	41	8,649	15,523	19,114	22,756
Fans - Variable Speed Control	12	553	5,368	10,604	17,953
RTU - Maintenance	63	7,964	14,458	16,620	17,882
Fans - Energy Efficient Motors	10	651	6,782	12,037	15,898
Photocell Controlled T8 Dimming Ballasts	0	61	535	3,439	11,527
Retrocommissioning - HVAC	5	580	5,758	9,457	11,492
Pumping System - Optimization	11	507	4,907	8,488	11,303
Compressed Air - System Optimization and Improvements	11	506	4,837	8,282	10,961
Interior Lighting - Occupancy Sensors	19	726	5,616	8,593	10,565
Motors - Variable Frequency Drive	18	2,220	4,618	6,980	9,747
Motors - Magnetic Adjustable Speed Drives	8	367	3,707	6,669	9,220
Water Heater - Faucet Aerators/Low Flow Nozzles	27	3,964	8,101	8,692	8,951
Interior Fluorescent - Delamp and Install Reflectors	18	728	5,429	7,830	8,868
Commissioning - Comprehensive	0	368	2,614	5,069	8,138
Compressed Air - System Controls	7	355	3,457	6,003	8,017
Chiller - Turbocor Compressor	4	276	3,008	5,418	7,421
Heat Pump - Maintenance	26	3,374	5,702	6,214	6,563
Roofs - High Reflectivity	2	54	426	2,330	6,494
Pumps - Variable Speed Control	5	250	2,395	4,102	5,432
Chiller - Condenser Water Temperature Reset	7	419	3,987	5,037	5,000
Chiller - VSD	3	208	2,116	3,705	4,914
Compressed Air - Compressor Replacement	4	203	1,982	3,451	4,615
Pumping System - Controls	4	202	1,942	3,332	4,417
Thermostat - Clock/Programmable	5	762	1,499	2,146	2,851
Exterior Lighting - Daylighting Controls	4	161	1,309	2,148	2,822
Commissioning - Lighting	0	248	842	1,639	2,748
Office Equipment - Energy Star Power Supply	9	1,205	2,400	2,551	2,596
Compressed Air - System Maintenance	13	717	1,198	1,647	2,149
Insulation - Ducting	1	145	1,221	1,778	2,100
Chiller - Chilled Water Reset	4	645	1,142	1,503	1,894
Water Heater - Heat Pump	1	69	870	1,531	1,850

Measure	2012	2017	2022	2027	2032
Cooking - Exhaust Hoods with Sensor Control	1	14	127	799	1,849
Pumping System - Maintenance	-	43	606	1,200	1,590
Furnace - Convert to Gas	0	39	527	1,071	1,547
Cooling - Economizer Installation	3	125	1,138	1,436	1,436
Exterior Lighting - Induction Lamps	0	29	430	914	1,369
Refrigeration - System Optimization	0	24	388	911	1,229
Insulation - Ceiling	0	2	29	266	999
Refrigeration - System Controls	0	17	272	641	865
Industrial Process Improvements	0	28	332	671	810
LED Exit Lighting	25	932	1,028	893	803
Insulation - Wall Cavity	0	12	177	418	696
Commissioning - HVAC	-	-	20	365	608
Water Heater - Tank Blanket/Insulation	4	255	449	489	513
Miscellaneous - Energy Star Water Cooler	0	59	173	287	423
Refrigeration - Floating Head Pressure	0	10	105	199	351
Refrigeration - Strip Curtain	-	1	34	187	319
Refrigeration - System Maintenance	0	5	78	183	248
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	8	81	152	211
Water Heater - Hot Water Saver	-	-	4	68	177
Water Heater - High Efficiency Circulation Pump	0	8	83	130	146
Vending Machine - Controller	0	39	66	86	111
Chiller - Chilled Water Variable-Flow System	0	6	51	80	98
Exterior Lighting - Cold Cathode Lighting	0	2	24	49	72
Laundry - High Efficiency Clothes Washer	0	9	16	23	25
Refrigeration - Night Covers	0	1	9	17	25
Total	**499**	**55,149**	**203,109**	**329,760**	**465,905**

By the mid-point of the study period, 2022, the greatest savings come from:

- Replacement of interior lamps (linear fluorescent, screw in, and HID systems: 42,202 MWh)
- Replacement of office equipment with more efficient units (101,556 MWh)
- Replacement of exterior lamps (40,855 GWh)
- Installation of Energy Management Systems (25,108 MWh)
- Retrocommissioning of lighting systems (21,760 MWh)

Together, these five measures account for 285,137 MWh or 47% of the Achievable potential savings in the commercial sector in 2022.

6.5 SENSITIVITY OF POTENTIAL TO AVOIDED COST

Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure 6-11 and Table 6-19 show how achievable potential varies under the four scenarios. The base case achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively. While the changes are significant, the relationship between avoided cost and achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of DSM becomes increasingly expensive.

Figure 6-11 Energy Savings, Achievable Potential Case by Avoided Costs Scenario (MWh)

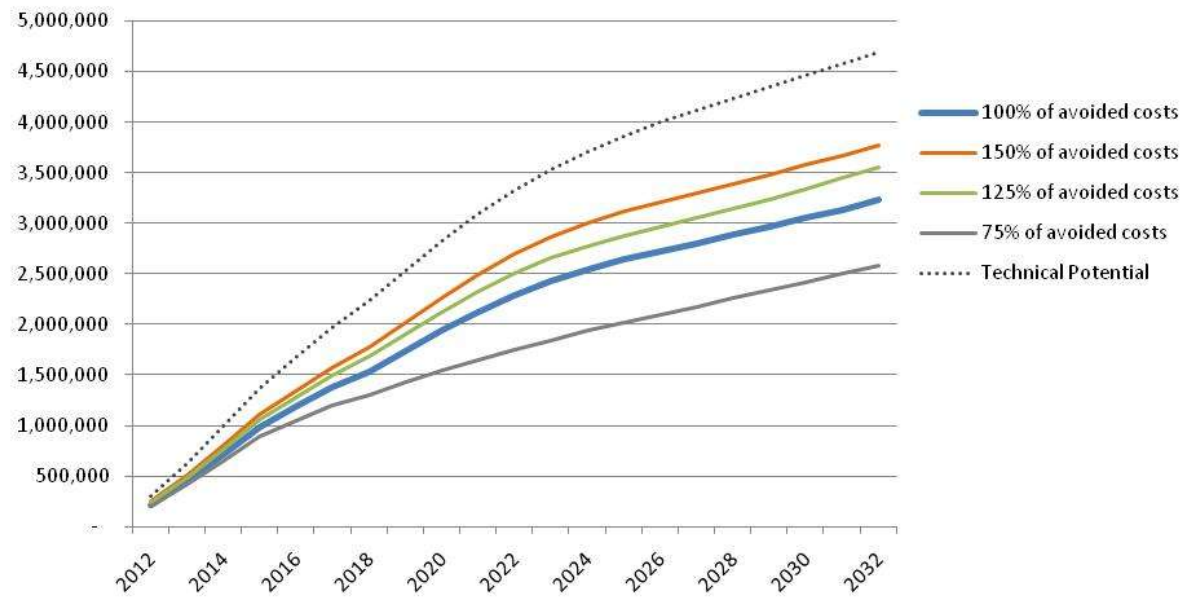


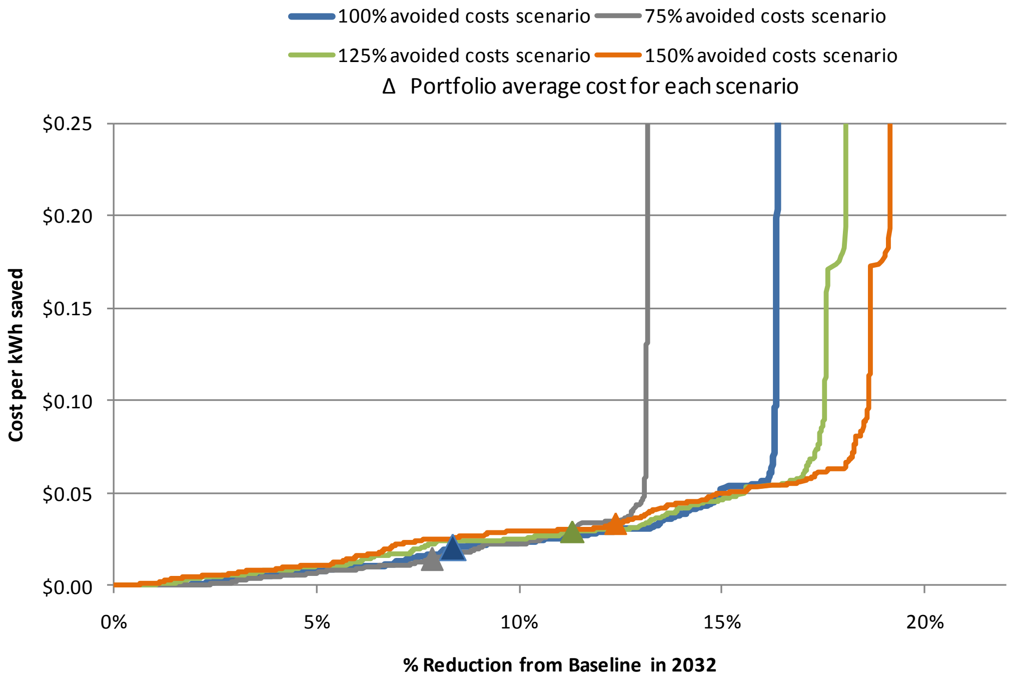
Table 6-19 Achievable Potential with Varying Avoided Costs

	Reference Scenario	75% of avoided costs	125% of avoided costs	150% of avoided costs
Achievable potential savings 2032 (MWh)	2,106,584	1,690,671	2,320,926	2,464,465
Percentage change in savings vs. 100% avoided cost scenario		-20%	10%	17%

The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure 6-12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. Because there is a gap in the cost of the energy efficiency measures as you move up the supply curve, the measures with a very high cost cause a rapid sloping of the supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15%

savings in 2032 at costs below $0.05/kWh. Results do not differ greatly until the curves begin to reach the increasingly high-cost measures.

Figure 6-12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



6.6 SENSITIVITY OF POTENTIAL TO CUSTOMER AND ECONOMIC GROWTH

This conservation potential assessment shows that DSM offsets roughly 50% of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that DSM can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, we used the LoadMAP model to evaluate several scenarios with lower customer and economic growth, as indicated in Table 6-20.

Table 6-20 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Household size	~ 1% per year growth	Capped at 110% of existing household size	Capped at 110% of existing household size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table 6-21 shows that as economic and customer growth decreases, the ability of DSM to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table 6-21 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

6.7 PUMPING POTENTIAL

Table 6-22 displays the 2009 electricity sales and peak demand of Avista's pumping customers. These customers include mostly municipal water systems and some irrigation customers. The pumping accounts represent 2.2% of total electricity sales and 0.8% of peak demand. (Total in this case refers to the rate classes listed in Table 3-1 and Table 3-2: residential, commercial, industrial, and pumping). Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table 6-22 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets based on 2007 sales. It provides annual conservation targets through 2019. Therefore, we trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results shown in Figure 6-13. Table 6-23 displays incremental annual savings potential for 2012–2015, while Table 6-24 provides cumulative potential for selected years.

Figure 6-13 Sixth Plan Calculator Agriculture Incremental Annual Potential

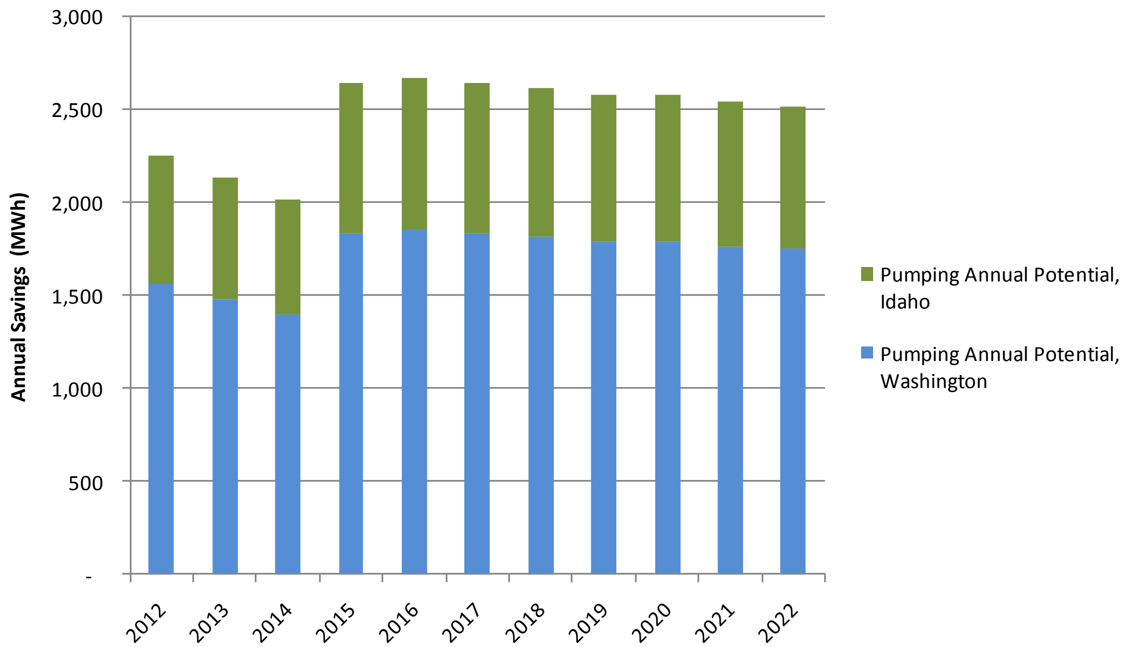


Table 6-23 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table 6-24 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	2,257	14,375	27,217

ABOUT GLOBAL

Global Energy Partners is a premier provider of energy and environmental engineering and technical services to utilities, energy companies, research organizations, government/regulatory agencies and private industry.

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