PacifiCorp Demand-Side Resource Potential Assessment for 2017-2036

Volume 2:
Class 2 DSM Analysis

Prepared for:
PacifiCorp

February 14, 2017
Updated March 14, 2017

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INTRODUCTION

In 2015, PacifiCorp commissioned Applied Energy Group, with subcontractor The Brattle Group, to conduct this Demand-Side Resource Potential Assessment. This study provides estimates of the potential for electric demand-side management (DSM) resources in PacifiCorp's six-state service territory,[1] including supply curves, for the 20-year planning horizon of 2017–2036 to inform the development of PacifiCorp's 2017 Integrated Resource Plan (IRP) and satisfy state-specific requirements associated with forecasting and DSM resource acquisition.

Since 1989, PacifiCorp has developed biennial Integrated Resource Plans (IRPs) to identify an optimal mix of resources that balance considerations of cost, risk, uncertainty, supply reliability/deliverability, and long-run public policy goals. The optimization process accounts for capital, energy, and ongoing operation costs as well as the risk profiles of various resource alternatives, including: traditional generation and market purchases, renewable generation, and DSM resources such as energy efficiency, and capacity-focused resources i.e. demand response and direct load control. Since the 2008 IRP, DSM resources have competed directly against supply-side options, allowing the IRP model to selectively choose the right mix of resources to meet the needs of PacifiCorp's customers while minimizing cost and risk. Thus, this study does not assess cost-effectiveness of demand-side resources.

This study primarily seeks to develop reliable estimates of the magnitude, timing, and costs of DSM resources likely available to PacifiCorp over the 20-year planning horizon mentioned above. The study focuses on resources assumed achievable during the planning horizon, recognizing known market dynamics that may hinder resource acquisition. Study results will be incorporated into PacifiCorp's 2017 IRP and subsequent DSM planning and program development efforts. This study serves as an update of similar studies completed in 2007, 2011, 2013, and 2015.[2]

DSM RESOURCE CLASSES

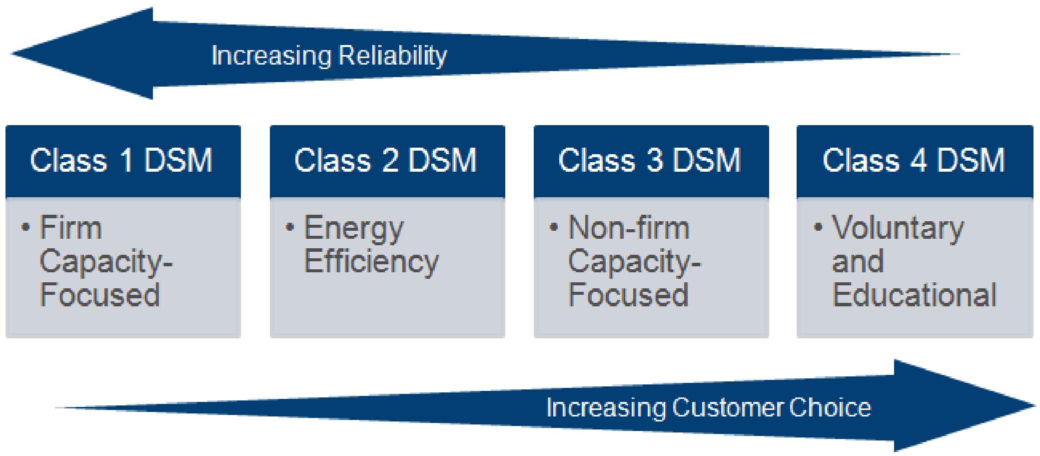
For resource planning purposes, PacifiCorp classifies DSM resources into four categories, differentiated by two primary characteristics: reliability and customer choice (see Figure 1-1). These resources are captured through programmatic efforts promoting efficient electricity use through various intervention strategies, aimed at changing: energy use peak levels (load curtailment), timing (price response and load shifting), intensity (energy efficiency), or behaviors (education and information).

From a system-planning perspective, Class 1 and Class 2 DSM resources (particularly Class 1 direct load control programs) are considered the most reliable, as once a customer elects to participate in a Class 1 DSM program, the resource is under the utility's control and can be dispatched as needed. Similarly, when a customer invests in a home or business efficiency improvement, the savings are locked in as a result of the installation and will occur during normal operation of the equipment. In contrast, savings resulting from energy education and awareness actions included in Class 4 DSM, tend to be the least reliable, as savings will vary due to greater customer control and the need for customers to take specific and consistent actions to lower their usage during peak periods.

[1] Class 2 analysis for Oregon is excluded from this report because it is assessed statewide by the Energy Trust of Oregon.

[2] The previous potential studies can be found at: http://www.pacificorp.com/es/dsm.html

Figure 1-1 Characteristics of DSM Resource Classes



PacifiCorp commissioned this DSM resource potential assessment to inform the Company's biennial IRP planning process, to satisfy other state-specific DSM planning requirements, and to assist PacifiCorp in revising designs of existing DSM programs and in developing new programs. The study's scope encompasses multi-sector assessments of long-term potential for DSM resources in PacifiCorp's Pacific Power (California, Oregon, and Washington) and Rocky Mountain Power (Idaho, Utah, and Wyoming) service territories. This study excludes an assessment of Oregon's Class 2 DSM potential, as this potential has been captured in assessment work conducted by the Energy Trust of Oregon, which provides Oregon energy-efficiency potential to PacifiCorp for resource planning purposes. This study does not include assessments of Class 4 DSM resources. Unless otherwise noted, all results presented in this report represent savings at generation; that is, savings at the customer meter have been grossed up to account for line losses.

Interactions Between Resources

This assessment includes multiple resources, actions, and interventions that would interact with each other if implemented in parallel. As explained in more detail later in this report, we take specific actions to account for these interactions to avoid double-counting the available potential. The interactive effects that we have analyzed occur within the major analysis sections; meaning that the interactions of energy efficiency resources are considered across all Class 2 DSM resources. Likewise, the analysis of capacity-focused Class 1 and 3 DSM resources explicitly considers interactions. It should be noted, however, that this study does not attempt to quantify potential interactions between energy-focused and capacity-focused resources due to uncertainties regarding resources likely to be found economic and pursued.

REPORT ORGANIZATION

This report is presented in five volumes as outlined below. This document is **Volume 2, Class 2 DSM Analysis.**

- Volume 1, Executive Summary
- Volume 2, Class 2 DSM Analysis
- Volume 3, Class 1 and 3 DSM Analysis
- Volume 4, Class 2 DSM Analysis APPENDIX
- Volume 5, Class 1 and 3 DSM Analysis APPENDIX

Abbreviations and Acronyms

Table 1-1 provides a list of abbreviations and acronyms used in this report, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
aMW	Average Megawatt, obtained by dividing Megawatt-hours by 8760
C&I	Commercial and Industrial
CAC	Central Air Conditioning
Council	Northwest Power and Conservation Council (NWPCC)
DHW	Domestic Hot Water
DEER	California's Database for Energy Efficient Resources
DSM	Demand-Side Management
DLC	Direct Load Control
EE	Energy Efficiency
EIA	Energy Information Administration
EUL	Effective Useful Life
EUI	Energy Usage Intensity
FERC	Federal Energy Regulatory Commission
HVAC	Heating Ventilation and Cooling
IECC	International Energy Conservation Code
IOU	Investor Owned Utility
NEEA	Northwest Energy Efficiency Alliance
NPV	Net Present Value
O&M	Operations and Maintenance
PCT	Programmable Communicating Thermostat
RTF	Regional Technical Forum
TRC	Total Resource Cost
UCT	Utility Cost Test
UEC	Unit Energy Consumption
UES	Unit Energy Savings
WH	Water Heater

2

ANALYSIS APPROACH

Class 2 DSM resources, or energy efficiency resources, are measures that reduce customers' energy consumption 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 process is largely similar to the Class 2 DSM analysis in the 2015 Resource Potential Assessment, with all assumptions updated using the most recent and applicable sources available.

OVERVIEW OF ANALYSIS STEPS

To perform the Class 2 DSM analysis, AEG used a bottom-up analysis approach following the major steps listed below. We describe these analysis steps in more detail throughout the remainder of this chapter.

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, 2014[3] in five states within PacifiCorp's service territory: California, Washington, Idaho, Utah, and Wyoming. Oregon is not covered in this analysis because the Energy Trust of Oregon handles the planning and implementation of all energy efficiency within PacifiCorp's Oregon service territory. 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 2015 through 2036, 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 annual potential for each year in the 20-year planning horizon for use in PacifiCorp's IRP, results presented in this volume focus on cumulative impacts at the end of the planning horizon, 2036.
5. Compare the results of the present study with those from PacifiCorp's previous (2015) DSM potential assessment[4] to identify important trends and changes.

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

[3] 2014 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.

[4] All five volumes of the 2015 study are available on the PacifiCorp website, http://www.pacificorp.com/es/dsm.html

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. Non-equipment 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 Achievable Technical 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 Plan as the customer adoption rates for this study. For the achievable technical 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.[5]

LoadMAP Model

For the energy efficiency potential analysis, we used AEG's Load Management Analysis and Planning tool (LoadMAP™) version 5.0 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 the EPRI National Potential Study and numerous utility-specific forecasting and potential studies since. 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.
- 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.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles we describe 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 types of potential.

[5] Council's 7th Power Plan applicability assumptions reference an "Achievable Savings" report published August 1, 2007. http://www.nwcouncil.org/reports/2007/2007-13/

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 2-1.

Table 2-1 Overview of Segmentation Scheme for Class 2 Potentials Modeling[6]

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

With the segmentation scheme defined, we then performed a market characterization of electricity sales in the base year to allocate sales to each customer segment. We used PacifiCorp billing data and customer saturation surveys to inform the bottom-up assembly of energy consumption among the various sectors and segments such that the total customer count and total energy consumption matched actual PacifiCorp system totals for 2014. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base year.

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

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

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.

- **Saturations** define the fraction of the market where various technologies are installed. (e.g., percent of homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use intensity**) describes the average energy consumed in 2014 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 2014 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 2014. 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 2015 through 2036 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 January 2016, even if they would not go into effect until a future date. The study does not, however, attempt to project 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 3-3 and Table 3-4. 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

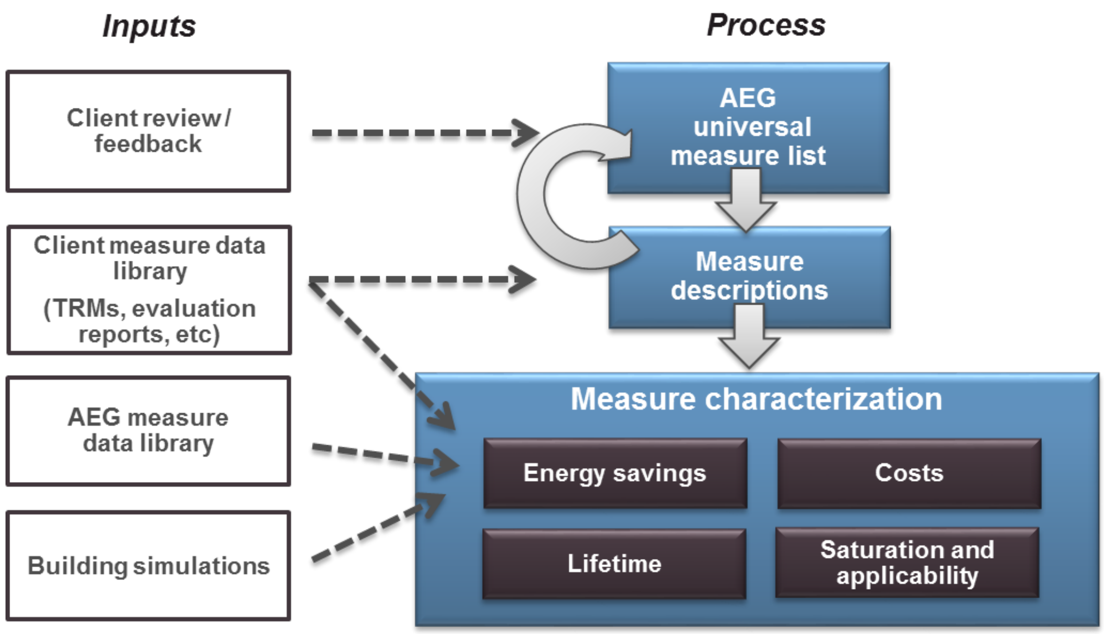
Regarding customer purchase behaviors, the study held purchase trends constant at current levels, except where overridden by a forthcoming code or standard.

Although it uses many of the same input assumptions and aligns very closely with PacifiCorp's official load forecast, 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 2-1 outlines the framework for measure analysis.

Figure 2-1 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), the Energy Trust of Oregon, AEG's own measure databases and building simulation models, and other secondary sources. 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 (LO) measures due to the fact that once a purchase decision is made, there will not be another opportunity to improve the efficiency of that equipment item until the lifetime expires again.
- **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 "non-lost opportunity" measures.[7] An example is a programmable thermostat, which can be pre-set 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 (thermostat, integrated lighting fixture controls)
- Equipment maintenance (cleaning filters, changing setpoints)
- Whole-building design (building orientation, passive solar lighting)
- Displacement measures (ceiling fan to reduce use of central air conditioners)
- Commissioning and retro-commissioning
- Residential behavioral programs
- Energy Management programs

We developed a preliminary list of EE measures, which was distributed to the PacifiCorp project team for review. We started will all measures analyzed in the previous study, updated or excluded obsolete measures (e.g., programmable thermostat removed in favor of Wi-Fi connected thermostat). The list was finalized after incorporating comments and is presented in appendix H 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 2-2 summarizes the number of measures evaluated for each segment within each sector. The study considered 324 unique measures across sectors, which expand to over 30,000 permutations when assessed separately by state, vintage, and market segment. This is lower than the 50,088 permutations in the prior study. A reduction in measure count from 465 to 324 was driven mainly by the consolidation of measures per 7th Power Plan updates. For example, previously discrete lighting controls measures have been bundled into new enhanced fixture controls measures. In addition, obsolete measures have also been removed or consolidated, such as the residential home energy management system and programmable thermostat measures being replaced by a single WiFi/ interactive thermostat option. Industrial motor and process measures were consolidated into a streamlined suite of optimization and controls measures, reflecting research performed by the United Nations Industrial Development Organization.

Table 2-2 Number of Class 2 Measures Evaluated

Sector	Measure Count	Measure Count w/ Permutations (States, Vintages, & Segments)
Residential	83	2,490 = count * 5 * 2 * 3
Commercial	109	15,260 = count * 5 * 2 * 14
Industrial	99	14,850 = count * 5 * 2 * 15
Irrigation	22	220 = count * 5 * 2 * 1
Street Lighting	11	220 = count * 5 * 2 * 2
Total Measures Evaluated	**324**	**33,040 =sum**

[7] An exception to this general definition is in the case of New Construction, where all measures, both equipment and non-equipment, are considered lost opportunity since there is a unique, one-time opportunity to install DSM measures at this time.

Calculating Class 2 Energy-Efficiency 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 Potential Studies (2007)[8] and the Northwest Power and Conservation Council's Seventh Power Plan (2016).[9] 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.[10]

Technical Potential

As described in Chapter 1, two types of potentials were developed as part of this effort: technical potential and achievable technical 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 applicability.

While theoretically, all discretionary resources could 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 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.

Achievable Technical Potential

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

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[8] 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.

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

[10] This is in contrast to 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 Achievable Technical 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 Achievable Technical Potential.

such as improved codes and standards and market transformation, can be used to capture portions of these resources, and are included within the achievable technical potential, per 7th 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 have been incorporated for all measures and market regions.

Estimated achievable technical 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, achievable technical 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 second year of the Seventh Power Plan ramp rates (2017) was aligned with this study's first year (2017). 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 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).

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. In the 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 Seventh Power Plan's emerging technology ramp rate are constrained to 65% of technical potential.

To calculate annual achievable technical 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.

Discretionary Resources

Discretionary resources differ from lost opportunity resources due to their acquisition availability at any point within the study horizon. From a theoretical perspective, all achievable technical 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 achievable technical potential for discretionary resources by spacing the acquisition according to the ramp rates specified for a given measure, thus creating annual, incremental values. To assess achievable technical potential, we then apply the 85% market achievability limit defined by the Council. Consistent with lost opportunity, discretionary measures on the Seventh Power Plan's emerging technology ramp rate are constrained to 65% of technical potential.

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

The 2015 assessment applied market ramp rates on top of measure ramp rates to reflect state-specific considerations affecting acquisition rates, such as age of programs, small and rural markets, and current delivery infrastructure. A market ramp rate was applied to the industrial market sector in Wyoming. Recent program accomplishments point to this trend continuing into future years, therefore the current assessment applies the same "Emerging" market ramp rate from the 2015 assessment, presented in Table E-1 in Volume 4 of this report, to industrial measures in Wyoming.

Levelized Cost of Measures

Using the cost data for measures developed in the characterization step above, we calculate the levelized cost of conserved energy (levelized cost) 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.[11] Table 2-3 summarizes components of levelized cost in each PacifiCorp state assessed in this study.

Table 2-3 Economic Components of Levelized Cost by State

Parameter	WA	ID	CA	WY	UT
Initial capital cost	Included				Utility incentive
Annual Incremental O&M	Included				Not included
Secondary Fuel Impacts	Included		Not included		
Non-Energy Impacts	Included		Not included		
Administrative costs	20% of incremental cost				

Utah's levelized cost is assessed on a Utility Cost Test (UCT) basis, while the other states are evaluated on a Total Resource Cost (TRC) basis. To maintain consistency with the Council, RTF and accepted regulatory practices, secondary benefits, non-energy impacts, and incremental O&M have been included for Washington and Idaho. 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's, considering 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-

[11] 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 a given jurisdiction.

year period.[12] 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 5 of its 15 years. In this way, all measures are considered on an equivalent, 20-year basis.

For PacifiCorp's Utah 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:

- Specific program measure (e.g., evaporative coolers and appliance recycling) 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.
- Incentives for all other measures represented 70% of the incremental measure cost[13], based on a robust incentive level aimed at achieving 85% of the technical potential.

An assumption of 20% of incremental costs was used to align with program history, previous potential assessments, industry benchmarks the assumption in the Seventh Power Plan.

[12] 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.

[13] 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.

3

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.
- **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.
- **PacifiCorp program data:** PacifiCorp provided information about past and current energy efficiency programs, including program descriptions, achievements to date, and evaluation reports.

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, the California Database for Energy Efficient Resources (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 numerous 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, Tacoma Power, Seattle City Light 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[14].

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.

- **Council 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.app.box.com/v/7thplanconservationdatafiles
- **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 http://www.nwcouncil.org/energy/rtf/measures/Default.asp.
- **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.
- **Residential Building Stock Assessment:** NEEA's 2011 Residential Building Stock Assessment (RBSA) provides results of a survey of thousands of homes in the Pacific Northwest: http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment
- **Commercial Building Stock Assessment:** NEEA's 2014 Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. http://neea.org/resource-center/regional-data-resources/commercial-building-stock-assessment
- **Industrial Facilities Site Assessment:** NEEA's 2014 Industrial Facilities Site Assessment (IFSA) provides data on regional industrial customers by major classification types. http://neea.org/resource-center/regional-data-resources/industrial-facilities-site-assessment
- **Bonneville Power Administration (BPA) Reference Deemed Measure List,** version 2.5, which was the most recent available when the study was performed.
- **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 2015 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/

[14] 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

- **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. The estimates were also compared with NEEA's CBSA study, estimates 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 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 3-1. 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.

DATA APPLICATION FOR BASELINE PROJECTION

Table 3-2 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 3-1 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 NEEA RBSA, CBSA, and IFSA AEG Energy Market Profiles AEO 2015 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 PacifiCorp Load Forecasting
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 Seventh 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	Seventh Plan workbooks, RTF AEG DEEM AEO 2015 DEER Other recent AEG studies

Table 3-2 Data Needs for the Baseline projection and Potentials 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 2015 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	Shipments data from AEO AEO 2015 regional forecast assumptions[15] 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 2015

[15] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2015), 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.

In addition, the baseline projection captures impacts of known future equipment standards enacted as of January 2016, as shown in Table 3-3 and Table 3-4.

Table 3-3 Residential Electric Equipment Standards[16]

<table>
<tr><th>Technology</th><th>2014</th><th>2015</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>Central AC</td><td colspan="12">SEER 13; SEER 14 in California</td></tr>
<tr><td>Room AC</td><td colspan="12">EER 11.0</td></tr>
<tr><td>Heat Pump</td><td colspan="12">SEER 14.0/HSPF 8.0</td></tr>
<tr><td>Water Heater (<=55 gallons)</td><td colspan="12">EF 0.95</td></tr>
<tr><td>Water Heater (>55 gallons)</td><td colspan="12">Heat Pump Water Heater</td></tr>
<tr><td>Screw-in/Pin Lamps</td><td colspan="6">Advanced Incandescent (~20 lumens/watt)</td><td colspan="6">Advanced Incandescent (45 lumens/watt)</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="4">T8 (89 lumens/watt)</td><td colspan="8">T8 (92.5 lumens/watt)</td></tr>
<tr><td>Refrigerator</td><td colspan="12">25% more efficient</td></tr>
<tr><td>Freezer</td><td colspan="12">25% more efficient</td></tr>
<tr><td>Clothes Washer</td><td colspan="4">1.29 IMEF top loader</td><td colspan="8">1.57 IMEF top loader</td></tr>
<tr><td>Clothes Dryer</td><td colspan="12">3.73 Combined EF</td></tr>
<tr><td>Furnace Fans</td><td colspan="5">Conventional</td><td colspan="7">40% more efficient</td></tr>
</table>

Table 3-4 Commercial Electric Equipment Standards

<table>
<tr><th>Technology</th><th>2014</th><th>2015</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>Chillers</td><td colspan="12">2007 ASHRAE 90.1</td></tr>
<tr><td>Roof Top Units</td><td colspan="12">EER 11.0/11.2</td></tr>
<tr><td>PTAC</td><td colspan="3">EER 11.7</td><td colspan="9">EER 11.9</td></tr>
<tr><td>Heat Pump</td><td colspan="12">EER 11.0/COP 3.3</td></tr>
<tr><td>PTHP</td><td colspan="12">EER 11.9/COP 3.3</td></tr>
<tr><td>Ventilation</td><td colspan="12">Constant Air Volume/Variable Air Volume</td></tr>
<tr><td>Screw-in/Pin Lamps</td><td colspan="6">Advanced Incandescent (~20 lumens/watt)</td><td colspan="6">Advanced Incandescent (45 lumens/watt)</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="4">T8 (89 lumens/watt)</td><td colspan="8">T8 (92.5 lumens/watt)</td></tr>
<tr><td>High Intensity Discharge</td><td colspan="3">EPACT 2005</td><td colspan="9">Metal Halide Ballast Improvement</td></tr>
<tr><td>Water Heater</td><td colspan="12">EF 0.97</td></tr>
<tr><td>Walk-in Refrigerator/Freezer</td><td colspan="3">EISA 2007</td><td colspan="9">10-38% more efficient</td></tr>
<tr><td>Reach-in Refrigerator/Freezer</td><td colspan="3">EPACT 2005</td><td colspan="9">40% more efficient</td></tr>
<tr><td>Glass Door Display</td><td colspan="3">EPACT 2005</td><td colspan="9">12-28% more efficient</td></tr>
<tr><td>Open Display Case</td><td colspan="3">EPACT 2005</td><td colspan="9">10-20% more efficient</td></tr>
<tr><td>Ice maker</td><td colspan="4">EPACT 2005</td><td colspan="8">15% more efficient</td></tr>
<tr><td>Pre-rinse Spray Valve</td><td colspan="5">1.6 GPM</td><td colspan="7">1.0 GPM</td></tr>
<tr><td>Motors</td><td colspan="2">EISA 2007</td><td colspan="10">Expanded EISA 2007</td></tr>
</table>

[16] 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 3-5 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 3-5 Data Applied for the Market Profiles

State	Residential Energy Code Used	Non-Residential Energy Code Used
California	2016 Building Energy Efficiency Standards, Title 24	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[17]	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

[17] LoadMAP baseline projections for this study were developed between November, 2015 and February, 2016, while Utah adopted an IECC 2015-based code on March 10, 2016, therefore this update was not incorporated.

Energy Efficiency Measure Data Application

Table 3-6 details the energy-efficiency data inputs to the LoadMAP model and identifies the key sources used in this study's analysis.

Table 3-6 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 Seventh Plan workbooks RTF BEST AEG DEEM AEO 2015 DEER Other secondary sources
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.	Seventh Plan workbooks RTF AEG DEEM AEO 2015 RS Means DEER Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	Seventh Plan workbooks RTF DEER AEG DEEM AEO 2015 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 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, and all demand-side measures from ACEEE's *New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030.*[18]

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 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 quantifiable cost and/or operating characteristics have been excluded from the analysis. 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, a number of economic assumptions were needed. All cost and benefit values were assumed to be represented in real 2014 dollars. PacifiCorp provided a discount rate of 6.57% 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.[19]

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 3-7, have been included in all levelized cost and potential figures.

Table 3-7 Line Loss Factors[20]

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%

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

[19] For LED lighting, the study relied on cost projections from Appendix C to the 2015 Annual Energy Outlook.

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

4

CLASS 2 DSM POTENTIAL RESULTS

This chapter presents the identified cumulative potential in 2036 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 2036 forecasted baseline sales presented in this report may differ from PacifiCorp's official sales forecast.

SUMMARY OF OVERALL ENERGY SAVINGS

Table 4-1 summarizes the 2036 cumulative technical and achievable technical energy-efficiency potential by sector, both in MWh and as a percentage of the 2036 baseline projection. Figure 4-1 shows the cumulative achievable technical 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 2036 are 11.2 million MWh, or 21.9% of the baseline projection.
- **Achievable Technical Potential**, which adjusts the technical potential by reflecting customer adoption constraints, shows cumulative savings of 8.9 million MWh, or 17.4% of baseline load in 2036. 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 energy savings, followed by residential then 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 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. In contrast, high and premium efficiency motors have been on the market and included in federal standards for 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 substantially lower than in other sectors. Detailed results by sector are presented later in this section.

Table 4-1 Cumulative Class 2 DSM Potential by Sector in 2036

Sector	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Residential	13,376,104	3,007,177	2,378,465	22.5%	17.8%
Commercial	17,171,688	5,727,689	4,513,141	33.4%	26.3%
Industrial	19,406,291	2,348,527	1,902,755	12.1%	9.8%
Irrigation	1,182,452	103,784	88,950	8.8%	7.5%
Street Lighting	115,667	56,597	47,464	48.9%	41.0%
Total	**51,252,203**	**11,243,775**	**8,930,775**	**21.9%**	**17.4%**

Figure 4-1 Cumulative Class 2 Achievable Technical Potential by Sector

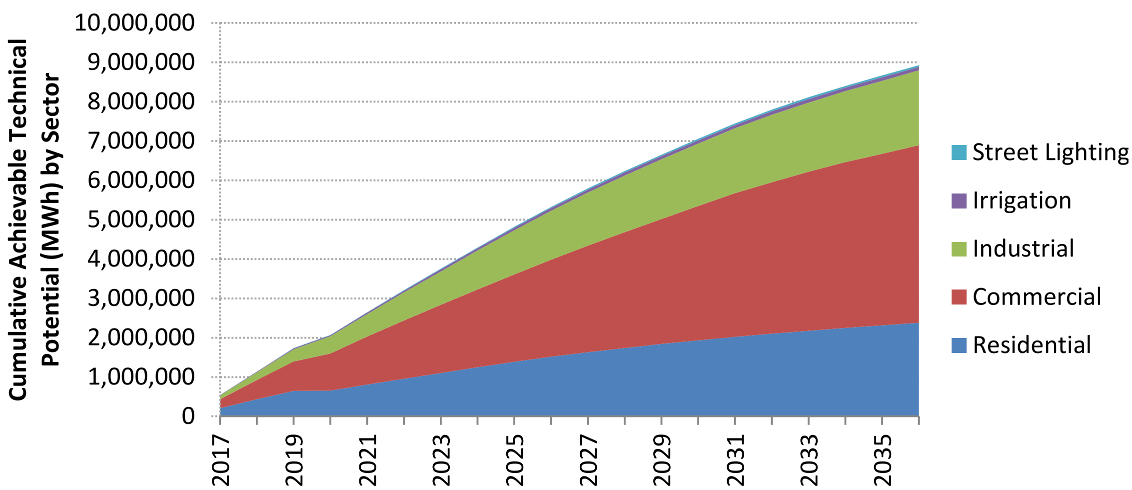

Table 4-2 summarizes the Class 2 DSM potential by state and by PacifiCorp operating company.[21] With the exception of Wyoming, potential as a percent of baseline loads is relatively constant across states; Wyoming results are heavily influenced by the large share of load in the industrial sector, which, as shown in Table 4-1, has lower identified potential as a percent of 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.

[21] 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 4-2 Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	796,946	209,714	167,969	26.3%	21.1%
	Washington	4,340,634	1,054,430	841,734	24.3%	19.4%
	Subtotal	**5,137,580**	**1,264,144**	**1,009,702**	**24.6%**	**19.7%**
Rocky Mountain Power	Idaho	2,850,113	599,873	478,183	21.0%	16.8%
	Utah	30,776,004	7,269,481	5,769,291	23.6%	18.7%
	Wyoming	12,488,506	2,110,277	1,673,599	16.9%	13.4%
	Subtotal	**46,114,622**	**9,979,631**	**7,921,073**	**21.6%**	**17.2%**
	Total	**51,252,203**	**11,243,775**	**8,930,775**	**21.9%**	**17.4%**

Table 4-3 summarizes the Class 2 DSM potential by resource type, differentiating between discretionary measures and lost opportunity measures. Across all sectors, 55% of the cumulative achievable technical potential in 2036 is attributable to lost opportunity 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 4-3 Cumulative Class 2 DSM Achievable Technical Potential by Resource Type in 2036

	Achievable Technical Potential (MWh)	
Sector	**Discretionary**	**Lost Opportunity**
Residential	1,074,632	1,303,833
Commercial	1,440,978	3,072,163
Industrial	1,448,678	454,077
Irrigation	88,950	0
Street Lighting	6,248	41,216
Total	**4,059,486**	**4,871,289**

Residential Sector

Table 4-4 presents estimates for cumulative technical and achievable technical potential in the residential sector by the end of the study period in 2036. The technical potential in 2036 from Class 2 DSM resources assessed in this study is 3.0 million MWh or 22.5% of the baseline projection. The corresponding achievable technical potential is 2.4 million MWh or 17.8% of the 2036 baseline. Savings as a percent of baseline are very consistent across states. California is slightly higher due to a relatively higher share of electric space heating and water heating.

Table 4-4 Residential Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	406,234	120,647	96,625	29.7%	23.8%
	Washington	1,722,625	434,556	347,281	25.2%	20.2%
	Subtotal	**2,128,859**	**555,203**	**443,906**	**26.1%**	**20.9%**
Rocky Mountain Power	Idaho	901,752	211,639	168,158	23.5%	18.6%
	Utah	9,176,669	1,960,907	1,547,355	21.4%	16.9%
	Wyoming	1,168,825	279,428	219,045	23.9%	18.7%
	Subtotal	**11,247,245**	**2,451,974**	**1,934,559**	**21.8%**	**17.2%**
	Total	**13,376,104**	**3,007,177**	**2,378,465**	**22.5%**	**17.8%**

The residential sector is composed of three segments in this analysis: single family, multifamily, and manufactured homes. Figure 4-2 below shows the share of 2036 achievable technical 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 achievable technical potential.

Figure 4-2 Residential Cumulative Achievable Technical Potential by Segment in 2036

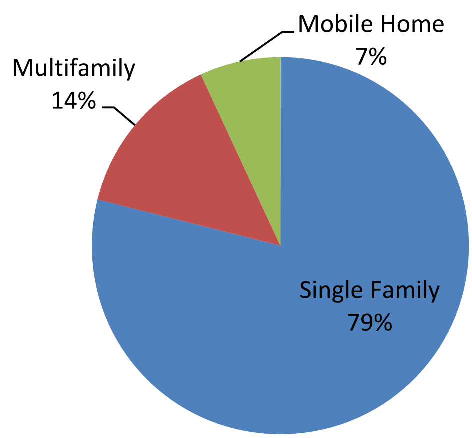

Figure 4-3 and Table 4-5 present the estimates of Class 2 DSM potential for the residential sector from an end-use perspective. Key findings and observations are outlined below:

- Nearly half of the achievable technical potential (42%) comes from HVAC systems through the application of equipment upgrades and building shell measures.
- The cooling end use comprises 21% of total residential achievable technical potential, driven by large air conditioning loads in Utah.
- The end use with the largest achievable technical potential is lighting, which accounts for 25% of the residential achievable technical potential, primarily due to LED lamps, which are modeled with lumen-per-watt performance substantially increasing over the lifetime of the study.
- Appliances are also a large source of potential.

- Water heating savings comprise 11% of the total achievable technical 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 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.

Figure 4-3 Residential Cumulative Achievable Technical Potential by End Use in 2036

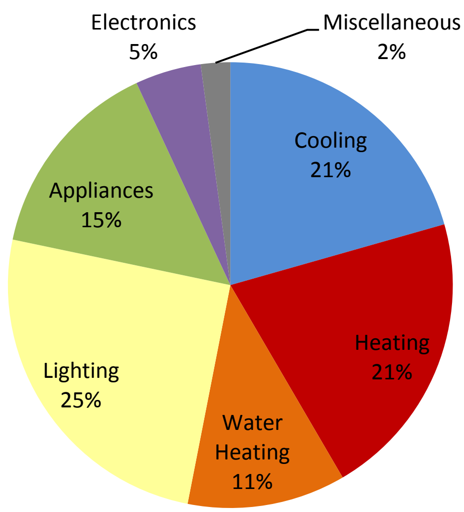

Table 4-5 Residential Cumulative Class 2 DSM Potential by End Use in 2036

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Achievable Technical Potential (% of Total)	Achievable Technical Potential (% of Baseline)
Space Cooling	2,347,558	596,012	489,992	20.6%	20.9%
Space Heating	2,499,719	578,240	498,836	21.0%	20.0%
Water Heating	837,274	350,950	273,697	11.5%	32.7%
Lighting	1,303,372	709,239	599,324	25.2%	46.0%
Appliances	3,099,818	587,593	351,683	14.8%	11.3%
Electronics	1,725,512	136,079	114,169	4.8%	6.6%
Miscellaneous	1,562,851	49,063	50,763	2.1%	3.2%
Total	**13,376,104**	**3,007,177**	**2,378,465**	**100.0%**	**17.8%**

Commercial Sector

Table 4-6 presents estimates for cumulative technical and achievable technical potential for the commercial sector by the end of the study period in 2036. From the Class 2 DSM resources assessed in this study, the technical potential savings are 5.7 million MWh or 33.4% of the baseline forecast in 2036. The corresponding achievable technical potential is 4.5 million MWh or 26.3% of the 2036 baseline. Savings as a percent of 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 4-6 Commercial Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	210,226	69,355	54,812	33.0%	26.1%
	Washington	1,850,920	509,627	402,599	27.5%	21.8%
	Subtotal	**2,061,146**	**578,982**	**457,411**	**28.1%**	**22.2%**
Rocky Mountain Power	Idaho	923,520	285,224	223,592	30.9%	24.2%
	Utah	12,151,616	4,120,938	3,251,218	33.9%	26.8%
	Wyoming	2,035,406	742,545	580,920	36.5%	28.5%
	Subtotal	**15,110,542**	**5,148,707**	**4,055,730**	**34.1%**	**26.8%**
	Total	**17,171,688**	**5,727,689**	**4,513,141**	**33.4%**	**26.3%**

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.[22] Figure 4-4 below shows the share of 2036 technical potential that is attributable to each segment. Small and large offices represent the largest share, with a combined 31% of total savings potential.

Figure 4-4 Commercial Cumulative Achievable Technical Potential by Segment in 2036

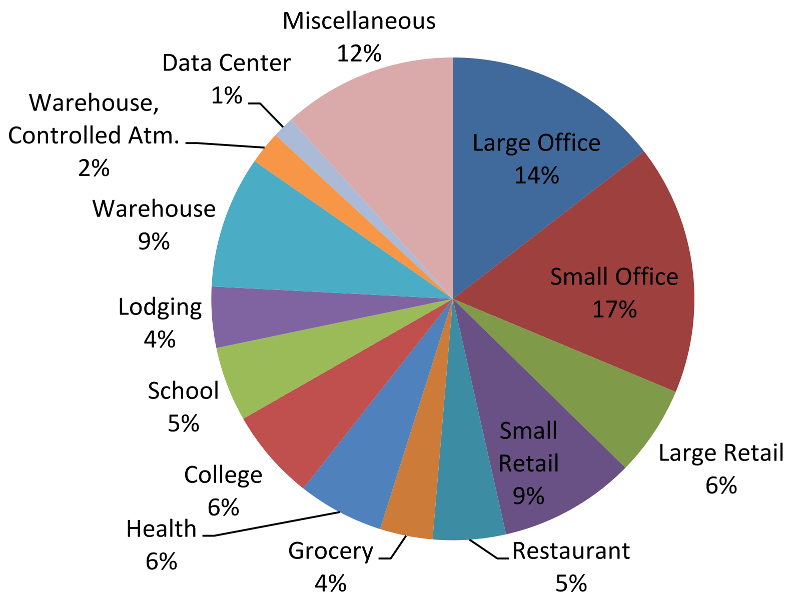

Figure 4-5 and Table 4-7 present the estimates of Class 2 DSM potential for the commercial sector from an end-use perspective. Key findings and observations are outlined below:

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

- Lighting opportunities represent over half of the identified commercial achievable technical 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 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 achievable technical potential from HVAC systems through the application of equipment upgrades and building shell measures within the cooling, heating, and ventilation end uses. The largest of these three is cooling, at 17% of total commercial potential, driven by large air conditioning loads in Utah.

Figure 4-5 Commercial Cumulative Achievable Technical Potential by End Use in 2036

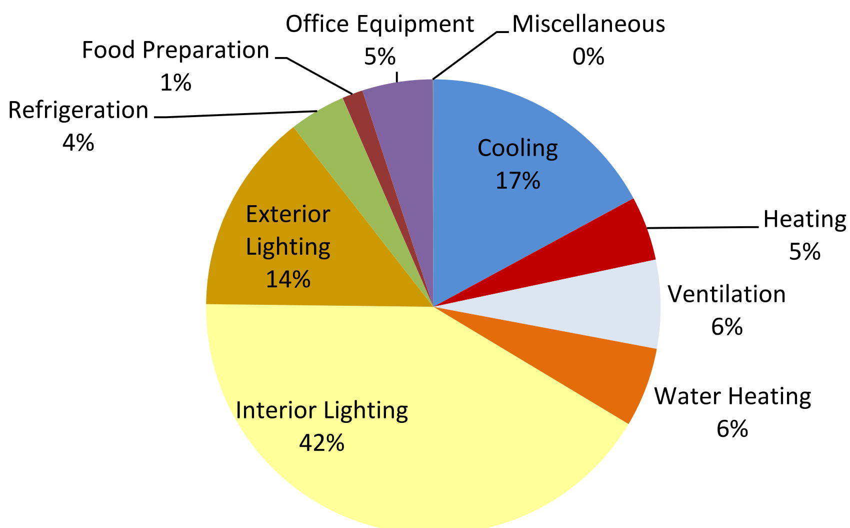

Table 4-7 Commercial Cumulative Class 2 DSM Potential by End Use in 2036

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Achievable Technical Potential (% of Total)	Achievable Technical Potential (% of Baseline)
Cooling	3,531,380	939,465	771,520	17.1%	21.8%
Heating	1,508,230	245,571	206,529	4.6%	13.7%
Ventilation	1,291,103	477,888	283,715	6.3%	22.0%
Water Heating	481,332	310,991	255,068	5.7%	53.0%
Interior Lighting	4,019,668	2,376,110	1,876,607	41.6%	46.7%
Exterior Lighting	1,307,020	815,378	643,933	14.3%	49.3%
Refrigeration	1,093,094	211,380	181,228	4.0%	16.6%
Food Preparation	353,195	82,389	65,927	1.5%	18.7%
Office Equipment	1,718,011	264,115	225,395	5.0%	13.1%
Miscellaneous	1,868,654	4,402	3,219	0.1%	0.2%
Total	**17,171,688**	**5,727,689**	**4,513,141**	**100.0%**	**26.3%**

INDUSTRIAL SECTOR

Table 4-8 presents estimates for cumulative technical and achievable technical potential for the industrial sector by the end of the study period in 2036. From the Class 2 DSM resources assessed in this study, the technical potential savings are 2.3 million MWh or 12.1% of the baseline forecast in 2036 in the absence of DSM programs. The corresponding achievable technical potential is 1.9 million MWh or 9.8% of the 2036 baseline. Savings as a percent of baseline are relatively consistent across states with the exception of Wyoming, which has a much larger industrial sector with loads predominantly in the mining and extraction industry. These industries have more rugged and demanding operating conditions which reduce the applicability of many relevant energy efficiency measures. Savings as a percent of baseline are higher in Washington, largely due to early-year measure installations and a decline in sector-level consumption over the study period.

Table 4-8 Industrial Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	69,563	8,828	7,225	12.7%	10.4%
	Washington	580,957	88,692	73,480	15.3%	12.6%
	Subtotal	**650,520**	**97,520**	**80,705**	**15.0%**	**12.4%**
Rocky Mountain Power	Idaho	361,618	45,327	37,037	12.5%	10.2%
	Utah	9,148,121	1,126,116	918,749	12.3%	10.0%
	Wyoming	9,246,032	1,079,565	866,265	11.7%	9.4%
	Subtotal	**18,755,770**	**2,251,007**	**1,822,050**	**12.0%**	**9.7%**
	Total	**19,406,291**	**2,348,527**	**1,902,755**	**12.1%**	**9.8%**

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 4-6 shows the allocation of 2036 achievable technical 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 52%.

Figure 4-6 Industrial Cumulative Achievable Technical Potential by Segment in 2036

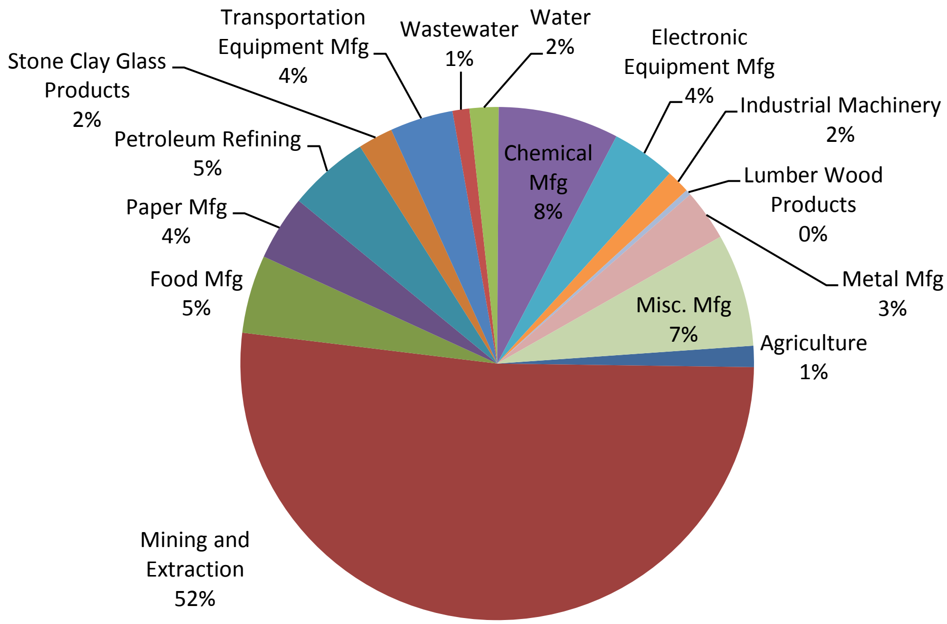

Figure 4-7 and Table 4-9 present the estimates of Class 2 DSM potential for the industrial sector from an end-use perspective. Key findings and observations are outlined below:

- Motor and process loads represent the largest share of end use consumption in the industrial sector and, correspondingly, have the largest identified achievable technical potential. Motor savings comprise 65% of the total sector potential, while process savings account for an additional 3%. [23] 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[24] from variable speed drives and control systems on pumps, drills, crushers, and conveyors.
- Similar to 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 one-quarter of the identified achievable technical potential.

[23] 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.

[24] 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 4-7 Industrial Cumulative Achievable Technical Potential by End Use in 2036

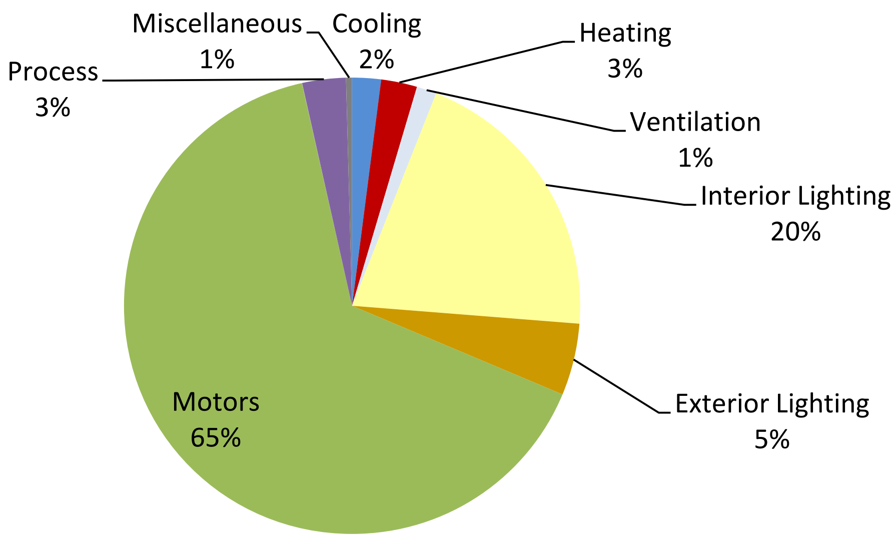

Table 4-9 Industrial Cumulative Class 2 DSM Potential by End Use in 2036

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Achievable Technical Potential (% of Total)	Achievable Technical Potential (% of Baseline)
Cooling	266,525	50,482	38,886	2.0%	14.6%
Heating	811,980	58,771	48,628	2.6%	6.0%
Ventilation	116,369	53,133	26,634	1.4%	22.9%
Interior Lighting	863,047	508,107	385,397	20.3%	44.7%
Exterior Lighting	200,079	127,962	96,621	5.1%	48.3%
Motors	13,728,946	1,468,449	1,239,614	65.1%	9.0%
Process	2,613,433	71,848	58,928	3.1%	2.3%
Miscellaneous	805,912	9,774	8,048	0.4%	1.0%
Total	**19,406,291**	**2,348,527**	**1,902,755**	**100.0%**	**9.8%**

Irrigation Sector

Table 4-10 presents estimates for cumulative technical and achievable technical potential for the Irrigation sector by the end of the study period in 2036. From the Class 2 DSM resources assessed in this study, the technical potential savings are 103,784 MWh or 8.8% of the baseline forecast in 2036. The corresponding achievable technical potential is 88,950 MWh or 7.5% of the 2036 baseline.

Table 4-10 Irrigation Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	108,224	9,631	8,254	8.9%	7.6%
	Washington	174,884	16,000	13,717	9.1%	7.8%
	Subtotal	**283,108**	**25,630**	**21,971**	**9.1%**	**7.8%**
Rocky Mountain Power	Idaho	660,279	56,154	48,114	8.5%	7.3%
	Utah	213,885	19,776	16,959	9.2%	7.9%
	Wyoming	25,181	2,224	1,906	8.8%	7.6%
	Subtotal	**899,344**	**78,153**	**66,979**	**8.7%**	**7.4%**
	Total	**1,182,452**	**103,784**	**88,950**	**8.8%**	**7.5%**

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 presence of surface water, type of crop, and 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 4-11 presents estimates for cumulative technical and achievable technical potential for the Street Lighting sector by the end of the study period in 2036. From the Class 2 resources assessed in this study, the technical potential savings are 56,597 MWh or 48.9% of the baseline forecast in 2036. The corresponding achievable technical potential is 47,464 MWh or 41.0% of the 2036 baseline.

Table 4-11 Street Lighting Cumulative Class 2 DSM Potential by State in 2036

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	2,699	1,253	1,053	46.4%	39.0%
	Washington	11,248	5,555	4,656	49.4%	41.4%
	Subtotal	**13,947**	**6,808**	**5,710**	**48.8%**	**40.9%**
Rocky Mountain Power	Idaho	2,944	1,530	1,282	52.0%	43.6%
	Utah	85,714	41,744	35,010	48.7%	40.8%
	Wyoming	13,062	6,516	5,462	49.9%	41.8%
	Subtotal	**101,720**	**49,789**	**41,754**	**48.9%**	**41.0%**
	Total	**115,667**	**56,597**	**47,464**	**48.9%**	**41.0%**

The Street Lighting sector in this analysis is divided into company-owned and customer-owned assets. Figure 4-8 below shows the allocation of 2036 achievable technical potential that is attributable to each of these segments. The majority of street lighting fixtures in PacifiCorp's service territory are customer owned, leading to this segment representing 59% of the identified achievable technical potential. Company-owned fixtures account for the remaining 41% of potential.

Figure 4-8 Street Lighting Cumulative Achievable Technical Potential by Segment in 2036

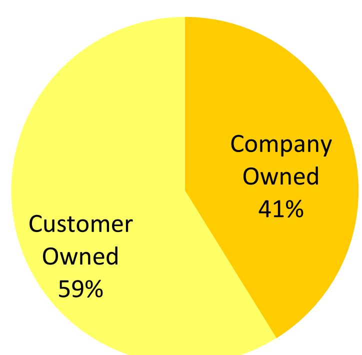

Table 4-12 presents the estimates of Class 2 DSM potential for the Street Lighting sector by segment and wattage range. Key findings and observations are outlined below:

- 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 achievable technical 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 4-12 Street Lighting Cumulative Class 2 DSM Potential by End Use in 2036

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Achievable Technical Potential (% of Total)	Achievable Technical Potential (% of Baseline)
Company - 100W	18,053	9,383	7,868	16.6%	43.6%
Company - 150W	7,315	3,357	2,815	5.9%	38.5%
Company - 250W	4,641	2,459	2,062	4.3%	44.4%
Company - 400W	3,560	2,072	1,737	3.7%	48.8%
Customer - 100W	18,431	9,300	7,799	16.4%	42.3%
Customer - 150W	21,425	9,352	7,845	16.5%	36.6%
Customer - 250W	10,277	4,131	3,466	7.3%	33.7%
Customer - 400W	16,585	9,428	7,905	16.7%	47.7%
Customer - 1000W	391	234	196	0.4%	50.1%
Other	14,989	6,882	5,772	12.2%	38.5%
Total	**115,667**	**56,597**	**47,464**	**100.0%**	**41.0%**

5

Comparison with Previous DSM Potential Assessment

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, and 2015. Conservation potentials 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 2015 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 2015:

- Incorporates substantial updates to measure assumptions and achievable ramp rates corresponding to the recently published Council's Seventh Power Plan.
- Accounts for state energy codes and equipment efficiency standards enacted as of January 31, 2016, even if they have not yet taken effect.
- Takes into account PacifiCorp's actual and projected DSM program accomplishments through 2016.
- Incorporates adjustments to measure savings, based on recent evaluation results, data available from the Regional Technical Forum (RTF), and other updated secondary sources available before January 31, 2016.
- Applies 2014 customer and sales information to determine segmentation; and utilizes updated sales and customer forecasts.
- Includes new emerging technologies and updates assumptions around applicability, cost, and efficacy of LED lighting.

Potential Results by Sector

Table 5-1 compares cumulative 20-year potential between the current and 2015 assessments, in absolute terms and as a percentage of projected loads, by sector. As shown, the current assessment estimated slightly lower achievable technical potential than the 2015 study: a decrease from 10,878,788 MWh to 8,930,775 MWh. Potential in the irrigation and street lighting sectors did not change materially between the two assessments. Potential for the residential, commercial, and industrial sectors is lower. This is primarily driven by changes in measure assumptions based on PacifiCorp program evaluations, the RTF, the Seventh Power Plan, new Seventh Power Plan ramp rates, and the baseline forecast. Factors leading to decreases in residential, commercial, and industrial potential are described in additional detail below.

Table 5-1 Comparison of Class 2 DSM Potential with Previous Assessments

	Achievable Technical Potential (Year-20 Cumulative MWh)		Achievable Technical Potential (Year-20 Cumulative as % of Baseline Loads)	
Sector	**2015 Assessment**	**CURRENT Assessment**	**2015 Assessment**	**CURRENT Assessment**
Residential	2,940,288	2,378,465	21%	18%
Commercial	5,310,374	4,513,141	31%	26%
Industrial	2,497,687	1,902,755	11%	10%
Irrigation	97,546	88,950	10%	8%
Street Lighting	32,893	47,464	31%	41%
Total	**10,878,788**	**8,930,775**	**20%**	**17%**

Residential Sector

As shown in Table 5-2, the residential achievable technical potential identified in this assessment is lower than the previous study, primarily driven by updates to space cooling and lighting measure data. Differences in cooling are primarily due to revised weatherization savings assumptions in the region. Differences in lighting are due to more conservative later-year LED efficacy projections, reflecting research and development efforts led by the U.S. DOE.

Table 5-2 Residential Comparison of Class 2 DSM Potential with Previous Assessment

End Use Grouping	Achievable Technical Potential (Year-20 Cumulative MWh) 2015 Assessment	Current Assessment	Key Drivers of Differences
Cooling	730,964	489,992	Updated information on end use and equipment saturations, applicable measures, and measure parameters. Revisions to weatherization measure assumptions lower potential.
Heating	473,752	498,836	Higher ductless heat pump applicability. Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Water Heating	315,005	273,697	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Lighting	683,073	599,324	Incorporation of 7th Power Plan and revised U.S. DOE solid state lighting projections, lowering potential.
Appliances	399,960	351,683	Update to appliance recycling program unit energy savings, lowering potential. Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Electronics	235,678	114,169	Increase in efficient technology equipment saturations in the baseline.
Miscellaneous	101,857	50,763	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Total	**2,940,288**	**2,378,465**	

Commercial Sector

The commercial potential in the current study is substantially lower than in the previous assessment, also primarily driven by updates to LED efficacy trends. The reduction in space cooling potential is due mainly to more efficient equipment technologies being installed in the baseline. A comparison of potential by end use can be seen in Table 5-3.

Table 5-3 Commercial Comparison of Class 2 DSM Potential with Previous Assessment

End Use Grouping	Achievable Technical Potential (Year-20 Cumulative MWh) 2015 Assessment	Current Assessment	Key Drivers of Differences
Cooling	1,047,866	771,520	Increase of efficient equipment saturation in baseline case. Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Heating	223,620	206,529	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Ventilation	233,125	283,715	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Water Heating	163,795	255,068	Increase in heat pump water heater measure applicability. Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Interior Lighting	2,561,109	1,876,607	Incorporation of 7th Power Plan and revised U.S. DOE solid state lighting projections, lowering potential. Update of lighting controls measures into "enhanced controls" measures on slower, lost opportunity ramp rate per Seventh Plan methodology lowers potential.
Exterior Lighting	554,855	643,933	Same as interior lighting.
Refrigeration	203,868	181,228	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Food Preparation	52,966	65,927	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Office Equipment	250,256	225,395	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Miscellaneous	18,914	3,219	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Total	**5,310,374**	**4,513,141**	

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 reduction of 228,911 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 system upgrade, optimization, and controls categories. A comparison of potential by end use can be seen in Table 5-4.

Table 5-4 Industrial Comparison of Class 2 DSM Potential with Previous Assessment

	Achievable Technical Potential (Year-20 Cumulative MWh)		
End Use Grouping	**2015 Assessment**	**Current Assessment**	**Key Drivers of Differences**
Cooling	79,599	38,886	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Heating	34,530	48,628	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Ventilation	7,810	26,634	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Interior Lighting	708,789	385,397	Incorporation of 7th Power Plan and revised U.S. DOE solid state lighting projections, lowering potential. Update of lighting controls measures into “enhanced controls” measures on slower, lost opportunity ramp rate lowers potential.
Exterior Lighting	122,684	96,621	Same as interior lighting.
Motors	1,299,839	1,239,614	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Process	227,615	58,928	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Miscellaneous	16,821	8,048	Updated information on end use and equipment saturations, applicable measures, and measure parameters.
Total	**2,497,687**	**1,902,755**	

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