AEG
Applied Energy Group

PACIFICORP CONSERVATION POTENTIAL ASSESSMENT FOR 2019-2038

Volume 2: Class 2 DSM Analysis

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Report prepared for:
PACIFICORP

Energy Solutions. Delivered.

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ANALYSIS APPROACH

Class 2 DSM resources, or energy efficiency resources, are measures that reduce customers' energy consumption required to power an end-use technology relative to what it would have been without installing or enacting the measure. In this chapter, we discuss the approach used to estimate the Class 2 DSM resource potential. This approach is largely similar to the Class 2 DSM analysis in the 2017 Demand-Side Resource Potential Assessment; however, all assumptions have been updated using the most recent and applicable sources available. A few key updates include the assessment of utility administrative costs at the state-level, incorporation of Waste Heat to Power and Regenerative Technologies (WHP & RT) directly within the CPA, and the inclusion of a wide range of emerging technology measures. We discuss these in more detail in this section and throughout the report.

Overview of Analysis Steps

To perform the Class 2 DSM analysis, AEG used a rigorous data-driven approach that follows the major steps listed below.

1. Perform a market characterization to describe sector-level electricity use for the residential, commercial, industrial, irrigation, and street lighting sectors for the base year, 2016[1] in five states within PacifiCorp's service territory: California, Washington, Idaho, Utah, and Wyoming. Oregon is not covered in this analysis since the Energy Trust of Oregon handles the planning and implementation of all energy efficiency within PacifiCorp's Oregon service territory[2]. To perform the market characterization, we used results from primary market research conducted by PacifiCorp wherever possible, supplemented by other secondary data sources available from regional and national organizations such as the Northwest Energy Efficiency Alliance (NEEA) and the Energy Information Administration (EIA).
2. Develop a baseline projection of energy consumption by state, sector, segment, and end use for 2017 through 2038, building upon the base-year characterization performed in Step 1 above.
3. Define and characterize energy-efficiency measures to be applied to all sectors, segments, and end uses.
4. Estimate the potential from the efficiency measures. While this analysis ultimately develops estimates of the annual potential for each year in the 20-year planning horizon for use in PacifiCorp's Integrated Resource Plan (IRP), results presented in this volume focus on cumulative impacts at the end of the planning horizon, 2038.
5. Compare the results of the present study with those from PacifiCorp's previous (2017) Demand-Side Resource Potential Assessment[3] to identify important trends and changes.

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[1] 2016 was selected as the base year for analysis, as it was the most recent calendar year with complete account data available at this step in the process.

[2] In 2018, PacifiCorp worked with the Energy Trust of Oregon and Public Utility Commission of Oregon Staff to compare and identify differences in study methodologies. As such, AEG will not be comparing Class 2 results for CA, ID, UT, WA, and WY with OR as part of this report.

[3] All five volumes of the 2017 study are available on the PacifiCorp website, http://www.pacificorp.com/es/dsm.html

We describe these analysis steps in more detail throughout the remainder of this chapter.

Definition of Potential

To assess the various levels of resource potential available in the PacifiCorp service territory, we investigated the following cases:

- Class 2 DSM Technical Potential – This case is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost or customer preferences. At the time of existing equipment failure, customers replace their equipment with the most efficient option available relative to applicable standards. In new construction, customers and developers also choose the most efficient equipment option relative to applicable codes and standards. These are generally considered lost opportunity measures. Non-equipment, or discretionary, measures which may be realistically installed apart from equipment replacements are implemented according to ramp rates developed by the Northwest Power and Conservation Council ("The Council") for its Seventh Power Plan, applied to 100% of the applicable market. This case is a theoretical construct and is provided primarily for planning and informational purposes.
- Class 2 DSM Technical Achievable Potential - This case refines technical potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that may affect market penetration of DSM measures. We used achievability assumptions from The Council's Seventh Power Plan as the customer adoption rates for this study. For the technical achievable case, ramp rates are applied to at most 85% of the applicable market, per Council methodology. This achievability factor represents potential which can reasonably be acquired by all mechanisms available, regardless of how conservation is achieved. Thus, the market applicability assumptions utilized in this study include savings outside of utility programs.[4]

LoadMAP Model

For the energy efficiency potential analysis, we used AEG's Load Management Analysis and Planning tool (LoadMAP™) version 6.0 to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for more than 80 utility-specific forecasting and potential studies. Built-in Microsoft Excel, the LoadMAP framework has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a simplified and more 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 and appliance vintage distributions.
- 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 and existing buildings separately.

[4] Northwest Power and Conservation Council's Seventh Power Plan applicability assumptions reference an "Achievable Savings" report published August 1, 2007. http://www.nwcouncil.org/reports/2007/2007-13/

- Uses a simple logic for appliance and equipment decisions, rather than complex decision choice algorithms or diffusion assumptions which tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or manual adjustment.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- Accommodates 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 below, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides forecasts of total energy use and energy-efficiency savings associated with the various levels of potential.

Market Characterization

The first step in the analysis approach is market characterization. In order to estimate the savings potential from energy-efficient measures, it is necessary to understand the equipment that is currently being used and its associated energy consumption. This characterization begins with a segmentation of PacifiCorp's electricity footprint to quantify energy use by state, sector, segment, end-use application, and the current set of technologies used.

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses, and other dimensions) that are relevant in the PacifiCorp service territory. The segmentation scheme for this project is presented in Table 1-1.

Table 1-1 Overview of Segmentation Scheme for Class 2 Potentials Modeling[5]

Dimension	Segmentation Variable	Description
1	State	Pacific Power: California and Washington Rocky Mountain Power: Idaho, Utah, Wyoming
2	Sector	Residential, commercial, industrial, irrigation, and street lighting
3	Customer Category	Residential: single family, multifamily, manufactured home Commercial: by building type Industrial: by industry type Irrigation: by pump horsepower Street lighting: customer-owned, company-owned, and other off-area lighting
4	Vintage	Existing and new construction
5	End uses	Cooling, space heating, lighting, water heating, motors, etc. (as appropriate by sector)
6	Appliances/end uses and technologies	Technologies such as lamp and fixture type, air conditioning equipment type, motors by application, etc.
7	Equipment efficiency for new purchases	Baseline and higher-efficiency options as appropriate for each technology

[5] For complete listings of the segmentation categories, please see Market Characterization and Energy Market Profiles in Appendix A in Volume 4 of this report.

Market Profiles

The next step was to develop base-year market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- Market size is a representation of the number of customers in the segment. For the residential sector, it is the number of households. In the commercial sector, it is the floor space, measured in square feet. For the industrial sector, it is the number of employees. For irrigation, it is the number of service points. For street lighting, it is the number of fixtures. Please note that while market size is derived from customer counts provided by PacifiCorp, these have been scaled to the market units listed above to normalize consumption when use per individual customer may vary wildly (e.g. commercial floor area may vary from thousands to hundreds of thousands of square feet per customer, so we unitize consumption to the square foot instead).
- Saturations define the fraction of the market where various technologies are installed. (e.g., percent of homes with electric space heating). In the case of end uses such as appliances and electronics, saturations of greater than 100% indicate that more than one of a given technology is present in an average home.
- UEC (unit energy consumption) or EUI (energy utilization index) describes the average energy consumed in 2016 by a specific technology within buildings that have the technology. UECs are expressed in kWh/household for the residential sector, and EUIs are expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors, respectively.
- Intensity for the residential sector represents the average energy use for the technology across all homes in 2016 and is computed as the product of the saturation and the UEC. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology per square foot or per employees in 2016. The sum of all energy intensities in a specific market segment will yield the total consumption per market unit (e.g., total kWh per household).
- Usage is the total annual energy use by an end-use technology within a given segment. It is the product of the market size and intensity and is quantified in gigawatt-hours (GWh). As mentioned above, this usage is calibrated to actual sales in the base year.

The market characterization results and the market profiles are presented in Appendix A in Volume 4 to this report.

Baseline Projection

The next step was to develop the baseline projection of annual electricity use for 2016 through 2038 by state, sector, customer segment, end use and technology without new utility DSM programs to avoid double counting of the available potential. The end-use projection includes the impacts of building codes and equipment efficiency standards that were enacted as of April 2018, even if they would not go into effect until a future date. The study does not, however, attempt to speculate on future changes to codes and standards beyond those which already have a known effective date. For a list of equipment efficiency standards included in residential and commercial baseline projections, see Table 2-3 and

Table *2-4*. The baseline projection is the foundation for the analysis of savings from future EE efforts as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- Current PacifiCorp customer growth forecasts
- Trends in equipment saturations
- Existing and approved changes to building codes and equipment standards

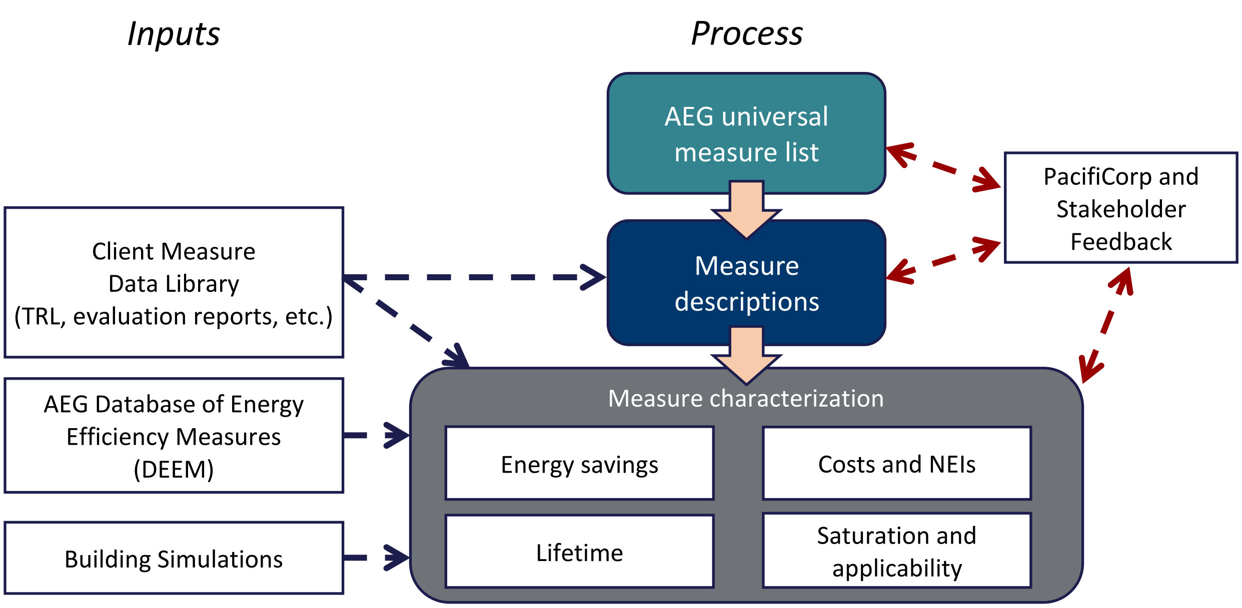
Regarding customer purchase behaviors, the study held purchase trends constant at current levels, except where overridden by a forthcoming code or standard.

The baseline projection for the potential model uses many of the same input assumptions and aligns very closely with PacifiCorp's official load forecast. However, the baseline projection for the potential model was developed as an independent projection to ensure that baseline assumptions were consistent with those used to assess energy efficiency measure savings and applicability. We present the baseline-projection results for the system as a whole and for each sector in Appendix B in Volume 4 to this report.

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 determining measure-level savings and levelized costs as well as the subsequent build up to sector- and state-level savings and levelized costs. For all measures, AEG assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. Figure 1-1 outlines the framework for measure analysis.

Figure 1-1 Approach for EE Measure Assessment



The framework for assessing savings, costs, and other attributes of energy efficiency measures involves identifying the list of energy efficiency measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and preparing for integration with the greater potential modeling process.

We compiled a robust list of energy efficiency measures for each customer sector, drawing upon PacifiCorp's program experience, The Council's Seventh Power Plan, the Regional Technical Forum (RTF), California Database for Energy Efficient Resources (DEER), the Energy Trust of Oregon, AEG's own measure databases and building simulation models, other secondary sources, and a comprehensive screen of emerging technologies within the region and country. This universal list of EE measures covers all major types of end-use equipment, as well as devices and actions which reduce energy consumption when installed or implemented.

The selected measures are categorized into two types according to the LoadMAP taxonomy: equipment measures and non-equipment measures.

- Equipment measures are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR® refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging 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 current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit. These measures are applied on a stock-turnover basis, and in general, are referred to as lost opportunity measures because once a purchasing decision is made, there will not be another opportunity to improve the efficiency of that equipment item until the lifetime expires again. New construction measures, such as ENERGY STAR home design and Advanced New Construction building design, are modeled as lost opportunity as well since the structure must be built with these designs in mind.
- Non-equipment measures save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment on a stock-turnover schedule (such as a refrigerator or air conditioner). For this reason, these measures are generally termed "discretionary" or "retrofit" measures. An example is a connected thermostat, which can be configured to run space heating and cooling systems only when people are home, and which can be installed at any time. Non-equipment measures can apply to more than one end use. For instance, adding wall insulation will reduce the energy use of both space heating and cooling systems. Non-equipment measures typically fall into one of the following categories:
    - Building shell (windows, insulation, roofing material)
    - Equipment controls (thermostats, integrated lighting fixture controls)
    - Equipment maintenance (heat pump commissioning, setpoint adjustments)
    - Displacement measures (destratification fan to reduce use of HVAC systems)
    - Commissioning and retrocommissioning
    - Residential behavioral programs (a possible expansion of the Home Energy Reports (HER) program into California is considered to be a Class 2 resource for the purposes of this study. Existing HER potential is already captured in the baseline and not modeled)Energy management programs

We developed a preliminary list of EE measures, which was distributed to the PacifiCorp project team for review and then to stakeholders as part of the IRP Public Input Process.[6] We started with all measures analyzed in the previous study, introduced new emerging technologies, and updated or excluded obsolete measures. The list was finalized after incorporating comments and is presented in Appendix I of Volume 4 to this report.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For each measure we also characterized incremental cost, effective useful life, and other performance factors.

Table 1-2 summarizes the number of measures evaluated for each segment within each sector. The study considered 359 unique measures across sectors, which expand to nearly 38,000 permutations when assessed separately by state, vintage, and market segment. This is higher than the 33,000 permutations in the prior study. An increase in measure count from 324 to 359 was driven mainly by the inclusion of additional emerging measures which are expected to realistically mature over the next five-to-ten years. For example, new products coming to market focused on smart homes and the internet of things, which has resulted in the addition of a "Connected Home Control System" measure to the list. This measure is expected to integrate smart thermostats, network-controllable LEDs, and smart appliances through a voice- or smartphone-controlled application to increase household controllability and efficiency. While various technology companies have begun offering these products in the past few years, full-household integration is still under development.

Table 1-2 Overview of Segmentation Scheme for Class 2 DSM Potentials Modeling

Sector	Measure Count	Vintages	Segments	States	Total of All Permutations
Residential	89	2	3	5	2,670
Commercial	130	2	14	5	18,200
Industrial	111	2	15	5	16,650
Irrigation	22	2	1	5	220
Street Lighting	7	2	2	5	140
Total Measures Evaluated	**359**				**37,880**

As part of the review process with PacifiCorp and stakeholders, AEG updated assumptions for a variety of measures. One notable example is a reduction in the incremental cost difference between an Energy Independence and Security Act of 2007 (EISA)-compliant halogen and an efficient, general service LED based on feedback gathered through the IRP Public Input Process described above.

Calculating Class 2 DSM Potential

The approach we used to calculate the energy efficiency potential adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting

[6] Additional details may be found within the "July 23, 2018 – Webinar Conservation Potential Assessment Measures" presentation on the PacifiCorp website. http://www.pacificorp.com/es/irp/pip.html

Potential Studies (2007)[7] and The Council's Seventh Power Plan (2016).[8] These sources represent authoritative and comprehensive industry standard practices for estimating energy-efficiency potential.

Measure Interactive Effects

When calculating potential, one cannot merely sum up savings from individual measure installations, as significant interactive effects can occur among measures. This analysis accounts for those interactions in the following ways:

- Interactions between equipment and non-equipment measures – As equipment burns out, the potential analysis assumes it will be replaced with higher-efficiency equipment available in the marketplace, which reduces average consumption across all customers. The lower average consumption causes non-equipment measures to save less than they would have, had the average efficiency of equipment remained constant over time. The stock-turnover accounting applied in the model manifests this effect as annual trends in equipment energy consumption. For example, installing insulation in a home where the central heating system has been upgraded produces lower savings than installing insulation in a home with an older heating system.
- Interactions among non-equipment measures – There are often multiple non-equipment measures that affect the same technology or end use. In this case, the savings (as a percentage of the relevant end use consumption) are stacked upon one another such that those with lower levelized cost are applied first.[9]

Technical Potential

As described in Chapter 1, two types of potentials were developed as part of this effort: technical potential and technical achievable potential. The calculation of technical potential is a straightforward algorithm, aggregating the full, energy-saving effects of all the individual Class 2 DSM measures included in the study at their maximum theoretical deployment levels, adjusting only for technical applicability.

While all discretionary resources could theoretically be acquired in the study's first year, this would skew the potential for equipment measures and provide an inaccurate picture of measure-level potential. Therefore, the study assumes the realization of these opportunities over the 20-year planning horizon according to the shape of corresponding The Council's Seventh Power Plan ramp rates, applied to 100% of applicable market units. By applying this assumption, natural equipment turnover rates, and other adjustments described above, the annual incremental and cumulative potential was estimated by state, sector, segment, construction vintage, end use, and measure. This allows the technical potential to be more closely compared with the technical achievable potential as defined below since a similar "phased-in" approach is used for both.

Technical Achievable Potential

To develop estimates for technical achievable potential, we constrain the technical potential by applying market adoption rates for each measure that estimate the percentage of customers who would be likely to select each measure, given consumer preferences (partially a function of incentive levels), retail energy

[7] 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.

[8] Seventh Northwest Conservation and Electric Power Plan (2016). https://www.nwcouncil.org/energy/powerplan/7/plan/

[9] This contrasts with equipment measures, which may require a mutually exclusive decision among multiple efficient options with energy savings relative to the baseline unit. In these cases, the algorithm selects the option that is most energy efficient for the Technical Potential Case and the unit that is most efficient for less than $250/MWh levelized for the Technical achievable Potential Case. For example, a SEER 13 central air conditioning baseline unit might be replaced with a SEER 24 variable refrigerant flow unit for Technical Potential and a SEER 16 unit for Technical achievable Potential.

rates, imperfect information, and real market barriers and conditions. These barriers tend to vary, depending on the customer sector, local energy market conditions, and other, hard-to-quantify factors. In addition to utility-sponsored programs, alternative acquisition methods, such as improved codes and standards and market transformation, can be used to capture portions of these resources, and are included within the technical achievable potential, per The Council's Seventh Power Plan methodology. This proves particularly relevant in the context of long-term Class 2 DSM resource acquisition plans, where incentives might be necessary in earlier years to motivate acceptance and installations. As acceptance increases, so would demand for energy-efficient products and services, likely leading to lower costs, and thereby obviating the need for incentives and (ultimately) preparing for transitions to codes and standards.

These market adoption rates are based on ramp rates from The Council's Seventh Power Plan. As discussed below, two types of ramp rates (lost opportunity and retrofit) have been incorporated for all measures and market regions.

Estimated technical achievable potential principally serves as a planning guideline. Acquiring such DSM resource levels depends on actual market acceptance of various technologies and measures, which partly depend on removing barriers (not all of which a utility can control). Additionally, technical achievable potential does not account for cost-effectiveness, which is assessed within PacifiCorp's IRP modeling.

Measure Ramp Rates

The study applied measure ramp rates to determine the annual availability of the identified potential for lost opportunity and discretionary resources, interpreting and applying these rates differently for each class (as described below). Measure ramp rates generally matched those used in The Council's Seventh Power Plan, although the study incorporated additional considerations for Class 2 DSM measure acquisition:

- The fourth year of the Seventh Power Plan ramp rates (2019) was aligned with this study's first year (2019). Since the Seventh Power Plan begins in 2016, it was appropriate to begin lost opportunity measures on the same calendar year to reflect the maturity of PacifiCorp's existing programs. For discretionary measures (utilizing the Seventh Plan's retrofit ramp rates), we began in year 1 since these measures may be installed at any time.
- For nonresidential lighting programs in Utah, where program accomplishments (particularly for linear lighting) were observed to outpace Seventh Power Plan ramp rates, AEG reviewed assumptions with PacifiCorp Customer Solutions, PacifiCorp program managers, and Utah stakeholders before accelerating these from the standard "LO20Fast" ramp rate to the fastest "LO50Fast" variant.
- For measures not included in the Seventh Power Plan, the study assigned a ramp rate considered appropriate for that technology (i.e., the same ramp rate as a similar measure in the Seventh Power Plan).

Details regarding the participation rates used in this analysis are presented in Appendix E in Volume 4 to this report.

Lost Opportunity Resources

Lost opportunity energy efficiency measures correspond to equipment measures, which follow a natural equipment turnover cycle, as well as non-equipment measures in new construction instances that are fundamentally different and typically easier to implement during the construction process as opposed to after construction has been completed. For general measures, annual turnover is modeled as equipment stock divided by a measure's effective useful life (EUL). When information on existing equipment vintage was available, particularly due to PacifiCorp's 2017 customer surveys, turnover is instead customized to the actual vintage distribution and varies by study year as units reach their EUL. In The Council's Seventh Power Plan, lighting fixture control measures are also modeled as lost opportunity measures, assumed that these advanced controls must be installed alongside new linear LED panels.

In addition to natural timing constraints imposed by equipment turnover and new construction rates, the AEG team applied measure ramp rates to reflect other resource acquisition limitations over the study horizon, such as market availability. These measure ramp rates had a maximum value of 85%, reflecting The Council's assumption that, on average, up to 85% of technical potential could be achieved by the end of a 20-year planning horizon. Measures on The Council's Seventh Power Plan's emerging technology ramp rate are constrained to 65% of technical potential.

To calculate the annual technical achievable potential for each lost-opportunity measure, the study multiplied the number of units turning over or available in any given year by the adoption factor provided by the ramp rate, consistent with The Council's methodology. Because of the interactions between equipment turnover and new construction, the lost opportunities of measure availability until the next life cycle, and the time frame limits at 20 years, The Council methodology for these measures produces potential less than 85% of technical potential.

Retrofit (Discretionary) Resources

Retrofit resources differ from lost opportunity resources due to their acquisition availability at any point within the study horizon. From a theoretical perspective, all technical achievable potential for discretionary resources could be acquired in the study's first year, but from a practical perspective, this outcome is realistically impossible to achieve due to infrastructure and cost constraints as well as customer preferences and considerations.

As a result, the study addresses the technical achievable potential for retrofit opportunities by spacing the acquisition according to the ramp rates specified for a given measure, thus creating annual, incremental values. To assess technical achievable potential, we then apply the 85% market achievability limit defined by The Council. Consistent with lost opportunity, discretionary measures on The Council's Seventh Power Plan's emerging technology ramp rate are constrained to 65% of technical potential. Since the opportunity is not limited by equipment turnover, technical achievable potential for these measures reaches 85% of the technical potential by the end of the 20-year period.

Tables of all measure ramp rates are available in Appendix E in Volume 4 to this report, both with and without the market achievability limits applied.

Market Ramp Rates

In the previous study, AEG applied market ramp rates on top of measure ramp rates to the Wyoming industrial market, reflecting state-specific considerations affecting acquisition rates, such as the age of programs, small and rural markets, and current delivery infrastructure. Based on a review of recent Wyoming industrial program accomplishments, AEG and PacifiCorp determined that this trend has come to an end. As a result, AEG removed the "Emerging" market ramp rate from the 2019 CPA.

Levelized Cost of Measures

Using the cost data for measures developed in the characterization step above, we calculate the levelized cost of conserved energy (LCOE) in order to create Class 2 DSM supply curves. Where possible, the study aligned its approach for calculating levelized costs for each measure with The Council's levelized-cost methodology, while recognizing differences in cost-effectiveness screening in each state within PacifiCorp's service territory.[10]

Changes in methodology from the previous study include:

- Variation in utility non-incentive administrative costs by state.
- Application of the Utility Cost Test (UCT) in Idaho, in contrast to the Total Resource Cost (TRC) test applied in the prior assessment[11].
- Reduction in maximum incentive cost from 70% of the incremental cost to 50% for nonresidential lighting programs in Utah based on discussions with program managers and feedback from stakeholders.

Table 1-3 summarizes components of levelized cost in each PacifiCorp state assessed in this study.

Table 1-3 Economic Components of Levelized Cost by State

Parameter	WA	CA	WY	UT	ID
Cost Test	Total Resource Cost (TRC)			Utility Cost Test (UCT)	
Initial Capital Cost	Included (100% of incremental cost, full measure cost for retrofit measures)			Utility Incentive (50%-70% of incremental cost)	
Annual Incremental O&M	Included	Not Included			
Secondary Fuel Impacts	Included	Not Included			
Non-Energy Impacts	Included	Not Included			
Administrative Costs (% of incremental cost)	35%	44%	27%	18%	36%

As an additional analysis step in this CPA, AEG tailored administrative costs for each state to reflect actual utility program costs within each jurisdiction. To do this, AEG reviewed state-level accomplishments and utility spending by program and measure category from 2014 through 2016, available through PacifiCorp's Annual Reports.[12] While the all-state value (minus Oregon) of 21% is very similar to the Power Council's and 2017 Demand-Side Resource Potential Assessment's assumption of 20%, this value varies substantially by state. As such, the non-incentive utility cost to administer DSM programs in Washington, California, and Idaho is higher than in Wyoming or Utah. A summary of AEG's approach and findings are available in Appendix G in Volume 4 to this report.

Levelized costs in Utah and Idaho are assessed on a Utility Cost Test (UCT) basis, while the other states are evaluated on a Total Resource Cost (TRC) basis. This contrasts with the 2017 CPA, where Idaho potential

[10] Failure to align costs used for IRP optimization with methods used to assess program cost-effectiveness could lead to an inability to deliver selected quantities in a cost-effective manner in each jurisdiction.

[11] Per Idaho Public Utilities Commission Order No. 33766

[12] State-level Annual Reports and other program filings may be found under the "Reports & Program Evaluations by Jurisdiction" header on PacifiCorp's DSM website, http://www.pacificorp.com/es/dsm.html

was levelized using the TRC test. To maintain consistency with The Council, RTF and accepted regulatory practices, secondary benefits, non-energy impacts, and incremental O&M have been included in Washington. For Washington resources, The Council's 10% conservation credit will be applied during the IRP modeling process, and this credit has not been included in the levelized costs presented in this report.

The approach to calculating a measure's levelized cost of conserved energy aligns with that of The Council, which considers the costs required to sustain savings over a 20-year study horizon, including reinstallation costs, for measures with useful lives less than 20 years. If a measure's useful life extends beyond the end of the 20-year study, the analysis incorporates an end effect, treating the measure's levelized cost over its useful life as an annual reinstallation cost for the remaining portion of the 20-year period.[13] For example, if a particular measure life is 15 years, a reinstallation of the measure will occur after year 15, and years 16 through 20 will reflect an annual levelized cost of installing that measure, prorated for the five of its 15 years. In this way, all measures are considered on an equivalent, 20-year basis as required for PacifiCorp's IRP process.

For PacifiCorp's Utah and Idaho service territory, the study adopted the utility's share of initial capital costs (i.e., an incentive amount) in the levelized cost calculation. The following assumptions regarding incentive amounts applied for Utah and Idaho:

- Specific program measure (e.g., lighting) incentives aligned with the current program design.
- Behavioral initiatives for residential customers included an incentive of 100%; indicating that the entire measure delivery is subsidized by the program. Behavioral initiatives for business customers, that is, energy management, included an incentive of 90% of the measure cost; indicating that most of the costs are subsidized by the program.
- Measures with zero or negative incremental cost used incentives based on existing PacifiCorp program offerings and typical industry levels.
- Company-owned street lighting incentives were set to 100% of incremental measure costs.
- The cost for lighting measures have continued to decline over the last several years. In the 2017 CPA, the cost of incentives were assumed to be 70% of the measure cost. Higher incentives were assumed necessary to realize the achievability levels in The Council's ramp rates. However, after a review of PacifiCorp's nonresidential lighting programs in Utah with program managers and stakeholders, incentives were set to 50% of the incremental measure cost,[14] reduced from the 70% value assumed in the 2017 CPA due to the increased participation in the program and the lower cost of lighting.
- Incentives for all other measures represented 70% of the incremental measure cost, based on a robust incentive level aimed at achieving 85% of the technical potential.

[13] This method applied both to measures with a useful life greater than 20 years and those with useful lives extending beyond the 20th year at the time of reinstallation.

[14] Incremental measure costs vary by resource type (i.e., discretionary or retrofit), with incremental costs equaling full costs for discretionary resources, and for lost opportunities, the incremental cost is the difference between the standard-efficiency and higher-efficiency alternatives.

2

DATA DEVELOPMENT

This section details the data sources used for the Class 2 DSM analysis, followed by a discussion of how these sources were applied. In general, data were adapted to local conditions. For example, local data sources were used for measure data and local weather was used for building simulations.

Data Sources

The data sources are organized into the following categories:

- PacifiCorp data
- AEG's databases and analysis tools
- Other secondary data and reports

PacifiCorp Data

Our highest priority data sources for this study were those specific to PacifiCorp's system and customers, including:

- PacifiCorp Customer Data: PacifiCorp provided customer-level billing data for all states and sectors including segment identifiers to parse out the various housing types and business types.
- Market Research Data: Data collected by PacifiCorp customers through recent saturation survey efforts.
- Load Forecasts: PacifiCorp provided state- and sector-level forecasts of energy consumption and customer counts. Before providing to AEG, PacifiCorp modified the standard load forecast to reflect a few DSM-specific considerations. First, forecasts of future utility DSM over the CPA planning period (2019-2037) were removed since that conservation would double-count with potential estimated as part of this study. Second, the forecasts were adjusted to be post-private generation (e.g. customer-sited solar). Finally, non-DSM-eligible special contracts were removed from the forecasts.
- Economic Information: PacifiCorp provided a system-wide discount rate and line loss factors by state and sector to calculate levelized costs and energy efficiency potential at the generator-level.
- PacifiCorp Program Data: PacifiCorp provided information about past and current energy efficiency programs, including program descriptions, achievements to date, and evaluation reports.

Northwest Region Data

The Northwest conducts collaborative research and the study used data from the following sources:

- Regional Technical Forum (RTF) Unit Energy Savings Measure Workbooks: The RTF maintains workbooks that characterize selected measures and provide data on unit energy savings (UES), measure cost, measure life, and non-energy benefits. These workbooks provide Pacific Northwest-specific measure assumptions, drawing upon primary research, energy modeling (using the RTF's Simple Energy Enthalpy Model (SEEM), regional third-party research, and well-vetted national data. Workbooks are available at https://rtf.nwcouncil.org/measures

- RTF Standard Protocols: The RTF also maintains standard workbooks containing useful information for characterizing more complex measures for which UES values have not been developed, such as commercial sector lighting. https://rtf.nwcouncil.org/standard-protocols
- Northwest Power and Conservation Council's Seventh Power Plan Conservation Supply Curve Workbooks, 2016. To develop its Power Plan, The Council created workbooks with detailed information about measures, available at https://nwcouncil.box.com/7thplanconservationdatafiles
- Residential Building Stock Assessment: NEEA's 2016 Residential Building Stock Assessment (RBSA) provides results of a survey of thousands of homes in the Pacific Northwest. This was updated since the 2011 RBSA used in the 2017 CPA: https://neea.org/data/residential-building-stock-assessment
- Commercial Building Stock Assessment: NEEA's 2014 Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. https://neea.org/data/commercial-building-stock-assessments
- Industrial Facilities Site Assessment: NEEA's 2014 Industrial Facilities Site Assessment (IFSA) provides data on regional industrial customers by major classification types. https://neea.org/data/industrial-facilties-site-assessment
- Bonneville Power Administration (BPA) Reference Deemed Measure List, version 2.5, which was the most recent available when the study was performed.

Applied Energy Group Data

AEG maintains several databases and modeling tools that we use for forecasting and potential studies.

- AEG Energy Market Profiles: For more than 10 years, AEG staff have maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit energy consumption estimates and annual energy use by fuel (electricity and natural gas) by customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- Building Energy Simulation Tool (BEST). AEG's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- AEG's Database of Energy Efficiency Measures (DEEM): AEG maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including The Council's Seventh Power Plan and RTF workbooks, DEER, the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data.
- Recent Studies. AEG has conducted over sixty planning studies of EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include studies in nearby jurisdictions for Avista Energy, Idaho Power, NV Energy, Tacoma Power, Black Hills Colorado Electric, Seattle City Light, Chelan PUD, and Cowlitz PUD. In addition, we used the

information about impacts of building codes and appliance standards from our recent reports for the Edison Electric Institute[15].

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- Other relevant regional sources: These include reports from the Consortium for Energy Efficiency (CEE), the Environmental Protection Agency (EPA), and the American Council for an Energy-Efficient Economy (ACEEE).
- Annual Energy Outlook. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2017 AEO.
- American Community Survey: The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. Data for PacifiCorp were available for this study. http://www.census.gov/acs/www/
- Weather Data: Weather from NOAA's National Climatic Data Center for representative cities in each PacifiCorp state service territory was used as the basis for building simulations. These cities were: Yakima, WA; Salt Lake City, UT; Medford, OR (most representative weather station for California service territory); Pocatello, ID; and Casper, WY. Data used is in the Typical Meteorological Year 3 (TMY3) format, which utilizes thirty years of meteorological data to create hourly weather conditions for a standard year.
- EPRI End-Use Models (REEPS and COMMEND). These models provide the econometric variables for elasticities we apply to electricity prices, household income, home size, and heating and cooling.
- 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) for the state of California. We used the DEER database to cross-check the measure savings we developed using BEST and DEEM.

Application of Data to the Analysis

We now discuss how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity use by households/floor space/employee/service point/fixture for the residential, commercial, industrial, irrigation, and street lighting sectors, we applied several data sources. PacifiCorp customer data was used first and foremost to allocate residential customers by housing type. This was compared to NEEA's RBSA and the American Community Survey (ACS) for verification. For the commercial sector, we used PacifiCorp billing data to estimate sales by building type. AEG's estimates were also compared with NEEA's CBSA study, estimates

[15] AEG staff who performed the PacifiCorp study have prepared three white papers on the topic of factors that affect U.S. electricity consumption, including appliance standards and building codes. Links to all three white papers are: http://www.edisonfoundation.net/IEE/Documents/IEE_RohmundApplianceStandardsEfficiencyCodes1209.pdf
http://www.edisonfoundation.net/iee/Documents/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf
http://www.edisonfoundation.net/iee/Documents/IEE_FactorsAffectingUSElecConsumption_Final.pdf

used by PacifiCorp Load Forecasting, and AEG's Energy Market Profiles Database. For the industrial sector, we used PacifiCorp billing data to estimate energy use and employment for the industrial sector, comparing it to employment allocations from the U.S. Bureau of Labor Statistics, NEEA's IFSA study, and AEG's Energy Market Profiles. For the irrigation sector, we used PacifiCorp sales data and customer counts to define the number of service points. Finally, for street lighting, we used PacifiCorp data for the number of and type of fixtures.

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-1. To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, estimated segment-level annual electricity use, and annual intensity defined as the kWh divided by the relevant unit of market size, be it households, square feet, employees, service points, or fixtures for the respective sectors.
2. Used recent PacifiCorp saturation surveys and secondary data sources to incorporate information on existing equipment saturations, appliance and equipment characteristics, and building characteristics.
3. Incorporated secondary data sources to supplement and corroborate the data from the two steps above.
4. Compared and cross-checked with regional data in the Energy Market Profiles Database and other recent AEG studies.
5. Ensured calibration to control totals for annual electricity sales in each sector and segment.
6. Worked with PacifiCorp staff to vet the data against their knowledge and experience.

Table 2-1 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, industrial employment, irrigation service points, and street lighting fixtures	PacifiCorp billing data PacifiCorp saturation surveys
Annual intensity	Residential: Annual energy use (kWh/household) Commercial: Annual energy use (kWh/Sq. Ft.) Industrial: Annual energy use (kWh/employee)	PacifiCorp saturation surveys and load research data NEEA RBSA, CBSA, and IFSA AEG Energy Market Profiles AEO 2017 Other recent AEG studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	PacifiCorp current saturation surveys NEEA RBSA, CBSA, and IFSA AEG Energy Market Profiles
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwellings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for PacifiCorp The Council's Seventh Power Plan workbooks, RTF Engineering analysis MECS data AEG DEEM Recent AEG studies
Appliance/equipment vintage distribution	Age distribution for each technology	PacifiCorp saturation survey Recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	The Council's Seventh Power Plan workbooks, RTF AEG DEEM AEO 2017 DEER Other recent AEG studies

Data Application for Baseline Projection

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

Table 2-2 Data Needs for the Baseline Projection and Potential Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	PacifiCorp load forecast AEO 2017 economic growth forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	AEO 2017 regional forecast assumptions[16] ENERGY STAR appliance shipment data for 2017 Appliance/efficiency standards analysis PacifiCorp program results and evaluation reports
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models AEO 2017

In addition, the baseline projection captures impacts of known future equipment standards enacted as of April 2018, as shown in Table 2-3and Table 2-4.

Table 2-3 Residential Electric Equipment Standards[17]

End Use	Technology	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13.0 in all states except California/ SEER 14.0 in California								SEER 14.0	
	Room AC	EER 10.8									
Cooling/ Heating	Air-Source Heat Pump	SEER 14.0 / HSPF 8.2									
Water Heating	Water Heater (<=55 gallons)	EF 0.95									
	Water Heater (>55 gallons)	EF 2.0 (Heat Pump Water Heater)									
Lighting	General Service	Advanced Incandescent (~20 lumens/watt)				Advanced Incandescent (~45 lumens/watt)					
	Linear Fluorescent	T8 (89 lm/W lamp)		T8 (92.5 lm/W lamp)							
Appliances	Refrigerator	25% more efficient than the 1997 Final Rule (62 FR 23102)									
	Freezer										
	Clothes Washer	IMEF 1.84 / WF 4.7									
	Clothes Dryer	3.73 Combined EF									
Miscellaneous	Furnace Fans	Conventional			ECM						

[16] We developed baseline purchase decisions using the Energy Information Agency's Annual Energy Outlook report (2017), 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 then held values constant for the study period. This removes any effects of naturally occurring conservation or effects of future DSM programs that may be embedded in the AEO forecasts.

[17] In California, the federal standard requires a minimum of SEER 14 for Central ACs. In addition, California state code accelerates phase two of the general service lighting standard (45 lm/W) to begin in 2019. These distinctions were incorporated into the study.

Table 2-4 Commercial Electric Equipment Standards

<table>
<tr><th>End Use</th><th>Technology</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="3">Cooling</td><td>Chillers</td><td colspan="10">2007 ASHRAE 90.1</td></tr>
<tr><td>RTUs</td><td colspan="10">EER 11.9/11.2</td></tr>
<tr><td>PTAC</td><td>EER 11.7</td><td colspan="9">EER 11.9</td></tr>
<tr><td rowspan="2">Cooling/ Heating</td><td>Heat Pump</td><td colspan="8">EER 11.0/ COP 3.3</td><td colspan="2">EER 11.3/ COP 3.3</td></tr>
<tr><td>PTHP</td><td colspan="10">EER 11.9/COP 3.3</td></tr>
<tr><td>Ventilation</td><td>All</td><td colspan="10">Constant Air Volume/Variable Air Volume</td></tr>
<tr><td rowspan="3">Lighting</td><td>General Service</td><td colspan="4">Advanced Incandescent (~20 lumens/watt)</td><td colspan="6">Advanced Incandescent (~45 lumens/watt)</td></tr>
<tr><td>Linear Lighting</td><td colspan="2">T8 (89 lm/W lamp)</td><td colspan="8">T8 (92.5 lm/W lamp)</td></tr>
<tr><td>High Bay</td><td colspan="2"></td><td colspan="8"></td></tr>
<tr><td rowspan="5">Refrigeration</td><td>Walk-In</td><td>EISA 2007</td><td colspan="3">10-38% more efficient</td><td colspan="6">24% more efficient than 2017</td></tr>
<tr><td>Reach-In</td><td>EPACT 2005</td><td colspan="9">40% more efficient</td></tr>
<tr><td>Glass Door</td><td>EPACT 2005</td><td colspan="9">12-28% more efficient</td></tr>
<tr><td>Open Display</td><td>EPACT 2005</td><td colspan="9">10-20% more efficient</td></tr>
<tr><td>Icemaker</td><td colspan="2">EPACT 2005</td><td colspan="8">15% more efficient</td></tr>
<tr><td>Food Service</td><td>Pre-Rinse</td><td colspan="3">1.6 GPM</td><td colspan="7">1.0 GPM</td></tr>
<tr><td>Motors</td><td>All</td><td colspan="10">Expanded EISA 2007</td></tr>
</table>

Table 2-5 summarizes the building energy codes that are accounted for in the new vintages of LoadMAP customers, buildings, and facilities that come online during the study time horizon. End-use consumption for these new construction buildings, therefore, accounts for current state-specific energy codes, but it does not attempt to project future changes to codes over the planning horizon.

Table 2-5 Guidance for Building Codes

State	Residential Energy Code Used	Non-Residential Energy Code Used
California	2019 Building Energy Efficiency Standards, Title 24[18]	2016 Building Energy Efficiency Standards, Title 24
Washington	Washington State Energy Code 2015 (WSEC 2015)	Washington State Energy Code 2015 (WSEC 2015)
Idaho	2012 IECC	2012 IECC
Utah	2012 IECC	2012 IECC
Wyoming	2009 IECC with adjustments based on survey data for new buildings	2009 IECC with adjustments based on survey data for new buildings

[18] While the rulemaking phase for these building codes is still underway, AEG incorporated energy code updates such as the zero-net energy-ready requirements for new homes.

Energy Efficiency Measure Data Application

Table 2-6 details the energy-efficiency data inputs to the LoadMAP model and identifies the key sources used in this study's analysis.

Table 2-6 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	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.	PacifiCorp program evaluations The Council's Seventh Plan workbooks, RTF BEST AEG DEEM AEO 2017 DEER Other secondary sources
Measure Costs	Equipment Measures: Includes the incremental measure cost of purchasing and installing the equipment on a per-household, per-square-foot, or per employee basis for the residential, commercial, and industrial sectors, respectively. Non-equipment measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	The Council's Seventh Plan workbooks, RTF AEG DEEM AEO 2017 RS Means DEER Other secondary sources
Administrative Costs	Cost for a utility to administer DSM programs within a state-level territory, expressed as a percent of measure costs (between 18% and 44%).	PacifiCorp Annual Reports for 2014 through 2016 E Source's "DSMdat" program database for benchmarking
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	The Council's Seventh Plan workbooks, RTF DEER AEG DEEM AEO 2017 Other secondary sources
Applicability	Estimate of the percentage of either dwellings in the residential sector or square feet/employment in the C&I sectors where the measure is applicable and where it is technically feasible to implement.	PacifiCorp customer surveys The Council's Seventh Plan workbooks, RTF RBSA/CBSA DEER AEG DEEM Other secondary sources
On-Market and Off-Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	AEG appliance standards and building codes analysis Emerging technology data sources

Emerging Technologies

The Class 2 DSM measures considered in this analysis come from a comprehensive review of measures implemented in current industry best practice programs and exhaustive research into the pipeline of technologies that may become viable over the study time horizon. This research leveraged resources such as The Council's Regional Technical Forum, the US Department of Energy's Annual Energy Outlook, Washington State University's *Energy Efficiency Emerging Technologies* (E3T) databases, NEEA research initiatives, California IOU white papers, the Northeast Energy Efficiency Partnerships (NEEP) when applicable for the western US, and all demand-side measures from *ACEEE's New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030*.[19]

The emerging technologies selected for inclusion in the study represent quantifiable projections of measures that have not yet gained mainstream adoption but can reasonably be expected to reach commercial availability within the study time horizon. The protracted development cycle for newer, emerging technologies is reflected where appropriate in the potential modeling through the assignment of an emerging technology measure ramp rate, which will introduce the resource over a more representative time period. Technologies that are still in the laboratory stage without a quantifiable cost and/or operating characteristics have been excluded from the analysis. AEG reviewed this list with the PacifiCorp Customer Solutions team and program managers, assessing the viability of each for PacifiCorp's customers and certainty of available assumptions prior to inclusion in the CPA. A list of all included emerging technologies, as well as those excluded and a rationale for the exclusion, can be found in Appendix D in Volume 4 of this report.

Data Application for Levelized Cost Calculations

To perform the levelized cost calculations, several economic assumptions were needed. All cost and benefit values were assumed to be represented in real 2016 dollars. PacifiCorp provided a discount rate of 6.91%[20] to use in present-value calculations. In general, inflationary effects are assumed to be offset by decreases in technology costs, arising from efficiencies and economies of scale in manufacturing, distribution, and marketing channels. In certain rapidly-changing markets (e.g., LED lighting) where industry-accepted cost projections were available, decreases in costs were assumed to outpace inflation.[21]

Unless otherwise specified, all energy impacts in this report are presented at the generator or system level, rather than at the customer meter. Therefore, electric delivery losses, as provided by PacifiCorp and presented in Table 2-7, have been included in all levelized cost and potential figures.

[19] The September 2015 ACEEE publication on emerging technology can be found on their website, http://aceee.org/research-report/u1507

[20] Consistent with PacifiCorp's 2019 Integrated Resource Plan.

[21] For LED lighting, the study relied on efficacy and cost projections from Appendix D of the U.S. DOE's Energy Savings Forecast of Solid-State Lighting in General Illumination Applications, September 2016. https://www.energy.gov/sites/prod/files/2016/09/f33/energysavingsforecast16_2.pdf

Table 2-7 Line Loss Factors[22]

Sector	CA	ID	UT	WA	WY
Residential	11.43%	11.47%	9.32%	9.67%	9.51%
Commercial	11.14%	10.75%	8.71%	9.53%	8.90%
Industrial	9.92%	7.52%	5.85%	8.16%	5.61%
Irrigation	11.43%	11.45%	9.24%	9.67%	9.28%
Street Lighting	11.43%	11.47%	9.32%	9.67%	9.51%

[22] Line loss factors were based on PacifiCorp's 2009 Analysis of System Losses study, conducted by Management Applications Consulting, Inc. dated November 2011.

3

CLASS 2 DSM POTENTIAL RESULTS

This chapter presents the identified cumulative potential in 2038 from Class 2 DSM, or energy efficiency, resources in absolute terms and relative to AEG's baseline projection. These savings draw upon forecasts of future consumption absent PacifiCorp Class 2 DSM program activities. While the baseline projection accounted for past PacifiCorp Class 2 DSM resource acquisition, the identified estimated potential is inclusive of (not in addition to) future planned program savings. As discussed previously, the 2038 forecasted baseline sales presented in this report may differ from PacifiCorp's official sales forecast.

Summary of Overall Energy Savings

Table 3-1 summarizes the 2038 cumulative technical and technical achievable energy-efficiency potential by sector, both in MWh and as a percentage of the 2038 baseline projection. Figure 3-1 shows the cumulative technical achievable potential by sector throughout the time horizon.

- Technical potential, which reflects the adoption of all energy efficiency measures regardless of cost or customer preferences, is a theoretical upper bound on savings. System-wide cumulative savings in 2038 are 12 million MWh, or 24.6% of the baseline projection.
- Technical Achievable Potential, which adjusts the technical potential by reflecting customer adoption constraints, shows cumulative savings of 9.6 million MWh, or 19.7% of the baseline load in 2038. This case represents potential which can reasonably be acquired by all mechanisms available, regardless of how conservation is achieved. This includes savings which may be realized from outside of utility programs.

The commercial sector accounts for the largest portion of the technical and technical achievable potential, followed by residential and industrial. Irrigation and street lighting, with much smaller baseline loads, contribute a smaller amount of potential relative to commercial, residential and industrial. Potential as a percentage of the baseline is largely influenced by the presence of various end uses in each sector. The presence of large lighting loads has the effect of increasing potential. Not only has the efficacy of lighting equipment increased greatly due to the development of LEDs, advanced control strategies are now capable of being implemented on a large scale. This can be seen in the residential, commercial, and street lighting sectors. Additionally, the presence of electric resistance water heating, particularly in Washington, California, and Idaho homes presents a larger opportunity for heat pump water heater (HPWH) equipment upgrades than in states where gas space and water heating are more prevalent.

In contrast, high- and premium-efficiency motors have been on the market and included in federal standards for several years. The remaining potential for this end use consists mainly of variable speed drives and complex control schemes which are not feasible in all applications. Accordingly, potential as a percent of baseline in the industrial and irrigation sectors is lower than in other sectors. Detailed results by sector are presented later in this section.

Table 3-1 Cumulative Class 2 DSM Potential by Sector in 2038

Sector	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Residential	13,594,729	3,353,613	2,674,197	24.7%	19.7%
Commercial	16,567,429	5,673,868	4,534,085	34.2%	27.4%
Industrial	17,342,377	2,822,528	2,244,656	16.3%	12.9%
Irrigation	1,270,654	144,441	122,775	11.4%	9.7%
Street Lighting	105,029	52,961	43,491	50.4%	41.4%
Total	**48,880,218**	**12,047,411**	**9,619,204**	**24.6%**	**19.7%**

Figure 3-1 Cumulative Class 2 Technical Achievable Potential by Sector

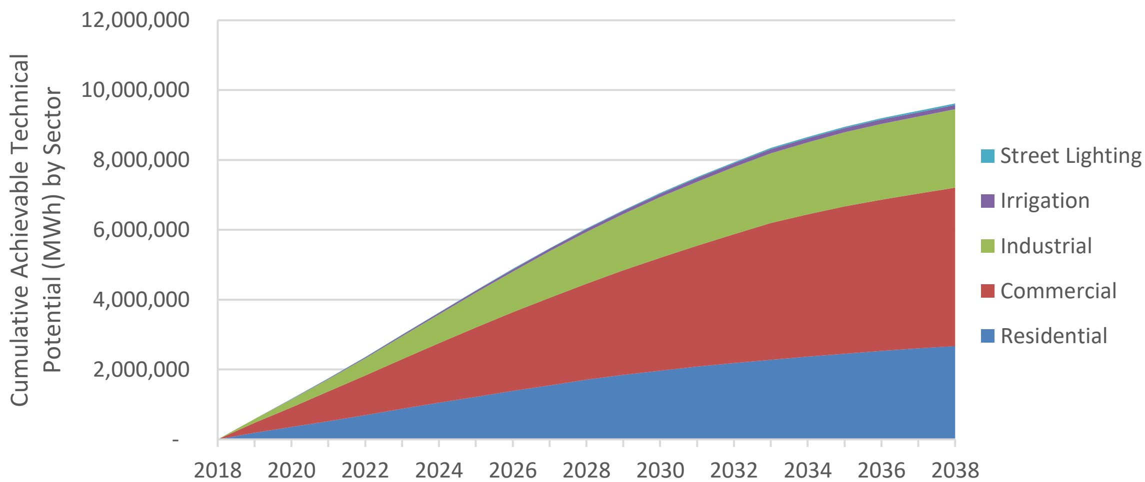


Table 3-2 summarizes the Class 2 DSM potential by state and by PacifiCorp operating company.[23] With the exception of Wyoming, potential as a percent of baseline loads is relatively constant across states; Wyoming results are heavily influenced by the large share of the load in the industrial sector, which, as shown in Table 3-1, has lower identified potential as a percent of the load than the residential and commercial sectors. Additional variations across states are a function of customer mix, climate, equipment saturations, current saturation or efficient equipment, and other related factors.

[23] Pacific Power also serves customers in Oregon, however, as discussed previously in this report, the Energy Trust of Oregon assesses energy efficiency in Oregon in a separate analysis.

Table 3-2 Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	797,306	263,734	211,495	33.1%	26.5%
	Washington	5,272,623	1,389,064	1,110,628	26.3%	21.1%
	Subtotal	**6,069,929**	**1,652,799**	**1,322,123**	**27.2%**	**21.8%**
Rocky Mountain Power	Idaho	2,700,824	640,509	517,148	23.7%	19.1%
	Utah	29,405,158	7,578,403	6,040,931	25.8%	20.5%
	Wyoming	10,704,307	2,175,701	1,739,002	20.3%	16.2%
	Subtotal	**42,810,289**	**10,394,612**	**8,297,081**	**24.3%**	**19.4%**
	Total	**48,880,218**	**12,047,411**	**9,619,204**	**24.6%**	**19.7%**

Table 3-3 summarizes the Class 2 DSM potential by resource type, differentiating between discretionary measures and lost opportunity measures. Across all sectors, 61% of the cumulative technical achievable potential in 2038 is attributable to discretionary resources. As described earlier in this section, potential in the industrial and irrigation sectors is largely due to motor system enhancements and controls rather than equipment improvements. These measures mostly fall into the discretionary category, whereas lost opportunity equipment upgrades are significant sources of potential in the residential, commercial, and street lighting market sectors.

Table 3-3 Cumulative Class 2 DSM Technical Achievable Potential by Resource Type in 2038

Sector	Technical Achievable Potential (MWh)	
	Discretionary	Lost Opportunity
Residential	1,582,691	1,091,506
Commercial	2,276,542	2,257,543
Industrial	1,895,806	348,850
Irrigation	122,775	-
Street Lighting	9,689	33,802
Total	**5,887,503**	**3,731,701**

Residential Sector

Table 3-4 presents estimates for cumulative technical and technical achievable potential in the residential sector by the end of the study period in 2038. The technical potential in 2038 from Class 2 DSM resources assessed in this study is 3.4 million MWh or 24.7% of the baseline projection. The corresponding technical achievable potential is 2.7 million MWh or 19.7% of the 2038 baseline. Savings as a percent of the baseline are very consistent across states. California is slightly higher due to a relatively higher share of electric space heating and water heating.

Table 3-4 Residential Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	402,597	156,588	126,785	38.9%	31.5%
	Washington	2,066,193	565,717	455,686	27.4%	22.1%
	Subtotal	**2,468,790**	**722,305**	**582,470**	**29.3%**	**23.6%**
Rocky Mountain Power	Idaho	927,482	256,185	206,534	27.6%	22.3%
	Utah	9,361,466	2,082,804	1,660,103	22.2%	17.7%
	Wyoming	836,990	292,321	225,090	34.9%	26.9%
	Subtotal	**11,125,939**	**2,631,309**	**2,091,727**	**23.7%**	**18.8%**
	Total	**13,594,729**	**3,353,613**	**2,674,197**	**24.7%**	**19.7%**

The residential sector is composed of three segments in this analysis: single family, multifamily, and manufactured homes. Figure 3-2 below shows the share of 2038 technical achievable potential that is attributable to each segment, largely driven by the share of sales in the baseline projection. Single-family homes represent the largest share, with 79% of total technical achievable potential.

Figure 3-2 Residential Cumulative Technical Achievable Potential by Segment in 2038

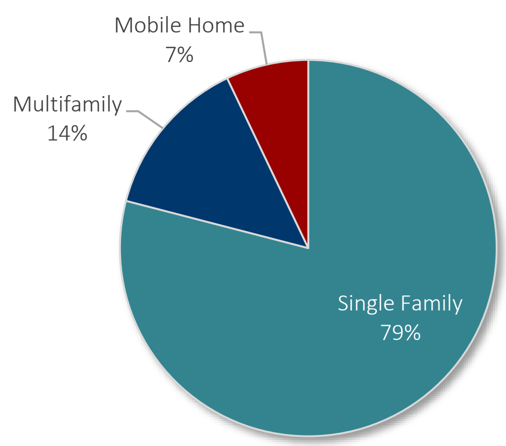


Figure 3-3 and Table 3-5 present the estimates of Class 2 DSM potential for the residential sector from an end- use perspective. Key findings and observations are outlined below:

- Nearly half of the technical achievable potential (47%) comes from HVAC systems through the application of equipment upgrades and building shell measures.
    - The space heating end use provides the largest share of potential, at 28% of total residential technical achievable potential, particularly driven by Washington, Idaho, and California where electric resistance heating is common.
    - The cooling end use comprises 19% of total residential technical achievable potential, driven by large air-conditioning loads in Utah.
- Water heating savings comprise 20% of the total technical achievable potential through the installation of efficient heat pump water heater systems and upgrades to water-consuming equipment (low flow showerheads, clothes washers, etc.) Consistent with The Council's Seventh Power Plan methodology, heat pump water heaters are assigned to the "LO1Slow" ramp rate, assumed to exhibit slow achievable adoption in early years of the study, but escalating to 85% of technical potential in the later years.
- The lighting end use accounts for 13% of the residential technical achievable potential, primarily due to LED lamps, which are modeled with lumen-per-watt performance substantially increasing over the lifetime of the study.
- The appliances, electronics, and miscellaneous end uses represent the remaining 20% of the potential.

Figure 3-3 Residential Cumulative Technical Achievable Potential by End Use in 2038

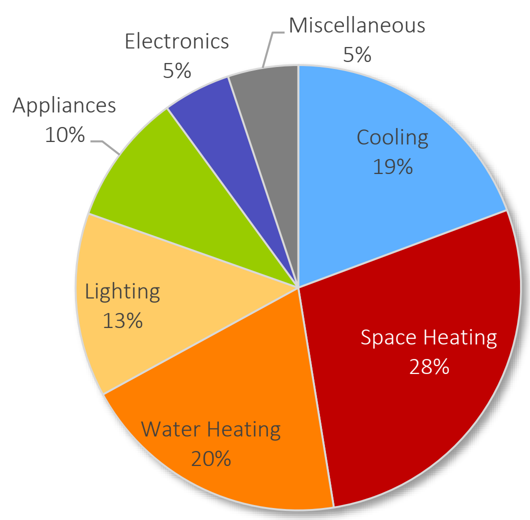


Table 3-5 Residential Cumulative Class 2 DSM Potential by End Use in 2038

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Achievable Potential (% of Total)	Technical Achievable Potential (% of Baseline)
Space Cooling	2,345,896	619,498	516,982	19.3%	22.0%
Space Heating	2,504,352	881,832	751,828	28.1%	30.0%
Water Heating	913,142	665,556	524,044	19.6%	57.4%
Lighting	958,748	502,177	357,457	13.4%	37.3%
Appliances	3,491,633	357,682	255,353	9.5%	7.3%
Electronics	1,313,308	155,763	131,862	4.9%	10.0%
Miscellaneous	2,067,649	171,104	136,671	5.1%	6.6%
Total	**13,594,729**	**3,353,613**	**2,674,197**	**100.0%**	**19.7%**

Commercial Sector

Table 3-6 presents estimates for cumulative technical and technical achievable potential for the commercial sector by the end of the study period in 2038. From the Class 2 DSM resources assessed in this study, the technical potential savings are 5.7 million MWh or 34.2% of the baseline forecast in 2038. The corresponding technical achievable potential is 4.5 million MWh or 27.4% of the 2038 baseline. Savings as a percent of the baseline are very consistent across states. Washington potential is slightly lower due to more stringent building codes and greater reach of past energy efficiency efforts. Utah's potential as a percent of the baseline projection is slightly higher, largely due to a greater presence of cooling loads and their associated potential.

Table 3-6 Commercial Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	209,798	81,458	63,347	38.8%	30.2%
	Washington	1,853,792	609,547	482,221	32.9%	26.0%
	Subtotal	**2,063,591**	**691,005**	**545,568**	**33.5%**	**26.4%**
Rocky Mountain Power	Idaho	720,530	247,517	196,402	34.4%	27.3%
	Utah	12,118,586	4,094,899	3,287,308	33.8%	27.1%
	Wyoming	1,664,722	640,448	504,808	38.5%	30.3%
	Subtotal	**14,503,838**	**4,982,863**	**3,988,517**	**34.4%**	**27.5%**
	Total	**16,567,429**	**5,673,868**	**4,534,085**	**34.2%**	**27.4%**

The commercial sector analysis considers fourteen segments: college, data center, grocery, health, large office, large retail, lodging, miscellaneous (or unclassified), restaurant, school, small office, small retail, warehouse, and controlled atmosphere or refrigerated warehouse.[24] Figure 3-4 below shows the share of 2038 technical potential that is attributable to each segment. Small and large offices represent the largest share, with a combined 27% of total savings potential.

Figure 3-4 Commercial Cumulative Technical Achievable Potential by Segment in 2038

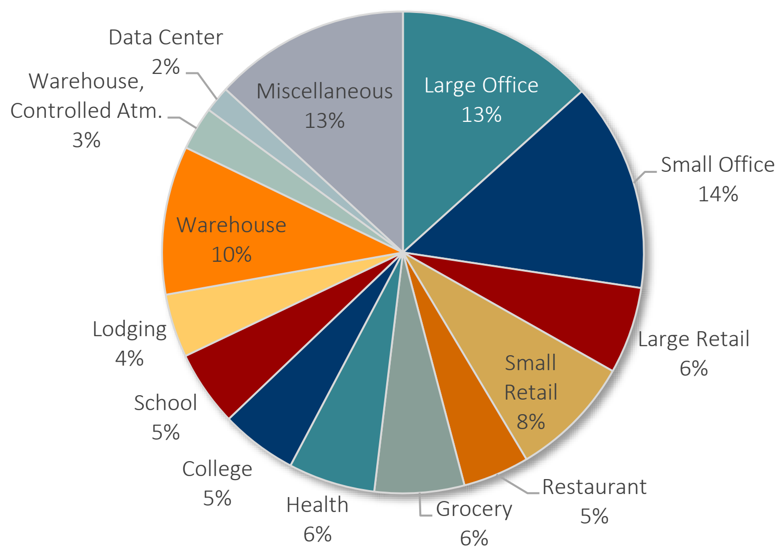


Figure 3-5 and Table 3-7 present the estimates of Class 2 DSM potential for the commercial sector from an end-use perspective. Key findings and observations are outlined below:

- Lighting opportunities represent roughly 52% of the identified commercial technical achievable potential, largely attributable to LED lighting. Based on the best projections available at the time of the analysis, these lamps are expected to become significantly more available and efficient over the study time period and be widely applicable for linear fluorescent, high bay, and screw-in applications. The Council's Seventh Power Plan's enhanced fixture control packages also represent a sizeable portion of 20-year savings and are modeled as a lost opportunity to be acquired at the time of fixture replacement.
- There is significant technical achievable potential from HVAC systems through the application of equipment upgrades and building shell measures within the cooling, heating, and ventilation end uses (35% of the potential). The largest of these three is cooling, driven by large air conditioning loads in Utah.
- Refrigeration makes up 8% of the total commercial potential, primarily from grocery stores throughout the region and the controlled atmosphere segment in Washington.
- The water heating, food preparation, office equipment, and miscellaneous end uses make up the remaining 5% of potential.

[24] Controlled Atmosphere warehouses are only modeled for Washington, where they are more prominent.

Figure 3-5 Commercial Cumulative Technical Achievable Potential by End Use in 2038

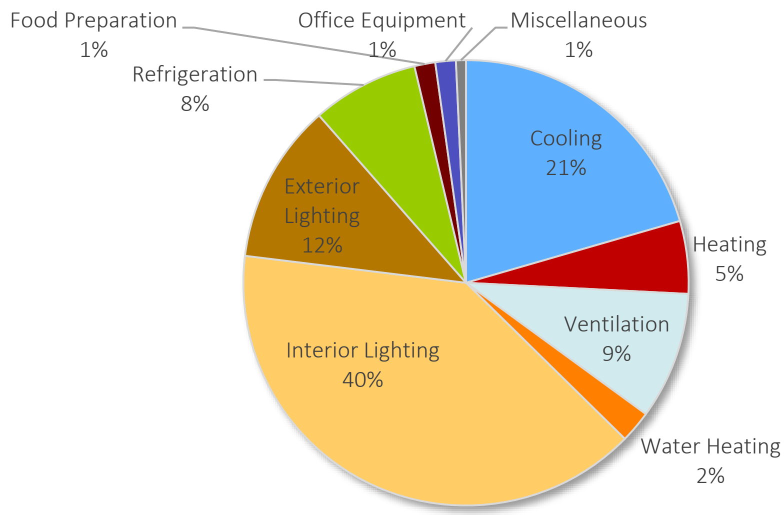


Table 3-7 Commercial Cumulative Class 2 DSM Potential by End Use in 2038

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Achievable Potential (% of Total)	Technical Achievable Potential (% of Baseline)
Cooling	3,154,997	1,136,883	930,405	20.5%	29.5%
Heating	1,427,124	284,452	239,168	5.3%	16.8%
Ventilation	1,334,205	679,934	418,854	9.2%	31.4%
Water Heating	668,563	124,737	105,405	2.3%	15.8%
Interior Lighting	3,439,809	2,160,686	1,794,372	39.6%	52.2%
Exterior Lighting	1,127,612	654,287	525,846	11.6%	46.6%
Refrigeration	1,156,414	414,148	351,233	7.7%	30.4%
Food Preparation	402,684	89,879	68,583	1.5%	17.0%
Office Equipment	1,574,096	79,330	67,446	1.5%	4.3%
Miscellaneous	2,281,924	49,531	32,773	0.7%	1.4%
Total	**16,567,429**	**5,673,867**	**4,534,085**	**100.0%**	**27.4%**

Industrial Sector

Table 3-8 presents estimates for cumulative technical and technical achievable potential for the industrial sector by the end of the study period in 2038. From the Class 2 DSM resources assessed in this study, the technical potential savings are 2.8 million MWh or 16.3% of the baseline forecast in 2038 in the absence of DSM programs. The corresponding technical achievable potential is 2.2 million MWh or 12.9% of the 2038 baseline. Savings as a percent of the baseline are relatively consistent across states. In contrast to the 2017 CPA, savings in Wyoming are comparable to other states as a percent of baseline. After observing a marked increase in recent-year conservation in PacifiCorp's industrial Wyoming programs, AEG removed the market ramp rate, which was previously applied on top of all measure ramp rates in this sector from the CPA, increasing Class 2 conservation potential in the earlier years of the study.

Table 3-8 Industrial Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	80,145	12,441	10,127	15.5%	12.6%
	Washington	1,168,972	187,350	150,422	16.0%	12.9%
	Subtotal	**1,249,118**	**199,791**	**160,549**	**16.0%**	**12.9%**
Rocky Mountain Power	Idaho	314,849	53,599	43,536	17.0%	13.8%
	Utah	7,614,576	1,336,316	1,039,868	17.5%	13.7%
	Wyoming	8,163,836	1,232,823	1,000,703	15.1%	12.3%
	Subtotal	**16,093,260**	**2,622,738**	**2,084,107**	**16.3%**	**13.0%**
	Total	**17,342,377**	**2,822,528**	**2,244,656**	**16.3%**	**12.9%**

The industrial sector is composed of fifteen segments in this analysis: agriculture, chemical manufacturing, electronic equipment manufacturing, food manufacturing, industrial machinery manufacturing, lumber and wood products, metal manufacturing, mining and extraction, miscellaneous manufacturing, paper manufacturing, petroleum refining, stone/clay/glass products, transportation equipment manufacturing, wastewater, and water. Figure 3-6 shows the allocation of 2038 technical achievable potential that is attributable to each segment. The mining and extraction segment, with large operations predominantly in Wyoming and Utah, represents the largest share of achievable potential at 45%.

Figure 3-6 Industrial Cumulative Technical Achievable Potential by Segment in 2038

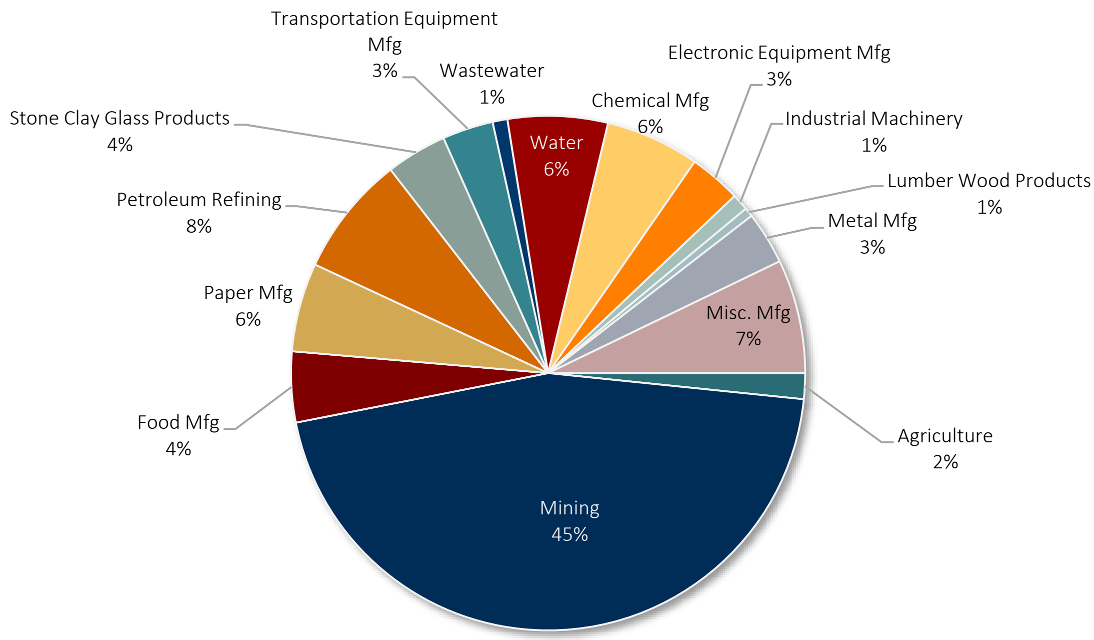


Figure 3-7 and Table 3-9 present the estimates of Class 2 DSM potential for the industrial sector from an end-use perspective. Key findings and observations are outlined below:

- Motor and process loads represent the largest share of end use consumption in the industrial sector (77% of savings) and, correspondingly, have the largest identified technical achievable potential.
  - Motor savings comprise 72% of the total sector potential, while process savings account for an additional 5%.[25] Potential savings for motor equipment change-outs have been essentially eliminated by the National Electrical Manufacturer's Association (NEMA) standards, which now make premium efficiency motors the baseline efficiency level for many motors. As a result, the savings opportunities in this end use come from controls, system optimization, and variable frequency drives, which improve system efficiencies where motors are utilized.
  - This study identified significant potential in the mining and extraction industry group[26] within PacifiCorp's Wyoming territory, including potential from pump energy management and submersible pump measures.
- Like the residential and commercial sectors, the projected improvements in performance and applicability of LED lighting technologies provides a large potential opportunity in the industrial sector, leading to lighting representing 16% of the identified technical achievable potential.
- Potential for the heating, cooling, ventilation, and miscellaneous end uses, represent the remaining 7% of potential, mainly realized within the non-industrial portions of the space (e.g. warehouse and office spaces).

[25] It is often difficult to distinguish between motors used for industrial process and non-process purposes, so in many ways, these two end-use categories can be viewed as a group.

[26] For the purposes of this study, a mining and extraction group was compiled from Standard Industrial Classification (SIC) codes 10XX through 14XX with the addition of several extraction and pipeline-related customers in SIC codes 46XX through 49XX, since many of the end uses are tied to moving fluids or materials as part of the extraction process.

Figure 3-7 Industrial Cumulative Technical Achievable Potential by End Use in 2038

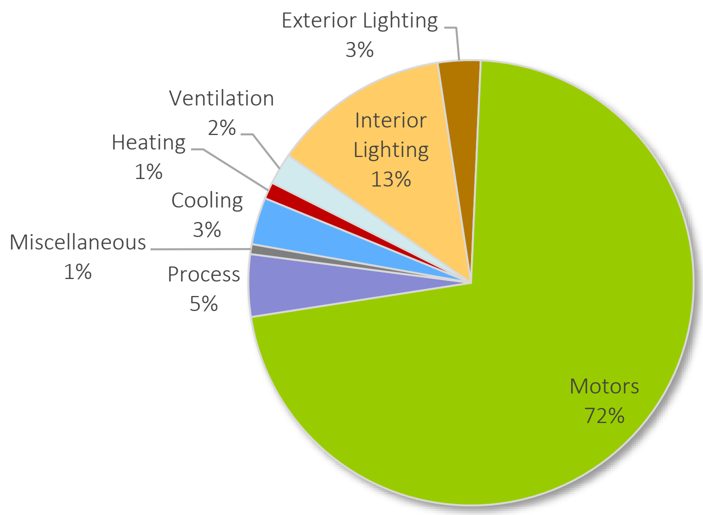


Table 3-9 Industrial Cumulative Class 2 DSM Potential by End Use in 2038

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Achievable Potential (% of Total)	Technical Achievable Potential (% of Baseline)
Cooling	497,115	104,587	76,813	3.4%	15.5%
Heating	406,927	32,951	27,264	1.2%	6.7%
Ventilation	219,573	107,309	51,068	2.3%	23.3%
Interior Lighting	638,138	364,737	289,832	12.9%	45.4%
Exterior Lighting	162,885	92,407	69,595	3.1%	42.7%
Motors	12,467,604	1,961,314	1,612,591	71.8%	12.9%
Process	2,212,923	140,353	101,453	4.5%	4.6%
Miscellaneous	737,212	18,870	16,039	0.7%	2.2%
Total	**17,342,377**	**2,822,528**	**2,244,656**	**100.0%**	**12.9%**

Irrigation Sector

Table 3-10 presents estimates for cumulative technical and technical achievable potential for the irrigation sector by the end of the study period in 2038. From the Class 2 DSM resources assessed in this study, the technical potential savings are 144,441 MWh or 11.4% of the baseline forecast in 2038. The corresponding technical achievable potential is 122,775 MWh or 9.7% of the 2038 baseline.

Table 3-10 Irrigation Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	102,649	12,311	10,464	12.0%	10.2%
	Washington	172,922	20,660	17,561	11.9%	10.2%
	Subtotal	**275,571**	**32,971**	**28,025**	**12.0%**	**10.2%**
Rocky Mountain Power	Idaho	735,021	81,542	69,311	11.1%	9.4%
	Utah	234,365	26,933	22,893	11.5%	9.8%
	Wyoming	25,697	2,995	2,546	11.7%	9.9%
	Subtotal	**995,083**	**111,470**	**94,750**	**11.2%**	**9.5%**
	Total	**1,270,654**	**144,441**	**122,775**	**11.4%**	**9.7%**

For all practical purposes, the irrigation sector is comprised entirely of motor loads that are driving water pumps of various sizes. Key findings and observations are outlined below:

- Similar to the industrial sector, potential savings for motor equipment change-outs have been essentially eliminated by the National Electrical Manufacturer's Association (NEMA) standards, which now make premium efficiency motors the baseline efficiency level. As a result, the savings opportunities for irrigation pumps come from discretionary, or non-equipment measures, such as controls, pressure regulation, and variable speed drives, which improve system efficiencies where motors are utilized.
- Energy consumption varies by state, based on the presence of surface water, type of crop, and the size of the irrigation market sector. In Pacific Power service territories, surface water and specialty crops are more prevalent, leading to smaller pump sizes. In Rocky Mountain Power territories, larger row crop fields and deeper water reservoirs require larger pumps.

Street Lighting Sector

Table 3-11 presents estimates for cumulative technical and technical achievable potential for the street lighting sector by the end of the study period in 2038. From the Class 2 resources assessed in this study, the technical potential savings are 52,961 MWh or 50.4% of the baseline forecast in 2038. The corresponding technical achievable potential is 43,491 MWh or 41.4% of the 2038 baseline.

Table 3-11 Street Lighting Cumulative Class 2 DSM Potential by State in 2038

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Potential (% of Baseline)	Technical Achievable Potential (% of Baseline)
Pacific Power	California	2,116	938	772	44.3%	36.5%
	Washington	10,744	5,790	4,738	53.9%	44.1%
	Subtotal	**12,859**	**6,728**	**5,510**	**52.3%**	**42.9%**
Rocky Mountain Power	Idaho	2,942	1,667	1,366	56.7%	46.4%
	Utah	76,166	37,452	30,759	49.2%	40.4%
	Wyoming	13,062	7,115	5,855	54.5%	44.8%
	Subtotal	**92,170**	**46,233**	**37,980**	**50.2%**	**41.2%**
	Total	**105,029**	**52,961**	**43,491**	**50.4%**	**41.4%**

The street lighting sector in this analysis is divided into company-owned and customer-owned assets. Figure 3-8 below shows the allocation of 2038 technical achievable potential that is attributable to each of these segments. Most street lighting fixtures in PacifiCorp's service territory are customer owned, leading to this segment representing 62% of the identified technical achievable potential. Company-owned fixtures account for the remaining 38% of potential.

Figure 3-8 Street Lighting Cumulative Technical Achievable Potential by Segment in 2038

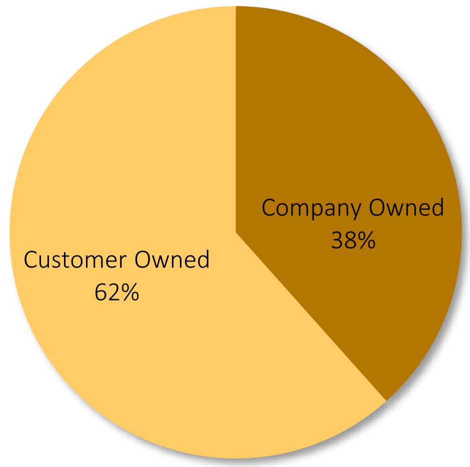


Table 3-12 presents the estimates of Class 2 DSM potential for the Street Lighting sector by segment and wattage range. Key findings and observations are outlined below:

- The primary mode of achieving savings in the street lighting sector is through LED equipment replacements and retrofits. As mentioned for other sectors, the improving performance and cost trends of LED lighting technologies provides a large potential opportunity in street lighting applications.
- The study also considers a smart dimming controller as a non-equipment or discretionary measure that is applicable to the street lighting sector. This measure, which can selectively dim or shut down individual bulbs on a multi-head fixture in response to a motion sensor or timer, was considered applicable in areas such as parking lots and low-traffic roadways. This measure represents 16% of the identified technical achievable potential.
- The "Other" category is applied to a subset of fixtures with more specific functionality such as security lighting or metered outdoor lighting. These fixtures have reduced energy savings potential.

Table 3-12 Street Lighting Cumulative Class 2 DSM Potential by End Use in 2038

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Technical Achievable Potential (MWh)	Technical Achievable Potential (% of Total)	Technical Achievable Potential (% of Baseline)
Company - 100W	16,583	9,546	7,832	18.0%	47.2%
Company - 150W	6,927	3,499	2,873	6.6%	41.5%
Company - 250W	4,282	2,493	2,045	4.7%	47.8%
Company - 400W	3,325	2,126	1,743	4.0%	52.4%
Customer - 100W	16,122	7,877	6,469	14.9%	40.1%
Customer - 150W	17,803	6,064	5,003	11.5%	28.1%
Customer - 250W	10,983	4,819	3,962	9.1%	36.1%
Customer - 400W	14,909	9,307	7,627	17.5%	51.2%
Customer - 1000W	347	230	188	0.4%	54.2%
Other	13,748	7,000	5,748	13.2%	41.8%
Total	**105,029**	**52,961**	**43,491**	**100.0%**	**41.4%**

4

COMPARISON WITH PREVIOUS STUDY

This assessment uses the same general industry-standard methods for assessing long-term energy efficiency potential as employed in PacifiCorp's previous assessments, published in 2007, 2011, 2013, 2015 and 2017. Conservation potential assessments, by nature, provide a best estimate of the available opportunity based on the best data available and accepted assumptions at the time of the analysis. As such, results between assessments will vary based on updated primary and secondary data sources, new building codes and equipment efficiency standards, increased availability and adoption of emerging technologies, and other factors. This chapter compares this assessment's results to those from the 2017 assessment and explains the drivers of key differences.

Key Differences

This assessment of Class 2 DSM reflects the following changes compared to the previous study conducted in 2017:

- State energy codes and equipment efficiency standards enacted as of April 2018, even if they have not yet taken effect.
- Feedback provided through PacifiCorp's 2019 IRP public meeting process, including a reduction in maximum incentive cost from 70% of the incremental cost to 50% for nonresidential lighting programs in Utah
- PacifiCorp's actual and projected DSM program accomplishments through 2017.
- Adjustments to measure savings, based on recent evaluation results, data available from the Regional Technical Forum (RTF), and other updated secondary sources available before April 2018.
- 2016 customer and sales information to determine segmentation; and updated sales and customer forecasts.
- A sizeable suite of new emerging technology measures
- Updated heat pump water heater analysis using the latest RTF and NEEA-tier data, increasing efficiency. Market conditions and guidance from the RTF indicate that more efficient NEEA Tier 3 units should be considered over the Tier 1 and Tier 2 units projected in the prior study.
- New emerging technologies and updated assumptions around applicability, cost, and efficacy of LED lighting.
- Addition and re-assessment of Waste Heat to Power and Regenerative Technology measures (these were previously considered outside the CPA)
- Variation of administrative costs by state
- Use of the Utility Cost Test in Idaho
- Removal of market ramp rate from the Wyoming industrial market, which increases opportunity in this state and segment.

- Removal of Oregon comparison analysis.[27]
    - Accordingly, the comparison to Energy Trust of Oregon methodology found in Sections E and F of the prior study's Volume 4 appendix has been removed.

Class 2 DSM Potential Results by Sector

Table 4-1 compares cumulative 20-year potential between the current and 2017 study, in absolute terms and as a percentage of projected loads, by sector. As shown, the 2019 CPA estimates slightly higher technical achievable potential than the 2017 study: an increase from 8,930,775 MWh to 9,619,204 MWh. The potential in the commercial and street lighting sectors did not change materially between the two assessments. The potential for the residential, industrial, and irrigation sectors are higher. This is primarily driven by changes in measure assumptions based on PacifiCorp program accomplishments and evaluations, the RTF (particularly heat pump water heaters), updates to the baseline projection. In the irrigation sector, an increase in baseline loads in Idaho and Utah drive potential higher. Factors leading to differences in residential, commercial, and industrial potential are described in additional detail below.

Table 4-1 Comparison of Class 2 DSM Potential with Previous Assessments

	Technical Achievable Potential (Year-20 Cumulative MWh)		Technical Achievable Potential (Year-20 Cumulative as % of Baseline Loads)	
Sector	2017 Assessment	CURRENT Assessment	2017 Assessment	CURRENT Assessment
Residential	2,378,465	2,674,197	17.8%	19.7%
Commercial	4,513,141	4,534,085	26.3%	27.4%
Industrial	1,902,755	2,244,656	9.8%	12.9%
Irrigation	88,950	122,775	7.5%	9.7%
Street Lighting	47,464	43,491	41.0%	41.4%
Total	**8,930,775**	**9,619,204**	**17.4%**	**19.7%**

[27] Oregon's 2017 IRP Acknowledgement Order (LC 67) required PacifiCorp to conduct an analysis comparison of Oregon's potential to this study in a separate report.

Residential Sector

As shown in Table 4-2, the residential technical achievable potential identified in this assessment is higher than the previous study, primarily driven by updates space heating, water heating, and lighting measure data. Increases in space heating are driven by revised weatherization savings assumptions and additional potential from converting electric resistance furnaces to air-source heat pumps (ASHPs). Differences in water heating are due to the use of Tier 3 heat pumps as the efficient option in all cases, rather than a mix of Tier 1, Tier 2, and Tier 3. The reduction in lighting is due to the removal of incremental potential in 2017 and 2018, both of which were under a far less efficient baseline.

Table 4-2 Residential Comparison of Class 2 DSM Potential with Previous Assessment

End Use Grouping	Technical Achievable Potential (Year-20 Cumulative MWh)		Key Drivers of Differences
	2017 Assessment	CURRENT Assessment	
Cooling	489,992	516,982	Increase in weatherization potential, mostly windows
Heating	498,836	751,828	Increase in weatherization potential, mostly windows. Higher potential from conversion of electric resistance furnaces to air-source heat pumps.
Water Heating	273,697	524,044	All potential assigned to NEEA Tier 3 heat pump water heaters (compared to a mix of NEEA Tier 1, NEEA Tier 2, and NEEA Tier 3 in the prior study. This is consistent with updated RTF methodology as discussed earlier in this section.
Lighting	599,324	357,457	Two years of pre-EISA 2020 backstop potential have been removed from current study but were present in prior (2017 and 2018)
Appliances	351,683	255,353	Baseline refrigerator and freezer efficiency improvements lower potential in current study
Electronics	114,169	131,862	No major changes in electronics potential.
Miscellaneous	50,763	136,671	Increased potential in measures affecting the miscellaneous end use (e.g. advanced new construction and zero-net energy homes).
Total	**2,378,465**	**2,674,197**	

Commercial Sector

The commercial potential in the current study is quite similar to the previous assessment. Decreases in water heating and office equipment potential are compensated for by the addition of new HVAC, refrigeration, and regenerative technology measures. A comparison of potential by end use can be seen in Table 4-3.

Table 4-3 Commercial Comparison of Class 2 DSM Potential with Previous Assessment

End Use Grouping	Technical Achievable Potential (Year-20 Cumulative MWh) 2017 Assessment	CURRENT Assessment	Key Drivers of Differences
Cooling	771,520	930,405	Addition of new measures and variants, such as dedicated outdoor air systems.
Heating	206,529	239,168	No major changes
Ventilation	283,715	418,854	UES update for ventilation equipment and addition of new measures and variants, such as dedicated outdoor air systems.
Water Heating	255,068	105,405	Increased water heater baseline efficiency and updated efficient option assumptions.
Interior Lighting	1,876,607	1,794,372	Due to recent accomplishments, an increase in baseline lighting efficiencies reduces potential.
Exterior Lighting	643,933	525,846	Due to recent accomplishments, an increase in baseline lighting efficiencies reduces potential.
Refrigeration	181,228	351,233	Increased consumption in Washington Controlled Atmosphere segment and new measures (such as Permanent Magnet Synchronous Motors (PMSMs) elevates potential.
Food Preparation	65,927	68,583	No major changes
Office Equipment	225,395	67,446	Updated assumptions on office equipment applicability – many systems are already efficient or do not conform to ENERGY STAR due to requisite features.
Miscellaneous	3,219	32,773	Addition of elevator regenerative breaking measure to the CPA.
Total	**4,513,141**	**4,534,085**	

Industrial Sector

The industrial potential in the current study is lower than in the previous assessment, driven in part by revised LED efficacy trends, similar to the residential and commercial models. Motors and process may be analyzed together, representing a combined increase of 415,503 MWh. This is due to a comprehensive update to motor management measures to a recently published United Nations Industrial Development Organization (UNIDO), which summarizes potential to a large set of measures in a system upgrade, optimization, and controls categories. A comparison of potential by end use can be seen in Table 4-4.

Table 4-4 Industrial Comparison of Class 2 DSM Potential with Previous Assessment

	Technical Achievable Potential (Year-20 Cumulative MWh)		
End Use Grouping	2017 Assessment	CURRENT Assessment	Key Drivers of Differences
Cooling	38,886	76,813	Addition of new measures and variants, such as dedicated outdoor air systems.
Heating	48,628	27,264	
Ventilation	26,634	51,068	
Interior Lighting	385,397	289,832	Due to recent accomplishments, an increase in baseline lighting efficiencies reduces potential.
Exterior Lighting	96,621	69,595	Due to recent accomplishments, an increase in baseline lighting efficiencies reduces potential.
Motors	1,239,614	1,612,591	Incorporation of new measures increases potential (mainly Waste Heat to Power (WHP) and petroleum pump measures). WHP measures were assumed to power motors and process, modeled as "savings" here.
Process	58,928	101,453	Incorporation of Waste Heat to Power measures increases potential (particularly Organic Rankine Cycle and high-temperature waste-heat recovery). WHP measures were assumed to power motors and process, modeled as "savings" here.
Miscellaneous	8,048	16,039	Incorporation of Conveyor Regeneration measure into the CPA increases potential.
Total	**1,902,755**	**2,244,656**	

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