PACIFICORP CONSERVATION POTENTIAL ASSESSMENT FOR 2023-2042

Volume 1

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EXECUTIVE SUMMARY

This Executive Summary presents a summary of the identified cumulative potential in 2042 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 2021, 2019, 2017, and 2015, incorporating the best information available and continuing to apply industry standard practices to provide accurate projections of available demand-side management (DSM) opportunities to inform PacifiCorp's planning efforts.

ES-1 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 the following:

- Sharing the CPA Work Plan and measure lists for review and comment
- Presenting key changes and findings at five IRP public input meetings and two Washington DSM Advisory Group meetings
- 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.

ES-2 Energy Efficiency Resources

Table ES-1 summarizes the 2042 cumulative achievable technical potential for energy efficiency resources by sector, both in megawatt-hours (MWh) and as a percentage of projected 2042 baseline loads. At the system level, the identified cumulative achievable technical potential by 2042 is over 13 terawatt-hours, or approximately 22 percent of projected baseline loads. Achievable technical potential represents savings opportunities that can reasonably be achieved, regardless of how conservation is 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 residential sector accounts for the largest portion of the achievable technical potential, followed by commercial and then industrial. The irrigation sector, with much smaller baseline loads, contributes a smaller amount of potential relative to the larger sectors.

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

Table ES-1 Cumulative Energy Efficiency Achievable Technical Potential by 2042 (MWh @ generator)

Sector	California	Idaho	Utah	Washington	Wyoming	All States	
						Achievable Technical Potential	% of Sector Baseline
Residential	95,115	311,392	4,685,387	479,086	230,263	5,801,244	24.8%
Commercial	51,890	243,344	3,942,204	405,792	549,628	5,192,859	26.7%
Industrial	7,665	51,926	1,130,945	201,281	769,899	2,161,716	12.6%
Irrigation	14,402	90,923	43,174	35,485	5,572	189,557	15.2%
Total	**169,073**	**697,585**	**9,801,710**	**1,121,645**	**1,555,363**	**13,345,375**	**21.8%**

Key energy efficiency findings by market sector are described below.

ES-2.1 Energy Efficiency: Residential Sector Key Findings

The 20-year residential achievable technical potential is 5.8 million MWh, or 24.8% of the 2042 residential sector baseline. Key findings include:

- By 2042, Utah is projected to represent roughly 80% of both the residential sales and energy efficiency potential across the five states.
- More than half of the achievable technical potential (58%) 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 33% of total residential achievable technical potential, driven by Washington, Idaho, and California, where electric resistance heating is relatively common, and Utah, where more electrification is expected in later years (consistent with PacifiCorp's load forecast).
  - The cooling end use comprises 25% of total residential achievable technical potential, driven by large air-conditioning loads in Utah and growing AC loads in all states.
- Water heating savings comprise 21% of the total achievable technical potential through the installation of efficient heat pump water heater systems and upgrades to water-consuming equipment (e.g., clothes washers and low-flow upgrades).
- Updated measure characterizations for HVAC and water heating, along with assumed building electrification (consistent with PacifiCorp's load forecast), contributed to a 96% increase in cumulative 20-year space heating and water heating potential relative to the previous study.
- Lighting end uses account for just 2% of the residential achievable technical potential. The potential for residential lighting has trended downward over the last several CPAs and has significantly decreased in the 2023 CPA due to federal standards and definitions of general service lighting that were adopted in 2022.
- The appliances, electronics, and miscellaneous end uses represent the remaining 19% of the potential.

ES-2.2 Energy Efficiency: Commercial Sector Key Findings

The 20-year commercial achievable technical potential is 5.2 million MWh, or 26.7% of the 2042 commercial sector baseline. Savings as a percent of baseline are very consistent across states. Key commercial findings and observations include:

- Lighting opportunities represent roughly 36% of the identified commercial achievable technical potential, largely attributable to LED lighting fixtures and controls. Based on the best projections available at the time of the analysis, these fixtures and advanced controls are expected to become significantly more available and efficient over the study horizon for linear fluorescent, high-bay, and area lighting 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 7% of the total commercial potential, primarily from grocery stores throughout the service territory and the controlled atmosphere segment in Washington.
- The water heating, food preparation, office equipment, and miscellaneous end uses make up the remaining 16% of potential.

ES-2.3 Energy Efficiency: Industrial Sector Key Findings

The 20-year industrial achievable technical potential is 2.2 million MWh, or 12.6% of the 2042 baseline. Savings as a percent of baseline are relatively consistent across states. Key industrial findings and observations include:

- Motor[2] and process loads[3] represent the largest share of end-use consumption in the industrial sector (70% of baseline sales) 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 7%.[4] 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 efficiencies for systems where motors are utilized.
- As in the commercial sector, the projected improvements in performance and applicability of LED lighting technologies and controls provides a large potential opportunity in the industrial sector, leading to lighting representing 17% of the identified achievable technical potential.
- Potential for the heating, cooling, ventilation, and miscellaneous end uses represent the remaining 13% of potential, mainly realized within the non-industrial portions of buildings (e.g., warehouse and office spaces).

ES-2.4 Energy Efficiency: Irrigation Sector Key Findings

The 20-year irrigation achievable technical potential is 0.2 million MWh, or 15.2% of the 2042 baseline. Key irrigation findings and observations include:

- 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.

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[2] Motor loads include but are not limited to pumps, fans, blowers, compressed air, and material handling associated with producing industrial output. Measures that target these loads may include system controls, optimization, and variable speed drives.

[3] Process loads include but are not limited to cooling, refrigeration, heating, and electrochemical loads. Measures that target these loads may include equipment upgrades, heat recovery (including Waste Heat to Power measures), and various optimization and process efficiency improvements.

[4] 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.

- 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-3 Demand Response Resources

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, AEG relied on a programmatic view of demand response to assess the potential from this resource class as opposed to the technology view used to assess the potential from energy efficiency resources.

Dependencies between the two types of resources exist, however, particularly as grid-enabled, energy-efficient technologies enter the market. For the 2023 CPA, AEG continued to improve alignment between the demand response and energy efficiency potential analyses by allowing the adoption of energy-efficient technologies to create new opportunities for demand response while lowering customers' capacity available for demand response programs because of an increasingly efficient peak demand baseline.

Consistent with previous studies, AEG focused the analysis on the ability of demand response programs to reduce demand over a sustained period during PacifiCorp's system peak, representing the common use case that PacifiCorp models in its IRP.

Table ES-2 presents program potential in 2042 by season for sustained events. The analysis and results focus on the incremental potential that excludes impacts from PacifiCorp's existing and planned demand response programs[5] and accounts for competition between programs targeting the same peak loads.

Key observations include:

- Over half of the estimated program potential is in Utah, driven by the following factors:
    - Significant projected residential customer growth creates opportunities to expand the existing Cool Keeper program with further opportunities to capture additional customers through a smart thermostat program.
    - Building electrification projections, consistent with PacifiCorp's load forecast, provide significant opportunities for the Domestic Hot Water (DHW) Direct Load Control (DLC) program by the end of the forecast period.
    - The updated battery forecast supports the continued growth of the existing UT program.
    - Significant growth of electric vehicles (EV) and their charging needs forecasted by PacifiCorp leads to high market saturation by the end of the forecast period.
- Oregon represents about 29% of the program potential, primarily from Grid-Interactive Water Heaters, EV DLC, and electric space heating DLC.
- California, Idaho, Washington, and Wyoming combined represent the remaining 19% of system-wide potential, almost 40% of which comes from Irrigation Load Control and Third-Party Contracts.
- Many planned and existing programs have expanded since the 2021 CPA, leading to reduced incremental potential from these programs in this study (particularly Irrigation Load Control and Third-Party Curtailment).
- Laws in Washington and Oregon require electric storage water heaters installed beginning in 2021 and 2022 (respectively) to include a CTA-2045-A communication interface, enabling interaction with the utility grid.

[5] Planned and existing resources already being modeled by PacifiCorp and not included in the potential shown here amounted to 454 MW for summer and 78 MW for winter.

Therefore, Grid-Interactive Water Heating (GIWH) DLC contributes substantially to the potential in these states.

Table ES-2 Demand Response Program Potential by Season and Event Type, 2042

Program	Summer MW	Winter MW
HVAC Direct Load Control (DLC)	170.5	209.4
Domestic Hot Water Heater (DHW) DLC	68.8	102.7
Grid-Interactive Water Heaters	98.2	143.1
Connected Thermostat DLC	113.5	99.9
Smart Homes DLC	0.9	1.8
Pool Pump DLC	0.8	0.3
Electric Vehicle Connected Charger DLC	131.6	131.6
Battery Energy Storage DLC	77.7	54.1
Third Party Contracts	50.4	62.9
Irrigation Load Control	23.7	0.0
Total All Sectors	**736.1**	**805.9**

ES-4 Demand-Side Rates

The demand-side rates analysis investigated the potential for voluntary rate options to reduce demand during peak periods. While demand-side rates (DSR) have similar objectives as demand response, i.e., reducing customers' demand during peak periods, they differ significantly in terms of resource firmness. Whereas the utility can rely on demand response program impacts in a given hour, either through direct control or a contractual agreement with a customer or third-parties, peak load reductions from varying rate designs depend entirely on customers' desire to respond to economic signals. As such, PacifiCorp does not use the results of this analysis to inform resource planning.

TTable ES-3 presents the potential from demand-side rate options in 2042 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. However, the DSR analysis assessed the rate options independently of one another, which illustrates the relative magnitude of each option if offered in isolation but does not consider any interactive effects between competing options. Therefore, totaling impacts across options would overstate the potential demand reduction from DSRs. *Chapter 2.3 Demand-Side Rates* provides further details on the DSR analysis approach.

Key observations from the analysis of the demand-side rates include the following:

- Savings from demand-side rates in Washington and Wyoming begin in 2026 when PacifiCorp projects to have full AMI deployment in these states. All other states are expected to have full AMI deployment by 2023, the first year in the study.
- Consistent with the previous CPA, Critical Peak Pricing (CPP), which is available to all customers, provides the largest estimated savings potential. In general, CPP has the highest contribution of the various demand-side rates because of higher on-to-off peak price ratios combined with an "event" type structure that encourages participants to shift more energy than a typical Time-of-Use (TOU) or demand rate.
- Peak Time Rebates (PTR) for residential customers offer the lowest savings potential of the residential rates options. While structurally similar to CPP, PTR programs reward customers for lowering demand during on-peak periods and events, whereas CPP penalizes customers for inaction. The latter tends to achieve higher impacts, which is reflected in the estimated potential presented in **Error! Reference source not found.**.

- For C&I customers, CPP carries significantly higher potential than TOU or Real-Time Pricing (RTP), at 71 MW in the summer by 2042. In the case of TOU, PacifiCorp has already captured significant impacts through existing rates. The RTP rate is not designed for widespread deployment like the CPP rate and is generally designed with specific, larger customers in mind.
- For Irrigation customers, CPP rates have significantly more summer savings potential in 2042 (12 MW) when compared to TOU rates (3 MW), but no potential is available in the winter due to the seasonality of these loads.

Table ES-3 Demand-Side Rates Potential in 2042

Rate Option	Summer Potential (MW)	Winter Potential (MW)
Residential TOU	108.8	43.7
Residential CPP	119.2	57.7
Residential PTR	76.6	53.5
C&I TOU	13.1	5.9
C&I CPP	70.6	33.3
C&I RTP	9.2	4.5
Irrigation TOU	2.6	0.0
Irrigation CPP	11.7	0.0
Residential Behavioral DR[6]	24.9	20.1

ES-5 Education and Information (E&I)

In addition to assessing potential for the three types of DSM resources described above, AEG also reviewed opportunities for Education and Information (E&I) resources. This term is used to refer to resources with non-incented, behavioral-based impacts achieved through broad energy education and communication efforts. The potential for these resources was assessed in PacifiCorp's first Conservation Potential Assessment but has not been revisited in subsequent assessments until the current study.

Due to their voluntary, unincented, behavior-based nature, the savings are less predictable, making these resources unsuitable to incorporate into resource planning, at least until their participation and customer behavior profiles provide sufficient information needed to model and plan for a reliable and predictable impact and cost. Furthermore, some of these programs may be more focused on community outreach and goodwill, with energy savings as the byproduct rather than the primary goal.

As this was the first assessment of these resources for PacifiCorp in over a decade, AEG focused the analysis on identifying E&I initiatives being implemented by other utilities, including whether savings are claimed and assumed persistence of savings, to inform PacifiCorp's future planning efforts. Targeted behavioral demand response (DR) messaging, real-time home energy use feedback, and building operator certification were identified as primary measures of interest. The estimated potential for residential behavioral DR is included in Table ES-3 above (25 MW in potential at summer peak and 20 MW at winter peak). Complete E&I findings, as well as AEG's methodology, data sources, and recommendations from this review, are presented in the Volume 2 appendices of this report.

[6] Residential behavioral DR could alternatively be considered an Education and Information resource since targeted customers are not incentivized to act.

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
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

Acronym	Explanation
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 2022, 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 demand-side management (DSM) planning requirements, and to assist PacifiCorp in reviewing designs of existing DSM programs and in developing new programs. The study's scope encompasses multi-sector assessments of long-term (2023-2042) potential for DSM resources in PacifiCorp's Pacific Power (California, Oregon, and Washington) and Rocky Mountain Power (Idaho, Utah, and Wyoming) service territories.[7]

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 and achieve policy goals while minimizing cost and risk. Thus, this study does not assess the cost-effectiveness of DSM resources.

This CPA provides reliable estimates of the magnitude, timing, and costs of DSM resources that are likely available to PacifiCorp over a 20-year planning horizon from 2023 to 2042. 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 2023 IRP and subsequent DSM planning and program development efforts. This study serves as an update to similar assessments of long-term DSM potential in PacifiCorp's service territory.[8]

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 or 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 businesses or home energy reports for 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 or 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.

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

[8] The previous CPA reports can be found at: https://www.pacificorp.com/environment/demand-side-management.html

- **Demand-Side Rates:** Resources from price-responsive energy and capacity product offerings or 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. While the potential for demand response and demand-side rates was evaluated for Oregon and are presented within this report, energy efficiency potential for Oregon is not included. Unless otherwise noted, all results presented in this report represent impacts at the generator; that is, impacts at the customer meter have been grossed up to account for line losses using values consistent with other PacifiCorp DSM planning efforts.

In addition to assessing potential for the three types of DSM resources noted above, AEG also reviewed opportunities for Education and Information (E&I) resources. This term is used to refer to resources with non-incented, behavioral-based impacts achieved through broad energy education and communication efforts. The potential for these resources was assessed in PacifiCorp's first Conservation Potential Assessment,[9] but has not been revisited in subsequent assessments until the current study to stay informed about its potential impacts. Due to their voluntary, unincented, behavior-based nature, the savings are less predictable, making these resources less suitable to incorporate into resource planning, at least until their participation and customer behavior profiles provide sufficient information needed to model and plan for a reliable and predictable impact. Furthermore, some of these programs may be more focused on community outreach and goodwill, with energy savings as the byproduct rather than the primary goal. 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. As this was the first assessment of these resources for PacifiCorp in over a decade, AEG focused the analysis on identifying E&I initiatives being implemented by other utilities, including whether savings are claimed and assumed persistence of savings, to inform PacifiCorp's future planning efforts. AEG's methodology, data sources, findings, and recommendations from this review are presented in the Volume 2 appendices of this report.

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 among demand response products that compete for the same end-use loads.

Interactions between energy efficiency and demand response resources were also accounted for. The technology adoption forecast from the energy efficiency analysis informed the demand response analysis, allowing opportunities for demand response to expand as DR-ready technologies (e.g., connected thermostats) are assumed to be adopted. Furthermore, the peak demand impacts from the energy efficiency potential were accounted for within the demand response analysis by subtracting the aggregated peak demand reduction due to efficiency from the peak demand forecast.

[9] *Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resources,* performed by Quantec. LLC, July 2007.

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 the following:

- Sharing the CPA Work Plan and measure lists for review and comment
- Presenting key changes and findings at five IRP public input meetings and two Washington DSM Advisory Group meetings
- 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

1.4 Report Organization

This report is presented in two volumes, as outlined below. This document is Volume 1, presenting an overview of the 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 DSM resource class.

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 the same as the energy efficiency analysis in the previous CPA; however, all assumptions have been updated using the most recent and applicable sources available. Primary enhancements made for this study include:

- Segmentation of residential customers by three levels of income in all states; the previous CPA only segmented residential customers by two levels of income in Washington.
- Expanded integration of non-energy impacts in applicable states.
- Integration of assumptions around accelerated measure penetration due to recent federal legislation such as the Inflation Reduction Act (IRA).
- A renewed emerging technology screen to capture more recent data on newly available, applicable, and quantifiable measures in the market.

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 for the base year, 2021,[10] in five states within PacifiCorp's service territory: California, Washington, Idaho, Utah, and Wyoming. To perform the market characterization, AEG used results from primary market research conducted by PacifiCorp wherever possible, supplemented by secondary data sources available from regional and national organizations such as the Northwest Energy Efficiency Alliance (NEEA) and the Energy Information Administration (EIA).
    a. While the Energy Trust of Oregon handles the planning and implementation of energy efficiency within PacifiCorp's Oregon service territory, AEG also characterized the residential market for Oregon to better reflect the baseline conditions for demand response in Oregon.
2. Develop a baseline projection of energy consumption by state, sector, segment, and end use for 2023 through 2042, 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 for energy 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, 2042.
5. Compare the results of the present study with those from the previous assessment[11] to identify important changes and trends.

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

[10] 2021 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.

[11] The 2021 CPA report, including all appendices, is 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 that 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 a 20-year period, but go up to 100% for certain measures.[12] This achievability factor represents potential that can reasonably be acquired by all mechanisms available, including utility programs, improved codes and standards, and market transformation. Thus, the market applicability assumptions utilized in this study include savings outside of utility programs.

2.1.1.2 AEG's LoadMAP Model

AEG performed the energy efficiency potential analysis using its Load Management Analysis and Planning tool (LoadMAP™) 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.
- Includes appliance and equipment models customized by end-use. For example, the logic for lighting is distinct from refrigerators and freezers.

[12] 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/

- 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

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 defines 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 expanded income-based segmentation in the residential sector.

Table 2-1 Overview of Segmentation Scheme for Energy Efficiency Potential Modeling [13]

Dimension	Segmentation Variable	Description
1	State	Pacific Power: California and Washington Rocky Mountain Power: Idaho, Utah, Wyoming
2	Sector	Residential, Commercial, Industrial, and Irrigation
3	Market Segment	Residential: single family, multifamily, and manufactured homes by income level (low, moderate, and above moderate) Commercial: office, restaurant, warehouse, etc. (building type) Industrial: mining, food manufacturing, wastewater, etc. (industry type) 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 high-efficiency options as appropriate for each technology

2.1.2.2 Residential Income-Based Segmentation

To estimate the number of households in each income group, AEG mapped address data for PacifiCorp residential accounts back to corresponding geographic "blocks" in the American Community Survey. Each customer account was assigned to the nearest matching US Census geographic block at the most granular level available based on service address. These geographic subtotals were then assigned proportional demographics such as housing types or average income per household and summed to produce the final estimates for modeling segment allocation.

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

Income segmentation was determined using the information found below in Table 2-2. Final totals for each state and segment were developed using the percentage allocations by segment from the US Census analysis and the official sector-level totals for customers and energy provided by PacifiCorp. AEG then leveraged PacifiCorp's most recent residential customer survey to inform the energy use characteristics across income levels and building types.

Table 2-2 Income Definitions Used for Residential Segmentation

Jurisdiction	Threshold Definitions		
	Low-Income:	Moderate-Income: Above LI and Below:	Regular Income:
CA	≤ 60% SMI	≤ 100% SMI	> 100% SMI
ID	≤ 200% FPG		
UT	≤ 200% FPG		
WA	≤ minimum of (60% SMI, 200% FPG)		
WY	≤ 60% SMI		

2.1.2.3 Market Profiles

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

- **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 the 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 the base year 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 the base year. 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 base-year energy sales.

The market profiles are presented in the Volume 2 appendices of this report.

2.1.3 Baseline Projection

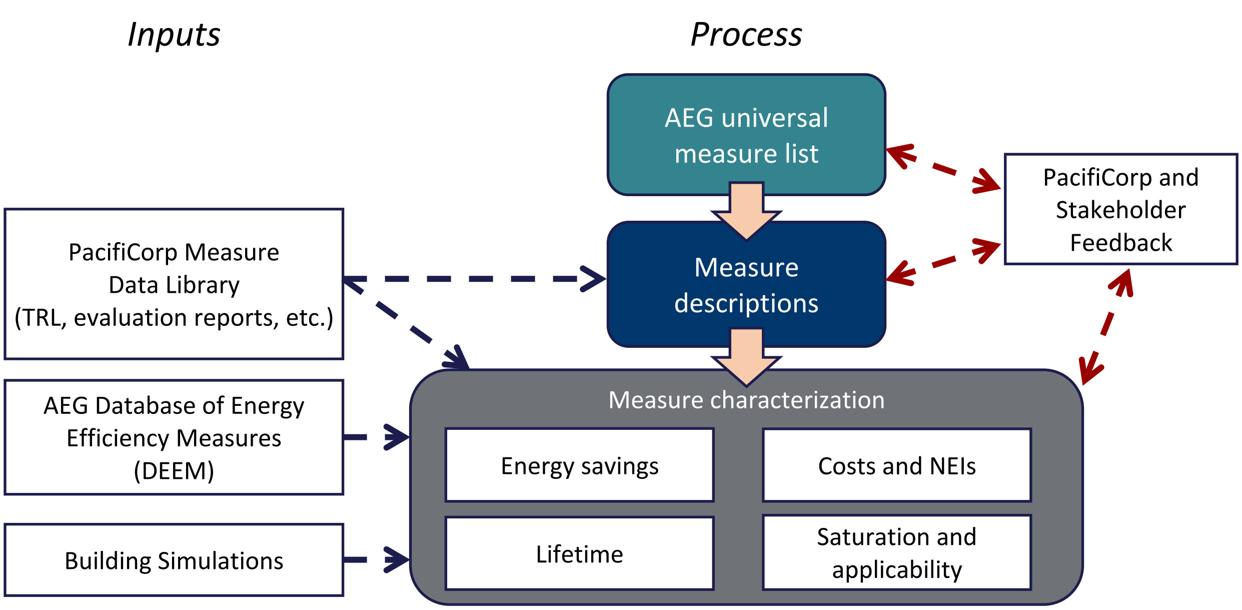
The next step in the analysis is to develop the baseline projection of annual electricity use for 2023 through 2042 by state, sector, customer segment, end use, and technology. To avoid understating the remaining energy efficiency potential, this projection excludes the impacts of future market intervention 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 August 2022, 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 the Volume 2 appendices 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 the 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 Electronic Technical Reference Manual (CA eTRM), 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 room/window air conditioners, this list begins with the current federal standard CEER 10.9 unit and spans a broad spectrum up to a maximum efficiency of a CEER 15.0 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 the use of HVAC systems)
  - Commissioning, retro-commissioning, 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.

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. [14]

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 [15] and

[14] Additional details are provided in the April 7, 2022, IRP Public Input Meeting as part of the 2023 IRP Public Input Process. https://www.pacificorp.com/energy/integrated-resource-plan/public-input-process.html

[15] 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.

the Northwest Power and Conservation Council's 2021 Power Plan. 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 from 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 (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 potential were developed for this study: 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 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 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.[16]

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 2021 Power Plan,[17] although the study incorporated additional considerations for energy efficiency measure acquisition.

- To account for differences in PacifiCorp's state-specific markets, in the previous CPA 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.
- The 2023 study also incorporated potential impacts of recent federal legislation, such as the Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA), by assuming accelerated adoption of measures within specific customer types that were targeted by these two laws.
- 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 2021 Power Plan).

The ramp rates used in this study are provided in the Volume 2 appendices of 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 (LCOE) for each measure to create energy efficiency supply curves for use in PacifiCorp's IRP modeling. The methodology for calculating measure levelized cost of conserved energy recognizes differences in regulatory requirements for cost-effectiveness screening in each state within PacifiCorp's service territory.[18]

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

- State-specific administrative costs were updated to reflect the average from 2014-2021 PacifiCorp program experience.
- The application of state-specific incentive assumptions based on PacifiCorp 2014-2021 program experience. The previous assessment assumed incentives of 70% incremental cost except for Utah non-residential

[16] 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 efficient for the technical potential case and the unit that is most efficient for less than $165/MWh levelized for the achievable technical potential case. For example, a SEER 14 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.

[17] *The 2021 Northwest Power Plan, Conservation Supply Curves*. Northwest Power and Conservation Council. 27 May 2022. Available at: https://www.nwcouncil.org/2021-power-plan-technical-information-and-data/

[18] 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.

lighting, which was set at 50% based on discussions with program managers and feedback from stakeholders.

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

Table 2-3 Economic Components of Levelized Cost by State

Parameter	WA	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[19]	Included	Not Included			
Secondary Fuel Impacts[19]	Included	Not Included			
Non-Energy Impacts	Included	Not Included			
Administrative Costs (% of incremental cost)	48%	45%	48%	22%	40%
Incentive Costs (% of incremental cost)	n/a[20]		43%	38%	39%

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 of 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.[21] For example, if a particular measure's 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.

In general, this study did not consider the cost of energy efficiency measures, as this analysis is performed within PacifiCorp's IRP. However, because, by default, the technical (and achievable technical) assumes that the highest efficiency equipment option will be adopted by all customers at the time of replacement, this has the potential to skew the amount of cost-effective potential. For example, assuming that all customers adopt high-cost SEER 24 central air conditioners would not only create a large amount of high-cost potential that the IRP model would be unlikely to select, but it would also reduce the available potential for lower-cost non-equipment measures that can save cooling load (e.g., insulation). To account for this, the achievable technical potential excluded equipment measures with significantly high upfront costs unlikely to be deemed economic within the IRP. This screening used a levelized cost threshold of $160/MWh for California, Utah, Idaho, and Wyoming, and a higher threshold of $175/MWh for Washington to reflect the 10% conservation credit applied within the IRP for measures in that state.

2.2 Demand Response

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, AEG

[19] O&M and secondary fuel impacts are included to the extent that the Regional Technical Forum and the California PUC eTRM specify them.

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

[21] This method is 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.

relied on a programmatic view of demand response to assess the potential from this resource class as opposed to the technology view used to assess the potential from energy efficiency resources.

Dependencies between the two types of resources exist, however, particularly as grid-enabled, energy-efficient technologies enter the market. In the current CPA, AEG continued to improve alignment between the demand response and energy efficiency potential analyses by ensuring consistent market characterization and customer segmentation. This process allowed the forecasted adoption of energy-efficient technologies to create new opportunities for demand response and accounted for peak demand reductions from energy efficiency adoption in the peak demand baseline forecast.

Consistent with previous studies, AEG focused the analysis on the ability of demand response programs to reduce demand over a sustained period during PacifiCorp's system peak, representing the common use-case that PacifiCorp models in its IRP. However, some program options are also capable of producing larger impacts with reduced notification times and shorter event periods. AEG investigated each program's ability to be called for these two types of events:

1. **Sustained Events** represent an event lasting at least one hour and providing customers either day-ahead or day-of notification in advance.
2. **Fast Events** represent an event lasting less than one hour and providing customers advanced notification of fifteen minutes or less with a near-instantaneous response.

For consistency with PacifiCorp's IRP modeling, the demand response potential presented in this report corresponds to the potential that could be achieved through sustained events only.

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. Program Characterization
3. Baseline Peak and Customer Forecasts
4. Levelized Cost Estimates

2.2.1 Demand Response Market Characterization

As in the previous CPA, AEG segmented PacifiCorp's customers by state, sector, and for the C&I sector size of the customer. Table 2-4 provides the final customer segments analyzed for the study. In general, the demand response customer segmentation aligned with the energy efficiency assessment, which allowed the demand response analysis to incorporate and properly weight segment-level saturations of enabling technologies, such as central cooling systems and electric water heating, and factor in the adoption of efficient equipment when determining customer eligibility for demand response program options.

Unlike the energy efficiency customer segmentation, AEG segmented C&I customers by the size of their peak load; this approach reflects how PacifiCorp offers demand response programs to customers better than the industry-based segmentation used in the energy efficiency assessment. AEG used monthly billing data provided by PacifiCorp to assign C&I customers to peak demand bins.[22]

Table 2-4 Demand Response Analysis Segmentation

Segmentation Variable	Description
State	UT, OR, WY, WA, ID, CA
Sector	Residential, Commercial and Industrial (C&I), and Irrigation

[22] The billing data included each customer's non-coincident maximum demand per month.

Segmentation Variable	Description		
Size (by maximum peak demand)	Residential: all customers		
	C&I:	Small C&I	≤30 kW
		Medium C&I	>30 kW and ≤500 kW
		Large C&I	>500 kW and ≤1,000 kW
		Extra-large C&I	>1,000 kW
	Irrigation: all customers		

2.2.2 Program Characterization

As discussed above, demand response resources do not exist outside of a programmatic structure. Therefore, to reflect how PacifiCorp might actually acquire the potential, AEG characterized a set of program options as opposed to individual technologies. Table 2-5 provides the demand response program options that AEG analyzed and notes which are currently offered or planned to be offered to PacifiCorp customers. This study included all programs assessed as part of the previous CPA.

Table 2-5 Demand Response Products Assessed in the Study

Demand Response Option	Eligible Customer Classes	Description	Currently Offered by PacifiCorp?
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	UT
Domestic Hot Water Heater (DHW) DLC	Residential, Small C&I, Medium C&I	Direct load control switch installed on customer's equipment	Planned in OR and WA
Grid-Interactive Water Heaters	Residential, Small C&I, Medium C&I	CTA-2045 or other integrated communication port	Planned in OR and WA
Connected Thermostat DLC	Residential, Small C&I, Medium C&I	Internet-enabled control of thermostat set points	Planned in OR and WA
Smart Homes DLC[1]	Residential	Internet-enabled control of operational cycles of white goods appliances and other smart technologies through a home energy management system	No
Pool Pump DLC	Residential	Direct load control switch installed on customer's equipment	No
Electric Vehicle Connected Charger DLC	Residential	Automated, level 2 EV chargers that postpone or curtail charging during peak hours	No
Battery Energy Storage DLC	Residential, All C&I	Internet-enabled control of battery charging and discharging	UT (planned in ID)
Third Party Contracts	Large C&I, Extra-large C&I	Customers enact their customized, mandatory curtailment plan (with penalties for non-performance)	Approved in UT, OR, and WA
Irrigation Load Control	Irrigation	Automated or pump controllers or direct load control switch installed on customer's equipment	Yes (ID, UT, OR, and WA)

[1] The previous CPA called this category "Smart Appliances DLC," but both programs targeted internet-enabled control of load.

AEG characterized each program option by:

- Defining the eligible pool of customers by controllable equipment,
- Gathering estimates of participation and peak demand reductions, and
- Assessing competition with other program options.

The following sections describe these steps in detail.

2.2.2.1 Controllable Equipment

Most of the program options rely either on grid-interactive technologies or separate equipment (e.g., a switch) that allows PacifiCorp or a third-party to control load during an event. AEG developed forecasts of controllable equipment adoption through the energy efficiency assessment, as described in the *Demand Response Market Characterization* section above, and through other secondary research and resources. Table 2-6 provides the program options dependent on controllable equipment.

Table 2-6 Demand Response Enabling Equipment by Program Option

Source	Controllable Equipment	Program Option
Energy Efficiency Assessment	Central AC, Heat Pumps, Rooftop Units, Electric Furnace	HVAC Direct Load Control (DLC) Connected Thermostat DLC
	Smart Thermostat	Connected Thermostat DLC
	Electric Water Heaters	Domestic Hot Water Heater (DHW) DLC Grid-Interactive Water Heaters DLC[23]
	Home Energy Management System	Smart Homes DLC
	Pool Pump	Pool Pump DLC
	Electric Vehicle Connected Charger	Electric Vehicle Connected Charger DLC
PacifiCorp's private generation forecast developed by DNV[24]	Batteries	Battery Energy Storage DLC

The previous CPA assessed all controllable equipment based on the type(s) of grid services they were capable of providing. For this CPA, AEG investigated whether program options relied on equipment that enabled participation in fast events. For example, while all C&I may be eligible for a third-party curtailment program, only customers with energy management systems could participate in a fast event. For the purposes of this report, AEG did not screen equipment or program options for their ability to be called for a fast event when determining customer eligibilities for sustained events.

2.2.2.2 Participation and Peak Impacts

AEG compiled secondary data to define the following parameters for each program option:

- Steady-State Participation Rate: the percentage of eligible customers expected to participate in the program option once it is fully up and running
- Peak Load Reduction: the amount of impact expected by an average participant during a system peak event

Most of the participation and peak reduction assumptions for each program came from the Northwest Power and Conservation Council's (Council's) 2021 Power Plan, consistent with the previous CPA.[25] For all existing and

[23] AEG assumed that all new electric water heater purchases in OR and WA were grid-interactive as required by code in these states. Conservative estimates of grid-interactive water heater saturations were used for other states in the study.

[24] Private Generation Forecast, IRA Update for IRP Load Forecast. DNV. Provided to AEG October 2022.

[25] At the time of the previous assessment, the Council's 2020 plan was in place. This assessment used the Council's 2021 plan.

planned programs, AEG adjusted the Council's assumptions as needed to better align with actual program achievements and planned targets.

Because PacifiCorp needs to design, contract for, and market new offerings, most program options are expected to take several years to grow to their steady-state participation rate. AEG relied on the ramp rates provided in the Council's 2021 Power Plan to forecast this growth, which assumes that most programs will fully mature in about five years.

The Volume 2 appendices provide detailed descriptions and key assumptions for each program option.

2.2.2.3 Competition Between Demand Response Program Options

Some of the program options target the same peak load. For example, the HVAC DLC and Connected Thermostat DLC programs both target central cooling load in the summer. To avoid double-counting demand response potential for these competing resources, AEG worked with PacifiCorp to develop a program hierarchy or "loading order." In general, the hierarchy prioritized customers for existing and planned programs over other demand response resources by removing participants of programs higher in the hierarchy from the pool of customers eligible for programs lower in the hierarchy.

However, not all program options would compete for the same peak load. AEG allowed dual enrollment in program options targeting separately metered equipment (e.g., EV Charging DLC) or distinct end uses (e.g., Smart Thermostat DLC and Water Heating DLC).

2.2.3 Baseline Peak and Customer Forecast

AEG developed the baseline peak demand forecast as follows:

1. Allocated system peak demand to each sector (residential, commercial, industrial, and irrigation) using base-year hourly peak demand data. PacifiCorp provided customer forecasts for each sector directly.
2. Allowed the observed growth in annual consumption (provided at the sector level) to inform changes in the base-year peak demand segmentation over the forecast period (as opposed to holding it fixed based on the base-year composition of system peak).
3. Further segmented the C&I peak load and customer forecasts by size bin based on the demand response market characterization.
4. Removed the peak demand savings potential generated through energy efficiency adoption forecasted in the Achievable Technical Potential scenario.

2.2.4 Potential Estimation

AEG calculated the potential for each program by first estimating participation in each year of the forecast period (via enabling equipment saturations, participation rates, and removing the participation from programs higher in the program hierarchy) and multiplying it by the per-customer peak reductions (some of which are of a percentage of baseline peak load).

The estimated potential included impacts from existing and planned resources that PacifiCorp already includes in its IRP model. AEG calibrated impacts for these program options to meet PacifiCorp's targets and then removed them from the total estimated potential so as not to double-count existing and planned resources. However, any associated growth in these program options was included as new, incremental potential.

2.2.5 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 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 the Volume 2 appendices 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 to align with PacifiCorp's typical procurement practices.
- 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 2021 Power Plan.
- 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.[26] 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 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 for programs that are less intrusive to customers. The Council also adopted this methodology for estimating total resource costs in its 2021 Power Plan.
- AEG updated the literature review from the 2021 CPA to explore the applicability of non-energy impacts to demand response programs and found that no new information regarding quantifiable non-energy impacts was available. Since no data on quantifiable impacts were found, AEG de-rated costs by 10% in Washington to reflect these non-quantifiable NEIs at PacifiCorp's request. The results of AEG's updated research are presented in the Volume 2 appendices 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 demand-side rates (DSR) have similar objectives as demand response, i.e., reducing customers' demand during peak periods, they differ significantly 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, peak load reductions from varying rate designs depend entirely on customers' desire to respond to economic signals.

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. The list of rates assessed is the same as the previous assessment except for Peak Time Rebates (PTR), which AEG added to the current assessment at the request of Stakeholders.

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

Table 2-7 Demand-Side Rates Assessed

Demand-Side Rate Option	Eligible Customer Classes	Analysis Approach	Whether Current PacifiCorp Offering
Time-Of-Use (TOU) Rate	Residential, C&I, and Irrigation	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.
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
Critical Peak Pricing (CPP) Rate	Residential, C&I, and Irrigation	Assess impacts associated with a CPP rate offering to all residential, C&I, and Irrigation customers.	No
Peak Time Rebates (PTR) Rate	Residential	Assess impacts associated with a PTR rate offering to residential customers.	No
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
Behavioral Demand Response (BDR)	Residential	Voluntary demand reductions in response to targeted behavioral messaging. Example programs exist in CA and other states. Requires AMI technology.	No

As in the demand response analysis, AEG developed estimates for customer eligibility, participation, and impacts for each rate option in the analysis. Participation and impact estimates were developed, assuming that pricing options would be offered on a voluntary, "opt-in" basis, consistent with the previous CPA. Participation and impact assumptions for dynamic pricing options were based on the extensive review of enrollment in full-scale, time-varying rates offered in the United States and internationally that was conducted for the PacifiCorp 2015 CPA by the Brattle Group. That review focused on rate offerings that had been heavily marketed to customers and had achieved significant levels of enrollment. Enrollment estimates were based on data reported to FERC by utilities and competitive retail suppliers, and other entities. The 2015 analysis also included survey-based market research studies from other comparable utilities and transferrable jurisdictions designed to gauge customer interest in time-varying rates. Inputs were consistent with those provided by the Council's 2021 Power Plan.

As part of the 2023 Conservation Potential Assessment (CPA), AEG updated the impacts of existing time-varying rates across PacifiCorp's territory. The analysis leveraged one completed by the Brattle Group in 2015 and incorporated updates to reflect PacifiCorp's current rate structures and participants; see the appendices in Volume 2 for details on the existing rates analysis.

To measure the impacts of time-varying rates, customers on DSRs must have Advanced Metering Infrastructure (AMI) to enable two-way communication between the customer and utility. Except for Washington and Wyoming, all PacifiCorp states will have full AMI deployment by 2023, the first year of the study period. It is assumed that Washington and Wyoming will have full AMI deployment by 2026.

2.3.1 Estimation of Demand-Side Rate Potential

AEG used similar analytical steps to assess demand-side rate potential as it used for the demand response analysis:

1. Segmented customer population as shown in Table 2-4,
2. Characterized the demand-side rate options shown in Table 2-7 by the participation and impacts AEG estimated each rate to achieve based on existing rate performance, the Council's plan, and secondary research as described in the previous section, and
3. Estimated participation and total potential for each rate in each year of the forecast period, removing any impacts estimated for existing rates.

Because PacifiCorp does not model incremental demand-side rate potential as an economic resource in its IRP, the current CPA did not assess the costs of delivering these rate options.

After characterizing the market and rate options, the process of calculating potential remains the same as presented for demand response.

3 DATA DEVELOPMENT

This section describes the key 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 study continued to align the energy efficiency and demand response resource assessments, allowing 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 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 [27]

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

- **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 advanced metering infrastructure (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

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

- 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 2021 Power Plan Conservation and Demand Response Supply Curve Workbooks.** To develop its 2021 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 2016-2017 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 2019 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 national 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 2021 and 2022 AEO.
- **American Community Survey:** The U.S. 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.
- **California Electronic Technical Reference Manual (CA eTRM).** Managed by the Future Energy Enterprises in their role as administrators of the California Technical Forum (CAL TF) and cooperatively owned and funded by the Cal TF sponsors, it 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 provided impact estimates for the demand response analysis for some enabling technologies and program options not included in the Council's 2021 plan. The study report is available here: https://buildings.lbl.gov/publications/2025-california-demand-response.

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	110	9,900
Commercial	143	20,020
Industrial	96	14,400
Irrigation	22	220
Total Measures Evaluated	**371**	**44,540**

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 Northwest Energy Efficiency Alliance (NEEA) research initiatives, the Bonneville Power Administration's emerging technology program, the California Emerging Technologies Coordinating Council (ETCC), the U.S. DOE Building Technologies Office Emerging Technologies Program, American Council for an Energy-Efficient Economy (ACEEE), California eTRM, Washington State University's *Energy Efficiency Emerging Technologies* (E3T) databases, the Consortium for Energy Efficiency (CEE), applicable measures from the Northeast Energy Efficiency Partnerships (NEEP), and other research reports as applicable.

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 the 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 the Volume 2 appendices 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, the 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

Priority	Washington	Idaho	Utah and Wyoming	California
Primary	RTF	RTF	RMP Ex-Ante Measure Characterizations** RTF with Adjustments***	California Technical Forum Electronic TRM (www.caetrm.com)****
Secondary	2021 Power Plan* Program-Specific Evaluations	RMP Ex-Ante Measure Characterizations** Idaho Power TRM Program-Specific Evaluations	Idaho Power TRM Xcel Energy Colorado DSM Plan Program-Specific Evaluations	RTF with Adjustments*** | 2021 CPUC P&G Study DEER and Non-DEER Workpapers**** Program-Specific Evaluations
Other	California eTRM RMP** | National Sources† Other Regularly Updated TRMs‡	2021PP* | California eTRM National Sources† Other Regularly Updated TRMs‡	2021PP* | California eTRM National Sources† Other Regularly Updated TRMs‡	CMUA TRM | 2021PP* National Sources† Other Regularly Updated TRMs‡

* The 2021 Power Plan measure data was only used for measures that are not in the RTF but are in the Power Plan (e.g., industrial and some agricultural measures).
** Includes ex-ante characterizations developed and/or reviewed for Rocky Mountain Power (RMP) by AEG in conjunction with RMP implementers as part of measure development, program design, and measure library updates from 2019 to present. Many characterizations were based on RTF data sources with additional adjustments, building energy simulations, or national sources and regularly updated TRMs.
*** Includes adjustments to weather and market assumptions, as applicable.
**** Per CPUC Resolution E-5152, the California eTRM has been approved as the data source of record for active, Commission-approved deemed statewide measure values for PY2021 and beyond.
† Includes national sources like the U.S. DOE Annual Energy Outlook, ENERGY STAR® Savings Calculators, etc.
‡ Includes Technical Reference Manuals from Illinois, Pennsylvania, New York, Minnesota, New Mexico, Massachusetts, Maine, and others as necessary

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 standard was rolled back in 2019 except in California, where LEDs are required by state law, and Washington, where the 45 lumen/Watt standard is required by state law. The current study assumes that the 45 lumen/Watt standard is present in all states throughout the study horizon as the DOE published a final rule on May 9, 2022, which stated that the 45 lm/W backstop was effective July 25, 2022. Since this standard does not currently have a widely available market analog and can only be met by either compact fluorescent lighting (already a minimal portion of the market) or LEDs, the general service lighting baselines in all states are predominantly comprised of LEDs past 2023.

In addition to efficiency standards, the demand response analysis incorporated one notable equipment standard in certain states. A Washington law[28] 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

End Use	Technology	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13.0 (14.0 in CA)		SEER 14.0 (15.0 in CA)		
	Room AC	EER 10.8				
Cool/Heating	Air-Source Heat Pump	SEER 14.0 / HSPF 8.2		SEER 15.0 / HSPF 8.8		
Water Heating	Water Heater (≤55 gallons)	EF 0.92				
	Water Heater (>55 gallons)	EF 2.0 (Heat Pump Water Heater)				
Lighting	General Service	Federal Backstop (45 lm/W lamp)[29] [100% LED in CA]				
	Linear Fluorescent	T8 (80.0 lm/W lamp)				
Appliances	Refrigerator & Freezer	25% more efficient than the 1997 Final Rule (62 FR 23102)				
	Clothes Washer	IMEF 1.84 / WF 4.7				
	Clothes Dryer	3.73 Combined EF				
Miscellaneous	Furnace Fans	ECM				

Table 3-5 Commercial and Industrial Electric Equipment Standards

End Use	Technology	2021	2022	2023	2024	2025
Cooling	Chillers	2016 ASHRAE 90.1				
	Roof Top Units	IEER 12.9		IEER 14.8		
	PTAC	EER 10.4				
Cool/Heating	Heat Pump	IEER 12.8 / COP 3.3		IEER 14.1 / COP 3.4		
	PTHP	EER 10.4 / COP 3.1				
Ventilation	All	Constant Air Volume/Variable Air Volume				
Lighting	General Service	Federal Backstop (45 lm/W lamp)[30] [100% LED in CA]				
	Linear Lighting	T8 (80.0 lm/W lamp)				
	High Bay	High-Efficiency Ballast (56.0 lm/W lamp)				
Refrigeration	Walk-In	EERE–2010–BT–STD–0003				
	Reach-In	EERE–2010–BT–STD–0003				
	Glass Door	EERE–2010–BT–STD–0003				
	Open Display	EERE–2010–BT–STD–0003				
	Icemaker	EERE-2010-BT-STD-0037				
Motors	All	Expanded EISA 2007				

[28] Washington Administrative Code 194-24-180

[29] The federal backstop of 45 lm/W becomes active in 2023, the first year of potential, in ID, UT and WY. The 45 lm/W standard has been active in WA since 2020 and LEDs for General Service Lighting are code in CA.

[30] Same note as above.

Table 3-6 summarizes the assumed building energy codes for new customers, buildings, and facilities that come online during the study horizon.

Table 3-6 Guidance for Building Codes

State	Residential Energy Code Used	Non-Residential Energy Code Used
California	2022 Building Energy Efficiency Standards, Title 24	2022 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	2018 IECC	2018 IECC
Utah	2015 IECC	2018 IECC
Wyoming	2009 IECC with adjustments based on survey data for new buildings	2009 IECC with adjustments based on survey data for new buildings

3.4 Treatment of New Federal Legislation

The Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) provide more than 25 billion dollars for programs and tax incentives to help with energy efficiency, electrification, and greenhouse gas reduction. These tax incentives became available starting on January 1st, 2023, the first year of this study's forecasting horizon. Most of the programs target low- and moderate-income households or disadvantaged communities. Funds are provided for but are not limited to, heating and cooling equipment upgrades, weatherization, and whole home upgrades.

AEG worked with PacifiCorp to develop an approach on how to incorporate IRA and IIJA in the study. Ultimately, the IRA and IIJA were accounted for by assuming the accelerated adoption of measures within specific customer types that were targeted by these two laws. While the Council ramp rates from the 2021 Power Plan were still leveraged, AEG chose ramp rates that represented quicker adoption than those used in the 2021 Power Plan for affected measures.

4 ENERGY EFFICIENCY POTENTIAL RESULTS

This chapter presents the identified cumulative potential in 2042 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 2042 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 2042 cumulative technical and achievable technical energy-efficiency potential by sector, both in MWh and as a percentage of the 2042 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 2042 are 16 million MWh, or 26% of the baseline projection.
- **Achievable Technical Potential**, which adjusts the technical potential by reflecting customer adoption constraints, shows cumulative savings of 13.3 million MWh, or 22% of the baseline load in 2042. This case represents potential that can reasonably be acquired by all mechanisms available, regardless of how conservation is achieved. This includes savings that may be realized from outside of utility programs.

The residential sector accounts for the largest portion of the technical and achievable technical potentials, followed by commercial and industrial. The irrigation sector, with much smaller baseline loads, contributes a smaller amount of potential relative to the residential, commercial, and industrial sectors. Details on sector-specific potential are provided later in this chapter.

Table 4-1 Cumulative Energy Efficiency Potential by Sector in 2042

Sector	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Residential	23,366,266	7,129,675	5,801,244	30.5%	24.8%
Commercial	19,463,809	6,098,810	5,192,859	31.3%	26.7%
Industrial	17,140,778	2,577,844	2,161,716	15.0%	12.6%
Irrigation	1,243,512	220,074	189,557	17.7%	15.2%
Total	**61,214,366**	**16,026,404**	**13,345,375**	**26.2%**	**21.8%**

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

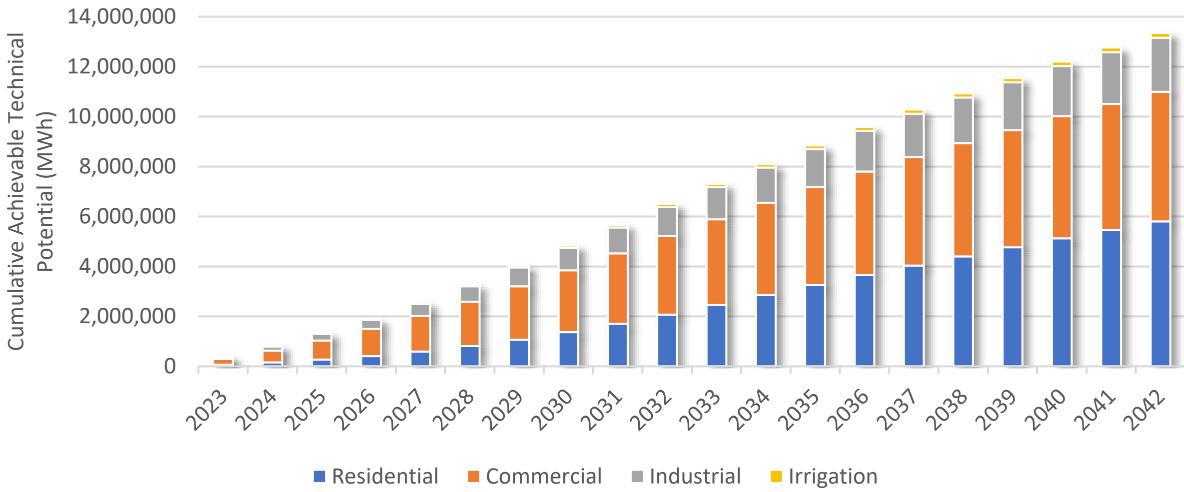


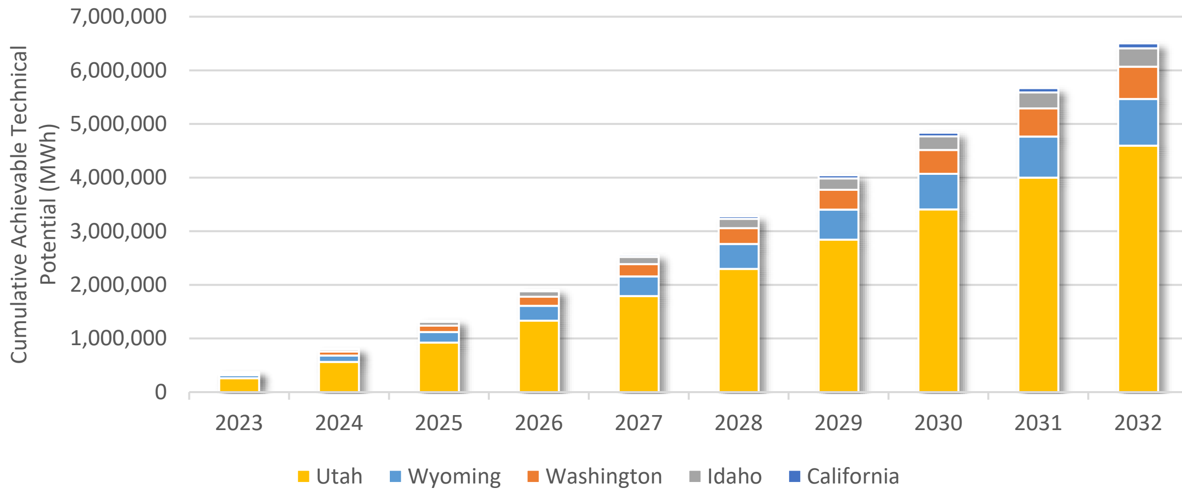
Table 4-2 summarizes the energy efficiency potential by state and by PacifiCorp operating company.[31] With the exception of Wyoming, potential as a percent of baseline loads is relatively constant across states; Wyoming's potential is heavily influenced by the large share of the load in the industrial sector, which, as shown in Table 4-2, has lower identified potential as a percent of the baseline projection 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. Annual cumulative achievable technical potential by state for the first 10 years of the study period is presented in Figure 4-2.

Table 4-2 Cumulative Energy Efficiency Potential by State in 2042

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	821,552	210,220	169,073	25.6%	20.6%
	Washington	5,174,858	1,366,436	1,121,645	26.4%	21.7%
	Subtotal	**5,996,409**	**1,576,656**	**1,290,718**	**26.3%**	**21.5%**
Rocky Mountain Power	Idaho	2,961,391	847,606	697,585	28.6%	23.6%
	Utah	41,837,645	11,723,010	9,801,710	28.0%	23.4%
	Wyoming	10,418,921	1,879,131	1,555,363	18.0%	14.9%
	Subtotal	**55,217,956**	**14,449,747**	**12,054,657**	**26.2%**	**21.8%**
	Total	**61,214,366**	**16,026,404**	**13,345,375**	**26.2%**	**21.8%**

[31] 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.

Figure 4-2 Total Cumulative Achievable Technical Potential Through 2032 (MWh), by State



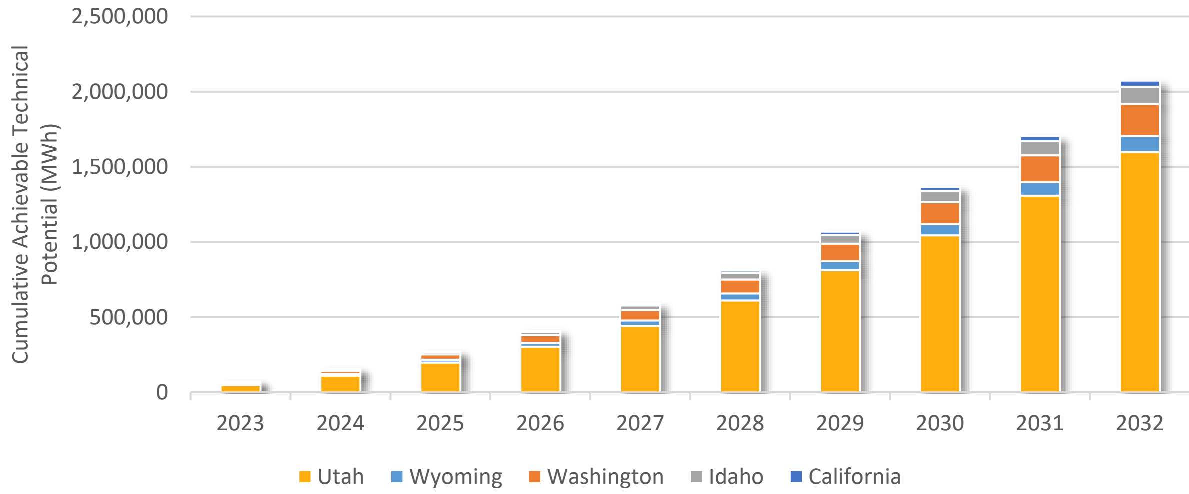
4.2 Residential Sector

Table 4-3 presents estimates for cumulative technical and achievable technical potential in the residential sector by the end of the study period in 2042. The technical potential in 2042 from energy efficiency resources assessed in this study is 7.1 million MWh or 31% of the baseline projection. The corresponding achievable technical potential is 5.8 million MWh or 25% of the 2042 baseline. Savings as a percent of the baseline vary across all states, largely driven by the relative amounts of space and water heating electrification expected in each respective territory. Cumulative residential achievable technical potential by state for the first 10 years of the study period is presented in Figure 4-3.

Table 4-3 Residential Cumulative Energy Efficiency Potential by State in 2042

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	422,970	121,765	95,115	28.8%	22.5%
	Washington	2,153,936	614,345	479,086	28.5%	22.2%
	Subtotal	**2,576,905**	**736,110**	**574,201**	**28.6%**	**22.3%**
Rocky Mountain Power	Idaho	1,180,556	392,673	311,392	33.3%	26.4%
	Utah	18,492,427	5,682,400	4,685,387	30.7%	25.3%
	Wyoming	1,116,377	318,492	230,263	28.5%	20.6%
	Subtotal	**20,789,361**	**6,393,566**	**5,227,042**	**30.8%**	**25.1%**
	Total	**23,366,266**	**7,129,675**	**5,801,244**	**30.5%**	**24.8%**

Figure 4-3 Residential Cumulative Achievable Technical Potential Through 2032, by State



The residential sector is composed of nine segments in this analysis: three housing types (single-family, multifamily, and manufactured homes) and three income levels (regular, moderate, and low). Figure 4-4 and Figure 4-5 below show the share of 2042 achievable technical potential that is attributable to each housing type and income level, largely driven by the share of sales in the baseline projection. Single-family homes represent the largest share (84%) of total achievable technical potential by home type, and regular income homes represent the largest share by income level, with 44% of total achievable technical potential. Moderate Income homes are a close second, with 43% of the total achievable technical potential.

Figure 4-4 Residential Cumulative Achievable Technical Potential by Housing Type in 2042

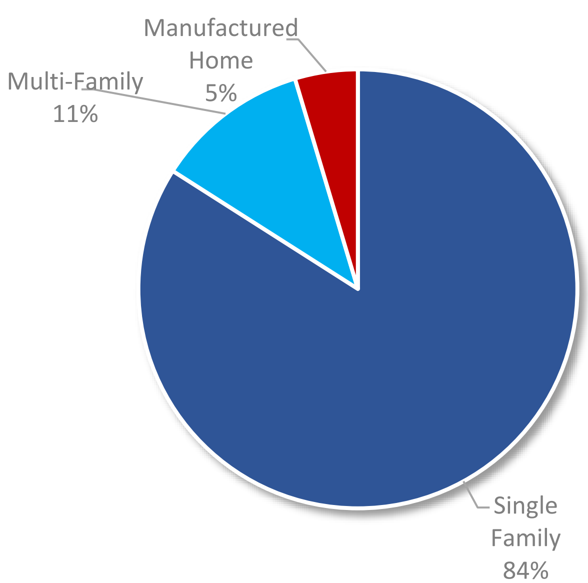


Figure 4-5 Residential Cumulative Achievable Technical Potential by Income Level in 2042

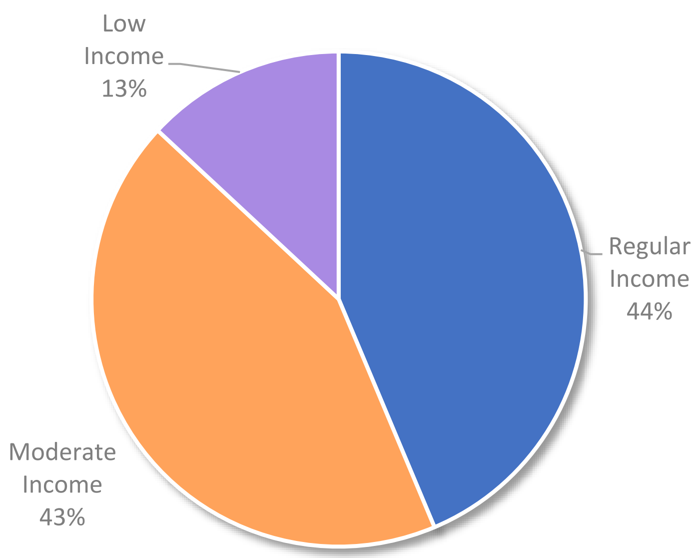


Figure 4-6 and Table 4-4 present the estimates of energy efficiency potential for the residential sector from an end-use perspective. Key findings and observations are outlined below:

- By 2042, Utah is projected to represent roughly 80% of both the residential sales and energy efficiency potential across the five states.
- More than half of the achievable technical potential (58%) comes from HVAC system interventions through the application of equipment upgrades and building shell measures.
    - The space heating end use provides the largest share of potential, at 33% of total residential achievable technical potential, driven by Washington, Idaho, and California, where electric resistance heating is relatively common, and Utah, where more electrification is expected in later years (consistent with PacifiCorp's load forecast).
    - The cooling end use comprises 25% of total residential achievable technical potential, driven by large air-conditioning loads in Utah.
- Water heating savings comprise 21% of the total achievable technical potential through the installation of efficient heat pump water heater systems and upgrades to water-consuming equipment (e.g., clothes washers and low-flow upgrades).
- Updated measure characterizations for HVAC and water heating, along with assumed building electrification (consistent with PacifiCorp's load forecast), contributed to a 96% increase in cumulative 20-year space heating and water heating potential relative to the previous study.
- Lighting end uses account for just 2% of the residential achievable technical potential. The potential for residential lighting has trended downward over the last several CPAs and has significantly decreased in the 2023 CPA due to federal standards and definitions of general service lighting that were adopted in 2022.
- The appliances, electronics, and miscellaneous end uses represent the remaining 19% of the potential.

Figure 4-6 Residential Cumulative Achievable Technical Potential by End Use in 2042

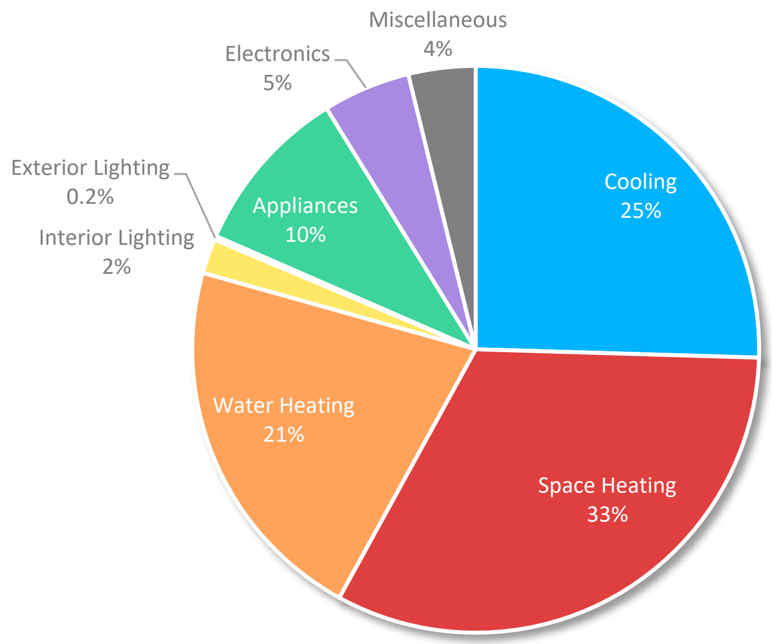


Table 4-4 Residential Cumulative Energy Efficiency Potential by End Use in 2042

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Cooling	3,730,062	1,804,420	1,477,638	48.4%	39.6%
Space Heating	5,403,822	2,185,732	1,886,597	40.5%	34.9%
Water Heating	2,266,018	1,473,527	1,239,012	65.0%	54.7%
Lighting	822,047	151,248	127,466	18.4%	15.5%
Appliances	3,524,134	935,550	558,732	26.6%	15.9%
Electronics	2,596,844	298,160	289,831	11.5%	11.2%
Miscellaneous	8,110,339	281,038	221,967	3.5%	2.7%
Generation	-3,087,001	N/A	N/A	N/A	N/A
Total	**23,366,266**	**7,129,675**	**5,801,244**	**30.5%**	**24.8%**

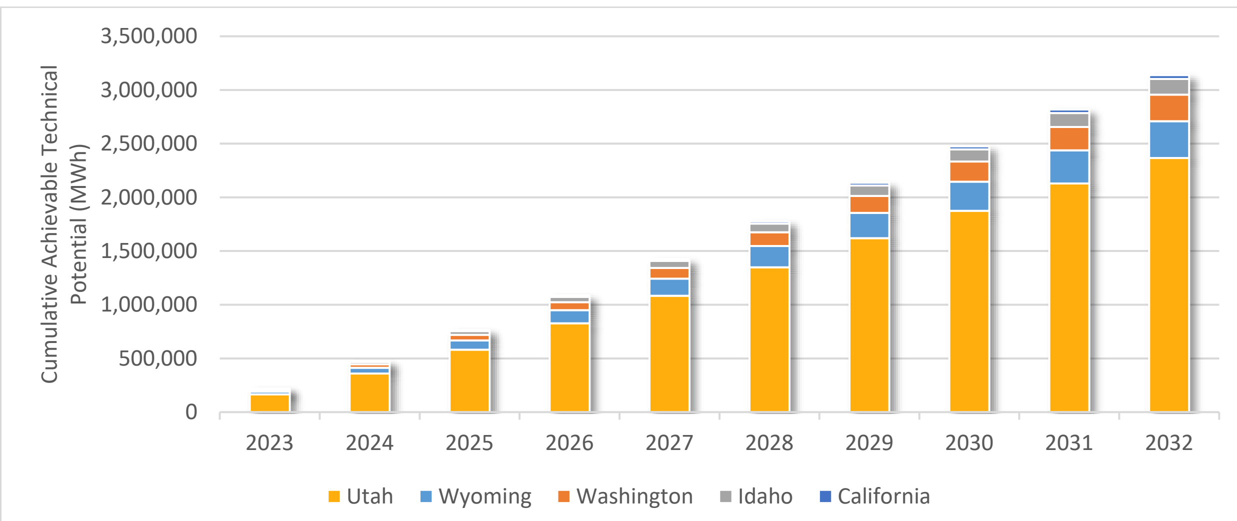
4.3 Commercial Sector

Table 4-5 presents the estimated cumulative technical and achievable technical potential for the commercial sector by the end of the study period in 2042. For the energy efficiency resources assessed in this study, the cumulative technical potential is 6.1 million MWh or 31% of the baseline projection in 2042. The corresponding achievable technical potential is 5.2 million MWh or 27% of the 2042 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 lower than other RMP states, largely due to substantial data center loads with less opportunity for energy efficiency coming online during the study. Cumulative commercial achievable technical potential by state for the first 10 years of the study period is presented in Figure 4-7.

Table 4-5 Commercial Cumulative Energy Efficiency Potential by State in 2042

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	220,045	62,472	51,890	28.4%	23.6%
	Washington	1,569,756	474,455	405,792	30.2%	25.9%
	Subtotal	**1,789,801**	**536,927**	**457,682**	**30.0%**	**25.6%**
Rocky Mountain Power	Idaho	709,356	286,733	243,344	40.4%	34.3%
	Utah	15,265,809	4,634,077	3,942,204	30.4%	25.8%
	Wyoming	1,698,843	641,074	549,628	37.7%	32.4%
	Subtotal	**17,674,008**	**5,561,884**	**4,735,176**	**31.5%**	**26.8%**
	Total	**19,463,809**	**6,098,810**	**5,192,859**	**31.3%**	**26.7%**

Figure 4-7 Commercial Cumulative Achievable Technical Potential Through 2032, by State



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 warehouse. Figure 4-8 below shows the share of 2042 achievable technical potential that is attributable to each segment. Small and large offices represent the largest share, with a combined 32% of long-term potential.

Figure 4-8 Commercial Cumulative Achievable Technical Potential by Segment in 2042

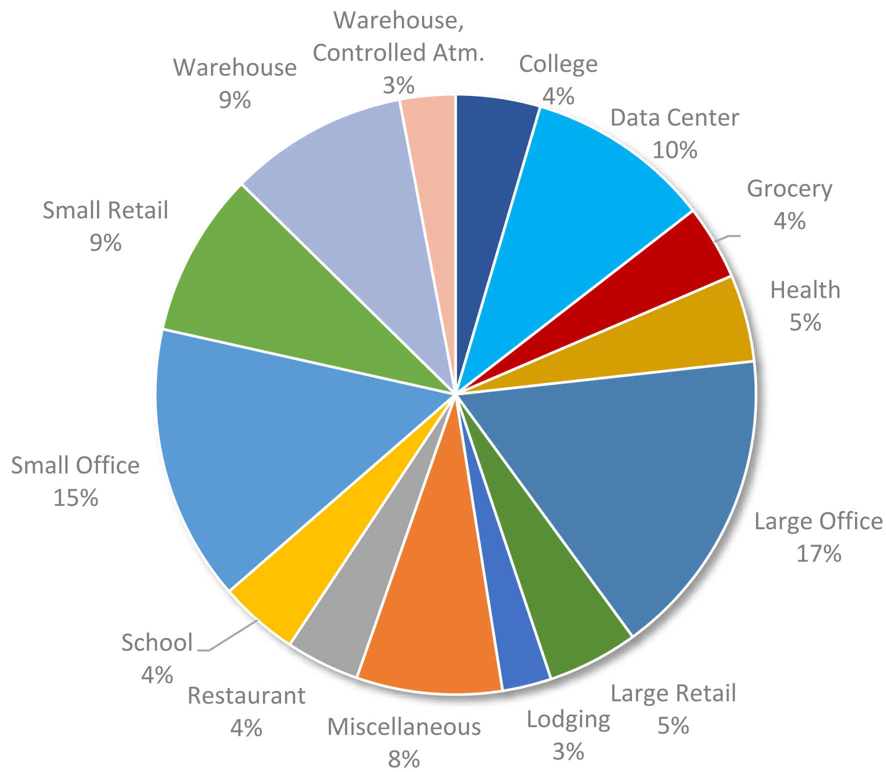


Figure 4-9 and Table 4-6 present the estimates of energy efficiency potential for the commercial sector from an end-use perspective. Key findings and observations are outlined below:

- Lighting opportunities represent roughly 36% of the identified commercial achievable technical potential, largely attributable to LED lighting and embedded controls. 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 horizon and to 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 7% of the total commercial potential, primarily from grocery stores throughout the service territory and the controlled atmosphere segment in Washington.
- The water heating, food preparation, office equipment, and miscellaneous end uses make up the remaining 16% of potential.

Figure 4-9 Commercial Cumulative Achievable Technical Potential by End Use in 2042

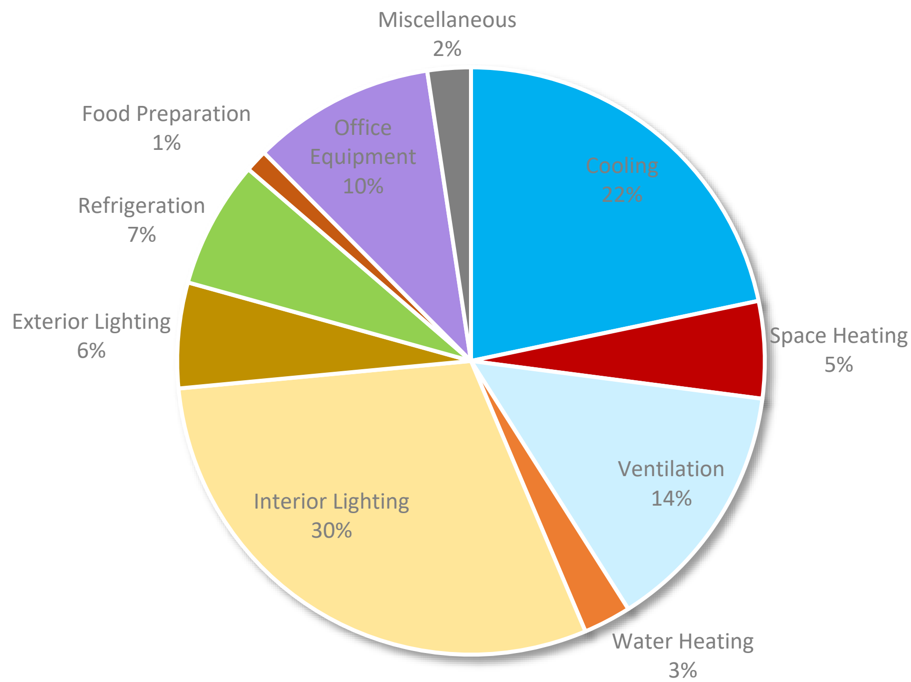


Table 4-6 Commercial Cumulative Energy Efficiency Potential by End Use in 2042

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Cooling	2,621,697	1,456,136	1,127,736	55.5%	43.0%
Space Heating	678,428	320,750	277,272	47.3%	40.9%
Ventilation	2,523,656	866,402	724,567	34.3%	28.7%
Water Heating	284,554	186,196	136,299	65.4%	47.9%
Lighting	3,791,470	2,010,316	1,852,622	53.0%	48.9%
Refrigeration	1,632,668	418,072	364,037	25.6%	22.3%
Food Preparation	440,647	80,358	63,961	18.2%	14.5%
Office Equipment	5,576,621	621,261	522,467	11.1%	9.4%
Miscellaneous	4,204,131	139,319	123,897	3.3%	3.0%
Generation	-2,290,063	N/A	N/A	N/A	N/A
Total	**19,463,809**	**6,098,810**	**5,192,859**	**31.3%**	**26.7%**

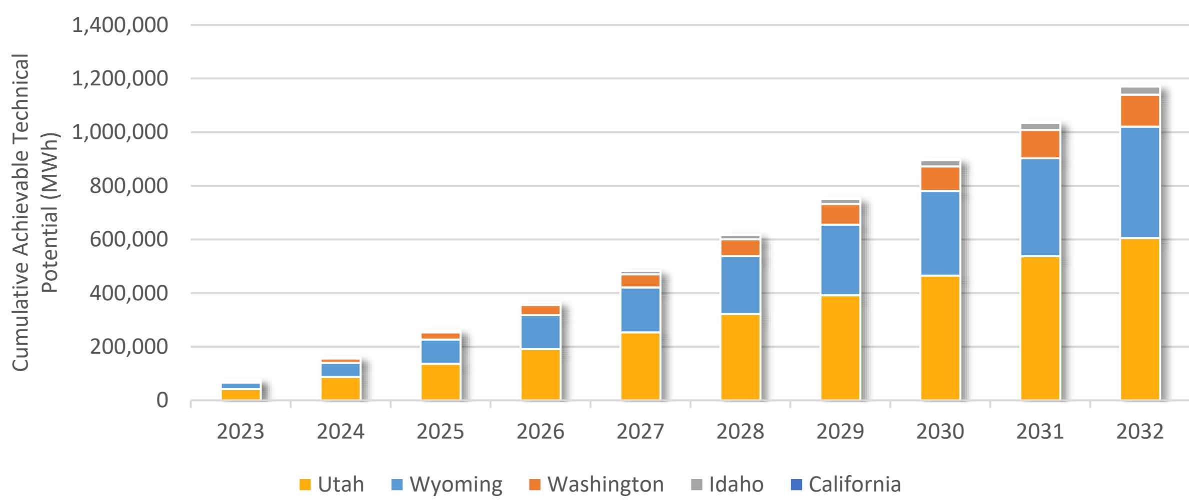
4.4 Industrial Sector

Table 4-7 presents estimates for cumulative technical and achievable technical potential for the industrial sector by the end of the study period in 2042. For the energy efficiency resources assessed in this study, the technical potential is 2.6 million MWh or 15% of the baseline forecast in 2042. The corresponding achievable technical potential is 2.2 million MWh or 13% of the 2042 baseline. Cumulative industrial achievable technical potential by state for the first 10 years of the study period is presented in Figure 4-10.

Table 4-7 Industrial Cumulative Energy Efficiency Potential by State in 2042

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	75,994	9,225	7,665	12.1%	10.1%
	Washington	1,270,555	236,582	201,281	18.6%	15.8%
	Subtotal	**1,346,548**	**245,806**	**208,946**	**18.3%**	**15.5%**
Rocky Mountain Power	Idaho	411,211	62,472	51,926	15.2%	12.6%
	Utah	7,815,195	1,356,475	1,130,945	17.4%	14.5%
	Wyoming	7,567,825	913,091	769,899	12.1%	10.2%
	Subtotal	**15,794,230**	**2,332,038**	**1,952,770**	**14.8%**	**12.4%**
	Total	**17,140,778**	**2,577,844**	**2,161,716**	**15.0%**	**12.6%**

Figure 4-10 Industrial Cumulative Achievable Technical Potential Through 2032, by State



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 4-11 shows the allocation of 2042 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 29%.[32]

Figure 4-11 Industrial Cumulative Achievable Technical Potential by Segment in 2042

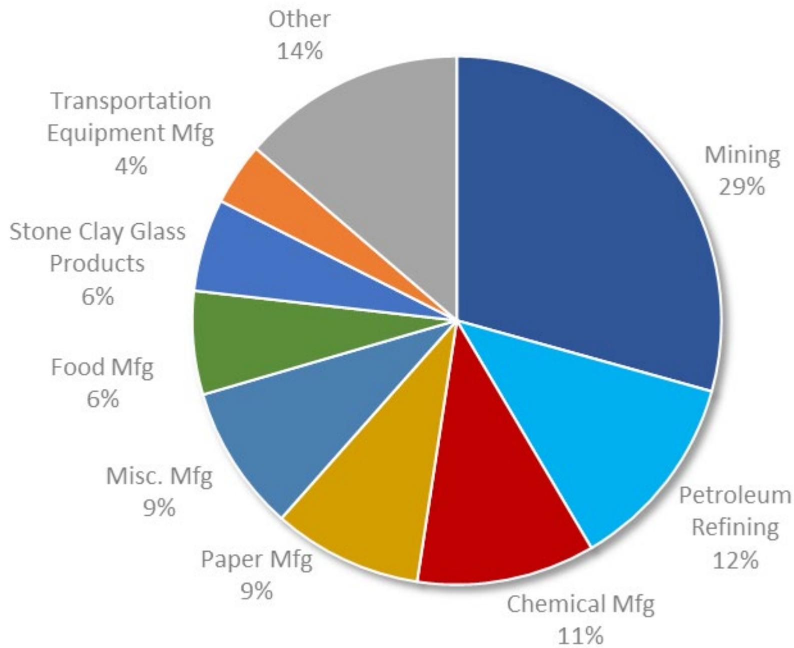


Figure 4-12 and Table 4-8 present the estimates of energy efficiency potential for the industrial sector from an end-use perspective. Key findings and observations are outlined below:

- Motor and process loads represent the largest share of end-use consumption in the industrial sector (70% of baseline sales) 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 7%.[33] Potential savings for motor equipment change-outs have been essentially eliminated by the National Electrical Manufacturer's Association (NEMA) standards, which made 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.
- As in the commercial sectors, the projected improvements in performance and applicability of LED lighting technologies and embedded controls provides a large potential opportunity in the industrial sector, leading to lighting representing 17% of the identified achievable technical potential.
- Potential for the heating, cooling, ventilation, and miscellaneous end uses represent the remaining 13% of potential, mainly realized within the non-industrial portions of buildings (e.g., warehouse and office spaces).

[32] 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.

[33] 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 4-12 Industrial Cumulative Achievable Technical Potential by End Use in 2042

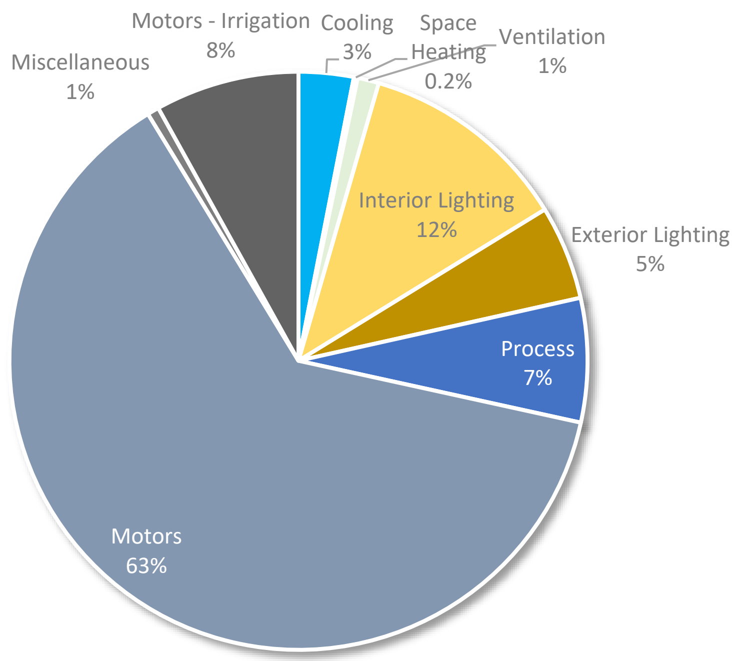


Table 4-8 Industrial Cumulative Energy Efficiency Potential by End Use in 2042

End Use	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Cooling	325,995	107,048	72,196	32.8%	22.2%
Space Heating	183,103	6,760	5,090	3.7%	2.8%
Ventilation	576,229	69,270	28,135	12.0%	4.9%
Lighting	895,672	477,524	400,142	53.3%	44.7%
Motors	11,740,909	1,710,211	1,477,728	14.6%	12.6%
Process	2,731,382	189,175	163,015	6.9%	6.0%
Miscellaneous	687,488	17,855	15,410	2.6%	2.2%
Total	**17,140,778**	**2,577,844**	**2,161,716**	**15.0%**	**12.6%**

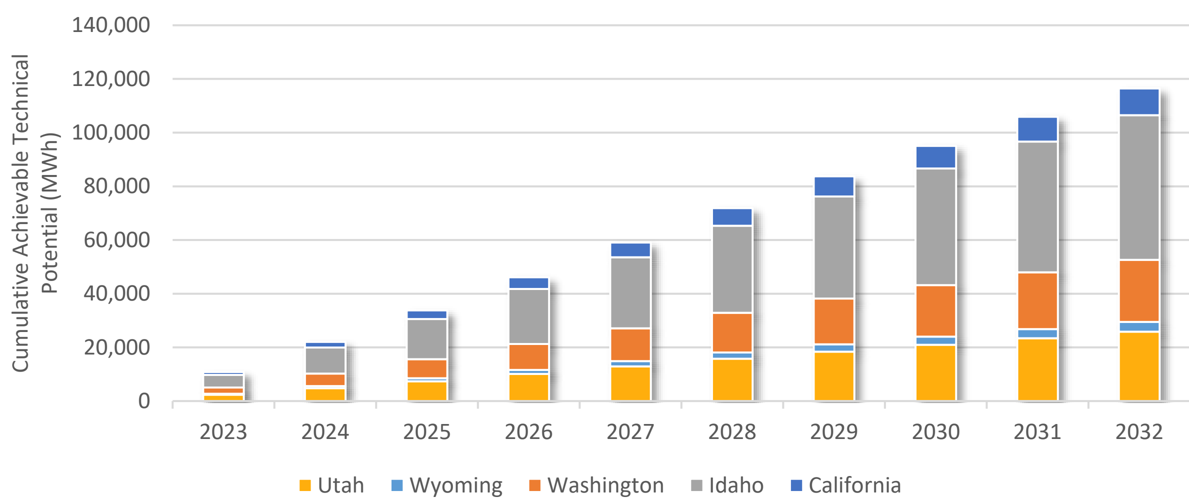
4.5 Irrigation Sector

Table 4-9 presents estimates for cumulative technical and achievable technical potential for the irrigation sector by the end of the study period in 2042. For the energy efficiency resources assessed in this study, the technical potential savings are roughly 220,000 MWh or 18% of the baseline forecast in 2042. The corresponding achievable technical potential is about 190,000 MWh or 15% of the 2042 baseline. Cumulative irrigation achievable technical potential by state for the first 10 years of the study period is presented in Figure 4-13.

Table 4-9 Irrigation Cumulative Energy Efficiency Potential by State in 2042

Territory	State	Baseline Loads (MWh)	Technical Potential (MWh)	Achievable Technical Potential (MWh)	Technical Potential (% of Baseline)	Achievable Technical Potential (% of Baseline)
Pacific Power	California	102,543	16,758	14,402	16.3%	14.1%
	Washington	180,612	41,055	35,485	22.7%	19.7%
	Subtotal	**283,155**	**57,814**	**49,888**	**20.4%**	**17.6%**
Rocky Mountain Power	Idaho	660,268	105,728	90,923	16.0%	13.8%
	Utah	264,214	50,059	43,174	19.0%	16.3%
	Wyoming	35,875	6,473	5,572	18.0%	15.5%
	Subtotal	**960,357**	**162,260**	**139,669**	**16.9%**	**14.5%**
	Total	**1,243,512**	**220,074**	**189,557**	**17.7%**	**15.2%**

Figure 4-13 Irrigation Cumulative Achievable Technical Potential Through 2032, by State



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 made 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 RESULTS

This section presents potential analysis results for demand response resources using the methodology outlined in Chapter 2.2 of this report. The demand response analysis references 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. Furthermore, in cases where PacifiCorp has existing or planned demand response programs, results are incremental to impacts from existing programs. Summary Program Potential Results

Table 5-1 presents the estimated program potential in 2042 by season for sustained events. The potential excludes the impacts from PacifiCorp's existing and planned demand response programs and accounts for competition between programs. In general, most programs are expected to achieve greater savings in the summer than in the winter, with the major exceptions being Domestic Hot Water Heater (DHW) DLC and Grid-Interactive Water Heaters. This is because water heaters consumption peaks in the early morning and evening, which align better with the winter peak period than the summer.

Table 5-1 Demand Response Program Potential by Season and Event Type, 2042

Program	Summer MW	Winter MW
HVAC Direct Load Control (DLC)	170.5	209.4
Domestic Hot Water Heater (DHW) DLC	68.8	102.7
Grid-Interactive Water Heaters	98.2	143.1
Connected Thermostat DLC	113.5	99.9
Smart Homes DLC	0.9	1.8
Pool Pump DLC	0.8	0.3
Electric Vehicle Connected Charger DLC	131.6	131.6
Battery Energy Storage DLC	77.7	54.1
Third Party Contracts	50.4	62.9
Irrigation Load Control	23.7	0.0
Total All Sectors	**736.1**	**805.9**

Table 5-2 shows the existing and planned resources PacifiCorp already plans to model in its IRP. This potential has already been removed from from the estimated potential presented in Table 5-1 to avoid double-counting resources.

Table 5-2 Existing and Planned Demand Response Resources (2023-2042)

Program	Summer MW	Winter MW
HVAC Direct Load Control (DLC)	135.0	0.0
Domestic Hot Water Heater (DHW) DLC	5.2	7.8
Grid-Interactive Water Heaters	0.4	1.2
Connected Thermostat DLC	1.5	0.0
Smart Homes DLC	0.0	0.0
Pool Pump DLC	0.0	0.0
Electric Vehicle Connected Charger DLC	0.0	0.0
Battery Energy Storage DLC	11.0	11.0
Third Party Contracts	85.0	58.0
Irrigation Load Control	216.0	0.0
Total All Sectors	**454.1**	**78.0**

5.1 State-Level Program Potential and Levelized Costs

5.1.1 Summer Peak

Table 5-3 shows total demand response potential results in 2042 by option and state during the summer peak, and Table 5-4 provides the existing and planned demand response potential that AEG removed to avoid double-counting resources in the IRP. Key observations include:

- Half of the estimated program potential is in Utah, driven by the following factors:
  - Significant projected residential customer growth creates opportunities to expand the existing Cool Keeper program and capture additional customers through a smart thermostat program.
  - Building electrification projections, consistent with PacifiCorp's load forecast, provide significant opportunities for the DHW DLC program by the end of the forecast period.
  - The updated battery forecast supports the continued growth of the existing UT program.
  - Significant growth of EVs and their charging need forecasted by PacifiCorp leads to high market saturation by the end of the forecast period.
- Oregon represents about 29% of the program potential, primarily from Grid-Interactive Water Heaters, EV DLC, and electric space heating DLC.
- California, Idaho, Washington, and Wyoming combined represent the remaining 19% of system-wide potential, almost 40% of which comes from Irrigation Load Control and Third-Party Contracts.
- Many planned and existing programs have expanded since the 2021 CPA, leading to reduced incremental potential from these programs in this study (particularly Irrigation Load Control and Third-Party Curtailment).
- Laws in Washington and Oregon require electric storage water heaters installed beginning in 2021 and 2022 (respectively) to include a CTA-2045-A communication interface, enabling interaction with the utility grid. Therefore, Grid-Interactive Water Heating (GIWH) DLC contributes substantially to the potential in these states.

Table 5-3 Incremental Demand Response Program Potential by State, 2042 (Summer Peak MW)

Program	CA	ID	OR	UT	WA	WY	Total
HVAC Direct Load Control (DLC)	2.3	7.4	39.9	101.9	11.1	7.9	**170.5**
Domestic Hot Water Heater (DHW) DLC	4.1	6.3	0.2	53.0	0.0	5.1	**68.8**
Grid-Interactive Water Heaters	0.3	0.5	76.1	4.4	16.5	0.4	**98.2**
Connected Thermostat DLC	1.3	3.1	33.7	64.0	6.9	4.5	**113.5**
Smart Homes DLC	0.0	0.0	0.2	0.5	0.0	0.1	**0.9**
Pool Pump DLC	0.0	0.0	0.3	0.4	0.1	0.0	**0.8**
Electric Vehicle (EV) Connected Charger DLC	0.4	0.3	42.5	84.6	3.4	0.4	**131.6**
Battery Energy Storage DLC	0.4	1.6	3.5	70.7	0.7	0.8	**77.7**
Third-Party Contracts	0.7	1.1	19.9	0.0	0.0	28.7	**50.4**
Irrigation Load Control	1.3	10.9	0.1	0.3	9.0	2.1	**23.7**
Total All Sectors	**10.9**	**31.3**	**216.3**	**379.8**	**47.8**	**50.1**	**736.1**

Table 5-4 Existing and Planned Demand Response Potential by State (Summer Peak MW)

Program	CA	ID	OR	UT	WA	WY	**Total**
HVAC Direct Load Control (DLC)	0.0	0.0	0.0	135.0	0.0	0.0	**135.0**
Domestic Hot Water Heater (DHW) DLC	0.0	0.0	3.5	0.0	1.7	0.0	**5.2**
Grid-Interactive Water Heaters	0.0	0.0	0.3	0.0	0.1	0.0	**0.4**
Connected Thermostat DLC	0.0	0.0	1.0	0.0	0.5	0.0	**1.5**
Smart Homes DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Pool Pump DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Electric Vehicle (EV) Connected Charger DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Battery Energy Storage DLC	0.0	1.0	0.0	10.0	0.0	0.0	**11.0**
Third-Party Contracts	0.0	0.0	40.0	30.0	15.0	0.0	**85.0**
Irrigation Load Control	0.0	170.0	20.0	20.0	6.0	0.0	**216.0**
Total All Sectors	**0.0**	**171.0**	**64.8**	**195.0**	**23.3**	**0.0**	**454.1**

Table 5-5 presents the levelized costs for summer peak impacts by program and state. As shown, Connected Thermostats DLC, Battery Energy Storage, Irrigation Load Control, and Third-Party Contracts 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:

- Connected Thermostats DLC and Battery Energy Storage DLC options are modeled under a "Bring-Your-Own" program design and do not include any equipment costs incurred by other programs.
- The Irrigation Load Control program builds from the existing program, which reduces the costs compared to launching an entirely new program.
- Similarly, the HVAC DLC program in Utah is much more low-cost compared to other states in part because of the existing infrastructure through the A/C Cool Keeper program. In addition, the program in UT experiences greater impacts on a per-customer basis than other states, driven by weather.
- For programs capable of providing impacts during both the summer and winter peak periods (i.e., excepting Irrigation Load Control DLC), 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 double.

- The Total Resource Cost methodology tends to decrease costs in Pacific Power states relative to Rocky Mountain Power states since only a portion of the incentive is included in the levelized cost calculation as a proxy for participant 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 5-5 Demand Response Summer Levelized Costs ($/kW-year)

Program	CA	ID	OR	UT	WA	WY
HVAC Direct Load Control (DLC)	$97	$115	$128	$37	$118	$107
Domestic Hot Water Heater (DHW) DLC	$156	$176	$140	$187	$124	$171
Grid-Interactive Water Heaters	$92	$129	$74	$134	$88	$130
Connected Thermostat DLC	$17	$21	$14	$20	$13	$23
Smart Homes DLC	$708	$791	$710	$820	$637	$787
Pool Pump DLC	$726	$792	$736	$815	$671	$777
Electric Vehicle Connected Charger DLC	$375	$358	$385	$408	$344	$369
Battery Energy Storage DLC	$35	$35	$33	$33	$29	$42
Third Party Contracts	$31	$40	$31	$40	$28	$41
Irrigation Load Control†	$26	$29	$24	$30	$22	$32

†Costs should not be doubled since the program does not provide any impacts during the winter peak.

5.1.2 Winter Peak

Table 5-6 presents the demand response potential results in 2042 by option for each state during the winter peak, and Table 5-7 provides the existing and planned demand response potential that AEG removed to avoid double-counting resources in the IRP. PacifiCorp plans to operate Third-Party Contracts, DHW DLC, Grid-Interactive Water Heaters, and Battery DLC in both summer and winter months, and so 78 MW of winter peak potential for these programs has been removed from the estimates shown in Table 5-6.

Key observations from the winter potential include:

- The overall magnitude of potential and distribution across states is similar to the summer potential, with Utah representing 47% of the system potential and Oregon generating an estimated 35%.
- Potential from water heating, including grid-interactive water heaters, exceeds summer potential because water heating loads have a higher coincidence with the winter peak periods. Therefore, potential from DHW DLC and Grid-Interactive Water Heaters continues to be large contributors of winter potential (31% of system winter potential across states, primarily from Oregon and Utah).
- Based on forecasted electrification efforts, especially in Utah and Oregon, space heating peak load reductions through an HVAC DLC or Connected Thermostat DLC program provides substantial opportunity across the states.
- Although irrigation load control contributes substantially to the summer potential, it does not generate any potential in the winter because of the seasonality of irrigation loads.

Table 5-6 Incremental Demand Response Program Potential by State, 2042 (Winter Peak MW)

Program	CA	ID	OR	UT	WA	WY	Total
HVAC Direct Load Control (DLC)	3.6	7.6	70.2	105.3	19.6	3.1	**209.4**
Domestic Hot Water Heater (DHW) DLC	6.1	9.4	0.3	79.1	0.1	7.7	**102.7**
Grid-Interactive Water Heaters	0.4	0.7	110.5	6.5	24.4	0.6	**143.1**
Connected Thermostat DLC	1.1	2.7	30.2	55.3	6.4	4.1	**99.9**
Smart Homes DLC	0.0	0.1	0.5	0.9	0.1	0.1	**1.8**
Pool Pump DLC	0.0	0.0	0.1	0.2	0.0	0.0	**0.3**
Electric Vehicle Connected Charger DLC	0.4	0.3	42.5	84.6	3.4	0.4	**131.6**
Battery Energy Storage DLC	0.4	2.0	3.4	47.0	0.5	0.9	**54.1**
Third Party Contracts	0.5	1.5	26.9	2.7	1.8	29.6	**62.9**
Irrigation Load Control	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total All Sectors	**12.6**	**24.3**	**284.6**	**381.5**	**56.3**	**46.5**	**805.9**

Table 5-7 Existing and Planned Demand Response Potential by State (Winter Peak MW)

Program	CA	ID	OR	UT	WA	WY	**Total**
HVAC Direct Load Control (DLC)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Domestic Hot Water Heater (DHW) DLC	0.0	0.0	5.2	0.0	2.6	0.0	**7.8**
Grid-Interactive Water Heaters	0.0	0.0	0.8	0.0	0.4	0.0	**1.2**
Connected Thermostat DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Smart Homes DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Pool Pump DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Electric Vehicle (EV) Connected Charger DLC	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Battery Energy Storage DLC	0.0	1.0	0.0	10.0	0.0	0.0	**11.0**
Third-Party Contracts	0.0	0.0	20.0	30.0	8.0	0.0	**58.0**
Irrigation Load Control	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total All Sectors	**0.0**	**1.0**	**26.0**	**40.0**	**11.0**	**0.0**	**78.0**

Table 5-8 presents the levelized costs for winter peak impacts by program and state. As in the summer analysis, Connected Thermostats DLC, Battery Energy Storage, and Third-Party Contracts were identified as relatively low-cost options for addressing winter peak demand. Space and water heating resources also tend to have lower costs in the winter for states with larger electric space heat and water heater markets, such as the Pacific Power states.

As with the summer levelized costs presented in Table 5-5, winter costs have been evenly split with summer costs, consistent with the previous CPA and the Council's plan. Therefore, estimated winter levelized costs should be doubled if PacifiCorp runs programs as winter-only options.

Table 5-8 Demand Response Winter Levelized Costs ($/kW-year)

Program	CA	ID	OR	UT	WA	WY
HVAC Direct Load Control (DLC)	$72	$142	$75	$258	$68	$270
Domestic Hot Water Heater (DHW) DLC	$104	$118	$94	$125	$83	$115
Grid-Interactive Water Heaters	$63	$89	$51	$92	$59	$89

Program	CA	ID	OR	UT	WA	WY
Connected Thermostat DLC	$18	$23	$16	$23	$14	$25
Smart Homes DLC	$358	$401	$359	$415	$323	$398
Pool Pump DLC	$1,915	$2,089	$1,940	$2,148	$1,769	$2,049
Electric Vehicle Connected Charger DLC	$375	$358	$385	$408	$344	$369
Battery Energy Storage DLC	$33	$26	$28	$53	$28	$38
Third Party Contracts	$42	$31	$36	$41	$29	$41
Irrigation Load Control	N/A	N/A	N/A	N/A	N/A	N/A

6 DEMAND-SIDE RATES POTENTIAL RESULTS

This section presents potential analysis results for demand-side rates using the methodology outlined in Chapter 2.2 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 it would overstate the total possible demand reduction from demand-side rates.

6.1 Summary of Potential Results

Table 6-1 presents the potential from demand-side rate options in 2042 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. The impacts of existing rates as they stand totaled 130 MW at generation and are not included in the impacts shown in

Key observations from the analysis include:

- Savings from demand-side rates in WA and WY begin in 2026, when PacifiCorp expects to have full AMI deployment in these states. All other states are expected to have full AMI deployment by 2023, the first year in the study.
- Consistent with the previous CPA, CPP, which is available to all customers, provides the largest estimated savings potential. In general, CPP has the highest contribution of the various demand-side rates because of higher on-to-off peak price ratios combined with an “event” type structure that encourages participants to shift more energy than a typical TOU or demand rate.
- PTR for residential customers offers the lowest savings potential of the residential rate options in the summer. While structurally similar to CPP, PTR programs reward customers for lowering demand during on-peak periods and events whereas CPP penalizes customers for inaction. The latter tends to achieve higher impacts, which the estimated potential in Table 6-1 reflects.
- For C&I customers, CPP carries significantly higher potential than TOU or Real-Time Pricing (RTP), at 71 MW in the summer by 2042. In the case of TOU, PacifiCorp has already captured significant impacts through existing rates. The RTP rate is not designed for widespread deployment like the CPP rate and is generally designed with specific, larger customers in mind.
- For Irrigation customers, CPP rates have significantly more summer savings potential in 2042 (12 MW) when compared to TOU rates (3 MW), but no potential is available in the winter due to the seasonality of these loads.

Table 6-1 Demand-Side Rates Potential in 2042

Rate Option	Summer Potential (MW)	Winter Potential (MW)
Residential TOU	108.8	43.7
Residential CPP	119.2	57.7
Residential PTR	76.6	53.5
C&I TOU	13.1	5.9
C&I CPP	70.6	33.3
C&I RTP	9.2	4.5
Irrigation TOU	2.6	0.0
Irrigation CPP	11.7	0.0
Residential Behavioral DR[34]	24.9	20.1

6.1.1 Impacts of Existing Demand-Side Rates

As part of the 2023 CPA, AEG estimated the impacts of certain existing time-varying rates across PacifiCorp's territory. The analysis leveraged analysis completed by the Brattle Group in 2015 but incorporated updates to reflect PacifiCorp's current rate structures and participants. Table 6-2 provides the estimated impacts of these existing rates.

Table 6-2 Impacts of Existing Time-Varying Rates

Rate Option	Summer Potential (MW)							Winter Potential (MW)						
	CA	ID	OR	UT	WA	WY	Total	CA	ID	OR	UT	WA	WY	Total
Residential TOU	0.0	1.3	0.2	0.1	0.0	0.0	**1.5**	0.0	0.7	0.1	0.0	0.0	0.0	**0.8**
C&I TOU	0.1	0.0	19.2	77.9	4.5	25.9	**127.6**	0.1	0.0	9.6	38.9	2.3	12.9	**63.7**
Irrigation TOU	0.0	0.0	0.5	0.7	0.0	0.0	**1.2**	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total	**0.1**	**1.3**	**19.8**	**78.7**	**4.5**	**25.9**	**130.3**	**0.1**	**0.7**	**9.6**	**38.9**	**2.3**	**12.9**	**64.5**

Detailed Potential Results by State and Customer Sector

Table 6-3 and Table 6-4 present the total 2042 demand-side rates potential by state during summer and winter peak periods, respectively. These include the impacts of expanding existing pricing options with new options that have incremental potential in future years. That is, the estimated impacts of existing rate programs as they stand (provided in Table 6-2) have already been removed.

Key observations follow.

- In Idaho, half of the new savings opportunities available through pricing options are in the irrigation sector. Similarly, in Wyoming, a state with a large peak load from industrial customers, over half of the estimated potential from rates comes from C&I CPP.
- CPP for residential customers consistently contributed the most potential compared to TOU and PTR across states, with the Utah and Oregon residential CPP rates driving most of the overall potential across all sectors.

[34] Residential behavioral DR could alternatively be considered an Education and Information resource since targeted customers are not incentivized to act.

- Consistent with findings from the DR potential assessment, Utah and Oregon contribute the most to estimated potential because of the size of their respective system peaks and customer populations. In these states, most of that potential comes from residential CPP, TOU, PTR, and C&I CPP.
- Similar trends continue in the winter peak season, with Utah and Oregon contributing the most potential due to the residential rate programs and C&I CPP.

Table 6-3 Demand-Side Rates Potential by Option and State in 2042 (Summer Peak MW)

Rate Option	CA	ID	OR	UT	WA	WY	Total
Residential TOU	1.5	2.1	25.9	66.7	9.5	3.1	**108.8**
Residential CPP	1.6	3.6	28.1	72.2	10.3	3.3	**119.2**
Residential PTR	1.0	2.3	18.1	46.4	6.6	2.2	**76.6**
C&I TOU	0.1	0.3	4.3	7.0	0.7	0.6	**13.1**
C&I CPP	0.6	1.0	25.5	24.0	5.0	14.5	**70.6**
C&I RTP	0.0	0.1	2.6	2.8	0.7	2.9	**9.2**
Irrigation TOU	0.0	2.2	0.0	0.0	0.4	0.1	**2.6**
Irrigation CPP	0.1	8.0	0.9	1.2	1.3	0.2	**11.7**
Residential Behavioral DR	0.3	0.8	5.9	15.1	2.1	0.7	**24.9**

Table 6-4 Demand-Side Rates Potential by Option and State in 2042 (Winter Peak MW)

Rate Option	CA	ID	OR	UT	WA	WY	Total
Residential TOU	0.7	1.3	12.8	23.5	3.7	1.7	**43.7**
Residential CPP	0.9	2.6	16.7	30.5	4.8	2.2	**57.7**
Residential PTR	0.9	2.4	15.5	28.3	4.5	2.1	**53.5**
C&I TOU	0.0	0.1	1.7	3.4	0.3	0.3	**5.9**
C&I CPP	0.2	0.5	10.2	13.2	1.7	7.4	**33.3**
C&I RTP	0.0	0.1	1.0	1.7	0.2	1.5	**4.5**
Irrigation TOU	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Irrigation CPP	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Residential Behavioral DR	0.3	0.9	5.8	10.6	1.7	0.8	**20.1**

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, 2019, and 2021. 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 2021 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 2020:

- 2021 customer and sales data to determine segmentation and energy use characteristics.
- Updated data associated with PacifiCorp load forecasts:
    - New construction customer growth.
    - Significant increase in projected loads for residential customers due to increased HVAC, water heating, and transportation loads.
- Segmentation of residential customers by three levels of income in all states; the previous CPA only segmented residential customers by two levels of income in Washington.
- State and federal energy codes and equipment efficiency standards enacted as of August 2022, even if they have not yet taken effect.
- Expanded source hierarchy to include more state-specific sources.
- Adjustments to measure savings, based on recent evaluation results, data available from the Regional Technical Forum (RTF), and other updated secondary sources available by June 2022.
- Expanded integration of non-energy impacts in applicable states.
- Integration of assumptions around accelerated measure penetration due to recent federal legislation such as the Inflation Reduction Act (IRA).
- A renewed emerging technology screen to capture more recent data on newly available, applicable, and quantifiable measures in the market.
- Feedback provided through PacifiCorp's 2023 IRP public meeting process.

7.1.2 Energy Efficiency Potential Comparison by Sector

Table 7-1 compares cumulative 20-year potential between the current and 2021 study, in absolute terms and as a percentage of projected loads, by sector. As shown, the 2023 CPA estimates slightly higher long-term achievable technical potential than the 2021 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.

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	3,676,536	5,801,244	20.1%	24.8%
Commercial	4,715,782	5,192,859	26.8%	26.7%
Industrial	2,366,665	2,161,716	13.8%	12.6%
Irrigation	170,571	189,557	13.8%	15.2%
Total	**10,929,555**	**13,345,375**	**20.1%**	**21.8%**

7.2 Demand Response

As discussed, the methodology for assessing demand response potential in the current CPA differs from the previous study. The previous study focused heavily on defining potential for individual grid services through a technology-view of DR, and while this approach improved our ability to assess potential under a range of circumstances, the use-case most appropriate for modeling in the IRP continued to be the sustained duration case. Therefore, the current analysis focused primarily on estimating potential for sustained events using the programmatic approach described in the methods section of the reporting.

This change in approach makes comparing results with the previous study difficult. Nonetheless, Table 7-2 and Table 7-3 compare 20-year demand response potential for sustained duration for 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 updated customer forecasts provided by PacifiCorp showed substantial growth in the residential customer population over the forecast period (40% in Utah and 20% in Oregon) and compared to the load forecast used in the previous study. Per-customer peak demand also increased based on electrification forecasts. Customer growth and electrification combined led to substantial increases demand response potential in most residential programs, most notably in HVAC DLC, Smart Thermostat DLC, and water heating DLC.
- While the residential sector experienced growth in most states, the C&I sector load decreased overall in Utah and Wyoming compared to the previous study, leading to some decreases in potential in these states. Conversely, the C&I sector load increased in Oregon and California.
- The expected emergence of grid-interactive water heaters increased the opportunity for water heater demand response in Oregon and Washington, where codes will require new water heaters to be grid-interactive. The current study also forecasted conservative growth in grid-interactive water heater saturations in states without codes compared to the previous study, shifting potential from grid-interactive to non-grid-interactive water heaters, which achieve higher peak demand reductions.
- An aggressive electric vehicle adoption forecast increased the potential for EV DLC option compared to the previous CPA, particularly in Oregon and Utah, which contribute the most to system peak demand.
- PacifiCorp included more demand response from existing and planned programs that AEG removed from estimated potential compared to the previous CPA, reducing the potential from new resources and continued program expansion. This mostly impacted Third-Party Contracts and Battery Energy Storage DLC, programs that needed no adjustments in the previous CPA.

- The updated private generation forecast included batteries and forecasted much lower instances of batteries on PV systems than assumed in the previous study, which substantially lowered the potential estimated potential from Battery Energy Storage DLC.
- The current study changed the definition of Smart Appliances DLC to Smart Homes DLC and used the saturation of home energy management systems to determine customer eligibility for the program, decreasing the program's potential.

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

DSM Options	Potential in Year-20 (Peak MW)	
	Previous Assessment	Current Assessment
HVAC Direct Load Control (DLC)	60.2	170.5
Domestic Hot Water Heater (DHW) DLC	3.8	68.8
Grid-Interactive Water Heaters	46.4	98.2
Connected Thermostat DLC	80.2	113.5
Smart Homes DLC	14.8	0.9
DLC of Pool Pumps	1.0	0.8
Electric Vehicle DLC Smart Chargers	51.2	131.6
Battery Energy Storage DLC	417.2	77.7
Third Party Contracts	207.9	50.4
Irrigation Load Control	21.0	23.7
Total Demand Response Potential	**903.7**	**736.1**

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

DSM Options	Potential in Year-20 (Peak MW)	
	Previous Assessment	Current Assessment
HVAC Direct Load Control (DLC)	131.9	209.4
Domestic Hot Water Heater (DHW) DLC	10.0	102.7
Grid-Interactive Water Heaters	133.4	143.1
Connected Thermostat DLC	32.1	99.9
Smart Appliances DLC	6.3	1.8
DLC of Pool Pumps	1.1	0.3
Electric Vehicle DLC Smart Chargers	52.4	131.6
Battery Energy Storage DLC	417.2	54.1
Third Party Contracts	172.7	62.9
Irrigation Load Control	0.2	0.0
Total Demand Response Potential	**957.2**	**805.9**

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. Potential remained generally constant relative to the respective study's baseline peak demand forecasts, and changes in these forecasts drive most substantive differences between the studies. Specific drivers of differences include the following.

- As discussed, most states experienced substantial growth in their residential sector in terms of customer population and average peak demand load, leading to increases in the potential from all residential rates.
- As in the demand response potential analysis, the aggressive electric vehicle adoption forecast increased the potential for the residential TOU EV rate compared to the previous CPA, particularly in Oregon and Utah.
- The current CPA allowed for some growth in C&I TOU beyond the existing rates, given expected participation rates for similar TOU programs, which increased the potential for C&I TOU compared to the previous study.
- The updated peak demand forecast found decreased peak load from C&I customers in Utah and Wyoming, leading to decreases in potential from C&I rates in these states that increases in other states (namely Oregon) only somewhat offset. Similarly, nearly every state experienced decreased peak load from the Irrigation sector.

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

DSM Options	Summer Potential in Year-20 (Peak MW)	
	Previous Assessment	Current Assessment
Residential TOU	77.4	108.8
Residential CPP	105.7	119.2
Residential PTR	N/A	76.6
C&I TOU	0.3	13.1
C&I CPP	91.0	70.6
C&I RTP	16.2	9.2
Irrigation TOU	4.3	2.6
Irrigation CPP	17.4	11.7
Residential Behavioral DR	18.5	24.9

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

DSM Options	Winter Potential in Year-20 (Peak MW)	
	Previous Assessment	Current Assessment
Residential TOU	40.7	43.7
Residential CPP	68.2	57.7
Residential PTR	N/A	53.5
C&I TOU	0.2	5.9
C&I CPP	39.5	33.3
C&I RTP	6.9	4.5
Irrigation TOU	0.0	0.0
Irrigation CPP	0.0	0.0
Residential Behavioral DR	9.3	20.1

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