Applied Energy Group

# PACIFICORP CONSERVATION POTENTIAL ASSESSMENT FOR 2021-2040

Volume 1

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Report prepared for:
PACIFICORP

Energy Solutions. Delivered.

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# EXECUTIVE SUMMARY

This Executive Summary presents a summary of the identified cumulative potential in 2040 from energy efficiency, demand response, and demand-side rates across PacifiCorp's six-state service territory.[1] This Conservation Potential Assessment (CPA) builds upon previous studies completed by AEG for PacifiCorp in 2019, 2017, and 2015, incorporating the best information available and continuing to apply industry standard practices to provide accurate projections of available DSM opportunities to inform PacifiCorp's planning efforts.

## ES-1 Note to the Reader

In previous assessments of conservation potential in PacifiCorp's service territory, demand-side resources were categorized into numerical classes (1-3) based on their level of relative reliability and customer choice. To increase alignment with standard industry terminology, resource types have been renamed for the current analysis as follows:

- Class 1 DSM is now referred to as "Demand Response"
- Class 2 DSM is now referred to as "Energy Efficiency"
- Class 3 DSM is now referred to as "Demand-Side Rates" or "DSR"

Demand-side resource types have been renamed throughout this report accordingly.

## ES-2 Stakeholder Engagement

To ensure that this CPA would be transparent and informative for all interested parties, AEG and PacifiCorp led a robust stakeholder engagement process, allowing DSM and IRP stakeholders to provide input into the assessment work plan, recommend sources to incorporate in the analysis, and review and provide feedback on draft results. This stakeholder engagement process included:

- Sharing the CPA Work Plan for review and comment
- Presenting at four public CPA workshops and one IRP public input meeting
- Soliciting and incorporating input on key CPA assumptions and draft results
- Posting draft and final materials to PacifiCorp's IRP website
- Providing responses to stakeholder feedback forms

The remainder of this section presents summary results for each type of demand-side resource analyzed in the CPA, followed by detailed chapters on methodology, data sources, and analysis results.[2]

## ES-3 Energy Efficiency Resources

Table ES-1 summarizes the 2040 cumulative technical and achievable technical potential for energy efficiency resources sector, both in megawatt-hours (MWh) and as a percentage of projected 2040 baseline sector loads. At the system level, the identified achievable technical potential by 2040 is over ten terawatt-hours, or approximately 20 percent of projected baseline loads. Achievable technical potential represents savings opportunities which can reasonably be achieved, regardless of how conservation is

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

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

acquired (including both utility and non-utility interventions) and ignoring cost-effectiveness considerations. The cost-effectiveness of the identified potential is assessed within PacifiCorp's IRP model through direct comparison with supply-side resource alternatives.

The commercial sector accounts for the largest portion of the achievable technical potential, followed by residential then industrial. Irrigation, with much smaller baseline loads, contribute a smaller amount of potential relative to the larger sectors. Although previous CPAs have included potential in the street lighting sector, the current CPA excluded this sector, as PacifiCorp's load forecast assumes that all streetlights will be converted to LEDs by the end of the 20-year study period.

*Table ES-1 Cumulative Energy Efficiency Achievable Technical Potential by 2040 (MWh @ generator)*

| | | | | | | All States | |
|---|---|---|---|---|---|---|---|
| Sector | California | Idaho | Utah | Washington | Wyoming | Technical Achievable Potential | % of Baseline |
| Residential | 83,753 | 213,121 | 2,607,996 | 437,213 | 276,214 | 3,618,297 | 20.1% |
| Commercial | 59,223 | 183,486 | 3,460,144 | 456,636 | 476,057 | 4,635,547 | 26.8% |
| Industrial | 7,961 | 55,630 | 1,219,204 | 177,729 | 912,234 | 2,372,759 | 13.8% |
| Irrigation | 19,029 | 82,127 | 30,191 | 35,892 | 4,041 | 171,279 | 13.8% |
| **Total** | **169,966** | **534,365** | **7,317,535** | **1,107,470** | **1,668,547** | **10,797,882** | **20.1%** |

Key energy efficiency findings by market sector are described below:

### ES-3.1 Energy Efficiency Residential Sector Key Findings

The 20-year residential achievable technical potential is 3.6 million MWh or 20.1% of the 2040 baseline. Key residential findings include:

- By 2040, Utah is projected to represent over 70% of both the residential sales and energy efficiency potential across the five states
- Nearly half of the achievable technical potential (46%) comes from HVAC systems through the application of equipment upgrades and building shell measures.
  - The space heating end use provides the largest share of potential, at 26% of total residential achievable technical potential, particularly driven by Washington, Idaho, and California where electric resistance heating is common.
  - The cooling end use comprises 20% of total residential achievable technical potential, driven by large air-conditioning loads in Utah.
- Water heating savings comprise 18% 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.)
- The lighting end uses accounts for 12% 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.
- The appliances, electronics, and miscellaneous end uses represent the remaining 24% of the potential.

### ES-3.2 Energy Efficiency Commercial Sector Key Findings

The 20-year commercial achievable technical potential is 4.6 million MWh or 26.8% of the 2040 baseline. Savings as a percent of baseline are very consistent across states. Key commercial findings and observations include:

- Lighting opportunities represent roughly 38% 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.
- 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 (41% of the potential). The largest of these three is cooling, driven by large air conditioning loads in Utah.
- Refrigeration makes up 12% of the total commercial potential, primarily from grocery stores throughout the region and the controlled atmosphere segment in Washington.
- The water heating, food preparation, office equipment, and miscellaneous end uses make up the remaining 9% of potential.

### ES-3.3 Energy Efficiency Industrial Sector Key Findings

The 20-year industrial achievable technical potential is 2.4 million MWh or 14% of the 2040 baseline. Savings as a percent of baseline are relatively consistent across states. Key industrial findings and observations include:

- Motor and process loads represent the largest share of end use consumption in the industrial sector (68% of savings) and, correspondingly, have the largest identified achievable technical potential.
- Motor savings comprise 63% of the total sector potential, while process savings account for an additional 8%.[3] 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.
- Like the residential and commercial sectors, the projected improvements in performance and applicability of LED lighting technologies provides a large potential opportunity in the industrial sector, leading to lighting representing 21% of the identified achievable technical potential.
- Potential for the heating, cooling, ventilation, and miscellaneous end uses, represent the remaining 9% of potential, mainly realized within the non-industrial portions of the space (e.g. warehouse and office spaces).

### ES-3.4 Energy Efficiency Irrigation Sector Key Findings

The 20-year irrigation achievable technical potential is 0.2 million MWh or 14% of the 2040 baseline. Key irrigation findings and observations include:

[3] 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.

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

## ES-4 Demand Response Resources

This section presents high-level potential analysis results for demand response resources using the methodology outlined in Chapter 2 of this report. As discussed in that chapter, the demand response analysis builds off of the energy efficiency assessment, assuming that PacifiCorp would first pursue energy efficiency resources, and that these programs may create new opportunities for demand response (e.g., connected thermostats). To avoid double-counting potential within the demand response analysis, results account for competition between program options. For example, a customer with a central air conditioner cannot participate in both a DLC program and a smart thermostat program, as both programs curtail the same piece of equipment. Additionally, in cases where PacifiCorp has existing demand response programs, results are addition to, not inclusive of, impacts from existing programs.[4]

Table ES-2 presents summary program potential in 2040 by season and event type. Whereas previous PacifiCorp CPAs have only considered demand response's ability to shave system peaks over multiple hours (sustained duration events), the current CPA also assessed the potential for short-duration events to provide additional insight into how demand response may be used to provide a variety of grid services to bring additional value to PacifiCorp's system. As shown, the impacts for short duration events tend to be higher than for sustained duration because equipment can be completely curtailed for a short period of time, rather than cycled over a longer period. Key observations from the demand-side rates analysis are:

- The study identified limited opportunity to expand PacifiCorp's existing summer demand response programs.
- Battery Energy Storage DLC represents a large, emerging demand response opportunity.
- The emergence of Grid-Interactive Water Heaters presents a large new opportunity for utility demand response, particularly as a means of reducing winter peaks.
- Third Party Contracts continue to represent a significant opportunity to reduce non-residential customer demand during system peak periods.

*Table ES-2 Demand Response Program Potential by Season and Event Type, 2040*

[4] PacifiCorp's current demand response programs target air conditioning and irrigation loads that are only available in the summer. As such, the winter potential represents both the incremental and total identified potential.

| Program | Summer MW | | Winter MW | |
|---|---|---|---|---|
| | Short Duration | Sustained Duration | Short Duration | Sustained Duration |
| HVAC Direct Load Control (DLC) | 117 | 60 | 198 | 132 |
| Domestic Hot Water Heater (DHW) DLC | 5 | 4 | 12 | 10 |
| Grid-Interactive Water Heaters | 57 | 46 | 158 | 133 |
| Connected Thermostat DLC | 148 | 80 | 57 | 32 |
| Smart Appliance DLC | 27 | 15 | 10 | 6 |
| Pool Pump DLC | 1 | 1 | 1 | 1 |
| Electric Vehicle Connected Charger DLC | 51 | 51 | 52 | 52 |
| Battery Energy Storage DLC | 676 | 417 | 676 | 417 |
| Third Party Contracts | 198 | 208 | 157 | 173 |
| Irrigation Load Control | 21 | 21 | 0 | 0 |
| **Total All Sectors** | **1,300** | **904** | **1,322** | **957** |

## ES-5 Demand-Side Rates

This section presents potential analysis results for demand-side rates using the methodology outlined in Chapter 2 of this report. Because the results of this analysis are not being used to inform resource planning, options are assessed independently of one another to illustrate the relative magnitude of each option if offered in isolation. That is, the analysis does not consider interactive effects between competing options, such as a time-of-use with or without a critical peak pricing component. Because of this, impacts should not be totaled across options, as this would overstate the total possible demand reduction from demand-side rates.

Table ES-3 presents the potential from demand-side rate options in 2040 during summer and winter peak periods. This potential captures any expansion opportunities for existing pricing options and new options that have incremental potential in future years. Key observations from the demand-side rates analysis are:

- In Idaho, roughly half of the savings opportunities from pricing options are in the irrigation sector.
- In Utah, residential CPP has the highest potential. The three C&I pricing options combined have roughly equal potential to residential CPP.
- Oregon has the second highest potential, after Utah. Residential pricing (TOU, TOU Demand Rate w/EV, and CPP) constitute more than half of the potential in Oregon.
- Wyoming ranks third in terms of potential contribution from pricing options. Most of the potential is derived from C&I customers, particularly large sized industrial customers.
- In Washington and California, the residential sector constitutes nearly half the total savings potential from pricing options.
- Similar trend continues in the winter peak season, with Utah and Oregon contributing the most potential due to the residential rate programs and C&I CPP.

*Table ES-3 Demand-Side Rates Potential in 2040*

| Rate Option | Summer Potential (MW) | Winter Potential (MW) |
|---|---|---|
| Residential TOU | 77.4 | 40.7 |
| Residential TOU with EV | 17.1 | 7.0 |
| Residential CPP | 105.7 | 68.2 |
| Residential Behavioral DR | 18.5 | 9.3 |
| C&I TOU | 0.3 | 0.2 |
| C&I CPP | 91.0 | 39.5 |
| C&I RTP | 16.2 | 6.9 |
| Irrigation TOU | 4.3 | - |
| Irrigation CPP | 17.4 | - |

## Abbreviations and Acronyms

Table ES-4 provides a list of key abbreviation or acronyms used throughout the remainder of the report.

*Table ES-4 Abbreviations and Acronyms*

| Acronym | Explanation |
|---|---|
| ACEEE | American Council for an Energy-Efficient Economy |
| ACS | American Community Survey |
| AEO | Annual Energy Outlook |
| AMI | Advanced Metering Infrastructure |
| C&I | Commercial and Industrial |
| CEE | Consortium for Energy Efficiency |
| COMMEND | EPRI's "Commercial End-Use" model |
| CPP | Critical Peak Pricing |
| CPUC | California Public Utilities Commission |
| Council | Northwest Power and Conservation Council (NWPCC) |
| CBSA | Commercial Building Stock Assessment |
| CPA | Conservation Potential Assessment |
| CPP | Critical Peak Pricing |
| DEER | California's Database for Energy Efficient Resources |
| DSM | Demand-Side Management |
| DSR | Demand-Side Rates |
| DLC | Direct Load Control |
| E3T | Energy Efficient Emerging Technologies Database |
| EIA | Energy Information Administration |

| Acronym | Explanation |
|---|---|
| EISA | Energy Independence and Security Act of 2007 |
| EPA | Environmental Protection Agency |
| EUL | Effective Useful Life |
| EUI | Energy Utilization Index |
| HPWH | Heat Pump Water Heater |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IECC | International Energy Conservation Code |
| IFSA | Industrial Facilities Site Assessment |
| IRP | Integrated Resource Plan |
| LED | Light-emitting diode |
| NAPEE | National Action Plan for Energy-Efficiency |
| NEEA | Northwest Energy Efficiency Alliance |
| NEEP | Northeast Energy Efficiency Partnerships |
| NEMA | National Electrical Manufacturer's Association |
| O&M | Operations and Maintenance |
| RBSA | Residential Building Stock Assessment |
| REEPS | EPRI's Residential End-Use Energy Policy System |
| RTP | Real-Time Pricing |
| RTF | Regional Technical Forum |
| SEEM | Simple Energy Enthalpy Model |
| SIC | Standard Industrial Classification |
| TRC | Total Resource Cost |
| TOU | Time-of-Use |
| UCT | Utility Cost Test, also known as the Program Administrator Cost Test (PACT) |
| UEC | Unit Energy Consumption |
| UES | Unit Energy Savings |
| WSEC | Washington State Energy Code |

# 1

# INTRODUCTION

In 2019, PacifiCorp commissioned Applied Energy Group (AEG) to conduct this Conservation Potential Assessment (CPA) to inform its biennial Integrated Resource Plan (IRP) planning process, to satisfy other state-specific DSM planning requirements, and to assist PacifiCorp in reviewing designs of existing demand-side management (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.[5] This study includes supply curves for the 20-year planning horizon (2021–2040) to inform the development of PacifiCorp's 2021 IRP and assist in satisfying state-specific requirements associated with planning for and pursuing 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-term public policy goals. The IRP's optimization process accounts for capital, energy, and ongoing operation costs as well as the risk profiles of various resources, including; traditional generation, market purchases, renewable generation, and DSM resources such as energy efficiency and demand response. Since the 2008 IRP, DSM resources have competed directly against supply-side options, allowing the IRP model to select the right mix of resources to meet the needs of PacifiCorp's customers while minimizing cost and risk. Thus, this study does not assess the cost-effectiveness of DSM resources.

This study provides reliable estimates of the magnitude, timing, and costs of DSM resources that are likely available to PacifiCorp over a 20-year planning horizon. The study focuses on resources assumed achievable during the planning horizon, recognizing that known market dynamics may hinder resource acquisition. Study results will be incorporated into PacifiCorp's 2021 IRP and subsequent DSM planning and program development efforts. This study serves as an update to similar studies completed previously for the IRP.[6]

## 1.1 Resource Assessed

As in previous assessments, the current CPA analyzed the potential of three distinct types of customer-sited resources:

- Energy Efficiency: Resources from non-dispatchable, firm energy and capacity product offerings/programs: Energy Efficiency programs are energy and related capacity savings which are achieved through facilitation of technological advancements in equipment, appliances, structures, or repeatable and predictable voluntary actions on a customer's part to manage the energy use at their business or home. These programs generally provide financial incentives or services to customers to improve the efficiency of existing or new residential or commercial buildings through: (1) the installation of more efficient equipment, such as lighting, motors, air conditioners, or appliances; (2) increasing building efficiency, such as improved insulation levels or windows; or (3) behavioral modifications, such as strategic energy management efforts at business or home energy reports for

[5] Energy efficiency analysis for Oregon is excluded from this report because it is assessed statewide by the Energy Trust of Oregon

[6] The previous CPA reports can be found at: http://www.pacificorp.com/es/dsm.html

residential customers. The savings are considered firm over the life of the improvement or customer action.

- Demand Response: Resources from fully dispatchable or scheduled firm capacity product offerings/programs: Demand Response programs are those for which capacity savings occur as a result of active company control or advanced scheduling. Once customers agree to participate in these programs, the timing and persistence of the load reduction is involuntary on their part within the agreed upon limits and parameters of the program. Program examples include residential and small commercial central air conditioner load control programs that are dispatchable, and irrigation load management and interruptible or curtailment programs (which may be dispatchable or scheduled firm, depending on the particular program design or event noticing requirements). Savings are typically only sustained for the duration of the event and there may also be return energy associated with the program.
- Demand-Side Rates: Resources from price-responsive energy and capacity product offerings/programs: Price response and load shifting programs seek to achieve short-duration (hour by hour) energy and capacity savings from actions taken by customers voluntarily, based on a financial incentive or signal. As a result of their voluntary nature, participation tends to be low and savings are less predictable, making these resources less suitable to incorporate into resource planning, at least until their size and customer behavior profile provide sufficient information needed to model and plan for a reliable and predictable impact. The impacts of these resources may not be explicitly considered in the resource planning process; however, they are captured naturally in long-term load growth patterns and forecasts. Program examples include time-of-use pricing plans, critical peak pricing plans, and inverted block tariff designs. Savings are typically only sustained for the duration of the incentive offering and, in many cases, loads tend to be shifted rather than being avoided.

This study excludes an assessment of Oregon's energy efficiency potential, as this potential has been captured in assessment work conducted by the Energy Trust of Oregon. 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 using values consistent with other PacifiCorp DSM planning projects.

## 1.2 Interactions Among 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, AEG takes specific actions to account for these interactions to avoid double-counting the available potential. The interactive effects analyzed occur within the major analysis sections; meaning that the interactions of energy efficiency resources are considered across all energy efficiency resources. Likewise, the analysis of demand response resources explicitly considers interactions.

Previous CPAs have not attempted to account for interaction between resource types due to uncertainties regarding resources likely to be found economic and pursued. As an enhancement for the current CPA, the technology adoption forecast from the energy efficiency analysis now informs the demand response analysis, allowing opportunities for demand response to expand as DR-ready technologies (e.g., connected thermostats) are assumed to be adopted.

## 1.3 Stakeholder Engagement

To ensure that this CPA would be transparent and informative for all interested parties, AEG and PacifiCorp led a robust stakeholder engagement process, allowing DSM and IRP stakeholders to provide input into the assessment work plan, recommend sources to incorporate in the analysis, and review and provide feedback on draft results. This stakeholder engagement process included:

- Sharing the CPA Work Plan for review and comment
- Presenting at four public CPA workshops and one IRP public input meeting
- Soliciting and incorporating input on key CPA assumptions and draft results
- Posting draft and final materials to PacifiCorp's IRP website
- Providing timely responses to stakeholder feedback forms

## 1.4 Report Organization

This report is presented in two volumes as outlined below. This document is Volume 1, presenting an overview of study methodology, data sources, and results. Volume 2 contains the study appendices, including detailed analysis inputs and outputs.

# 2

# ANALYSIS APPROACH

This chapter describes AEG's approach for assessing potential within each of the three resource categories.

## 2.1 Energy Efficiency

Energy efficiency resources reduce the energy required to power end-use technologies while continuing to provide the same level of service to the customer. In this chapter, we discuss the approach used to estimate the energy efficiency resource potential. This approach is largely similar to the energy efficiency analysis in the previous CPA; however, all assumptions have been updated using the most recent and applicable sources available. New areas of analysis in this CPA include an analysis of historical incentive levels by state and an assessment of current program participation to inform ramp rate starting points.

### 2.1.1 Overview of Analysis Steps

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

1. Perform a market characterization to describe sector-level electricity use for the residential, commercial, industrial, and irrigation sectors[7] for the base year, 2018,[8] in five states within PacifiCorp's service territory: California, Washington, Idaho, Utah, and Wyoming. Oregon is not covered in this analysis since the Energy Trust of Oregon handles the planning and implementation of all energy efficiency within PacifiCorp's Oregon service territory.[9] To perform the market characterization, AEG 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 2021 through 2040, building upon the base-year characterization performed in Step 1 above.
3. Define and characterize energy efficiency measures to be applied to all sectors, segments, and end uses.
4. Estimate the potential from the efficiency measures. While this analysis ultimately develops estimates of the annual potential for each year in the 20-year planning horizon for use in PacifiCorp's Integrated Resource Plan (IRP), results presented in this volume focus on cumulative impacts at the end of the planning horizon, 2040.
5. Compare the results of the present study with those from the previous[10] to identify important trends and changes.

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

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[7] Previous CPAs have included an assessment of potential in the street lighting sector. However, because PacifiCorp's load forecast now assumes that all street lights will be converted to LEDs during the planning period, this sector was excluded from the current CPA analysis.

[8] 2018 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.

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

[10] All five volumes of the 2019 study are available on the PacifiCorp website, http://www.pacificorp.com/es/dsm.html

#### 2.1.1.1 Definition of Potential

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

- Technical Potential – This case is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost or customer preferences. At the time of existing equipment failure, customers replace their equipment with the most efficient option available relative to applicable standards. In new construction, customers and developers also choose the most efficient equipment option relative to applicable codes and standards. These are generally considered lost opportunity measures. Non-equipment, or discretionary, measures which may be realistically installed apart from equipment replacements are implemented according to ramp rates developed by the Northwest Power and Conservation Council (The Council) for its 2021 Power Plan, applied to 100% of the applicable market. This case is a theoretical construct and is provided primarily for planning and informational purposes.
- 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. For the current CPA, AEG used achievability assumptions from The Council's Draft 2021 Power Plan as the customer adoption rates, which typically assume that 85% of the technical potential could be acquired over ra 20-year period. This achievability factor represents potential which can reasonably be acquired by all mechanisms available, including utility programs, codes and standards, and market transformation. Thus, the market applicability assumptions utilized in this study include savings outside of utility programs.[11]

#### 2.1.1.2 AEG's LoadMAP Model

AEG performed the energy efficiency potential analysis using its Load Management Analysis and Planning tool (LoadMAP$^{TM}$) to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for more than 80 utility-specific forecasting and potential studies. Built-in Microsoft Excel, the LoadMAP framework has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a simplified and more accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- 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.

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

- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- Accommodates various levels of segmentation. Analysis can be performed at the sector-level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles described below, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides forecasts of total energy use and energy-efficiency savings associated with the various levels of potential.

### 2.1.2 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 base-year energy use by state, sector, segment, end-use application, and the current set of technologies used.

#### *2.1.2.1 Customer Segmentation*

The market characterization first defined the market segments (building types, end uses, and other dimensions) that are relevant to PacifiCorp's service territory. The segmentation scheme for the current CPA is presented in Table 2-1 and is the same as in the previous CPA, with the exception of the removal of the street lighting segment, as noted above.

*Table 2-1 Overview of Segmentation Scheme for Energy Efficiency Potentials Modeling*[12]

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

#### *2.1.2.2 Market Profiles*

Market profiles define base-year energy use for each sector, market segment, end use, and technology using the following elements:

[12] For complete listings of the segmentation categories, please see Energy Market Profiles and Baseline Projections in Appendix A in Volume 2 of this report.

- **Market size** is a representation of the number of customers in the segment. For the residential sector, this is the number of households. In the commercial sector, it is the floor space, measured in square feet. For the industrial sector, it is the number of employees. For irrigation, it is the number of service points. Note that while market size is derived from customer counts provided by PacifiCorp, the units listed above are used to normalize consumption across customers of varying size within a market segment.
- **Saturations** define the fraction of the market where various technologies are installed. (e.g., percent of homes with electric space heating). In the case of end uses such as appliances and electronics, saturations of greater than 100% indicate that more than one of a given technology is present in an average home.
- **UEC (unit energy consumption) or EUI (energy utilization index)** describes the average energy consumed in 2018 by a specific technology within buildings where that technology is present. 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 2018 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 2018. 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 profiles are presented in Appendix A in Volume 2 of this report.

### 2.1.3 Baseline Projection

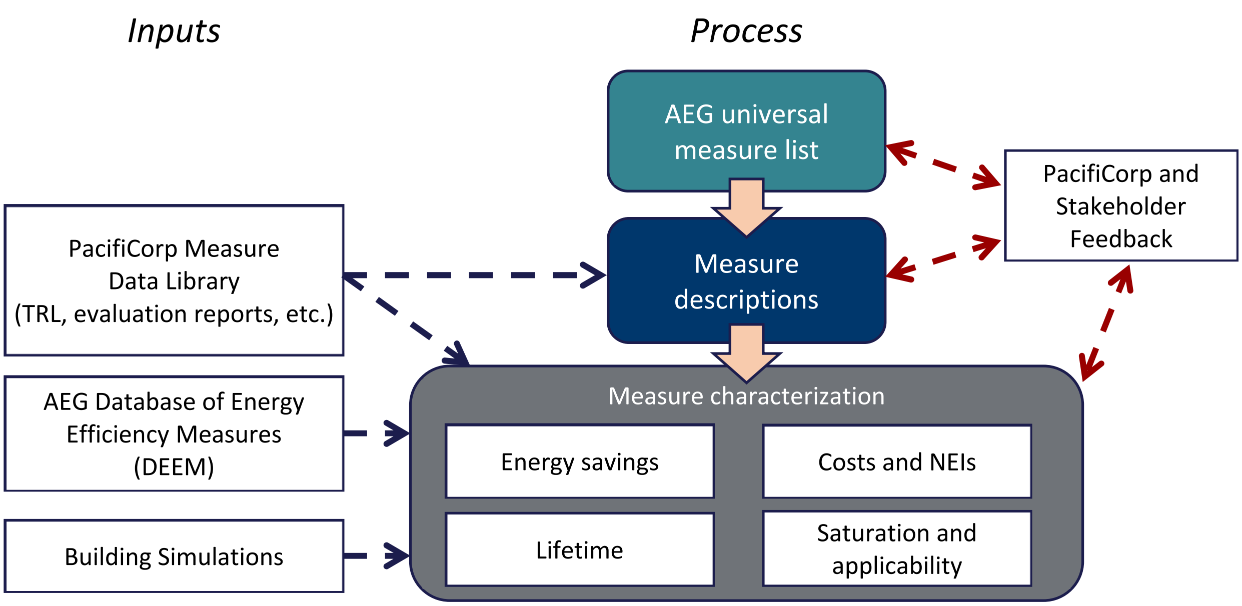
The next step in the analysis is to develop the baseline projection of annual electricity use for 2021 through 2040 by state, sector, customer segment, end use and technology. To avoid understating the remaining energy efficiency potential, this projection excludes the impacts of future market intervention through utility DSM programs or other efforts. The end-use projection includes the impacts of building codes and equipment efficiency standards that were enacted as of April 2020, even if they would not go into effect until a future date. The study does not, however, attempt to speculate on future changes to codes and standards beyond those which already have a known effective date. For a list of equipment efficiency standards included in residential and commercial baseline projections, see Table 3-4 and Table 3-5.

The baseline projection is not only the foundation for the analysis of savings from future energy efficiency efforts, but also the metric against which potential savings are measured, as presenting the potential as a percentage of the baseline projection allows for simpler comparison across assessments than comparing absolute energy savings. AEG's baseline projection uses many of the same input assumptions and aligns very closely with PacifiCorp's official load forecast. However, the baseline projection for the potential model was developed as an independent projection to ensure that baseline assumptions were consistent with those used to assess energy efficiency measure savings and applicability. Detailed baseline-projection results are provided in Appendix A in Volume 2 of this report.

### 2.1.4 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.

AEG compiled a robust list of energy efficiency measures for each customer sector, drawing upon PacifiCorp's program experience, The Council's Draft 2021 Power Plan, the Regional Technical Forum (RTF), California Database for Energy Efficient Resources (DEER), AEG's own measure databases and building simulation models, other secondary sources, and a comprehensive screen of emerging technologies within the region and country. This universal list of energy efficiency measures covers all major types of end-use equipment, as well as devices and actions which reduce energy consumption when installed or implemented.

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

- Equipment measures are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR® refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit. These measures are applied on a stock-turnover basis, and in general, are referred to as lost opportunity measures because once a purchasing decision is made, there will not be another opportunity to improve the efficiency of that equipment item until the lifetime expires again.

- Non-equipment measures save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment on a stock-turnover schedule (such as a refrigerator or air conditioner). For this reason, these measures are generally termed "discretionary" or "retrofit" measures. An example is a connected thermostat, which can be configured to run space heating and cooling systems only when people are home, and which can be installed at any time, not only when end-use equipment is being replaced. Non-equipment measures can apply to more than one end use. For instance, adding wall insulation will reduce the energy use of both space heating and cooling systems. Non-equipment measures typically fall into one of the following categories:
    - Building shell (windows, insulation, roofing material)
    - Equipment controls (thermostats, integrated lighting fixture controls)
    - Equipment maintenance (heat pump commissioning, setpoint adjustments)
    - Displacement measures (destratification fan to reduce use of HVAC systems)
    - Commissioning, retrocommissioning, and energy management
    - Residential behavioral programs. Impacts of PacifiCorp's existing Home Energy Reports program are captured in the baseline projection, however, the CPA considers the potential to expand this program to additional customers.

Similar to equipment measures, non-equipment measures in new construction are considered lost opportunities, since decisions about measure installation are made at the time of construction.

To develop the list of measures to include in this CPA, AEG started with all measures analyzed in the previous study, introduced new emerging technologies, and updated or excluded obsolete measures. A preliminary list of energy efficiency measures to assess was distributed to the PacifiCorp project team for review and then to stakeholders as part of the IRP Public Input Process.[13]

### 2.1.5 Calculating Energy Efficiency Potential

The approach 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).[14] and The Council's Draft 2021 Power Plan (2016) These sources represent authoritative and comprehensive industry standard practices for estimating energy-efficiency potential.

#### *2.1.5.1 Energy Efficiency Measure Application*

Energy efficiency potential is estimated by developing an alternate projection of energy consumption if efficient measures are adopted and calculating the difference form the baseline forecast. In these alternate projections, measures are only allowed to be adopted where they are applicable (e.g., insulation will only save electricity in homes with electric heating or cooling) and where the measure is not already installed

[13] Additional details are provided in the February 18, 2020 CPA Workshop as part of the 2021 IRP Public Input Process. https://www.pacificorp.com/energy/integrated-resource-plan/public-input-process.html

[14] 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.

(e.g., if a home already has high levels of insulation, there is no potential associated with installing insulation). For this study, two types of potential were calculated, as described below.

#### 2.1.5.2 Technical Potential

As mentioned above, 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 energy efficiency measures included in the study at their maximum theoretical deployment levels, adjusting only for technical applicability.

While all discretionary resources could theoretically be acquired in the study's first year, this would skew the potential for equipment measures and provide an inaccurate picture of measure-level potential. Therefore, the study assumes the realization of these opportunities over the 20-year planning horizon according to the shape of corresponding Draft 2021 Power Plan ramp rates, applied to 100% of applicable market units. By applying this assumption, natural equipment turnover rates, and other adjustments described above, the annual incremental and cumulative potential was estimated by state, sector, segment, construction vintage, end use, and measure. This allows the technical potential to be more closely compared with the achievable technical potential as defined below since a similar "phased-in" approach is used for both.

#### 2.1.5.3 Achievable Technical Potential

To develop estimates for achievable technical potential, AEG applied market adoption rates for each measure that estimate the percentage of customers who would be likely to select each measure, given consumer preferences (partially a function of incentive levels), retail energy rates, imperfect information, and real market barriers and conditions. These barriers tend to vary, depending on the customer sector, local energy market conditions, and other, hard-to-quantify factors. In addition to utility-sponsored programs, alternative acquisition methods, such as improved codes and standards and market transformation, can be used to capture portions of these resources, and are included within the achievable technical potential, per Power Plan methodology. This proves particularly relevant in the context of long-term energy efficiency 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 Draft 2021 Power Plan. As discussed below, two types of ramp rates (lost opportunity and retrofit) have been incorporated for all measures and market regions.

Estimated achievable technical potential principally serves as a planning guideline. Acquiring such 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.

#### 2.1.5.4 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.[15]

#### 2.1.5.5 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 type (as described below). Measure ramp rates generally matched those used in the Council's Draft 2021 Power Plan, although the study incorporated additional considerations for energy efficiency measure acquisition:

- To account for differences in PacifiCorp's state-specific markets, AEG compared projected and historic adoption for major measures using the Council's ramp rates. In cases where projected participation varied significantly from observed program participation, ramp rates were adjusted to provide the best estimate of uptake in each state's market.
- For measures not included in the 2021 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).

The ramp rates used in this study are provide in Appendix C in Volume 2 to this report.

### 2.1.6 Levelized Cost of Conserved Energy

Using the cost data for measures developed in the characterization step above, AEG calculated the levelized cost of conserved energy for each measure in order to create energy efficiency 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 regulatory requirements for cost-effectiveness screening in each state within PacifiCorp's service territory.[16]

Changes in levelized cost methodology and assumptions from the previous study include:

- State-specific administrative costs were updated to reflect the average from 2014-2018 PacifiCorp program experience.
- The application of state-specific incentive assumptions based on PacifiCorp 2014-2018 program experience. The previous assessment assumed incentives of 70% incremental cost except for Utah non-residential lighting, which was set at 50% based on discussions with program managers and feedback from stakeholders.

[15] This contrasts with equipment measures, which may require a mutually exclusive decision among multiple efficient options with energy savings relative to the baseline unit. In these cases, the algorithm selects the option that is most energy efficient for the Technical Potential Case and the unit that is most efficient for less than $250/MWh levelized for the 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 case.

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

- Application of the Utility Cost Test (UCT) in Wyoming, in contrast to the Total Resource Cost (TRC) test applied in the prior assessment.

Table 2-2 summarizes components of levelized cost in each PacifiCorp state assessed in this study.

*Table 2-2 Economic Components of Levelized Cost by State*

| Parameter | WA | CA | WY | UT | ID |
|---|---|---|---|---|---|
| Cost Test | Total Resource Cost (TRC) | | Utility Cost Test (UCT) | | |
| Initial Capital Cost | Included (100% of incremental cost, full measure cost for retrofit measures) | | Utility Incentive | | |
| Annual Incremental O&M | Included | Not Included | | | |
| Secondary Fuel Impacts | Included | Not Included | | | |
| Non-Energy Impacts | Included | Not Included | | | |
| Administrative Costs (% of incremental cost) | 38% | 54% | 37% | 20% | 46% |
| Incentive Costs (% of incremental cost) | n/a[17] | | 40% | 38% | 43% |

The approach to calculating a measure's levelized cost of conserved energy aligns with that of the Council, which considers the costs required to sustain savings over a 20-year study horizon, including reinstallation costs, for measures with useful lives less than 20 years. If a measure's useful life extends beyond the end of the 20-year study, the analysis incorporates an end effect, treating the measure's levelized cost over its useful life as an annual reinstallation cost for the remaining portion of the 20-year period.[18] For example, if a particular measure life is 15 years, a reinstallation of the measure will occur after year 15, and years 16 through 20 will reflect an annual levelized cost of installing that measure, prorated for the five of its 15 years. In this way, all measures are considered on an equivalent, 20-year basis as required for PacifiCorp's IRP process.

## 2.2 Demand Response

In previous CPAs, although energy efficiency and demand response analyses relied on many common data sources, the assessments were distinct, reflecting a technology-based view of energy efficiency and a program-based view of demand response. However, the two types of resources are becoming more closely linked as grid-enabled, energy efficient technologies enter the market. In the current CPA, AEG has

[17] Because Washington and California measures are assessed on a Total Resource Cost basis, incentive assumptions are not used in the analysis.

[18] 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.

increased alignment between the two analyses by using a common baseline forecast and allowing the forecasted adoption of energy efficient technologies to create new opportunities for demand response.

Transitioning to a technology-based view of demand response also allowed AEG to investigate the potential for a variety of different use cases for demand response, reflecting industry trends and the evolving value of demand response to PacifiCorp's system. Whereas previous studies examined the ability for demand response programs to reduce demand over a sustained period during PacifiCorp's system peak, the updated analysis looks at individual technologies' ability to provide a variety of different grid services, defined by the time required for advance notice, full deployment, and even duration, as shown in Table 2-3.

*Table 2-3 Demand Response Grid Services Definitions*[19]

| Market Participation | Grid Services | Demand Response Products | Advance Notice (mins) | Full Deployment (mins) | Duration (mins) |
|---|---|---|---|---|---|
| PAC BAA | Capacity & Energy | Capacity & Energy | 55+ | 55+ | 60 |
| PAC BAA | Regulation | Regulation | <1-30 | <30 | <1-60 |
| EIM | Flexibility & Regulation | EIM Capacity & Energy | 52.5 | 60 | 60+ |
| EIM | Flexibility & Regulation | EIM Capacity & Energy FMM | 22.5 | 15 | 15+ |
| EIM | Flexibility & Regulation | EIM Capacity & Energy RTD | 2.5 | 5 | 5+ |
| PAC BAA | Non-Spinning Reserves | Non-Spinning Reserves | 10 | 10 | 60 |
| PAC BAA | Spinning Reserves | Spinning Reserves | <1 | 10 | 60 |
| PAC BAA | Frequency Response | Frequency Response | <1 | <1 | 1 |

Detailed potential by grid service is provided in Appendix H in Volume 2 of this report, however, for the purpose of presentation in this document, demand response potential is summarized into two categories:

1. Sustained Duration Potential represent the impacts that could be realized over a period of at least two hours. This is comparable to how demand response potential was presented in previous CPAs.
2. Short Duration Potential represents the impacts that could be achieved over a period of 10 minutes or less. This potential is shown as a proxy for the shorter-duration grid services.

The major steps used to perform the demand response assessment are listed below. Throughout the remainder of this section, we describe these analysis steps in more detail.

1. Market Characterization
2. Identify and Assess Controllable Technologies
3. Bundle Technologies into Programs
4. Develop Program Cost Assumptions and Levelized Costs

[19] Grid service definitions provided by PacifiCorp.

### 2.2.1 Demand Response Market Characterization

As noted above, in this CPA, the demand response customer segmentation is aligned with the energy efficiency segmentation, allowing the same data to be utilized for both analyses. Because the demand respone analysis is based on specific hours of the year, rather than simply annual energy, the results of the energy efficiency baseline characterization were spread over hourly end use or technology load shapes to identify the forecasted load in each hour of the study period.

### 2.2.2 Controllable Technology Identification and Assessment

AEG worked with PacifiCorp and stakeholders to identify technologies that could be controlled for demand response, either thorugh grid-interactive features, or though separate equipment allowing PacifiCorp or a third-party to control the technology during an event. Each identified technology was then cross-referenced with the analyzed grid services to identify which it could be eligible to participate in based on its controllability characteristics.

Despite the change from a program-based to a technology-based potential analysis, most of the technologies assessed were included in programs in the previous CPA. However, there are two notable exceptions, representing new opportuniteis in the current CPA. As shown in Chapter 5, both technologies present significant long-term opporutnity for demand response potential:

1. Grid-Interactive Water Heaters include an on-board communications port, allowing the unit to be controlled remotely without installing a separate switch. Water heating demand response was included in the previous CPA, however it was assumed that a switches would only be installed in homes that were already participaitng in an HVAC DLC program, limiting the opportunites. The emergence of grid-interactive water heater options presents an opporutnity for utilities to run non-intrusive, standalone water heating programs. This opportunity is of particular note in Washington, where all new electric storage water heaters will be required to be grid-interactive beginning in 2021.[20]
2. Battery Energy Storage refers to customer-sited systems with charging and discharging patterns that can be controlled to maximize value for the customer and/or the utility. Although batteries can be used for many purposes, consistent with the intent of this assessment, the demand response analysis only investigated batteries' ability to discharge (i.e., reduce energy provided by the utility grid) in response to a utility signal. Because battery energy storage systems are not included in the energy efficiency analysis, AEG developed a separate forecast of potential battery adoption tied to solar adoption projections from PacifiCorp's *Private Generation Long-Term Resource Assessment (2021-2040* performed by Navigant Consulting.[21]

Once the technologies and grid service applicability were established, AEG compiled secondary data to define the following parameters for each tehcnology:

- Controllability: The percent of equipment controllable within demand response programs based on technology characteristics

[20] The analysis assumes that a similar standard in will require new units in Oregon to be grid-interactive beginning in 2022.

[21] PacifiCorp and AEG presented key battery energy storage adoption assumptions to stakeholders at an October 2020 IRP public input meeting. See slide 9 of the following presentation:
https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/PacifiCorp_2021_IRP_PIM_October_22_2020.pdf

- Sheddability: The fraction of controllable load that can be shed during a demand response event. Some technologies have different factors for short and sustained duration events, reflecting that impacts may not be sustainable over a long period.
- Program Participation: The percent of controllable and sheddable load assumed to participate in a demand response program over the long-term.

The potential for each controllable technology is then calculated by multiplying the baseline summer and winter demand by controllability, sheddability, and assumed program participation factors. This process, combined with the grid services eligibility analysis, allows for a detailed assessment of demand response options for a broad set of technologies, seasons, and use cases and creates an opportunity for an hourly assessment of demand response resource availability. AEG and PacifiCorp tested the ability to assess 8760 availability of demand response technologies in the current CPA, but additional work is required to fully vet this approach and to consider how this level of granularity could inform PacifiCorp's future IRP modeling.

The list of technologies assessed, including the grid services eligibility matrix and the above parameters, is provided in Appendix H of Volume 2 of this report.

### 2.2.3 Program Bundling

In contrast to energy efficiency, where customers may choose to install energy-efficient technologies in the absence of utility programs, demand response resources do not exist outside of utility offerings. Therefore, although the core analysis is performed at a detailed technology level, to assess the costs of deploying demand response and to reflect how PacifiCorp might actually acquire the potential, AEG aggregated technology impacts into program bundles. The demand response products analyzed in this assessment are listed in Table 2-4. As shown this study includes two new products not analyzed in the previous CPA: grid-interactive water heaters and battery energy storage DLC. Detailed program descriptions and key assumptions for each product are provided in Appendix H.

*Table 2-4 Demand Response Products Assessed in the Study*

| Demand Response Option | Eligible Customer Classes | Mechanism | Currently Offered by PacifiCorp? | Considered in Previous CPA? |
|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | Residential, Small C&I, Medium C&I | Direct load control switch installed on customer's heating and/or cooling equipment | Yes, AC offered in UT | Yes |
| Domestic Hot Water Heater (DHW) DLC | Residential, Small C&I, Medium C&I | Direct load control switch installed on customer's equipment | No | Yes |
| Grid-Interactive Water Heaters | Residential, Small C&I, Medium C&I | CTA-2045 or other integrated communication port | No | No |
| Connected Thermostat DLC | Residential, Small C&I Medium C&I | Internet-enabled control of thermostat set points | No | Yes |
| Smart Appliance DLC | Residential | Internet-enabled control of operational cycles of white goods appliances | No | Yes |
| Pool Pump DLC | Residential | Direct load control switch installed on customer's equipment | No | No |
| Electric Vehicle Connected Charger DLC | Residential | Automated, level 2 EV chargers that postpone or curtail charging during peak hours. | No | Yes |
| Battery Energy Storage DLC | Residential, All C&I | Internet-enabled control of battery charging and discharging | Yes, new UT program | No |
| Third Party Contracts | Large C&I, Extra-large C&I | Customers enact their customized, mandatory curtailment plan. Penalties apply for non-performance. | No | Yes |
| Irrigation Load Control | Irrigation | Automated pump controllers | Yes, in ID, UT, pilot in OR | Yes |

Two demand response product options modeled as standalone offerings in the previous CPA were rolled into other products:

- Ancillary Services refer to functions that help grid operators maintain a reliable electricity system. Whereas the previous CPA considered a separate demand response product capable of responding very quickly to changing grid conditions, the current CPA analyzed the applicability of various grid services for each analyzed product. As such, analyzing a standalone Ancillary Services product was no longer necessary.
- Thermal Energy Storage refers to peak shifting of space cooling loads using stored ice. In the current CPA this option is treated as a possible technology for enabling demand reductions through the Third Party Contracts product.

AEG calculated annual potential for each program by aggregating the impacts of the underlying technologies, and accounting for competition between program options to avoid double counting. For example, a central air conditioner would not participate in both the DLC program and the connected thermostat program.

Because program participation factors are based on the percent of customers who might participate in mature programs, when assessing annual resource availability, it is important to account for the time required to ramp up to full participation. In this CPA, AEG assumed that programs would ramp up to maximum participation over three years, beginning in 2022 for new program and 2021 for existing programs. This distinction between existing and new programs reflects the time required for PacifiCorp to design, contract for, and market new offerings. As discussed above, program potential was developed for each of the applicable grid services and summarized event length for the purpose of presentation.

### 2.2.4 Develop Program Levelized Cost Estimates

For each of the demand response program options, AEG developed representative assumptions to estimate the costs required to capture the identified potential, including program development and administration, customer marketing and recruitment, incentive payments, enabling technology, and ongoing operations and maintenance (O&M, where applicable. These cost estimates were based on PacifiCorp's demand response program experience, Council Draft 2021 Power Plan assumptions, and other applicable sources. Program management costs are assumed to be shared across states, reflecting that PacifiCorp would likely have a single program manager for the same program across multiple states, if implemented. Program cost assumptions are presented in Appendix H of this report.

While total annual program costs are useful in assessing the impacts on utility DSM portfolio budgets, this information is not sufficient for comparing demand response programs to other options for meeting peak load, which requires assessing the life-cycle costs of competing resource options on equal footing. Therefore, to enable comparison of resource options in PacifiCorp's IRP, AEG developed levelized costs for each demand response program option by state and season. AEG notes the following key considerations related to levelized costs:

- AEG calculated the levelized cost of each demand response program option as the ratio of net present value cost and impacts over a five-year period. The previous CPA assumed contract periods between three and 20 years varying by program options, but this assumption was updated to a constant five years to align with PacifiCorp's current procurement practices.
- The assumed five-year contract period includes the three-year ramp up period. As such, levelized costs represent what would be required to ramp up a new program to full participation. Once programs are at full participation, ongoing costs may be reduced.
- For consistency with previous CPAs, levelized costs presented in this report are based on potential demand reduction during sustained duration events. Impacts, and thus levelized costs, may be higher or lower if assessed during short duration events.
- For programs that can provide impacts in both summer and winter, costs have been spread evenly across the two seasons, consistent with the methodology in the Council's Draft 2021 Power Plan. This is a change from the previous CPA, where the two seasons were assessed independently. All things constant, this change decreased season-specific levelized costs relative to the previous CPA.
- In Rocky Mountain Power states, which use the Utility Cost Test as the primary cost-effectiveness perspective, all costs incurred by the utility are included in the levelized cost calculation. In Pacific Power states, where the Total Resource Cost test is used as the primary cost-effectiveness perspective, AEG used the cost methodology from the California Public Utilities Commission's (CPUC's) 2016 Demand Response Cost Effectiveness Protocols.[22] The CPUC protocols address participant costs as being equal to the sum of transaction costs and the Value of Service Lost. However, given that those two costs are extremely difficult to quantify, other costs are often used as a proxy. Specifically, the

[22] More information on the protocols can be found here: http://www.cpuc.ca.gov/general.aspx?id=7023

CPUC protocols recommend estimating participant costs as a percentage of incentives, assuming that customers would not participate in demand response programs if the cost to do so is higher than the benefits received. Lower percentages are used to reflect programs that are less intrusive to customers. The Council also adopted this methodology for estimating total resource costs in its 2021 Power Plan.

- The CPA did not attempt to attribute or quantify non-energy impacts of demand response. However, at stakeholders' request, AEG researched the applicability and application of non-energy impacts to demand response programs to inform future assessments. The results of AEG's research are presented in Appendix J in Volume 2 of this report.

### 2.2.5 Develop Levelized Cost Scenarios

At stakeholders' request, AEG developed base, low, and high avoided cost estimates by varying the percent of incentives assumed to reflect customers' costs to participate in the program. The CPUC protocols recommend a default base assumption of 75% with low and high values of 50% and 100%, respectively. AEG used these values as defaults, and updated values for specific programs with the CPUC protocol or Council 2021 Power Plan assumptions when those values differed from the defaults. The percentages used, by program and scenario are provided in Table 2-5. Note that these scenarios are only applicable to Pacific Power states, for the reason that these assumptions have no impact on levelized costs from a Utility Cost Test perspective.

*Table 2-5 Demand Response Participant Cost Scenario Assumptions – Pacific Power Only*

| | Participant Cost (% of Incentive) | | |
|---|---|---|---|
| Program | Low | Base | High |
| HVAC Direct Load Control (DLC) | 10% | 35% | 60% |
| Domestic Hot Water Heater (DHW) DLC | 15% | 25% | 35% |
| Grid-Interactive Water Heaters | 15% | 25% | 35% |
| Connected Thermostat DLC | 10% | 35% | 60% |
| Smart Appliances DLC | 50% | 75% | 100% |
| DLC of Pool Pumps | 50% | 75% | 100% |
| Electric Vehicle DLC Smart Chargers | 50% | 75% | 100% |
| Battery Energy Storage DLC | 50% | 75% | 100% |
| Third Party Contracts | 50% | 75% | 100% |
| Irrigation Load Control | 50% | 75% | 100% |

Detailed Levelized Cost results, including for the three Pacific Power scenarios, are included in Appendix I in Volume 2 of this report.

## 2.3 Demand-Side Rates

The demand-side rates analysis investigated the potential for voluntary rate options to reduce demand during peak periods. While the objectives of implementing demand-side rates is similar to demand response, there is a significant difference in terms of resource firmness. Whereas the utility can rely on demand response program impacts, either through direct control or a contractual agreement with a customer or third-parties, customers' response to varying rate design is dependent on their desire to respond to economic signals

While the analytical steps used to assess demand-side rate potential are similar to the demand response analysis, because demand-side rates lack the controllability and ability to respond instantaneously to changing utility system conditions, the methodology has not changed significantly from the previous CPA, Rather, the assessment of demand-side rate potential focused on updating to incorporating PacifiCorp's pilot experience and other newly available data sources. Additionally, because PacifiCorp no longer models incremental demand-side rate potential as a resource in its IRP, the current CPA did not assess the costs of delivering these rate options.

The major steps used to perform the demand response assessment are listed below. Throughout the remainder of this section, we describe these analysis steps in more detail.

1. Market Characterization
2. Rate Identification and Definition
3. Potential Estimation

### 2.3.1 Demand-Side Rates Market Characterization

As in the previous CPA, AEG segmented PacifiCorp's customers as follows:

- By state
- By sector: residential, commercial and industrial (C&I), and irrigation
- By customer class: C&I customers are further segmented into customer classes based on maximum demand, typically following utility rate schedules. A uniform segmentation approach is applied across all six states. Note that the breakpoint of 200 kW is included to create a minimum threshold for customers that are typically recruited for third-party delivered capacity reduction programs. Extremely large customers, who are served through special contracts, are outside the scope of this analysis as they are currently providing load reduction through specialized agreements and are already accounted for in PacifiCorp's existing resource base.

Table 2-6 summarizes the overall market segmentation approach for the study.

*Table 2-6 Analysis Segmentation*

| Market Dimension | Segmentation Variable | Description |
|---|---|---|
| Dimension 1 | State | UT, OR, WY, WA, ID, CA |
| Dimension 2 | Sector | Residential, Commercial and Industrial (C&I), and Irrigation |
| Dimension 3 | Customer Class | Residential: all customers |
| | | C&I: by maximum peak demand<br>Small C&I: ≤30 kW<br>Medium C&I: >30 kW and ≤200 kW<br>Large C&I: >200 kW and ≤1,000 kW<br>Extra-large C&I: >1,000 kW |
| | | Irrigation: all customers |

### 2.3.2 Define Demand-Side Rate Options

Table 2-7 lists the demand-side rate options analyzed in this study. To develop this list, AEG began with the list from the previous CPA and reviewed available literature to identify any additional options that should be included. AEG then reviewed the draft list with PacifiCorp and stakeholders. Ultimately, the list of rates assessed is the same as the previous assessment except for the exclusion of TOU Demand rates, as discussed following the table.

*Table 2-7 Demand-Side Rates Assessed*

| Demand-Side Rate Option | Eligible Customer Classes | Analysis Approach | Whether Current PacifiCorp Offering | Considered in Previous CPA? |
|---|---|---|---|---|
| Time-Of-Use Rate | Residential | In states without existing TOU rates (WA, WY, CA), analyze impacts associated with new TOU rates. | Optional TOU rates in ID, UT, and OR | Yes |
| TOU Rate for Electric Vehicle Owners | Residential | This rate has the same structure as the TOU Demand Rate listed above but reflects the group of customers who would participate while owning and charging an electric vehicle. These participants would in effect have an "enabling technology" in the form of their EV that would enable them to shift usage and demand off-peak. | Limited pilot in UT | Yes |
| Critical Peak Pricing Rate | Residential | Assess impacts associated with a CPP rate offering to all residential customers.[23] | No | Yes |
| Behavioral Demand Response | Residential | Voluntary demand reductions in response to behavioral messaging. Example programs exist in CA and other states. Requires AMI technology. | No | Yes |
| Time-Of-Use (TOU) Rate | All C&I | For states and customer classes without existing TOU rates, study analyzes impacts associated with new TOU rates. | Offered on voluntary or mandatory basis depending on state and customer class. | Yes |
| Critical Peak Pricing (CPP) Rate | All C&I, Irrigation | Assess impacts associated with a CPP rate offering to all C&I customers. | No | Yes |
| Real Time Pricing (RTP) Rate | Large and Extra-large C&I | Assess impacts associated with an RTP rate offering for extra-large C&I customers. Impacts are estimated with both opt-in and opt-out provisions. | No | Yes |

[23] We do not estimate impacts for rates with enabling technology due to higher costs associated with that option.

| Demand-Side Rate Option | Eligible Customer Classes | Analysis Approach | Whether Current PacifiCorp Offering | Considered in Previous CPA? |
|---|---|---|---|---|
| Irrigation Time-Of-Use (TOU) Rate | Irrigation | For states without existing irrigation TOU rates (ID, WA, WY), study analyzes impacts associated with new TOU rates. | Offered in California, Oregon and Utah | Yes |

In addition to the demand-side rate options ultimately included in this study, we considered several options that were qualitatively screened out of the potential analysis. A listing of these options and the rationale for not including each is below.

- Existing Pricing Options - PacifiCorp currently offers IBR and TOU rates for several customer classes across its service territories. AEG estimated the embedded impacts for these rates as a parallel analysis in the 2015 CPA, and no substantive changes to their implementation have occurred in the interim. These impacts are embedded in the baseline forecast and do not represent incremental potential available for selection by the IRP.
- Demand Buyback / Energy Exchange – This was a program previously offered by PacifiCorp where customers would enact their customized, voluntary curtailment plan in response for a market-based economic incentive with no penalties for non-performance. This program was omitted from the current study as the program has been ended in all states. The associated savings potential is captured in the Third Party Agreements demand response offering.
- Residential TOU Demand Rate with and without electric vehicles – These options are similar to the assessed residential TOU rates, but in addition to a basic charge and energy charges, also include a charge based on customer demand. As these options largely overlap with the residential TOU rate and no longer align with PacifiCorp's time-varying rate design strategy, they were excluded from the current study.

For each option assessed, AEG developed estimates for customer eligibility, participation, and impacts based on the most applicable data sources. As discussed above, this analysis represents a refresh of previous assessments, incorporating updated information where available. Participation assumptions for dynamic pricing options are largely based on the 2015 CPA, which included an extensive review of enrollment in full-scale, time-varying rates being offered in the United States and internationally, as well as findings of recent market research studies. With respect to full-scale deployments, the review focused specifically on rate offerings that have been heavily marketed to customers and have achieved significant levels of enrollment. Enrollment estimates are based on data reported to FERC by utilities and competitive retail suppliers and other entities. To provide additional insight, the analysis included survey-based market research studies from other comparable utilities and transferrable jurisdictions designed to gauge customer interest in time-varying rates. The surveys are from a statistically valid sample of respondents who are representative of all considered customers.

### 2.3.3 Estimation of Demand-Side Rate Potential

After the market is characterized and rate options are defined, the process of calculating potential is fairly straightforward. That is, potential for demand-side rates is simply the peak demand of the class of eligible customers times the percent of customers assumed to participate times the per-customer percent demand reduction. Participation and impact estimates were developed assuming that pricing options would be offered on a voluntary, "opt-in" basis, consistent with the previous CPA. Additionally, the analysis assumes that dynamic pricing options require an Advanced Metering Infrastructure (AMI) to enable two-way communication between the customer and utility for notification and billing purposes, except in cases where existing rates and infrastructure have already been established. AMI assumptions used in this assessment are presented in Section 3.1.1.

# 3

# DATA DEVELOPMENT

This section describes the data sources used to complete this study. To make the results of the study as representative of PacifiCorp's service territory as possible, AEG prioritized PacifiCorp-specific data where available, supplemented by regional and national data sources. As discussed above, the current CPA improved alignment between the energy efficiency and demand response resource assessments, allowing the many of the same data sources to flow through both analyses.

## 3.1 Data Sources

### 3.1.1 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 residential survey efforts.
- Load Forecasts: PacifiCorp provided state- and sector-level forecasts of energy consumption, peak demand, and customer counts. Before providing to AEG, PacifiCorp modified the standard load forecast to reflect a few DSM-specific considerations. First, forecasts of future utility DSM over the CPA planning period (2021-2040) were removed to avoid double-counting the available potential. Second, the forecasts were adjusted to be post-private generation (e.g. customer-sited solar). Finally, non-DSM-eligible special contracts were removed from the forecasts.
- Discount Rate: PacifiCorp provided a system-wide discount rate (6.91% nominal) based on its weighted average cost of capital.
- Line Losses: Line loss percentages by state and sector were used to calculate levelized costs and potential at the generator-level. The percentages used in the analysis are presented in Table 3-1.

*Table 3-1 Line Loss Percentages*[24]

| Sector | CA | ID | UT | WA | WY |
|---|---|---|---|---|---|
| Residential | 8.78% | 7.68% | 9.06% | 6.36% | 10.27% |
| Commercial | 8.63% | 7.60% | 8.59% | 5.86% | 10.00% |
| Industrial | 8.53% | 6.82% | 3.83% | 4.10% | 5.85% |
| Irrigation | 8.78% | 7.68% | 9.05% | 6.34% | 10.21% |

[24] Line loss percentages were based on PacifiCorp's 2018 Line Loss Study.

- **PacifiCorp Program Data:** PacifiCorp provided information about past and current energy efficiency and demand response programs, including program descriptions, measure-level achievements to date, and evaluation reports.
- **AMI Deployment Schedule:** The AMI deployment schedule is important for certain demand response and demand-side rate options that require one- or two-way communication with customers. Based on direction from PacifiCorp, this assessment assumed the following AMI deployment schedule:
  - By 2021, fully deployed in California and Oregon
  - By 2023, fully deployed in Idaho and Utah
  - By 2026, fully deployed in Washington and Wyoming

### 3.1.2 Northwest Region Data

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

- **Regional Technical Forum (RTF) Unit Energy Savings Measure Workbooks:** The RTF maintains workbooks that characterize selected measures and provide data on unit energy savings (UES), measure cost, measure life, and non-energy benefits. These workbooks provide Pacific Northwest-specific measure assumptions, drawing upon primary research, energy modeling (using the RTF's Simple Energy Enthalpy Model (SEEM), regional third-party research, and well-vetted national data. Workbooks are available at https://rtf.nwcouncil.org/measures
- **RTF Standard Protocols:** The RTF also maintains standard workbooks containing useful information for characterizing more complex measures for which UES values have not been developed, such as commercial sector lighting. https://rtf.nwcouncil.org/standard-protocols
- **Northwest Power and Conservation Council's Draft 2021 Power Plan Conservation and Demand Response Supply Curve Workbooks, 2020.** To develop its Power Plan, the Council created workbooks with detailed information about energy efficiency and demand response opportunities, available at https://www.nwcouncil.org/2021-power-plan-technical-information-and-data
- **Residential Building Stock Assessment:** NEEA's 2016 Residential Building Stock Assessment (RBSA) provides results of a survey of thousands of homes in the Pacific Northwest. https://neea.org/data/residential-building-stock-assessment
- **Commercial Building Stock Assessment:** NEEA's 2014 Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. https://neea.org/data/commercial-building-stock-assessments
- **Industrial Facilities Site Assessment:** NEEA's 2014 Industrial Facilities Site Assessment (IFSA) provides data on regional industrial customers by major classification types. https://neea.org/data/industrial-facilties-site-assessment

### 3.1.3 Other Secondary Data and Reports

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

- **Other relevant regional sources:** These include reports from the Consortium for Energy Efficiency (CEE), the Environmental Protection Agency (EPA), and the American Council for an Energy-Efficient Economy (ACEEE).

- **Annual Energy Outlook.** The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2019 AEO.
- **American Community Survey:** The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. Data for PacifiCorp were available for this study. http://www.census.gov/acs/www/
- **Weather Data:** Weather from NOAA's National Climatic Data Center for representative cities in each PacifiCorp state service territory was used as the basis for building simulations. These cities were: Yakima, WA; Salt Lake City, UT; Medford, OR (most representative weather station for California service territory); Pocatello, ID; and Casper, WY. Data used is in the Typical Meteorological Year 3 (TMY3) format, which utilizes thirty years of meteorological data to create hourly weather conditions for a standard year.
- **EPRI End-Use Models (REEPS and COMMEND).** These models provide the econometric variables for elasticities we apply to electricity prices, household income, home size, and heating and cooling.
- **Database for Energy Efficient Resources (DEER).** The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California.
- **2025 California Demand Response Potential Study.** The California Demand Response Potential Study was used to develop controllability and sheddability estimates for the demand response analysis and to investigate opportunities for demand response to provide different grid services. The study report is available here: https://www.cpuc.ca.gov/general.aspx?id=10622.

## 3.2 Energy Efficiency Measure Development

### 3.2.1 Measure List

To provide a robust estimate of available energy efficiency potential over the study period, AEG compiled a comprehensive list of existing and emerging efficient technology options across states, sectors, market segments, end uses, and construction vintages. Table 3-2 summarizes the number of unique measures evaluated within each sector and the total number of permutations assessed after expanding this list to applicable states, market segments, construction vintages, and end uses.

*Table 3-2 Energy Efficiency Measures Assessed*

| Sector | Unique Measure Count | Total of All Permutations |
|---|---|---|
| Residential | 98 | 3,798 |
| Commercial | 138 | 15,212 |
| Industrial | 96 | 9,508 |
| Irrigation | 25 | 250 |
| **Total Measures Evaluated** | **357** | **28,768** |

### 3.2.2 Emerging Technologies

The energy efficiency measures considered in this analysis come from a comprehensive review of measures implemented in current industry best practice programs and exhaustive research into the pipeline of technologies that may become viable over the study time horizon. This research leveraged resources such as The Council's Regional Technical Forum, the US Department of Energy's Annual Energy Outlook, Washington State University's *Energy Efficiency Emerging Technologies* (E3T) databases, NEEA research initiatives, California IOU white papers, the Northeast Energy Efficiency Partnerships (NEEP) when applicable for the western US, and all demand-side measures from *ACEEE's New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030*..[25]

The emerging technologies selected for inclusion in the study represent quantifiable projections of measures that have not yet gained mainstream adoption but can reasonably be expected to reach commercial availability within the study time horizon. The protracted development cycle for newer, emerging technologies is reflected where appropriate in the potential modeling through the assignment of an emerging technology measure ramp rate, which will introduce the resource over a more representative time period. Technologies that are still in the laboratory stage without a quantifiable cost and/or operating characteristics have been excluded from the analysis. AEG reviewed this list with the PacifiCorp staff and stakeholders, assessing the viability of each for PacifiCorp's customers and certainty of available assumptions prior to inclusion in the CPA. A list of all included emerging technologies, as well as those considered but excluded is provided in Appendix B in Volume 2 of this report.

### 3.2.3 Measure Data Sources

To accurately characterize these energy efficiency measures across PacifiCorp's service territory, incorporating differences in customer characteristics, climate, markets, applicability of regional sources, and stakeholder expectations, AEG developed a hierarchy of sources to use for each state. AEG presented this hierarchy, provided in Table 3-3, to PacifiCorp's IRP stakeholders at a January 2020 public input meeting

*Table 3-3 Energy Efficiency Measure Source Hierarchy*

<table>
<tr><th>Source Hierarchy</th><th>Utah and Wyoming</th><th>Idaho and Washington</th><th>California</th></tr>
<tr><td>Primary</td><td rowspan="3">RMP Measure Characterization; Xcel Colorado TRM; RTF with Adjustments†, National Sources,†† DSM Plan, Other Regularly Updated TRs†††</td><td>RTF, 2021 Power Plan</td><td>DEER and non-DEER Workpapers</td></tr>
<tr><td>Secondary</td><td rowspan="2">National Sources,†† Idaho Power TRM, Other Regularly Updated TRMs†††</td><td>CMUA TRM; RTF with Adjustments†</td></tr>
<tr><td>Other</td><td>National Sources,†† Other Regularly Updated TRMs†††</td></tr>
<tr><td colspan="4">† Adjustments include weather and baselines (replace market with code/standard)<br>†† Includes national sources such as the Annual Energy Outlook, ENERGY STAR® Savings Calculators, etc.<br>††† Includes Technical Reference Manuals from Illinois, Wisconsin, Pennsylvania, New York, Minnesota, Maine, and others as necessary</td></tr>
</table>

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

## 3.3 Codes and Standards

To ensure that energy efficiency potential represents savings above and beyond what is required by code, AEG incorporates current building code and equipment standards into the baseline projection. Because there is often a sizeable gap between when a new code or standard is adopted and when it takes effect, the analysis incorporates all applicable codes and standards that have been adopted, regardless of whether they have taken effect at the beginning of the study period; AEG does not attempt to predict future codes or standards that may take effect beyond what has already been adopted. However, it is important to note that the Council's achievability assumptions used to estimate achievable potential assume that some potential may be acquired through future improvements in building codes and/or equipment efficiency standards.

The current and future residential and non-residential equipment efficiency standards incorporated into the baseline projection are presented in Table 3-4 and Table 3-5, respectively. A notable change relative to the previous CPA is the treatment of lighting standards stemming from the Energy Independence and Security Act of 2017 (EISA). The previous assessment assumed the EISA backstop provision would take effect, requiring a minimum efficacy of 45 lumens/Watt for general service lamps beginning in 2020. In December 2019, this federal standard was rolled back and the current standard is reflected in this CPA. The exception to this is California and Washington, where the 45 lumen/Watt standard is required by state law.

In addition to efficiency standards, the demand response analysis incorporated one notable equipment standard in certain states. A new Washington law[26] requires that electric storage water heaters installed beginning in 2021 to include a CTA-2045-A communication interface, enabling interaction with the utility grid. The analysis assumed that a similar standard would take effect in Oregon in 2022. For all other states, the study assumed that a certain percentage of new water heaters would include a CTA-2045 port, but that this would not be a requirement.

*Table 3-4 Residential Electric Equipment Standards*[27]

<table>
<tr><th>End Use</th><th>Technology</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="2">Cooling</td><td>Central AC</td><td colspan="6">SEER 13.0 in all states except California/ SEER 14.0 in California</td><td colspan="2">SEER 14.0</td></tr>
<tr><td>Room AC</td><td colspan="8">CEER 10.9</td></tr>
<tr><td>Cooling/ Heating</td><td>Air-Source Heat Pump</td><td colspan="6">SEER 14.0 / HSPF 8.2</td><td colspan="2">SEER 15.0 / HSPF 8.8</td></tr>
<tr><td rowspan="2">Water Heating</td><td>Water Heater (<=55 gallons)</td><td colspan="8">EF 0.95</td></tr>
<tr><td>Water Heater (>55 gallons)</td><td colspan="8">EF 2.0 (Heat Pump Water Heater)</td></tr>
<tr><td rowspan="2">Lighting</td><td>General Service</td><td colspan="8">Advanced Incandescent (~20 lumens/watt)[28]</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="8">T8 (89 lm/W lamp)</td></tr>
<tr><td rowspan="3">Appliances</td><td>Refrigerator</td><td colspan="8" rowspan="2">25% more efficient than the 1997 Final Rule (62 FR 23102)</td></tr>
<tr><td>Freezer</td></tr>
<tr><td>Clothes Washer</td><td colspan="8">IMEF 1.84 / IWF 4.7</td></tr>
</table>

[26] Washington Administrative Code 194-24-180

[27] In California, the state standard requires a minimum of SEER 14 for Central ACs and SEER 15 starting in 2023. 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.

[28] As required by state laws, a 45 lm/W standard is used in California and Washington beginning in 2019 and 2020, respectively.

| | | | |
|---|---|---|---|
| | Clothes Dryer | 3.73 Combined EF | |
| Miscellaneous | Furnace Fans | Conventional | ECM |

*Table 3-5 Commercial Electric Equipment Standards*

| End Use | Technology | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|
| Cooling | Chillers | 2007 ASHRAE 90.1 | | | | | | | |
| | RTUs | IEER 12.9 | | | | | | | |
| | PTAC | EER 10.4[29] | | | | | | | |
| Cooling/ Heating | Heat Pump | IEER 12.2/COP 3.3 | | | | | | IEER 14.1/COP 3.4 | |
| | PTHP | EER 10.4/COP 3.1[30] | | | | | | | |
| Ventilation | All | Constant Air Volume/Variable Air Volume | | | | | | | |
| Lighting | General Service | Advanced Incandescent (~20 lumens/watt)[31] | | | | | | | |
| | Linear Lighting | T8 (~89 lm/W lamp) | | | | | | | |
| | High Bay | Metal Halide (~54 lm/W lamp) | | | | | | | |
| Refrigeration | Walk-In | 10-38% more efficient | | 24% more efficient than 2017 | | | | | |
| | Reach-In | 40% more efficient | | | | | | | |
| | Glass Door | 12-28% more efficient | | | | | | | |
| | Open Display | 10-20% more efficient | | | | | | | |
| | Icemaker | 15% more efficient | | | | | | | |
| Food Service | Pre-Rinse | 1.6 GPM | 1.0 GPM | | | | | | |
| Motors | All | Expanded EISA 2007 | | | | | | | |

Table 3-6 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.

*Table 3-6 Guidance for Building Codes*

| State | Residential Energy Code Used | Non-Residential Energy Code Used |
|---|---|---|
| California | 2019 Building Energy Efficiency Standards, Title 24[32] | 2016 Building Energy Efficiency Standards, Title 24 |
| Washington | Washington State Energy Code 2015 (WSEC 2015) with HB1444 adjustments. | Washington State Energy Code 2015 (WSEC 2015) with HB1444 adjustments. |
| Idaho | 2012 IECC | 2015 IECC |
| Utah | 2015 IECC | 2018 IECC |

[29] Assumed a 12 kBtu/h PTAC unit.

[30] Assumed a 12 kBtu/h PTHP unit.

[31] As required by state laws, a 45 lm/W standard is used in California and Washington beginning in 2019 and 2020, respectively.

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

| State | Residential Energy Code Used | Non-Residential Energy Code Used |
|---|---|---|
| Wyoming | 2009 IECC with adjustments based on survey data for new buildings | 2009 IECC with adjustments based on survey data for new buildings |

# 4

# ENERGY EFFICIENCY POTENTIAL RESULTS

This chapter presents the identified cumulative potential in 2040 from energy efficiency resources in absolute terms and relative to AEG's baseline projection. These savings draw upon forecasts of future consumption absent PacifiCorp energy efficiency program activities. While the baseline projection accounted for past PacifiCorp energy efficiency resource acquisition, the identified estimated potential is inclusive of (not in addition to) future planned program savings. As discussed previously, the 2040 forecasted baseline sales presented in this report may differ from PacifiCorp's official sales forecast.

## 4.1 Summary of Overall Energy Savings

Table 4-1 summarizes the 2040 cumulative technical and achievable technical energy-efficiency potential by sector, both in MWh and as a percentage of the 2040 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 2040 are 15.3 million MWh, or 28.2% of the baseline projection.
- Achievable Technical Potential, which adjusts the technical potential by reflecting customer adoption constraints, shows cumulative savings of 10.9 million MWh, or 20.2% of the baseline load in 2040. This case represents potential which can reasonably be acquired by all mechanisms available, regardless of how conservation is achieved. This includes savings which may be realized from outside of utility programs.

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

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

*Table 4-1 Cumulative Energy Efficiency Potential by Sector in 2040*

| Sector | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|
| Residential | 17,986,738 | 5,967,919 | 3,618,297 | 33.18% | 20.1% |
| Commercial | 17,283,715 | 6,099,590 | 4,635,547 | 35.29% | 26.8% |
| Industrial | 17,184,134 | 2,829,408 | 2,372,759 | 16.47% | 13.8% |
| Irrigation | 1,243,976 | 198,877 | 171,279 | 15.99% | 13.8% |
| **Total** | **53,698,564** | **15,095,795** | **10,797,882** | **28.11%** | **20.1%** |

*Figure 4-1 Cumulative Energy Efficiency Achievable Technical Potential by Sector*

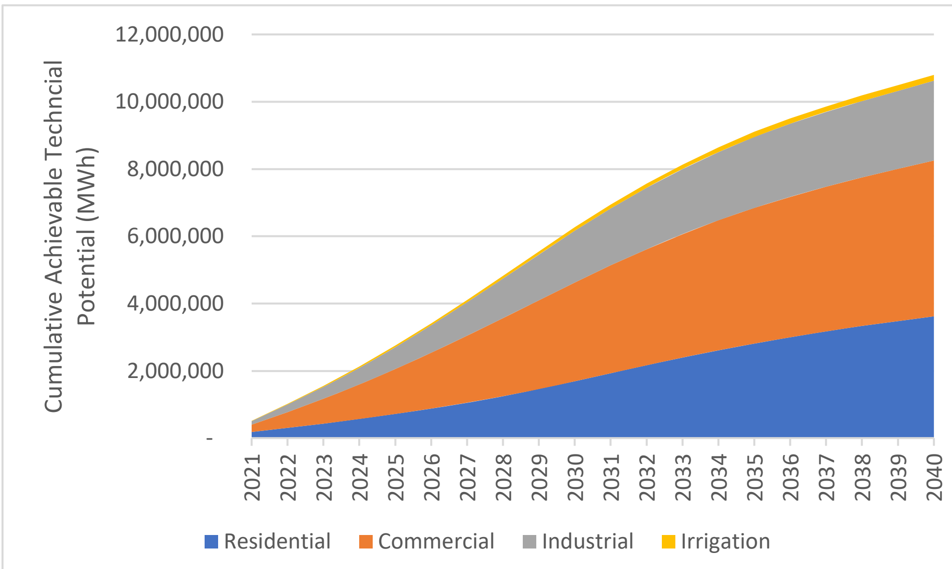



Table 4-2 summarizes the energy efficiency potential by state and by PacifiCorp operating company.[33] With the exception of Wyoming, potential as a percent of baseline loads is relatively constant across states; Wyoming results are heavily influenced by the large share of the load in the industrial sector, which, as shown in Table 4-3, has lower identified potential as a percent of the load than the residential and commercial sectors. Additional variations across states are a function of customer mix, climate, equipment saturations, current saturation or efficient equipment, and other related factors. Cumulative achievable technical potential by state for the first 10 years of the study period is presented in Table 4-3.

[33] 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 Energy Efficiency Potential by State in 2040*

| Territory | State | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|---|
| Pacific Power | California | 800,237 | 246,790 | 169,966 | 30.8% | 21.2% |
| | Washington | 5,310,704 | 1,500,581 | 1,107,470 | 28.3% | 20.9% |
| | **Subtotal** | **6,110,942** | **1,747,371** | **1,277,435** | **28.6%** | **20.9%** |
| Rocky Mountain Power | Idaho | 2,770,301 | 730,789 | 534,365 | 26.4% | 19.3% |
| | Utah | 33,497,939 | 10,486,274 | 7,317,535 | 31.3% | 21.8% |
| | Wyoming | 11,319,382 | 2,131,361 | 1,668,547 | 18.8% | 14.7% |
| | **Subtotal** | **47,587,622** | **13,348,424** | **9,520,447** | **28.1%** | **20.0%** |
| | **Total** | **53,698,564** | **15,095,795** | **10,797,882** | **28.1%** | **20.1%** |

*Table 4-3 Cumulative Energy Efficiency Achievable Technical Potential Through 2030*

| State | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| California | 5,614 | 11,916 | 19,107 | 27,316 | 36,659 | 47,264 | 58,839 | 71,017 | 83,401 | 95,586 |
| Washington | 44,376 | 92,365 | 144,948 | 203,080 | 268,622 | 341,240 | 418,352 | 497,882 | 577,377 | 656,302 |
| Idaho | 26,858 | 47,484 | 70,310 | 94,987 | 123,251 | 154,923 | 189,020 | 224,959 | 261,502 | 298,449 |
| Utah | 364,163 | 702,147 | 1,061,084 | 1,441,377 | 1,860,582 | 2,282,019 | 2,732,986 | 3,198,580 | 3,665,242 | 4,136,484 |
| Wyoming | 78,593 | 163,910 | 259,064 | 359,697 | 468,702 | 585,581 | 708,878 | 835,272 | 958,863 | 1,080,669 |
| **Total** | **519,604** | **1,017,821** | **1,554,513** | **2,126,456** | **2,757,815** | **3,411,027** | **4,108,076** | **4,827,710** | **5,546,385** | **6,267,490** |

## 4.2 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 2040. The technical potential in 2040 from energy efficiency resources assessed in this study is 6 million MWh or 33% of the baseline projection. The corresponding achievable technical potential is 3.6 million MWh or 20% of the 2040 baseline. Savings as a percent of the baseline are very consistent across states. Cumulative residential achievable technical potential by state for the first 10 years of the study period is presented in Table 4-5.

*Table 4-4 Residential Cumulative Energy Efficiency Potential by State in 2040*

| Territory | State | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|---|
| Pacific Power | California | 394,689 | 135,666 | 83,753 | 34.4% | 21.2% |
| | Washington | 2,058,256 | 650,097 | 437,213 | 31.6% | 21.2% |
| | **Subtotal** | **2,452,945** | **785,763** | **520,966** | **32.0%** | **21.2%** |
| Rocky Mountain Power | Idaho | 1,018,998 | 322,842 | 213,121 | 31.7% | 20.9% |
| | Utah | 13,359,825 | 4,443,762 | 2,607,996 | 33.3% | 19.5% |
| | Wyoming | 1,154,971 | 415,552 | 276,214 | 36.0% | 23.9% |
| | **Subtotal** | **15,533,794** | **5,182,157** | **3,097,331** | **33.4%** | **19.9%** |
| | **Total** | **17,986,738** | **5,967,919** | **3,618,297** | **33.2%** | **20.1%** |

*Table 4-5 Residential Cumulative Energy Efficiency Achievable Technical Potential Through 2030*

| State | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| California | 1,444 | 3,195 | 5,384 | 8,079 | 11,408 | 15,496 | 20,327 | 25,727 | 31,528 | 37,566 |
| Washington | 8,354 | 17,974 | 29,801 | 44,640 | 63,174 | 86,372 | 113,867 | 144,845 | 178,044 | 212,341 |
| Idaho | 11,956 | 16,646 | 22,282 | 28,288 | 35,701 | 45,000 | 56,117 | 68,923 | 83,083 | 98,191 |
| Utah | 146,470 | 240,371 | 334,908 | 436,235 | 542,250 | 644,272 | 761,202 | 895,220 | 1,043,799 | 1,202,579 |
| Wyoming | 13,983 | 25,817 | 39,235 | 53,761 | 68,590 | 82,304 | 96,910 | 112,560 | 129,489 | 147,271 |
| **Total** | **182,207** | **304,003** | **431,610** | **571,003** | **721,123** | **873,444** | **1,048,424** | **1,247,274** | **1,465,945** | **1,697,949** |

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 2040 achievable technical potential that is attributable to each segment, largely driven by the share of sales in the baseline projection.[34] Single-family homes represent the largest share, with 80% of total achievable technical potential.

[34] Figure excludes potential for incremental Home Energy Reports, which was not assigned to specific segments or end uses.

*Figure 4-2 Residential Cumulative Achievable Technical Potential by Segment in 2040*

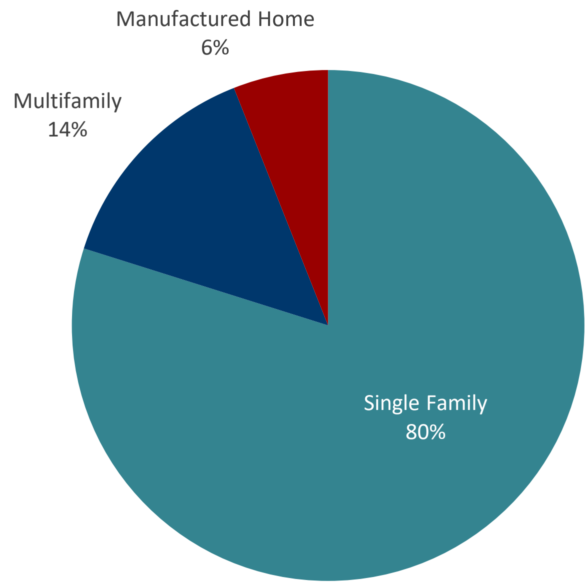



Figure 4-3 and Table 4-6 present the estimates of Energy efficiency potential for the residential sector from an end- use perspective.[35] Key findings and observations are outlined below:

- Nearly half of the achievable technical potential (46%) comes from HVAC systems through the application of equipment upgrades and building shell measures.
    - The space heating end use provides the largest share of potential, at 26% of total residential achievable technical potential, particularly driven by Washington, Idaho, and California where electric resistance heating is common.
    - The cooling end use comprises 20% of total residential achievable technical potential, driven by large air-conditioning loads in Utah.
- Water heating savings comprise 18% 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.)
- The lighting end uses accounts for 12% 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.
- The appliances, electronics, and miscellaneous end uses represent the remaining 24% of the potential.

[35] Figure excludes potential for incremental Home Energy Reports, which was not assigned to specific segments or end uses.

*Figure 4-3 Residential Cumulative Achievable Technical Potential by End Use in 2040*

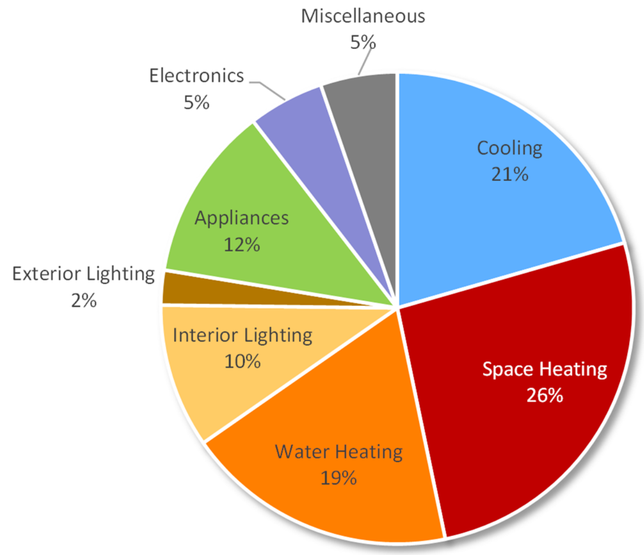



*Table 4-6 Residential Cumulative Energy Efficiency Potential by End Use in 2040*

| End Use | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Achievable Technical Potential (% of Total) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|
| Space Cooling | 2,857,965 | 1,367,247 | 722,497 | 20.0% | 25.3% |
| Space Heating | 3,207,959 | 1,109,672 | 932,419 | 25.8% | 29.1% |
| Water Heating | 1,504,345 | 991,943 | 656,944 | 18.2% | 43.7% |
| Lighting | 1,251,740 | 553,155 | 431,355 | 11.9% | 34.5% |
| Appliances | 3,926,493 | 1,416,193 | 422,234 | 11.7% | 10.8% |
| Electronics | 1,689,144 | 215,902 | 183,154 | 5.1% | 10.8% |
| Miscellaneous | 4,140,196 | 229,660 | 185,549 | 5.1% | 4.5% |
| Home Energy Reports | N/A | 84,146 | 84,146 | 2.3% | N?A |
| Generation | -591,103 | N/A | N/A | N/A | N?A |
| **Total** | **17,986,738** | **5,967,919** | **3,618,297** | **100.0%** | **20.1%** |

## 4.3 Commercial Sector

Table 4-7 presents estimates for cumulative technical and achievable technical potential for the commercial sector by the end of the study period in 2040. From the energy efficiency resources assessed in this study, the technical potential savings are 6.1 million MWh or 35% of the baseline forecast in 2040. The corresponding achievable technical potential is 4.6 million MWh or 27% of the 2040 baseline. Savings as a percent of the baseline are fairly consistent across states, with California and Washington showing lower opportunities on a percentage basis due to more stringent building codes. 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. Cumulative commercial achievable technical potential by state for the first 10 years of the study period is presented in Table 4-8.

*Table 4-7 Commercial Cumulative Energy Efficiency Potential by State in 2040*

| Territory | State | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|---|
| Pacific Power | California | 243,425 | 79,464 | 59,223 | 32.6% | 24.3% |
| | Washington | 1,948,667 | 597,756 | 456,636 | 30.7% | 23.4% |
| | **Subtotal** | **2,192,092** | **677,220** | **515,859** | **30.9%** | **23.5%** |
| Rocky Mountain Power | Idaho | 682,752 | 245,714 | 183,486 | 36.0% | 26.9% |
| | Utah | 12,637,629 | 4,552,218 | 3,460,144 | 36.0% | 27.4% |
| | Wyoming | 1,771,242 | 624,438 | 476,057 | 35.3% | 26.9% |
| | **Subtotal** | **15,091,623** | **5,422,370** | **4,119,688** | **35.9%** | **27.3%** |
| | **Total** | **17,283,715** | **6,099,590** | **4,635,547** | **35.3%** | **26.8%** |

*Table 4-8 Commercial Cumulative Energy Efficiency Achievable Technical Potential Through 2030*

| State | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| California | 2,906 | 6,110 | 9,660 | 13,580 | 17,845 | 22,483 | 27,290 | 32,086 | 36,690 | 40,868 |
| Washington | 26,158 | 53,717 | 82,641 | 112,856 | 145,481 | 179,044 | 212,081 | 243,644 | 273,565 | 302,155 |
| Idaho | 7,983 | 16,585 | 25,958 | 36,204 | 47,927 | 60,548 | 73,714 | 86,763 | 99,376 | 111,542 |
| Utah | 159,362 | 340,713 | 539,614 | 746,991 | 982,418 | 1,219,286 | 1,465,336 | 1,707,161 | 1,939,415 | 2,162,573 |
| Wyoming | 24,771 | 52,703 | 83,444 | 114,502 | 149,505 | 183,784 | 219,106 | 253,274 | 285,592 | 316,174 |
| **Total** | **221,180** | **469,828** | **741,317** | **1,024,132** | **1,343,177** | **1,665,145** | **1,997,526** | **2,322,928** | **2,634,639** | **2,933,313** |

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..[36] Figure 4-4 below shows the share of 2040 technical potential that is attributable to each segment. Small and large offices represent the largest share, with a combined 32% of total savings potential.

36 Controlled Atmosphere warehouses are only modeled for Washington, where they are more prominent.

*Figure 4-4 Commercial Cumulative Achievable Technical Potential by Segment in 2040*

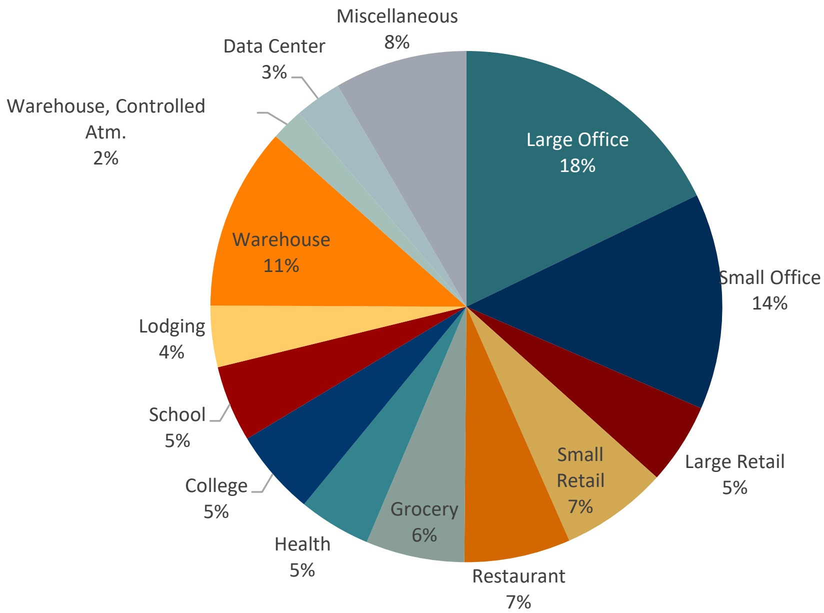



Figure 4-5 and Table 4-9 present the estimates of energy efficiency potential for the commercial sector from an end-use perspective. Key findings and observations are outlined below:

- Lighting opportunities represent roughly 38% 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.
- 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 (41% of the potential). The largest of these three is cooling, driven by large air conditioning loads in Utah.
- Refrigeration makes up 12% of the total commercial potential, primarily from grocery stores throughout the region and the controlled atmosphere segment in Washington.
- The water heating, food preparation, office equipment, and miscellaneous end uses make up the remaining 9% of potential.

*Figure 4-5 Commercial Cumulative Achievable Technical Potential by End Use in 2040*

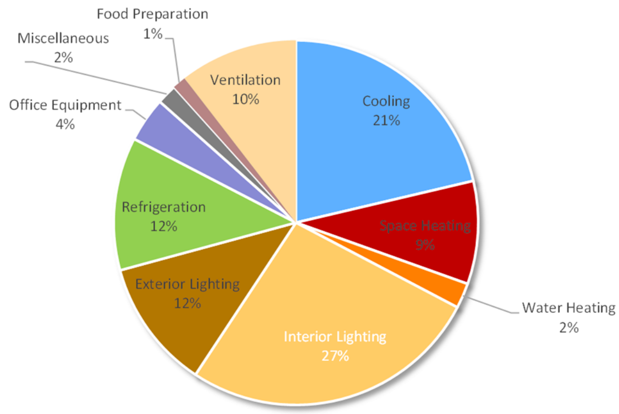



*Table 4-9 Commercial Cumulative Energy Efficiency Potential by End Use in 2040*

| End Use | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Achievable Technical Potential (% of Total) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|
| Cooling | 1,901,862 | 1,351,184 | 987,186 | 21.3% | 51.9% |
| Heating | 673,691 | 499,468 | 423,282 | 9.1% | 62.8% |
| Ventilation | 2,288,186 | 646,034 | 485,527 | 10.5% | 21.2% |
| Water Heating | 420,336 | 341,947 | 103,894 | 2.2% | 24.7% |
| Interior Lighting | 2,900,615 | 1,493,022 | 1,232,065 | 26.6% | 42.5% |
| Exterior Lighting | 1,171,615 | 664,135 | 532,293 | 11.5% | 45.4% |
| Refrigeration | 1,524,430 | 653,651 | 550,465 | 11.9% | 36.1% |
| Food Preparation | 478,826 | 83,347 | 55,229 | 1.2% | 11.5% |
| Office Equipment | 2,643,582 | 266,066 | 182,948 | 3.9% | 6.9% |
| Miscellaneous | 3,429,862 | 100,736 | 82,657 | 1.8% | 2.4% |
| Generation | (149,291) | N/A | N/A | N/A | N/A |
| **Total** | **17,283,715** | **6,099,590** | **4,635,547** | **100%** | **26.8%** |

## 4.4 Industrial Sector

Table 4-10 presents estimates for cumulative technical and achievable technical potential for the industrial sector by the end of the study period in 2040. From the energy efficiency resources assessed in this study, the technical potential savings are 2.8 million MWh or 17% of the baseline forecast in 2040 in the absence of DSM programs. The corresponding achievable technical potential is 2.4 million MWh or 14% of the 2040 baseline. Cumulative industrial achievable technical potential by state for the first 10 years of the study period is presented in Table 4-11.

*Table 4-10 Industrial Cumulative Energy Efficiency Potential by State in 2040*

| Territory | State | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|---|
| Pacific Power | California | 68,623 | 9,682 | 7,961 | 14.1% | 11.6% |
| | Washington | 1,137,560 | 211,325 | 177,729 | 18.6% | 15.6% |
| | **Subtotal** | **1,206,183** | **221,007** | **185,690** | **18.3%** | **15.4%** |
| Rocky Mountain Power | Idaho | 352,624 | 66,562 | 55,630 | 18.9% | 15.8% |
| | Utah | 7,258,435 | 1,455,158 | 1,219,204 | 20.0% | 16.8% |
| | Wyoming | 8,366,892 | 1,086,681 | 912,234 | 13.0% | 10.9% |
| | **Subtotal** | **15,977,951** | **2,608,401** | **2,187,069** | **16.3%** | **13.7%** |
| | **Total** | **17,184,134** | **2,829,408** | **2,372,759** | **16.5%** | **13.8%** |

*Table 4-11 Industrial Cumulative Energy Efficiency Achievable Technical Potential Through 2030*

| State | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| California | 320 | 700 | 1,142 | 1,661 | 2,251 | 2,932 | 3,667 | 4,423 | 5,150 | 5,854 |
| Washington | 7,901 | 16,713 | 26,472 | 37,368 | 49,425 | 62,921 | 77,191 | 91,873 | 105,931 | 119,657 |
| Idaho | 2,869 | 6,038 | 9,488 | 13,265 | 17,378 | 21,963 | 26,638 | 31,519 | 35,997 | 40,315 |
| Utah | 56,675 | 117,717 | 181,466 | 251,212 | 327,014 | 407,578 | 493,636 | 581,473 | 665,383 | 752,773 |
| Wyoming | 39,566 | 84,843 | 135,556 | 190,314 | 249,187 | 317,780 | 390,879 | 467,201 | 541,299 | 614,504 |
| **Total** | **107,331** | **226,011** | **354,123** | **493,819** | **645,255** | **813,174** | **992,012** | **1,176,488** | **1,353,760** | **1,533,104** |

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 2040 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 33%..[37]

[37] 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 4-6 Industrial Cumulative Achievable Technical Potential by Segment in 2040*

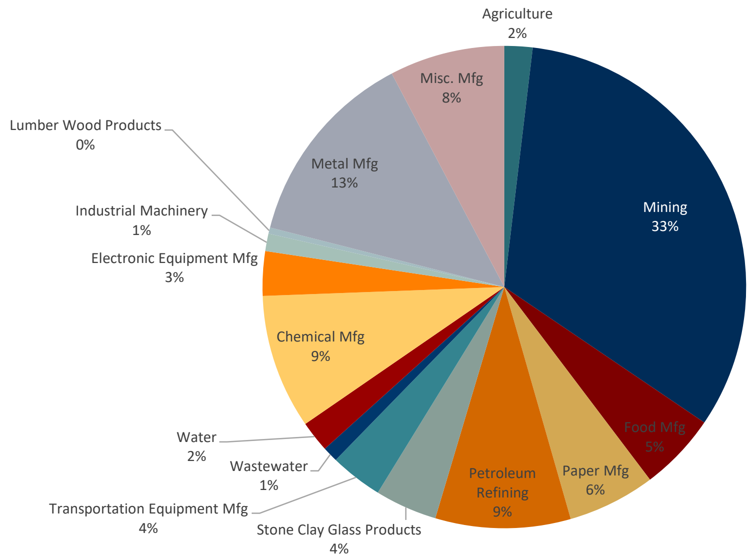



Figure 4-7 and Table 4-12 present the estimates of energy efficiency potential for the industrial sector from an end-use perspective. Key findings and observations are outlined below:

- Motor and process loads represent the largest share of end use consumption in the industrial sector (68% of savings) and, correspondingly, have the largest identified achievable technical potential.
- Motor savings comprise 63% of the total sector potential, while process savings account for an additional 8%.[38] 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.
- Like the residential and commercial sectors, the projected improvements in performance and applicability of LED lighting technologies provides a large potential opportunity in the industrial sector, leading to lighting representing 21% of the identified achievable technical potential.
- Potential for the heating, cooling, ventilation, and miscellaneous end uses, represent the remaining 9% of potential, mainly realized within the non-industrial portions of the space (e.g. warehouse and office spaces).

[38] 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.

*Figure 4-7 Industrial Cumulative Achievable Technical Potential by End Use in 2040*

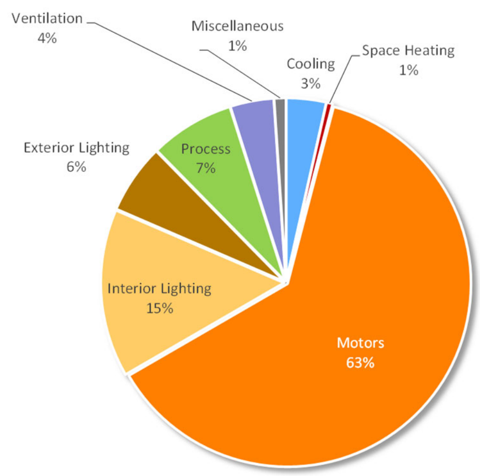



*Table 4-12 Industrial Cumulative Energy Efficiency Potential by End Use in 2040*

| End Use | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Achievable Technical Potential (% of Total) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|
| Cooling | 316,862 | 116,693 | 83,205 | 3.5% | 26.3% |
| Heating | 184,711 | 16,054 | 12,797 | 0.5% | 6.9% |
| Ventilation | 601,011 | 163,035 | 91,169 | 3.8% | 15.2% |
| Interior Lighting | 568,945 | 383,296 | 352,564 | 14.9% | 62.0% |
| Exterior Lighting | 284,024 | 166,036 | 146,167 | 6.2% | 51.5% |
| Motors | 11,661,289 | 1,747,189 | 1,485,249 | 62.6% | 12.7% |
| Process | 2,656,844 | 208,084 | 176,904 | 7.5% | 6.7% |
| Miscellaneous | 910,448 | 29,022 | 24,704 | 1.0% | 2.7% |
| **Total** | **17,184,134** | **2,829,408** | **2,372,759** | **100.0%** | **13.8%** |

## 4.5 Irrigation Sector

Table 4-13 presents estimates for cumulative technical and achievable technical potential for the irrigation sector by the end of the study period in 2040. From the energy efficiency resources assessed in this study, the technical potential savings are roughly 200,000 MWh or 16% of the baseline forecast in 2040. The corresponding achievable technical potential is about 170,000 MWh or 14% of the 2040 baseline. Cumulative irrigation achievable technical potential by state for the first 10 years of the study period is presented in Table 4-14.

*Table 4-13 Irrigation Cumulative Energy Efficiency Potential by State in 2040*

| Territory | State | Baseline Loads (MWh) | Technical Potential (MWh) | Achievable Technical Potential (MWh) | Technical Potential (% of Baseline) | Achievable Technical Potential (% of Baseline) |
|---|---|---|---|---|---|---|
| Pacific Power | California | 93,501 | 21,978 | 19,029 | 23.5% | 20.4% |
| | Washington | 166,221 | 41,403 | 35,892 | 24.9% | 21.6% |
| | **Subtotal** | **259,721** | **63,381** | **54,920** | **24.4%** | **21.1%** |
| Rocky Mountain Power | Idaho | 715,928 | 95,671 | 82,127 | 13.4% | 11.5% |
| | Utah | 242,050 | 35,135 | 30,191 | 14.5% | 12.5% |
| | Wyoming | 26,277 | 4,690 | 4,041 | 17.8% | 15.4% |
| | **Subtotal** | **984,255** | **135,496** | **116,359** | **13.8%** | **11.8%** |
| | **Total** | **1,243,976** | **198,877** | **171,279** | **16.0%** | **13.8%** |

*Table 4-14 Irrigation Cumulative Energy Efficiency Achievable Technical Potential Through 2030*

| State | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| California | 944 | 1,910 | 2,921 | 3,996 | 5,154 | 6,353 | 7,555 | 8,782 | 10,033 | 11,298 |
| Washington | 1,963 | 3,961 | 6,034 | 8,216 | 10,541 | 12,902 | 15,213 | 17,520 | 19,836 | 22,149 |
| Idaho | 4,050 | 8,214 | 12,581 | 17,231 | 22,244 | 27,413 | 32,551 | 37,753 | 43,046 | 48,400 |
| Utah | 1,656 | 3,345 | 5,097 | 6,939 | 8,900 | 10,884 | 12,812 | 14,727 | 16,644 | 18,558 |
| Wyoming | 273 | 548 | 829 | 1,119 | 1,419 | 1,712 | 1,982 | 2,238 | 2,483 | 2,719 |
| **Total** | **8,885** | **17,978** | **27,463** | **37,502** | **48,259** | **59,265** | **70,114** | **81,019** | **92,042** | **103,124** |

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

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

crops are more prevalent, leading to smaller pump sizes. In Rocky Mountain Power territories, larger row crop fields and deeper water reservoirs require larger pumps.

# 5

# DEMAND RESPONSE POTENTIAL

This section presents potential analysis results for demand response resources using the methodology outlined in Chapter 2 of this report. To avoid double-counting potential, results account for competition between program options. For example, a customer with a central air conditioner cannot participate in both a DLC program and a smart thermostat program, as both programs curtail the same piece of equipment. To account for this, our analysis made assumptions about the choices that eligible customers would make if competing options were offered in parallel, based on observed customer preference in similar pilots and full-scale deployments from other utility programs.

The demand response analysis builds off of the energy efficiency assessment, assuming that PacifiCorp would first pursue energy efficiency resources, and that these programs may create new opportunities for demand response (e.g., connected thermostats). To avoid double-counting potential within the demand response analysis, results account for competition between program options. For example, a customer with a central air conditioner cannot participate in both a DLC program and a smart thermostat program, as both programs curtail the same piece of equipment. Additionally, in cases where PacifiCorp has existing demand response programs, results are addition to, not inclusive of, impacts from existing programs.[39]

## 5.1 Summary Program Potential Results

Demand response potential starts with a strong resource base already in place and increases rapidly in the early years as new programs are assumed to become available. After this, participation more or less reaches a steady state such that savings potential grows only with the growth of new eligible equipment or customers. In our analysis we assumed new program offerings would be available for implementation beginning in 2022 to allow for vendor selection, contracting and regulatory approvals and that program participation would ramp up over three years.

Table 5-1 presents the identified program potential in 2040 by season and event type. As discussed previously, new for this CPA was the assessment of demand response impacts for both short and sustained duration, reflecting different opportunities for demand reduction depending on use case. As shown, the impacts for short duration events tend to be higher than for sustained duration because equipment can be completely curtailed for a short period of time, rather than cycled over a longer period.

*Table 5-1 Demand Response Program Potential by Season and Event Type, 2040*

| | Summer MW | | Winter MW | |
|---|---|---|---|---|
| Program | Short Duration | Sustained Duration | Short Duration | Sustained Duration |
| HVAC Direct Load Control (DLC) | 117 | 60 | 198 | 132 |
| Domestic Hot Water Heater (DHW) DLC | 5 | 4 | 12 | 10 |
| Grid-Interactive Water Heaters | 57 | 46 | 158 | 133 |
| Connected Thermostat DLC | 148 | 80 | 57 | 32 |
| Smart Appliance DLC | 27 | 15 | 10 | 6 |
| Pool Pump DLC | 1 | 1 | 1 | 1 |

[39] PacifiCorp's current demand response programs target air conditioning and irrigation loads that are only available in the summer. As such, the winter potential represents both the incremental and total identified potential.

| | | | | |
|---|---|---|---|---|
| Electric Vehicle Connected Charger DLC | 51 | 51 | 52 | 52 |
| Battery Energy Storage DLC | 676 | 417 | 676 | 417 |
| Third Party Contracts | 198 | 208 | 157 | 173 |
| Irrigation Load Control | 21 | 21 | 0 | 0 |
| **Total All Sectors** | **1,300** | **904** | **1,322** | **957** |

For direct comparison to previous assessments, the remainder of this chapter focuses on impacts during sustained duration events. Detailed potential during short duration events is provided in Appendix I.

## 5.2 State-Level Program Potential and Levelized Costs

### 5.2.1 Summer Peak

Table 5-2 shows total demand response potential results in 2040 by option and state during the summer peak. Again, the potential includes the impacts from PacifiCorp's existing demand response programs and accounts for competition between potential offerings. Key observations are:

- Roughly half of the identified program potential is in Utah, driven by the following factors:
  - Significant projected residential customer and load growth, created opportunities to expand the existing Cool Keeper program
  - High solar PV adoption, which is a key driver in the battery energy storage analysis.
  - A large, concentrated base on non-residential customers who may participate in the Third Party Contracts program.
- Oregon represents about 27% of the program potential, primarily from Battery Energy Storage, Connected Thermostats, and Third Party Agreements.
- California, Idaho, Washington, and Wyoming combined represent the remaining 20% of system-wide potential, about 40% of which is associated with battery energy storage.

*Table 5-2 Sustained Duration Demand Response Program Potential by State, 2040 (Summer Peak MW)*

| Program | CA | ID | OR | UT | WA | WY | Total |
|---|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | 1 | 3 | 10 | 39 | 3 | 4 | 60 |
| Domestic Hot Water Heater (DHW) DLC | 0 | 0 | 1 | 2 | 0 | 0 | 4 |
| Grid-Interactive Water Heaters | 1 | 2 | 17 | 20 | 5 | 2 | 46 |
| Connected Thermostat DLC | 1 | 1 | 55 | 7 | 15 | 2 | 80 |
| Smart Appliance DLC | 0 | 0 | 10 | 1 | 3 | 0 | 15 |
| Pool Pump DLC | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Electric Vehicle Connected Charger DLC | 0 | 0 | 12 | 36 | 2 | 1 | 51 |
| Battery Energy Storage DLC | 19 | 32 | 89 | 254 | 8 | 16 | 417 |
| Third Party Contracts | 2 | 7 | 44 | 105 | 16 | 34 | 208 |
| Irrigation Load Control | 1 | 0 | 4 | 12 | 2 | 1 | 21 |
| **Total All Sectors** | **26** | **46** | **242** | **476** | **54** | **59** | **904** |

Table 5-3 presents the levelized costs for summer peak impacts by program and state. As shown, Battery Energy Storage, Irrigation Load Control, and Connected Thermostats represent the lowest-cost options at under $100/kW-year in almost all instances. As discussed previously there are several factors of note in the levelized cost calculations:

- For programs capable of providing impacts during both the summer and winter peak periods, costs have been allocated evenly across the two seasons. Therefore, if a program were to be run for only one season, the levelized costs presented below would be expected to double.
- The Total Resource Cost methodology tends to decrease costs in Pacific Power states relative to Rocky Mountain Power states, because only a portion of the incentive is included in the levelized cost calculation as a proxy for participant costs.
- Levelized costs are calculated over a five-year period, which includes the three-year participation ramp-up period. Hence, programs at scale may be able to operate at lower costs.
- Because program-level potential incorporates competition between options, levelized costs may not reflect actual costs if only one program is implemented. For example, because of the existing Cool Keeper program infrastructure, the analysis assumes Rocky Mountain Power would expand this program to acquire additional cooling potential rather than implementing a Connected Thermostat Program. Therefore, all of the remaining residential cooling potential is allocated to the HVAC DLC program, and the costs presented below may not be reflective of a full-scale Connected Thermostat program.

*Table 5-3 Demand Response Summer Levelized Costs ($/kW-year)*

| Program | CA | ID | OR | UT | WA | WY |
|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | $220 | $358 | $170 | $74 | $155 | $299 |
| Domestic Hot Water Heater (DHW) DLC | $76 | $225 | $58 | $114 | $57 | $182 |
| Grid-Interactive Water Heaters | $195 | $524 | $129 | $226 | $127 | $387 |
| Connected Thermostat DLC | $66 | $201 | $29 | $18 | $28 | $89 |
| Smart Appliance DLC | $224 | $978 | $84 | $971 | $74 | $966 |
| Pool Pump DLC | $558 | $971 | $484 | $379 | $484 | $473 |
| Electric Vehicle Connected Charger DLC | $135 | $144 | $143 | $162 | $147 | $143 |
| Battery Energy Storage DLC | $49 | $62 | $49 | $62 | $49 | $62 |
| Third Party Contracts | $1,108 | $1,424 | $284 | $125 | $153 | $259 |
| Irrigation Load Control | $50 | $65 | $57 | $65 | $41 | $59 |

### 5.2.2 Winter Peak

Table 5-4 presents the demand response potential results in 2040 by option for each state during the winter peak. Note that PacifiCorp does not currently have any winter-focused demand response programs, so unlike summer, the potential results are all incremental to what is being realized today. Key observations from the winter potential are:

- The overall magnitude of potential and distribution across states is similar to the summer potential
- Battery energy storage is by far the largest opportunity, representing 44% of the total identified potential.

- Potential for grid-interactive water heaters is higher in the winter than in the summer due to higher coincidence of water heating loads with peak periods.
- Although irrigation load control is a large contributor to summer potential, there is no potential in the winter due to the seasonality of irrigation loads.

*Table 5-4 Sustained Duration Demand Response Program Potential State, 2040 (Winter Peak MW)*

| Program | CA | ID | OR | UT | WA | WY | Total |
|---|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | 3 | 7 | 39 | 59 | 18 | 7 | 132 |
| Domestic Hot Water Heater (DHW) DLC | 0 | 1 | 2 | 6 | 0 | 1 | 10 |
| Grid-Interactive Water Heaters | 4 | 5 | 49 | 55 | 15 | 5 | 133 |
| Connected Thermostat DLC | 0 | 0 | 21 | 4 | 6 | 1 | 32 |
| Smart Appliance DLC | 0 | 0 | 4 | 1 | 1 | 0 | 6 |
| Pool Pump DLC | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Electric Vehicle Connected Charger DLC | 0 | 0 | 12 | 37 | 3 | 1 | 52 |
| Battery Energy Storage DLC | 19 | 32 | 89 | 254 | 8 | 16 | 417 |
| Third Party Contracts | 1 | 5 | 41 | 81 | 13 | 31 | 173 |
| Irrigation Load Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total All Sectors** | **28** | **50** | **257** | **497** | **64** | **62** | **958** |

Table 5-5 presents the levelized costs for winter peak impacts by program and state. As in the summer analysis, Battery Energy Storage was identified as a relatively low-cost option for addressing winter peak demand, Water heater and connected thermostat programs also tend to have relatively low costs in the winter, at least in states with larger markets or higher saturations of electric space and water heating. year in almost all instances. The same caveats apply to these levelized costs as presented in the Summer Peak section above.

*Table 5-5 Demand Response Winter Levelized Costs ($/kW-year)*

| Program | CA | ID | OR | UT | WA | WY |
|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | $104 | $221 | $83 | $214 | $47 | $190 |
| Domestic Hot Water Heater (DHW) DLC | $34 | $94 | $27 | $58 | $27 | $84 |
| Grid-Interactive Water Heaters | $86 | $214 | $59 | $114 | $57 | $175 |
| Connected Thermostat DLC | $157 | $1,318 | $59 | $53 | $60 | $438 |
| Smart Appliances DLC | $353 | $1,069 | $162 | $1,016 | $158 | $1,020 |
| Smart Appliance DLC | $548 | $953 | $479 | $359 | $467 | $438 |
| Pool Pump DLC | $138 | $149 | $145 | $162 | $144 | $145 |
| Electric Vehicle Connected Charger DLC | $49 | $62 | $49 | $62 | $49 | $62 |
| Third Party Contracts | $1,448 | $2,320 | $342 | $185 | $202 | $306 |
| Irrigation Load Control | N/A | N/A | N/A | N/A | N/A | N/A |

## 5.3 Pacific Power Levelized Cost Scenarios

As discussed in Chapter 2, levelized costs were developed for Pacific Power states using the CPUC's 2016 Demand Response Cost Effectiveness Protocols. Per these protocols, rather than counting the full incentive (as in states using the Utility Cost Test), only the portion of the incentive assumed to represent the participant's cost to participate in the program is included.

AEG developed base demand response participant cost assumptions using guidance from the CPUC Protocols and the Council's Draft 2021 Power Plan. Levelized cost values presented previously in this chapter reflect these assumptions. However, because participant costs are difficult to quantify, and in response to a stakeholder request, AEG also calculated levelized costs in Pacific Power states using low and high participant cost assumptions. These low and high assumptions were based on guidance from the CPUC Protocols and are presented in Table 2-5. The levelized costs incorporating low, base and high assumptions are presented in Table 5-6 and Table 5-7 for summer and winter peak periods, respectively. Note, because demand response is assessed on a Utility Cost Test basis in Rocky Mountain Power states, the full incentive is included and participant costs are not relevant, therefore, the low and high levelized cost cases do not apply in Idaho, Utah, and Wyoming.

*Table 5-6 Demand Response Summer Levelized Cost Scenarios ($/kW-year)*

| Rate Option | CA Low | CA Base | CA High | OR Low | OR Base | OR High | WA Low | WA Base | WA High |
|---|---|---|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | $204 | $220 | $237 | $157 | $170 | $183 | $143 | $155 | $166 |
| Domestic Hot Water Heater (DHW) DLC | $66 | $76 | $85 | $50 | $58 | $66 | $50 | $57 | $65 |
| Grid-Interactive Water Heaters | $181 | $195 | $210 | $117 | $129 | $141 | $115 | $127 | $139 |
| Connected Thermostat DLC | $54 | $66 | $78 | $24 | $29 | $34 | $23 | $28 | $33 |
| Smart Appliance DLC | $193 | $224 | $255 | $73 | $84 | $95 | $64 | $74 | $83 |
| Pool Pump DLC | $515 | $558 | $601 | $447 | $484 | $521 | $446 | $484 | $521 |
| Electric Vehicle Connected Charger DLC | $124 | $135 | $146 | $132 | $143 | $155 | $135 | $147 | $158 |
| Battery Energy Storage DLC | $36 | $49 | $61 | $37 | $49 | $62 | $36 | $49 | $61 |
| Third Party Contracts | $1,081 | $1,108 | $1,136 | $274 | $284 | $295 | $146 | $153 | $160 |
| Irrigation Load Control | $42 | $50 | $57 | $50 | $57 | $65 | $34 | $41 | $49 |

*Table 5-7 Demand Response Winter Levelized Cost Scenarios ($/kW-year)*

| Rate Option | CA Low | CA Base | CA High | OR Low | OR Base | OR High | WA Low | WA Base | WA High |
|---|---|---|---|---|---|---|---|---|---|
| HVAC Direct Load Control (DLC) | $96 | $104 | $111 | $76 | $83 | $89 | $43 | $47 | $50 |
| Domestic Hot Water Heater (DHW) DLC | $30 | $34 | $39 | $24 | $27 | $31 | $23 | $27 | $30 |
| Grid-Interactive Water Heaters | $79 | $86 | $92 | $53 | $59 | $64 | $52 | $57 | $62 |
| Connected Thermostat DLC | $127 | $157 | $187 | $48 | $59 | $70 | $49 | $60 | $70 |
| Smart Appliance DLC | $305 | $353 | $402 | $141 | $162 | $184 | $138 | $158 | $179 |
| Pool Pump DLC | $506 | $548 | $590 | $443 | $479 | $516 | $432 | $467 | $503 |
| Electric Vehicle Connected Charger DLC | $127 | $138 | $150 | $133 | $145 | $156 | $133 | $144 | $156 |
| Battery Energy Storage DLC | $36 | $49 | $61 | $37 | $49 | $62 | $36 | $49 | $61 |
| Third Party Contracts | $1,413 | $1,448 | $1,484 | $329 | $342 | $355 | $192 | $202 | $211 |
| Irrigation Load Control | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

# 6

# DEMAND-SIDE RATES POTENTIAL

This section presents potential analysis results for demand-side rates using the methodology outlined in Chapter 2 of this report. Because the results of this analysis are not being used to inform resource planning, options are assessed independently of one another to illustrate the relative magnitude of each option if offered in isolation. That is, the analysis does not consider interactive effects between competing options, such as a time-of-use with or without a critical peak pricing component. Because of this, impacts should not be totaled across options, as this would overstate the total possible demand reduction from demand-side rates.

## 6.1 Summary Potential Results

Table 6-1 presents the potential from demand-side rate options in 2040 during summer and winter peak periods. This total captures any expansion opportunities for existing pricing options and new options that have incremental potential in future years. Key observations from our analysis are:

- Savings from new TOU rates, RTP, and CPP are realized from 2021 onward, based on when AMI is available in each state as mentioned above. Because PacifiCorp has a long-standing residential TOU offering in Idaho with high participation, no additional potential was identified.
- Throughout the forecast period, CPP has the largest savings potential. In general, CPP has the highest contribution of the various demand-side rates because higher on-to-off peak price ratios combined with an "event" type structure typically encourage participants to shift more energy than a typical TOU or demand rate.
- For C&I customers, CPP carries significantly higher potential than other pricing options, at 91 MW in the summer by 2040. Commercial savings opportunities from RTP and TOU are considerably lower in 2040, particularly in the case of TOU, where PacifiCorp has already captured significant impacts through existing rates.
- For Irrigation customers, CPP rates have significantly more savings summer potential in 2040 (17 MW) when compared to TOU rates (5 MW), but no potential is available in the winter due to the seasonality of these loads.

*Table 6-1 Demand-Side Rates Potential in 2040*

| Rate Option | Summer Potential (MW) | Winter Potential (MW) |
|---|---|---|
| Residential TOU | 77.4 | 40.7 |
| Residential TOU with EV | 17.1 | 7.0 |
| Residential CPP | 105.7 | 68.2 |
| Residential Behavioral DR | 18.5 | 9.3 |
| C&I TOU | 0.3 | 0.2 |
| C&I CPP | 91.0 | 39.5 |
| C&I RTP | 16.2 | 6.9 |
| Irrigation TOU | 4.3 | - |
| Irrigation CPP | 17.4 | - |

## 6.2 Detailed Potential Results by State and Customer Sector

Table 6-2 and Table 6-3 present the total 2040 demand-side rates potential by state during summer and winter peak periods, respectively. This combines the effects of existing pricing options with new options that have incremental potential in future years. Key observations are:

- In Idaho, roughly half of the savings opportunities from pricing options are in the irrigation sector.
- In Utah, residential CPP has the highest contribution to potential. The three C&I pricing options combined have roughly equal potential to residential CPP.
- Oregon has the second highest potential, after Utah. Residential pricing (TOU, TOU Demand Rate w/EV, and CPP) constitute more than half of the potential in Oregon.
- Wyoming ranks third in terms of potential contribution from pricing options. Most of the potential is derived from C&I customers, particularly large sized industrial customers.
- In Washington and California, the residential sector constitutes nearly half the total savings potential from pricing options.
- Similar trend continues in the winter peak season, with Utah and Oregon contributing the most potential due to the residential rate programs and C&I CPP.

*Table 6-2 Demand-Side Rates Potential by Option and State in 2040 (Summer Peak MW)*

| Rate Option | CA | ID | OR | UT | WA | WY | Total |
|---|---|---|---|---|---|---|---|
| Residential TOU | 0.9 | - | 18.0 | 47.7 | 6.9 | 3.9 | **77.4** |
| Residential TOU with EV | 0.2 | - | 3.5 | 12.5 | 0.7 | 0.3 | **17.1** |
| Residential CPP | 1.2 | 2.3 | 24.1 | 63.6 | 9.2 | 5.2 | **105.7** |
| Residential Behavioral DR | 0.3 | 0.8 | 5.4 | 9.9 | 1.0 | 1.1 | **18.5** |
| C&I TOU | 0.0 | 0.3 | - | - | - | - | **0.3** |
| C&I CPP | 0.6 | 1.4 | 18.9 | 45.5 | 6.4 | 18.1 | **91.0** |
| C&I RTP | 0.1 | 0.2 | 3.3 | 7.6 | 0.9 | 4.2 | **16.2** |
| Irrigation TOU | 0.2 | 2.7 | 0.6 | 0.4 | 0.4 | 0.1 | **4.3** |
| Irrigation CPP | 0.8 | 10.3 | 2.4 | 2.3 | 1.4 | 0.3 | **17.4** |

*Table 6-3 Demand-Side Rates Potential by Option and State in 2040 (Winter Peak MW)*

| Rate Option | CA | ID | OR | UT | WA | WY | Total |
|---|---|---|---|---|---|---|---|
| Residential TOU | 1.0 | - | 15.0 | 17.5 | 4.5 | 2.7 | **40.7** |
| Residential TOU with EV | 0.1 | - | 1.4 | 5.1 | 0.3 | 0.1 | **7.0** |
| Residential CPP | 1.6 | 2.9 | 24.1 | 28.0 | 7.3 | 4.3 | **68.2** |
| Residential Behavioral DR | 0.2 | 0.4 | 2.7 | 4.9 | 0.5 | 0.6 | **9.3** |
| C&I TOU | - | 0.2 | - | - | - | - | **0.2** |
| C&I CPP | 0.3 | 0.7 | 10.2 | 16.9 | 3.1 | 8.4 | **39.5** |
| C&I RTP | 0.0 | 0.1 | 1.8 | 2.6 | 0.4 | 1.9 | **6.9** |
| Irrigation TOU | - | - | - | - | - | - | **-** |
| Irrigation CPP | - | - | - | - | - | - | **-** |

7

# COMPARISON WITH PREVIOUS STUDY

This assessment uses the same general industry-standard methods for assessing long-term energy efficiency potential as employed in PacifiCorp's previous assessments, published in 2007, 2011, 2013, 2015 2017, and 2019. Conservation potential assessments, by nature, provide a best estimate of the available opportunity based on the best data available and accepted assumptions at the time of the analysis. As such, results between assessments will vary based on updated primary and secondary data sources, new building codes and equipment efficiency standards, increased availability and adoption of emerging technologies, and other factors. This chapter compares this assessment's results to those from the 2019 assessment and explains the drivers of key differences.

## 7.1 Energy Efficiency

### 7.1.1 Key Differences

This assessment of energy efficiency reflects the following changes compared to the previous study conducted in 2017:

- Updated PacifiCorp load forecasts, including a significant increase in projected loads for residential customers in Utah.
- State energy codes and equipment efficiency standards enacted as of April 2020, even if they have not yet taken effect.
- Feedback provided through PacifiCorp's 2021 IRP public meeting process, including new assumptions for administrative and incentive costs
- Adjustments to measure savings, based on recent evaluation results, data available from the Regional Technical Forum (RTF), and other updated secondary sources available before April 2020.
- 2018 customer and sales information to determine segmentation; and updated sales and customer forecasts.
- A comprehensive review of emerging technology measures
- New emerging technologies and updated assumptions around applicability, cost, and efficacy of LED lighting.
- Transition to the Utility Cost Test in Wyoming

### 7.1.2 Energy Efficiency Potential Comparison by Sector

Table 7-1 compares cumulative 20-year potential between the current and 2019 study, in absolute terms and as a percentage of projected loads, by sector. As shown, the 2021 CPA estimates slightly higher long-term achievable technical potential than the 2019 study, driven primarily by the residential sector, which incorporates a significantly higher baseline projection in Utah. Non-residential potential is very similar between the two studies. As discussed previously in this report, street lighting potential was not included in the current assessment because PacifiCorp's load forecast assumes all streetlights will be converted to LED over the 20-year period.

*Table 7-1 Comparison of Energy efficiency Potential with Previous Assessment*

| Sector | Achievable Technical Potential (Year-20 Cumulative MWh) | | Achievable Technical Potential (Year-20 Cumulative as % of Baseline Loads) | |
|---|---|---|---|---|
| | Previous Assessment | Current Assessment | Previous Assessment | Current Assessment |
| Residential | 2,674,197 | 3,676,536 | 19.7% | 20.1% |
| Commercial | 4,534,085 | 4,715,782 | 27.4% | 26.8% |
| Industrial | 2,244,656 | 2,366,665 | 12.9% | 13.8% |
| Irrigation | 122,775 | 170,571 | 9.7% | 13.8% |
| Street Lighting | 43,491 | N/A | 41.4% | N/A |
| **Total** | **9,619,204** | **10,929,555** | **19.7%** | **20.1%** |

## 7.2 Demand Response

As discussed throughout this report, the methodology for assessing demand response potential in the current CPA is significantly different from precious studies. While this updated methodology reflects a step forward in terms of integration with the energy efficiency analysis and the ability to assess potential during different types of events, it makes it difficult to compare results to previous studies. Nonetheless, Table 7-2 and Table 7-3 compares 20-year demand response potential for sustained duration.[40] summer and winter demand response options, respectively. Aside from overall methodology, AEG notes the following key drivers of changes in potential between the two studies:

- The inclusion of battery energy storage creates a large new opportunity in the current CPA.
- The emergence of grid-interactive water heaters, their inclusion in new equipment standards in the Northwest, and new studies assessing per-unit impacts increased the opportunity for water heater demand response.
- The current CPA assumes that in Rocky Mountain Power states, PacifiCorp would prioritize expanding the existing air conditioning load control network over beginning new connected thermostat programs.
- A higher electric vehicle adoption forecast and updated information on the controllability of electric vehicle chargers increased the potential for this option relative to the previous CPA.

[40] The previous CPA included a separately Ancillary Services product, which is not included in the comparison tables, as it was focused on short-duration demand reductions.

*Table 7-2 Comparison of Demand Response Potential with Previous Assessment (Summer)*

| DSM Options | Potential in Year-20 (Peak MW) | |
|---|---|---|
| | Previous Assessment | Current Assessment |
| HVAC Direct Load Control (DLC) | 63 | 60 |
| Domestic Hot Water Heater (DHW) DLC | 39 | 4 |
| Grid-Interactive Water Heaters | - | 46 |
| Connected Thermostat DLC | 252 | 80 |
| Smart Appliances DLC | 15 | 15 |
| DLC of Pool Pumps | - | 1 |
| Electric Vehicle DLC Smart Chargers | 7 | 51 |
| Battery Energy Storage DLC | - | 417 |
| Third Party Contracts | 175 | 208 |
| Irrigation Load Control | 56 | 21 |
| **Total Demand Response Potential** | **608** | **904** |

*Table 7-3 Comparison of Demand Response Potential with Previous Assessment (Winter)*

| DSM Options | Potential in Year-20 (Peak MW) | |
|---|---|---|
| | Previous Assessment | Current Assessment |
| HVAC Direct Load Control (DLC) | 138 | 132 |
| Domestic Hot Water Heater (DHW) DLC | 39 | 10 |
| Grid-Interactive Water Heaters | - | 133 |
| Connected Thermostat DLC | 127 | 32 |
| Smart Appliances DLC | 15 | 6 |
| DLC of Pool Pumps | - | 1 |
| Electric Vehicle DLC Smart Chargers | 7 | 52 |
| Battery Energy Storage DLC | - | 417 |
| Third Party Contracts | 134 | 173 |
| Irrigation Load Control | - | 0 |
| **Total Demand Response Potential** | **459** | **957** |

## 7.3 Demand-Side Rates

Table 7-4 and Table 7-5 compare the 20-year demand-side rates potential between the current and previous CPA during summer and winter peak periods, respectively. As shown, potential is very similar between the two studies. In general, potential is higher in the residential sector in the current study, driven by a significantly higher baseline projection of residential sales in Utah.

*Table 7-4 Comparison of Demand-Side Rates Potential with Previous Assessment (Summer)*

| DSM Options | Summer Potential in Year-20 | |
|---|---|---|
| | Previous Assessment | Current Assessment |
| Res TOU Demand Rate | 37.3 | N/A |
| Res TOU Demand Rate with EV | 7.9 | N/A |
| Res TOU | 65.9 | 77.4 |
| Res TOU with EV | 15.4 | 17.1 |
| Res CPP | 89.8 | 105.7 |
| Res Behavioral DR | 17.1 | 18.5 |
| C&I TOU | 0.3 | 0.3 |
| C&I CPP | 76.8 | 91.0 |
| C&I RTP | 13.7 | 16.2 |
| Irrigation TOU | 3.5 | 4.3 |
| Irrigation CPP | 14.3 | 17.4 |

*Table 7-5 Comparison of Demand-Side Rates Potential with Previous Assessment (Winter)*

| DSM Options | Winter Potential in Year-20 | |
|---|---|---|
| | Previous Assessment | Current Assessment |
| Res TOU Demand Rate | 4.6 | N/A |
| Res TOU Demand Rate with EV | 3.9 | N/A |
| Res TOU | 31.0 | 40.7 |
| Res TOU with EV | 7.7 | 7.0 |
| Res CPP | 42.4 | 68.2 |
| Res Behavioral DR | 8.6 | 9.3 |
| C&I TOU | 0.2 | 0.2 |
| C&I CPP | 30.1 | 39.5 |
| C&I RTP | 5.3 | 6.9 |
| Irrigation TOU | - | - |
| Irrigation CPP | - | - |

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