2021 CONSERVATION POTENTIAL ASSESSMENT

Clark Public Utilities

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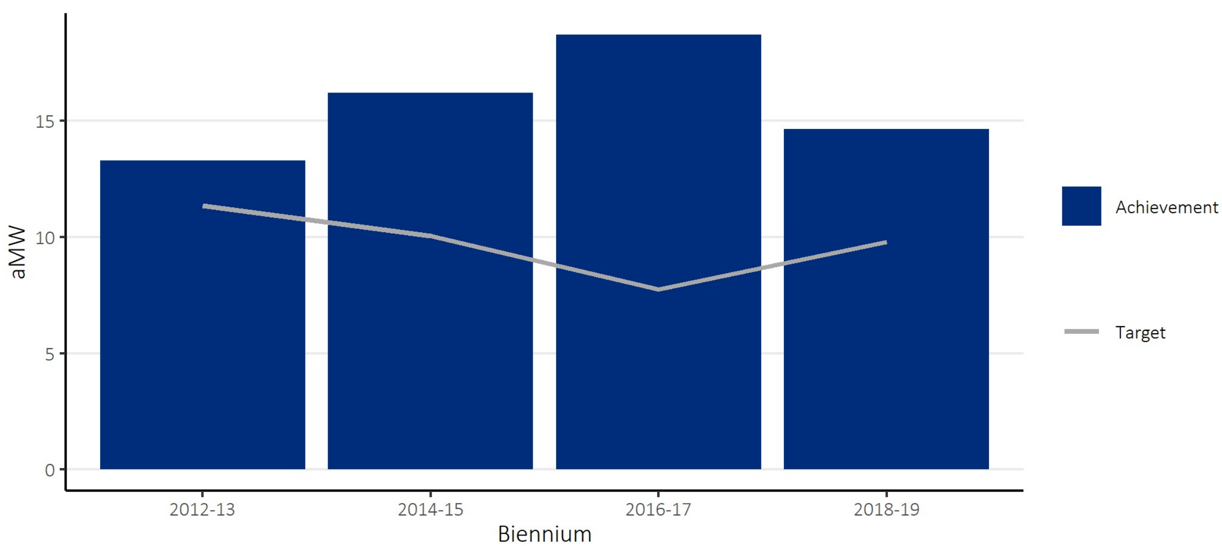
Executive Summary

Overview

This report describes the methodology and results of a conservation potential assessment (CPA) conducted by Lighthouse Energy Consulting (Lighthouse) for Clark Public Utilities (CPU). The assessment estimated the cost-effective energy efficiency savings potential for the period of 2022 to 2041. This report describes the results of the full 20-year period, with additional detail on the two- and 10-year periods that are the focus of Washington's Energy Independence Act (EIA), and the four-year period covered by the interim compliance period of the first Clean Energy Implementation Plan (CEIP).

CPU provides electricity service to approximately 211,000 customers across Clark County, Washington. The EIA requires that utilities with more than 25,000 customers identify and acquire all cost-effective energy efficiency resources and meet targets set every two years through a CPA. CPU's history of consistently exceeding its biennium conservation targets is shown in Figure 1, which is based on EIA compliance data reported to Washington's Department of Commerce.

Figure 1: Historic Targets and Achievements



The EIA specifies the requirements for setting conservation targets in RCW 19.285.040 and WAC 194-37-070 Section (5), parts (a) through (d). The methodology used in this assessment complies with these requirements and is consistent with the methodology used by the Northwest Power and Conservation Council (Council) in the Seventh and draft 2021 Power Plans. Washington's Clean Energy Transformation Act (CETA) has additional requirements for CPAs; namely, that the assessment of cost-effectiveness make use of specific values for the social cost of carbon. Appendix III details these requirements and how this assessment fulfills those requirements.

This CPA used much of the draft 2021 Power Plan materials, with customizations to make the results specific to CPU's service territory and customers. Notable changes in this CPA relative to CPU's previous assessment include the following:

- Energy Efficiency Measures
    - This assessment uses the measures savings, costs, and other characteristics based on the measures included in the draft 2021 Power Plan, with updates from the Regional Technical Forum (RTF) and additional customizations to make the measures specific to CPU.
    - Several measures included in previous CPAs are covered by Washington's HB 1444, a law that specifies efficiency standards for numerous products, including screw-in lighting, showerheads, and aerators.
- Avoided Costs
    - A new market price forecast was incorporated which decreased slightly from the 2019 CPA.
- Customer Characteristics
    - Updated counts of residential homes
    - Updated estimates of commercial floor area using the 2019 Commercial Building Stock Assessment
    - Updated breakdowns of CPU's industrial sector loads
    - Updated sector growth rates
- Program Impacts
    - Consideration of CPU's recent conservation program achievements

Results

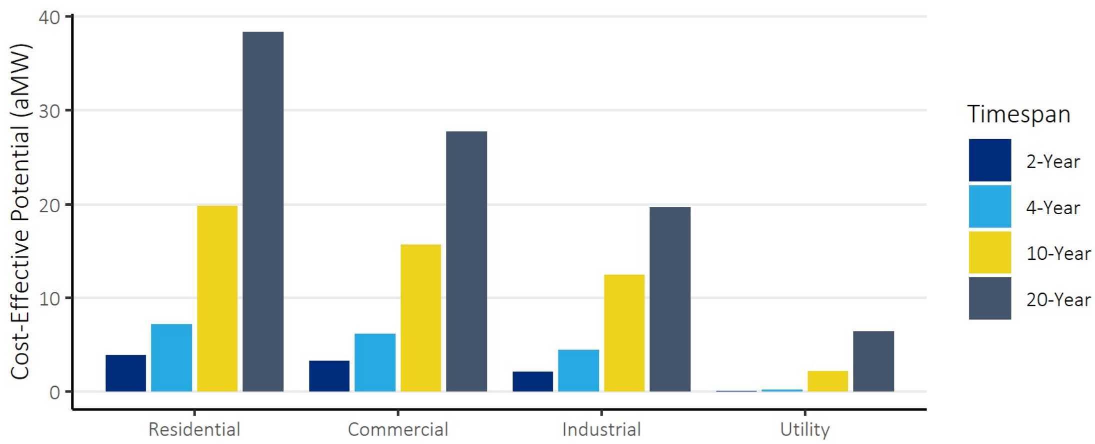
Table 1 and Figure 2 show the cost-effective energy efficiency potential by sector over two-, four-, 10-, and 20-year periods. Over the 20-year planning period, CPU has approximately 92 aMW of cost-effective conservation available, which is approximately 16% of its projected 2041 load. The EIA focuses on the two- and 10-year potential, which are 9.37 aMW and 50.07 aMW, respectively. There is 17.91 aMW of cost-effective potential available in the four-year period covered by the upcoming CEIP.

Table 1: Cost-Effective Energy Savings Potential by Sector (aMW)

Sector	2-Year	4-Year	10-Year	20-Year
Residential	3.91	7.17	19.81	38.37
Commercial	3.28	6.12	15.66	27.78
Industrial	2.13	4.41	12.43	19.67
Utility	0.05	0.20	2.17	6.38
Total	**9.37**	**17.91**	**50.07**	**92.20**

Note: In this and all subsequent tables, totals may not match due to rounding.

Figure 2: Cost-Effective Energy Savings Potential by Sector



The residential sector has the largest potential, followed by the commercial and industrial sectors. A much smaller amount of potential is available in the utility sector.

This assessment does not specify how the energy efficiency potential will be achieved. Possible mechanisms include:

- CPU's energy efficiency programs
- CPU's behavior program
- Market transformation driven by the Northwest Energy Efficiency Alliance (NEEA)
- State building codes
- State or federal product standards.

Often, the savings associated with a measure will be acquired by several of the above mechanisms over the course of its technological maturity. For example, heat pump water heaters started as one of NEEA's market transformation initiatives. Subsequently, they became a regular offering in utility programs across the Northwest and are starting to work their way into federal product standards.

Energy efficiency also contributes to reductions in peak demand. This assessment used hourly load profiles developed by the Council to identify the demand savings from each measure that would occur at the time of CPU's system peak. The cost-effective energy savings potential identified in this assessment will result in nearly 170 MW of peak demand savings over the 20-year planning period, as shown in Table 2. This represents approximately 17% of CPU's estimated 2041 peak demand.

Table 2: Cost-Effective Peak Demand Savings Potential by Sector (MW)

Sector	2-Year	4-Year	10-Year	20-Year
Residential	12.6	21.6	54.8	103.9
Commercial	3.9	7.4	18.8	33.4
Industrial	2.5	5.2	14.7	23.3
Utility	0.1	0.3	3.0	8.8
Total	19.1	34.5	91.3	169.4

The estimates of annual energy efficiency potential are based on ramp rates developed by the Council. Ramp rates are used to reflect the share of available potential that can be acquired in each year. For this CPA, Lighthouse selected ramp rates that would align near-term potential with CPU's recent program history. CPU staff provided program achievements for 2019 and 2020. Based on this data, 2020 savings levels exceeded 2019 in the commercial sector but experienced a notable decline in the residential sector. Lighthouse assigned ramp rates for each measure so that the acquisition of energy efficiency was aligned with recent program history while still allowing for the acquisition of all cost-effective conservation potential over the 20-year planning period.

The estimate of annual energy efficiency potential by sector is shown in Figure 3. The available cost-effective potential starts at 5.14 aMW in 2022 and grows to a maximum of 5.82 aMW in 2031. After that point, the available potential diminishes as the remaining available potential diminishes. The higher residential potential in 2022 is due to savings expected as part of a behavior program offered in that year.

Figure 3: Annual Incremental Energy Efficiency Potential

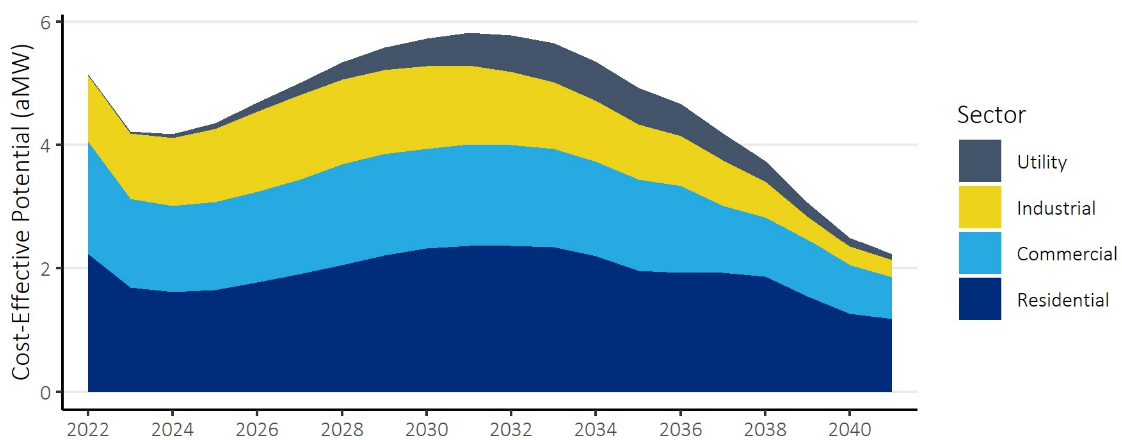
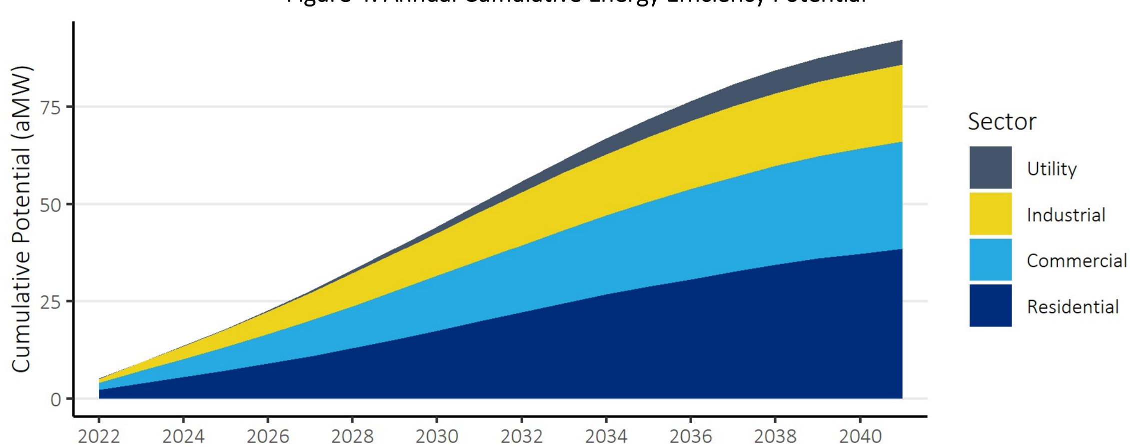


Figure 4 shows how the energy efficiency potential grows on a cumulative basis through the study period, totaling nearly 92 aMW over the 20-year planning period.

Figure 4: Annual Cumulative Energy Efficiency Potential



Comparison to Previous Assessment

Table 3 shows a comparison of the two-, 10-, and 20-year cost-effective potential by sector as quantified by the previous 2019 CPA and this 2021 CPA. The two-year comparison shows a slight increase in the overall potential with increases and decreases within the individual sectors. Over the longer-term, the 10-year potential has increased slightly, with even more potential over the 20-year period. These differences reflect a shift in the makeup of the overall potential. Many measures that have been drivers of savings in the past are now covered by product standards while the potential that remains will take longer to acquire as programs shift focus to new measures, some of which are only available during end-of-life replacement cycles.

Table 3: Comparison of 2019 and 2021 CPA Cost-Effective Potential (MWh)

Sector	2-Year Potential			10-Year Potential			20-Year Potential		
	2019 CPA	2021 CPA	% Change	2019 CPA	2021 CPA	% Change	2019 CPA	2021 CPA	% Change
Residential	3.04	3.91	29%	17.81	19.79	11%	23.75	38.16	61%
Commercial	4.08	3.28	-20%	16.10	15.66	-3%	21.22	27.78	31%
Industrial	1.77	2.13	21%	6.71	12.43	85%	7.15	19.67	175%
Utility	0.09	0.05	-43%	1.21	2.17	80%	3.41	6.38	87%
Total	8.97	9.37	4%	41.83	50.07	20%	55.53	92.20	66%

Additional discussion of the factors leading to these changes is provided below.

Avoided Costs

The lower market prices used in this CPA put pressure on measures with previously marginal cost-effectiveness. These avoided costs, along with updated measure costs and savings developed for the 2021 Power Plan, have resulted in less cost-effective potential from measures like residential weatherization and air source heat pumps.

Product Standards

A Washington State lighting standard that took effect in 2020 impacted the potential for many screw-in bulbs, requiring levels of efficiency that are only currently available with compact fluorescent light (CFL) or light-emitting diode (LED) technology. Further, studies of the retail lighting market have found that CFL lights are quickly losing market share due to consumer preference for LEDs and shifting manufacturing production. Consequently, consumers in Washington will now likely only be able to purchase LED bulbs for many bulb types, and utility programs may no longer be necessary to encourage the purchase of more efficient lighting. Some residential lighting potential remains from integrated LED fixtures, which do not require separate screw-in bulbs. However, the potential is limited from these measures as the savings are relative to efficient LED baselines.

The same law also specifies efficiency standards for other products beginning in 2021, including low-flow showerheads and faucet aerators. Measures impacted by these standards were not included in this assessment.

New Measures

The 2021 Power Plan includes new measures for motor-driven systems, including fans, pumps, air compressors, and other systems applicable to the commercial and industrial sectors. This resulted in significant additional potential in both sectors. However, this potential is driven by equipment replacement cycles, so it is projected to be acquired slowly over time.

In addition, this CPA included new per-unit estimates of savings from several measures, including smart thermostats and heat pump water heaters. This resulted in additional potential for these measures, but at a slow rate of adoption.

Customer Characteristics

This CPA used updated customer data for each sector. The count of homes is based on residential account data provided by CPU and reflects a 7% increase from 2020.

In the commercial sector, CPU provided updated load data by commercial building type. Lighthouse translated these loads to estimates of floor area with new estimates of energy use intensities (EUI) from the recently published 2019 Commercial Building Stock Assessment (CBSA). The new EUI values generally decreased by 20% to more than 40%, depending on the building type. This change resulted in an increase in the estimated floor area by approximately 30%.

The industrial sector now includes water treatment and wastewater loads that previously were included in the commercial sector. Excluding this change, the loads in the industrial sector have decreased slightly relative to the 2019 CPA. Despite this change, the new measures described above have added potential to the industrial sector.

Conclusion

This report summarizes the CPA conducted for CPU for the 2022 to 2041 timeframe. The CPA identified a similar amount of cost-effective potential in the near-term relative to the 2019 CPA, with larger potential available in the long-term.

Lower near-term potential in some sectors and end uses is due to low avoided costs, updated measure costs and savings, continued program achievements, and new product standards taking effect. The potential in all sectors was also adjusted to align with recent program history. The remaining potential, including some measures with higher per-unit savings and new motor-driven system measures characterized for the commercial and industrial sectors, is driven by equipment replacement cycles, and is expected to be acquired slowly over time.

Introduction

Objectives

This report describes the methodology and results of a CPA conducted for CPU by Lighthouse. The CPA estimated the cost-effective energy savings potential for the period of 2022 to 2041. This report describes the results of the full 20-year study period, with additional detail on the two- and 10-year periods that are the focus of Washington's EIA and the four-year period that aligns with the interim compliance period covered by the first CEIP.

This assessment was conducted in a manner consistent with the requirements of Washington's RCW 19.285, and WAC 194-37. As such, this report is part of the documentation of CPU's compliance with these requirements. The state of Washington's recently passed CETA includes an additional requirement for CPAs to use specific values for the social cost of carbon, which were incorporated in this analysis.

The results of this assessment can be used to assist CPU in planning its energy efficiency programs by identifying the amount of cost-effective energy savings available in various sectors, end uses, and measures. It can also inform CPU's integrated resource planning.

Background

Washington State's EIA defines "qualifying utilities" as those with 25,000 customers or more and requires them to achieve all conservation that is cost-effective, reliable, and feasible. Since CPU serves more than 25,000 customers, it is required to comply with the EIA. The requirements of the EIA specify that all qualifying utilities complete the following by January 1 of every even-numbered year:[1]

- Identify the achievable cost-effective conservation potential for the upcoming 10 years using methodologies consistent with the Council's latest power plan.
- Establish a biennial acquisition target for cost-effective conservation that is no lower than the utility's pro rata share of the 10-year cost-effective conservation potential for the subsequent 10 years.

Appendix III further details how this assessment complies with each of the requirements specified for CPA by Washington's EIA.

Recent Legislative Changes

Another new law, Washington HB 1444 of the 2019 legislative session, concerns efficiency standards for a variety of appliances, including lighting, showerheads, and aerators. Except for lighting, the law generally applies to products manufactured after January 1, 2021. Accordingly, measures impacted by these product standards were removed from this assessment.

The law's efficiency standard for lighting took effect in 2020. The standard covers many screw-in lights common in the residential and commercial sectors and specifies a level of efficiency that is currently only possible with compact fluorescent light (CFL) or light-emitting diode (LED) technologies. Recent studies of lighting market trends have identified that CFLs are rapidly decreasing in market share due to consumer preference for LEDs. Manufacturers are also contributing to this trend, following consumer preferences, and shifting production from CFLs to LEDs. As a result, consumers may only be able to purchase LED lights

[1] Washington RCW 19.285.040

for many applications, and utility lighting programs may be unnecessary. Lighting measures were included in this assessment, but the potential is limited.

Study Uncertainties

The recent rapid changes in economic conditions because of the COVID-19 pandemic illustrate the uncertainties inherent in long-term planning. While this assessment makes use of the latest forecasts of customers and loads, it is still subject to remaining uncertainties and limitations. These uncertainties include, but are not limited to:

- Customer Characteristic Data: This assessment used the best available data to reflect CPU's customers. In some cases, however, the assessment relied upon data beyond CPU's service territory due to limitations of available data and adequate sample sizes. There are uncertainties, therefore, related to the extent that this data is reflective of CPU's customer base.
- Measure Data: Measure savings and cost estimates are based on values prepared by the Council and RTF. These estimates will vary across the region due to local climate variations and market conditions. Additionally, some measure inputs such as applicability are based on limited data or professional judgement.
- Market Price Forecasts: This assessment uses an updated market price forecast that was based on prices in March of 2021. Market prices and forecasts are continually changing.
- Utility System Assumptions: Measures in this CPA reflect cost credits based on their ability to provide transmission and distribution system capacity. The actual value of these credits is dependent on local conditions, which vary across CPU's service territory. Additionally, a value for generation capacity is included, but the value of this credit is subject to the evolving need for capacity in the Northwest.
- Load and Customer Growth Forecasts: This CPA projects future customer growth based on 20-year forecasts of growth. These forecasts inherently include a significant level of uncertainty.
- Continuing Impacts of the COVID-19 Pandemic: The study makes use of the latest and best available information at the time of development, but new and unforeseen impacts of the COVID-19 pandemic may cause deviations, including impacts to energy prices, supply chains, and other factors.

Due to these uncertainties and the continually changing planning environment, the EIA requires qualifying utilities to update their CPAs every two years to reflect the best available data and latest market conditions.

Report Organization

The remainder of this report is organized into the following sections:

- Methodology
- Historic Conservation Achievement
- Customer Characteristics
- Results
- Scenario Results
- Summary
- References & Appendices

Methodology

This section provides an overview of the methodology used to develop the estimate of cost-effective conservation potential for CPU.

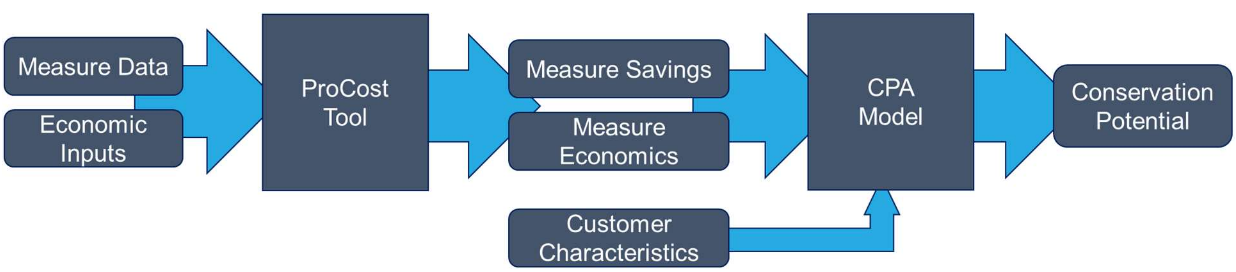
Requirements for this CPA are laid out in RCW 19.285.040 and WAC 194-37-070, Section 5 parts (a) through (d). Additional requirements are specified in the CETA. The methodology used to produce this assessment is consistent with these requirements. The development of the conservation potential follows much of the methodology used by the Council in developing its regional power plans, including the Seventh Power Plan and material from the draft 2021 Power Plan that was available during the development of this CPA.

Appendix III provides a detailed breakdown of the requirements of the EIA and CETA and how this assessment complies with those standards.

High-level Methodology

The methodology used for this assessment is illustrated in Figure 5. At a high level, the process combines data on individual energy efficiency measures and economic assumptions using the Council's ProCost tool. This tool calculates a benefit-cost ratio using the Total Resource Cost (TRC) test, which is used to determine whether a measure is cost-effective. The measure savings and economic results are combined with customer data in Lighthouse's CPA model, which quantifies the number of remaining implementation opportunities. The savings associated with each of these opportunities is aggregated in the CPA model to determine the overall potential.

Figure 5: Conservation Potential Assessment Methodology



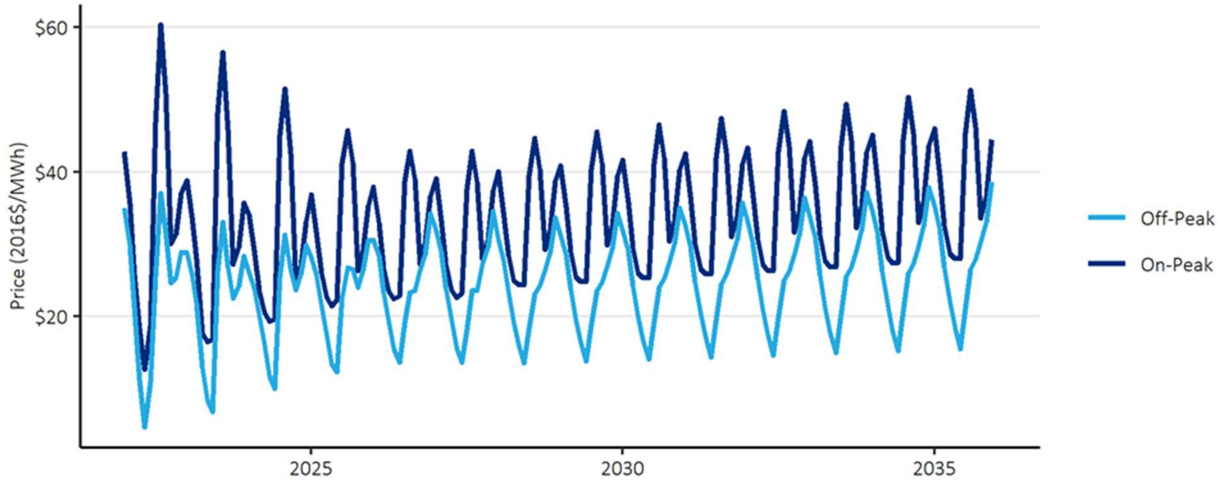
Economic Inputs

Lighthouse worked closely with CPU staff to define the economic inputs that were used in this CPA. These inputs include avoided energy costs, carbon costs, transmission and distribution capacity costs, and generation capacity costs. Each of these are discussed below.

Avoided Energy Costs

Avoided energy costs represent the cost of energy purchases that are avoided through energy efficiency savings. The EIA requires utilities to "set avoided costs equal to a forecast of market prices." For this CPA, CPU provided a forecast of avoided on- and off-peak energy prices at the Mid-Columbia trading hub from The Energy Authority, which was extrapolated at an annual growth rate of 2% to cover the full 20-year study period. Figure 6 below shows the market price forecast that was used for the base case scenario of this assessment. For clarity, the figure does not show the full 20-year forecast. High and low scenario price forecasts were developed based on this forecast and are discussed in Appendix IV.

Figure 6: Avoided Energy Costs



Social Cost of Carbon

In addition to avoiding purchases of energy, energy efficiency measures have the potential to avoid emissions of greenhouse gases like carbon dioxide. The EIA requires that CPAs include the social cost of carbon, which the U.S. EPA defines as "a measure of the long-term damage done by a ton of carbon dioxide emissions in a given year." It includes, among other things, changes in agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, including increases in the costs of cooling and decreases in heating costs.[2] In addition to this requirement, Washington's CETA requires that utilities use the social cost of carbon values developed in 2016 by the Federal Interagency Workgroup using a 2.5% discount rate.

To implement a cost of carbon emissions, additional assumptions must be made about the intensity of carbon emissions. This assessment uses the market rate emissions factors developed for the 2021 Plan with modifications to reflect that CETA requires carbon-free energy beginning in 2030.

Renewable Portfolio Standard Compliance Costs

By reducing CPU's overall load, energy efficiency reduces the cost of complying with Washington's requirements for renewable and carbon-neutral energy. Currently, CPU is required to source 15% of its power from renewable energy resources, which it does through the purchase of renewable energy credits (RECs). In 2030, CETA requires all sales to be greenhouse gas neutral, while allowing up to 20% of the requirement to be met through REC purchases. Conservation can reduce the cost of complying with these requirements by reducing CPU's load. Further details are discussed in Appendix IV.

Deferred Transmission and Distribution System Costs

Unlike supply-side resources, energy efficiency does not require capacity on transmission and distribution infrastructure. Instead, it frees up capacity by reducing the peak demands on these systems and can help defer future capacity expansions and the associated capital costs.

In the development of the draft 2021 Power Plan, the Council developed a standard methodology for calculating these values and surveyed Northwest utilities to update the values associated with these cost

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[2] See https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

deferrals. This CPA uses the values developed by the Council through that process. The resulting values are $3.08 and $6.85 per kW-year (in 2016 dollars) for transmission and distribution capacity, respectively. These values are applied to the demand savings coincident with the timing of the respective system peaks.

Program Administration Costs

In each of the past three power plans, the Council has assumed that program administrative costs are equal to 20% of the cost of each measure. This CPA uses that assumption, which is also consistent with CPU's previous CPA.

Risk Mitigation

Investing in energy efficiency can reduce the risks that utilities face by the fact that it is made in small increments over time, rather than the large, singular sums required for generation resources. A decision not to invest in energy efficiency could result in exposure to higher market prices than forecast, an unneeded infrastructure investment, or one that cannot economically dispatch due to low market prices. While over-investments in energy efficiency are possible, the small and discrete amounts invested in energy efficiency over time limit the ultimate exposure to this risk.

This CPA follows the process used in CPU's 2017 and 2019 CPAs. A scenario analysis is used to account for uncertainty, where present, in avoided cost values. The variation in inputs covers a range of possible outcomes and the amount of cost-effective energy efficiency potential is presented under each scenario. In selecting its biennial target based on this range of outcomes, CPU is selecting its preferred risk strategy and the associated risk credit.

Northwest Power Act Credit

The EIA requires that a 10% cost credit be given to energy efficiency measures. This benefit is specified in the Northwest Electric Power Planning and Conservation Act and is included by the Council in their power planning work.

Other Financial Assumptions

In addition, this assessment makes use of an assumed discount rate to convert future costs and benefits to present-year values so that values occurring in different years can be compared. This assessment uses a real discount rate of 3.75%, which is the value developed for the 2021 Power Plan and a slight decrease from the 4% value used in CPU's 2019 CPA. Energy efficiency benefits accrue over the lifetime of the measure, so a lower discount rate results in higher present values for benefits occurring in future years.

Assumptions about finance costs are applied to measures as well. The cost of each measure is assumed to be split across various entities, including Bonneville Power Administration (BPA), CPU, and end use customers. For each of these entities, additional assumptions are made about whether the measure costs are financed and the cost of that financing. This assessment uses the finance cost assumptions that were used in the draft 2021 Power Plan materials.

Measure Characterization

Measure characterization is the process of defining each individual measure, including the savings at the meter as well as the cost, lifetime, non-energy impacts, and a load shape that defines when the savings occur. The Council's draft 2021 Power Plan materials are the primary source for this information, although updates from the RTF have been incorporated, where available.

Measure savings are typically defined by a “last in” approach. With this methodology, each measure’s savings is determined as if it was the last measure installed. For example, savings from home weatherization measures are determined based on the assumption that the home’s heating system has already been upgraded. Similarly, the heating system measures are quantified based on the assumption that the home has already been weatherized. This approach is conservative but prevents double counting savings over the long-term as homes are likely to install both measures.

Measure savings also consider measure interaction. Interaction occurs when measures in one end use impact the energy use of other end uses. Examples of this include energy efficient lighting and other appliances. The efficiency of these appliances results in less wasted energy released as heat and the corresponding impacts to heating and cooling system energy demands.

These measure characteristics, along with the economic assumptions, are used as inputs to the Council’s ProCost tool. This tool determines the savings at the generator, factoring in line losses, as well as the demand savings that occur coincident with CPU’s system peak. It also determines the levelized-cost and benefit-cost ratios, which are used to determine whether measures are cost-effective.

Customer Characteristics

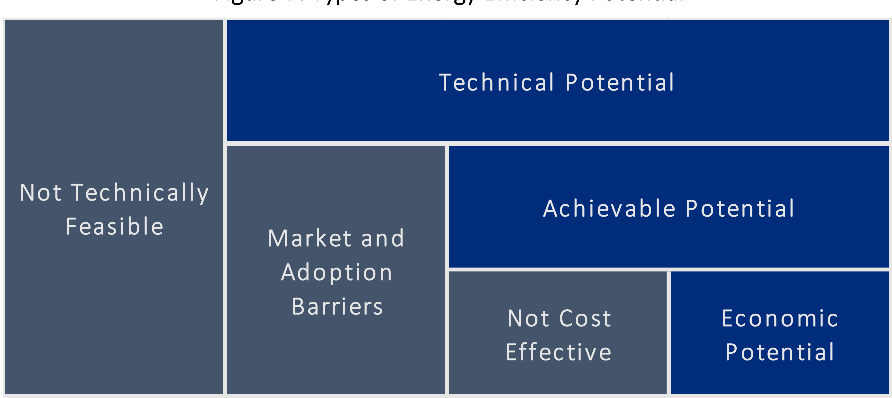
The assessment of customer characteristics is used to determine the number of available measure installation opportunities for each measure. This includes both the number of opportunities overall, as well as the share, or saturation, that have already been completed. The characterization of CPU’s customer base was completed using data provided by CPU, NEEA’s commercial and residential building stock assessments, U.S. Census data, and other data sources. Details for each sector are described subsequently in this report.

This CPA used baseline measure saturation data from the Council’s draft 2021 Power Plan. This data was developed from NEEA’s stock assessments, market research and other studies. This data was supplemented with CPU’s conservation achievements, where applicable. This achievement is discussed in the next section.

Energy Efficiency Potential

The energy efficiency measure data and customer characteristics are combined in the CPA model. The model calculates the economic or cost-effective potential by progressing through the types of energy efficiency potential shown in Figure 7 below. Each is discussed in further detail below.

Figure 7: Types of Energy Efficiency Potential



First, technical potential is the theoretical maximum of energy efficiency available, regardless of cost or market constraints. It is determined by multiplying the measure savings by the number of remaining feasible installation opportunities.

The model then applies several filters that incorporate market and adoption barriers, resulting in the achievable potential. These filters include an assumption about the maximum potential adoption and the pace of annual achievements. Energy efficiency planners generally assume that not all measure opportunities will be installed; some portion of the technically possible measure opportunities will remain unavailable due to unsurmountable barriers. In the Seventh Power Plan, it was assumed that 85% of all measure opportunities can be achieved. This assumption came from a pilot study conducted in Hood River, Oregon, where home weatherization measures were offered at no cost. The pilot was able to reach over 90% of homes and complete 85% of identified measure opportunities. In the draft 2021 Power Plan, the Council has taken a more nuanced approach to this assumption. Measures that are likely to be subject to future codes or product standards have higher maximum achievability assumptions. This CPA follows the Council's new approach.

In addition, ramp rates are used to identify the portion of the available potential that can be acquired each year. The selection of ramp rates incorporates the different levels of program and market maturity as well as the practical constraints of what utility programs can accomplish each year.

Finally, economic, or cost-effective potential is determined by limiting the achievable potential to those measures that pass an economic screen. Per the EIA, this assessment uses the TRC test to determine economic potential. The TRC evaluates all measure costs and benefits, regardless of whom they accrue to. The costs and benefits include the full incremental capital cost of the measure, any operations and maintenance costs, program administrative costs, avoided energy and carbon costs, deferred capacity costs, and quantifiable non-energy impacts.

Recent Conservation Achievement

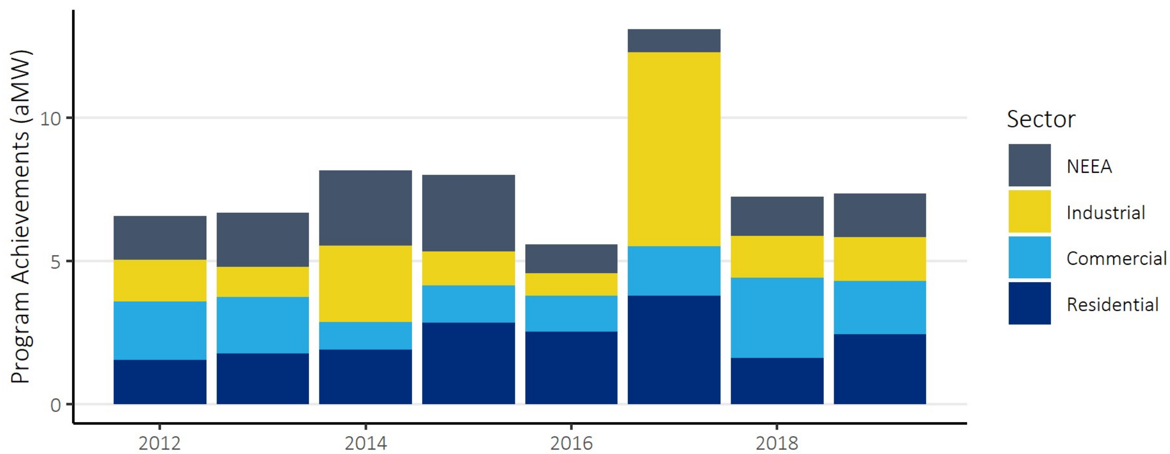
CPU has a long history of energy efficiency achievement and, according to the RTF's 2020 Regional Conservation Progress Report[3], has averaged savings equal to 1.3% of its retail sales in each year over the 2016-2020 time period, putting it among top saving utilities in the region.

CPU currently offers programs for its residential, commercial, and industrial customers. In addition to these programs, CPU receives credit for the market transformation initiatives of NEEA that occur within its service territory. NEEA's work has helped to bring energy efficient emerging technologies, like ductless heat pumps and heat pump water heaters, to the Northwest.

Overall

Figure 8 summarizes CPU's conservation achievements from 2012-2019 by sector, as reported under Washington's EIA.

Figure 8: Recent Conservation Achievements by Sector



The average savings over this eight-year period is 7.85 aMW per year. Savings from NEEA's market transformation initiatives are primarily in the residential sector, so most of the historical savings are from CPU's residential sector.

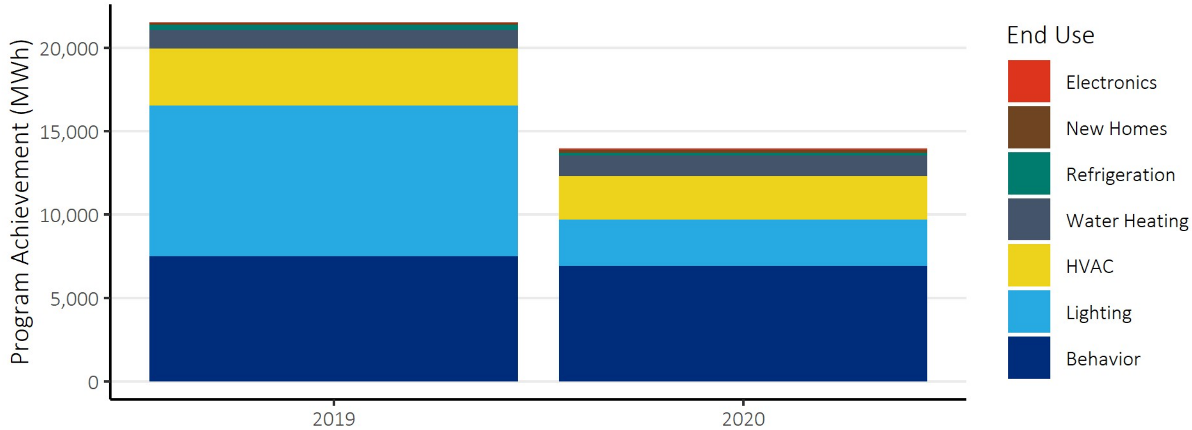
CPU provided additional detail on savings for 2019 and 2020 for each sector, which is discussed below.

Residential

The recent residential program achievements by end use are shown in Figure 9. Most of the savings are in the behavior, lighting, and HVAC end uses. Note that the HVAC end use includes both weatherization and heating system equipment. Smaller amounts of savings were achieved in the water heating, refrigeration, new homes, and electronics category. Savings in the electronics category include advanced power strips. Residential savings declined in 2020 due to the impacts of the COVID-19 pandemic and a reduction in lighting savings.

[3] https://rtf.nwcouncil.org/about-rtf/conservation-achievements/2020

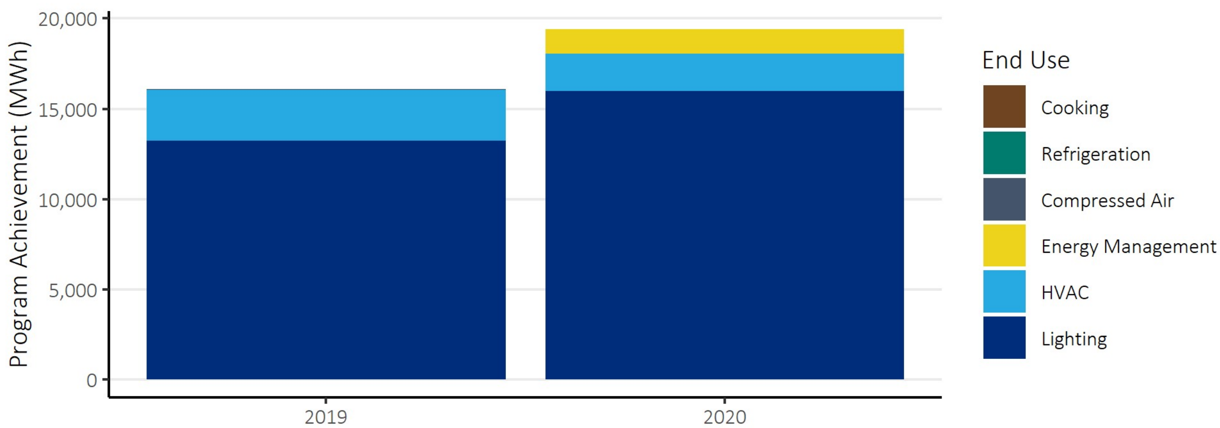
Figure 9: 2019-2020 Residential Program Achievements by End Use



Commercial

The majority of CPU's commercial savings are in the lighting end use, as shown in Figure 10. Smaller amounts of savings come from projects in the HVAC, energy management, and several other end uses.

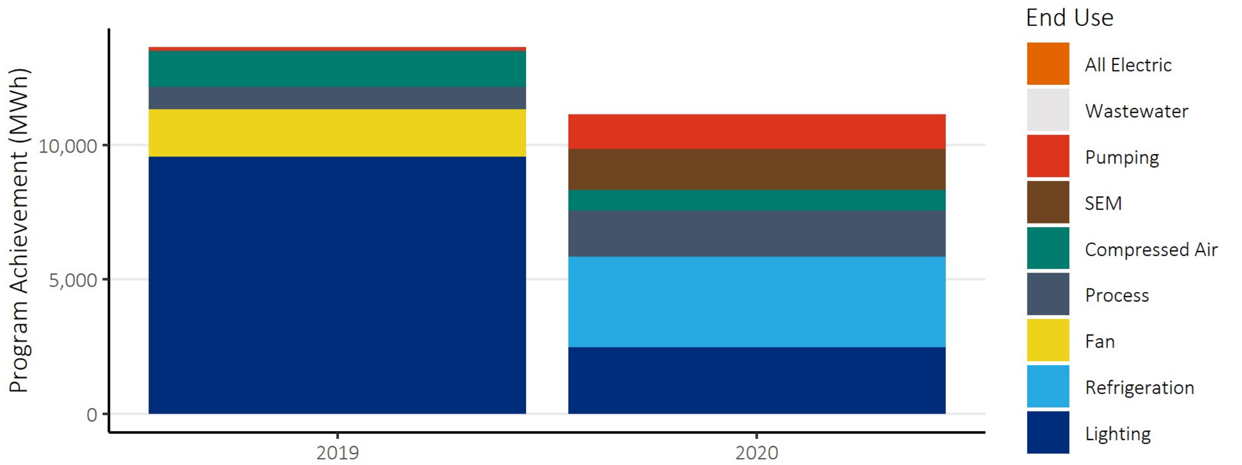
Figure 10: 2019-2020 Commercial Program Achievements by End Use



Industrial

In the industrial sector, lighting savings make up the largest historical source of savings while savings from numerous other end uses contribute additional savings. Savings from the industrial sector are often lumpy with savings varying from year to year, depending on the projects identified and chosen for capital investment by industrial facilities. These savings are summarized in Figure 11 below.

Figure 11: 2019-2020 Industrial Program Achievements by End Use



Customer Characteristics

This section describes the characterization of CPU's customer base. This process includes defining the makeup and characteristics of each individual sector. Defining the customer base determines the type and quantity of remaining opportunities to implement energy efficiency measures. Additional information about the local climate and service territory population is used to characterize some measures. This information is summarized in Table 4.

Table 4: Service Territory Characteristics

Heating Zone	Cooling Zone	Total Homes (2020)	Total Population (2020)
1	1	197,577	495,778

The count of homes is based on residential account data provided by CPU and reflects a 7% increase from 2020. Future residential growth was assumed to be 1.4% per year, based on CPU projections. An additional demolition rate, based on assumptions for Washington State from the Council's 2021 Power Plan, was also used. The demolition rate is used to quantify the number of existing homes that are converted to new homes without adding to the overall count of homes. The population is based on census data for Clark County.

Residential

Within the residential sector, the key characteristics are the number and type of homes as well as the saturation of end use appliances such as space and water heating equipment. The distribution of home types was updated based on American Community Survey data. HVAC and other appliance saturation data was based on NEEA's 2016 Residential Building Stock Assessment. Table 5 and Table 6 summarize the characteristics that were used for this assessment for existing homes and new homes, respectively.

Table 5: Residential Existing Home Characteristics

	Single Family	Low Rise Multifamily	High Rise Multifamily	Manufactured
Share of Homes	74%	6%	15%	5%
HVAC Equipment				
Electric Forced Air Furnace	3%	0%	0%	55%
Air Source Heat Pump	19%	5%	5%	26%
Ductless Heat Pump	10%	0%	0%	6%
Electric Zonal/Baseboard	26%	91%	91%	3%
Central Air Conditioning	31%	0%	0%	0%
Room Air Conditioning	11%	29%	29%	29%
Other Appliances				
Electric Water Heater	58%	95%	95%	90%
Refrigerator	137%	104%	104%	126%
Freezer	44%	5%	5%	39%
Clothes Washer	97%	35%	35%	94%
Electric Clothes Dryer	90%	29%	29%	94%
Dishwasher	87%	60%	60%	77%
Electric Oven	95%	98%	98%	100%
Desktop	68%	27%	27%	65%
Laptop	67%	29%	29%	29%
Monitor	81%	31%	31%	65%

Table 6: Residential New Home Characteristics

	Single Family	Low Rise Multifamily	High Rise Multifamily	Manufactured
HVAC Equipment				
Electric Forced Air Furnace	3%	0%	0%	55%
Air Source Heat Pump	19%	5%	5%	26%
Ductless Heat Pump	10%	0%	0%	6%
Electric Zonal/Baseboard	26%	91%	91%	3%
Central Air Conditioning	31%	0%	0%	0%
Room Air Conditioning	11%	29%	29%	29%
Other Appliances				
Electric Water Heater	58%	95%	95%	90%
Refrigerator	137%	104%	104%	126%
Freezer	44%	5%	5%	39%
Clothes Washer	97%	35%	35%	94%
Electric Clothes Dryer	90%	29%	29%	94%
Dishwasher	87%	60%	60%	77%
Electric Oven	95%	98%	98%	100%
Desktop	68%	27%	27%	65%
Laptop	67%	29%	29%	29%
Monitor	81%	31%	31%	65%

In the tables above, numbers greater than 100% imply an average of more than one appliance per home. For example, the single-family refrigerator saturation of 137% means that single family homes average approximately 1.4 refrigerators per home.

Commercial

In the commercial sector, building floor area is the key variable in determining the number of conservation opportunities, as many of the commercial measures are quantified based on the applicable square feet of floor area. To estimate the commercial floor area in CPU's service territory, CPU provided 2020 sales by commercial building type. The loads were combined with energy use intensities (EUIs) from the 2019 CBSA, which found that EUIs had decreased relative to the previous (2012) study by 24-45% across many building types, largely due to more efficient lighting. The net result of this is a 30 percent increase in the estimated commercial floor area relative to the 2019 CPA. The commercial floor area was assigned a growth rate of 0.22% based on the growth in commercial sales reported to the EIA from 2013 to 2019.

Table 7 summarizes the resulting floor area estimates for each of the 18 commercial building segments.

Table 7: Commercial Floor Area by Segment

Building Type	2020 Floor Area (square feet)
Large Office	6,401,858
Medium Office	6,100,327
Small Office	6,675,786
Extra Large Retail	7,674,348
Large Retail	2,111,262
Medium Retail	8,144,421
Small Retail	7,767,779
School (K-12)	4,566,576
University	2,194,257
Warehouse	16,977,151
Supermarket	268,630
Mini Mart	1,959,533
Restaurant	2,135,207
Lodging	8,842,466
Hospital	1,131,927
Residential Care	3,933,589
Assembly	1,701,106
Other Commercial	1,919,273
Total	90,505,496

Industrial

The methodology used to estimate potential in the industrial sector is different from the residential and commercial sectors. Instead of building a bottom-up estimate of the savings associated with individual measures, potential in the industrial sector is quantified using a top-down approach that uses the annual energy consumption within individual industrial segments, which is then further disaggregated into end uses. Savings for individual measures are calculated by applying assumptions on the percent of savings to the applicable end use consumption within each industrial segment.

To quantify the industrial segment loads, CPU provided 2020 energy consumption data for its industrial customers categorized by industry. The overall industrial consumption totals 955,295 MWh, as summarized in Table 8. This represents a slight decrease over the 2019 CPA after accounting for the fact that loads for water supply and wastewater treatment were moved to the industrial sector, which were previously included in the commercial sector.

Lighthouse based the growth rate based on the compound annual growth of industrial sales reported to the EIA, which was 0.12%.

Table 8: Industrial Sector Sales by Segment

Segment	2020 Sales (MWh)
Water Supply	53,693
Sewage Treatment	28,324
Other Food	80,379
Wood - Lumber	8,352
Wood - Panel	44
Wood - Other	11,040
Paper Conversion Plants	14,556
Refinery	1,127
Chemical Manufacturing	134,571
Silicon Growing/Manufacturing	247,461
Cement/Concrete Products	7,279
Primary Metal Manufacturing	2,427
Fabricated Metal Manufacturing	40,856
Semiconductor Manufacturing	203,213
Transportation Equipment	14,363
Misc. Manufacturing	79,797
Refrigerated Warehouse	6,887
Fruit Storage	6,275
Indoor Agriculture	14,650
Water Supply	53,693
Total	955,295

Distribution System Efficiency

The draft 2021 Power Plan materials include a new approach for quantifying the potential energy savings in measures that improve the efficiency of utility distribution systems. The Council's new approach estimates potential based on an estimate of the number of distribution substations and feeders for each utility, as well as the 2018 sales within each sector as reported to the U.S. EIA. Table 9 summarizes the assumptions used for this sector.

Table 9: Utility Distribution System Efficiency Assumptions

Characteristic	Count
Distribution Substations*	42
Residential/Commercial Substations*	35
Urban Feeders*	68
Rural Feeders*	29
2018 Residential Sales (MWh)	2,364,873
2018 Commercial Sales (MWh)	1,335,558
2018 Industrial/Other Sales (MWh)	764,602

**Note that these are estimates from the Council and may not reflect CPU's actual system*

Results

This section discusses the results of the 2021 CPA. It begins with a discussion of the high-level achievable and cost-effective conservation potential and then covers the cost-effective potential within individual sectors and end uses.

Achievable Conservation Potential

The achievable conservation potential is the amount of energy efficiency that can be saved without considering the cost-effectiveness of measures. It considers market barriers and the practical limits of acquiring energy savings by efficiency programs, but not cost.

Figure 12 shows the supply curve of achievable potential over the 20-year study period. A supply curve depicts the cumulative potential against the levelized cost of energy savings, with the measures sorted in order of ascending cost. No economic screening is applied. Levelized costs are used to make the costs comparable between measures with different lifetimes as well as supply-side resources considered in utility integrated resource plans. The costs include credits for deferred transmission and distribution system costs, avoided generation capacity, avoided periodic replacements, and non-energy impacts. With these credits, some of the lowest-cost measures have a net levelized cost that is negative, meaning that the credits exceed the measure costs.

Figure 12: 20-Year Supply Curve

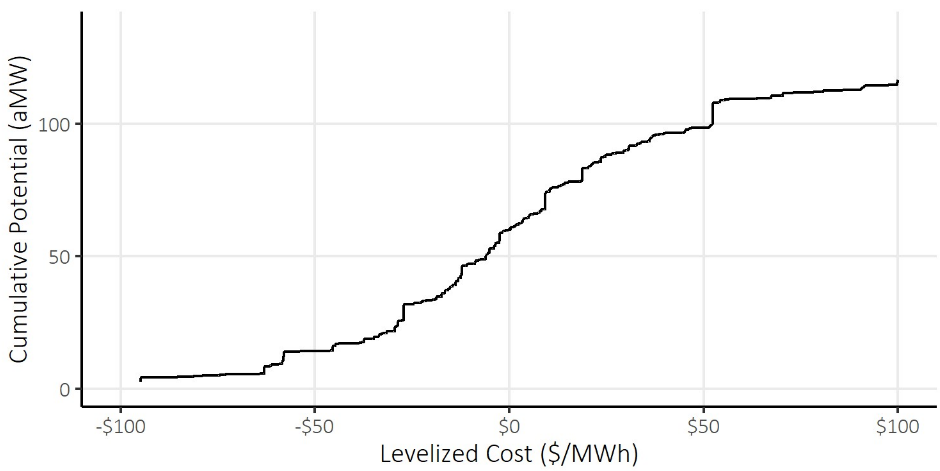


Figure 12 shows that approximately 60 aMW of potential are available at a levelized cost at or below $0/MWh. These are measures where benefits such as the deferral of capacity costs and non-energy benefits exceed the measure costs. Just under 100 aMW of achievable potential is available at costs at or below approximately $50/MWh. A total of more than 135 aMW is available in CPU's service territory over the 20-year period, but only potential below $100/MWh is shown in the supply curve. After a cost just above $50/MWh, the supply curve flattens and any increases in potential come at increasingly higher costs.

Supply curves based on levelized cost are limited in that not all energy savings are equally valued. For example, two measures could have the same levelized cost but provide different reductions in peak demand. An alternative to the supply curve based on levelized cost is one based on the benefit-cost ratio. This is shown below in Figure 13.

Figure 13: 20-Year Benefit-Cost Ratio Supply Curve

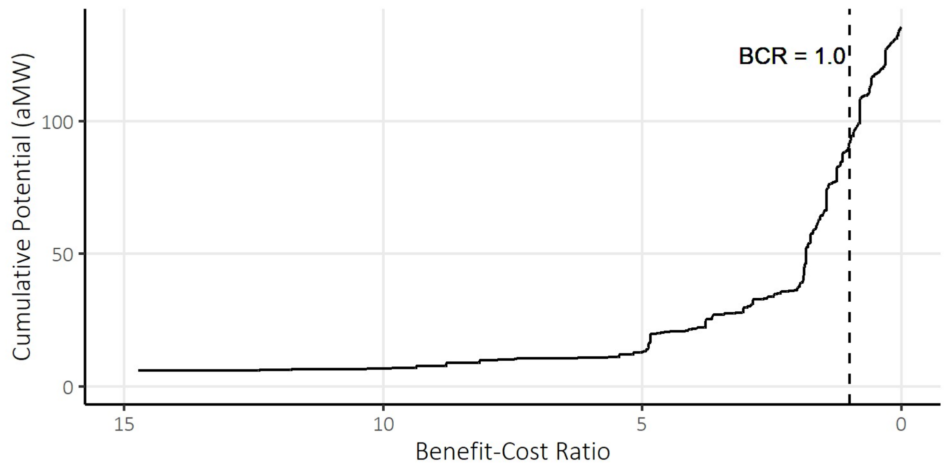
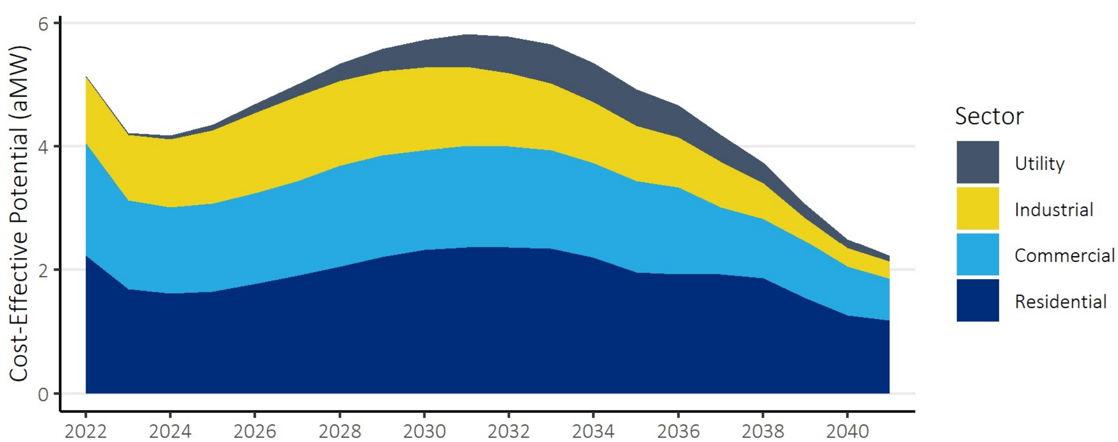


Figure 13 includes a dashed line where the benefit-cost ratio is equal to one. There are approximately 92 aMW of cost-effective savings potential to the left of this line, with benefit-cost ratios greater than one. The slope of the line is equally steep on both sides of the point where the benefit-cost ratio equals one. This suggests approximately equal sensitivities to higher and lower avoided costs, which would effectively shift the dashed line to the right or left, respectively. The cost-effective potential is described further below.

Cost-Effective Conservation Potential

Figure 14 shows the cost-effective potential by sector on an annual basis. Most of the potential is in CPU's residential sector, followed by the commercial and industrial sectors, with smaller amounts available in the utility sector.

Figure 14: Annual Cost-Effective Potential by Sector



Ramp rates from the 2021 Power Plan were used to establish reasonable rates of acquisition for all sectors. Lighthouse made modifications to the assigned ramp rates for some measures to align the near-term potential with recent and expected savings in each sector given the current economic conditions. Appendix VII has more detail on the alignment of ramp rates with program expectations.

Sector Summary

The sections below describe the cost-effective potential within each sector.

Residential

Relative to the 2019 CPA, the cost-effective potential in the residential sector has increased in near term, largely due to savings expected from a planned behavioral program. State product standards for lighting, showerheads, and aerators have resulted in reductions in potential from these measures, while additional savings are now available in measures with slower adoption rates.

Figure 15 shows the cost-effective potential by end use for the first 10 years of the study period. Measures in the HVAC (which includes both equipment and weatherization) and water heating end uses make up the largest share of potential in the sector in the initial 10 years. Savings in the Other end use include the planned behavior program discussed above, as well as smaller amounts of savings from the cooking and EV supply equipment end uses.

The potential for the HVAC and water heating end uses grows during the initial 10 years of the study as the expected market share of heat pump water heaters and adoption of HVAC measures increases. Potential in the appliances (including clothes washers, dryers, refrigerators, and freezers), lighting, and electronics end uses have smaller amounts of potential in the initial 10 years.

Note that some residential measures, such as smart thermostats and heat pump water heaters, can provide benefits as both energy efficiency and demand response resources. Any demand response benefits were not included in this CPA, although energy efficiency programs can help build a stock of equipment that could be called upon by demand response programs. Lighthouse assessed the demand response potential of these measures in CPU's *2021 Demand Response Potential Assessment*.

Figure 15: Annual Residential Potential by End Use

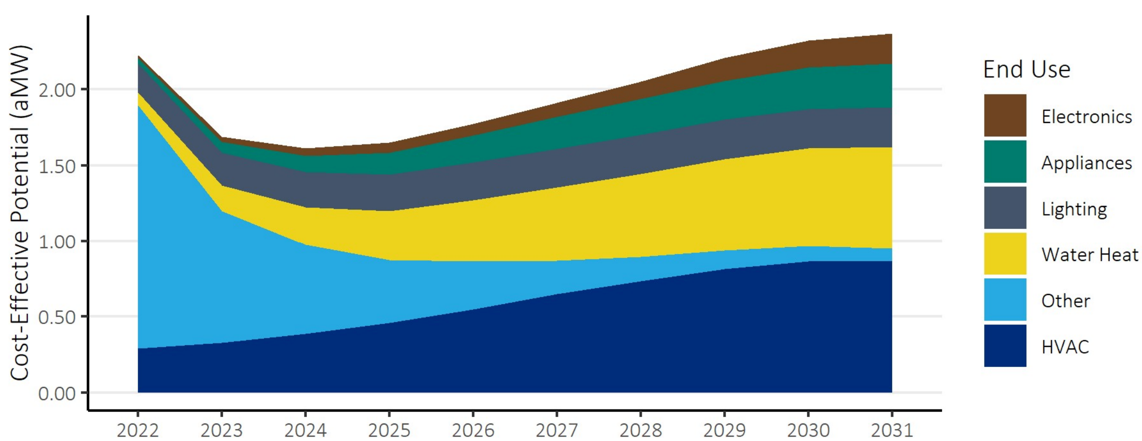
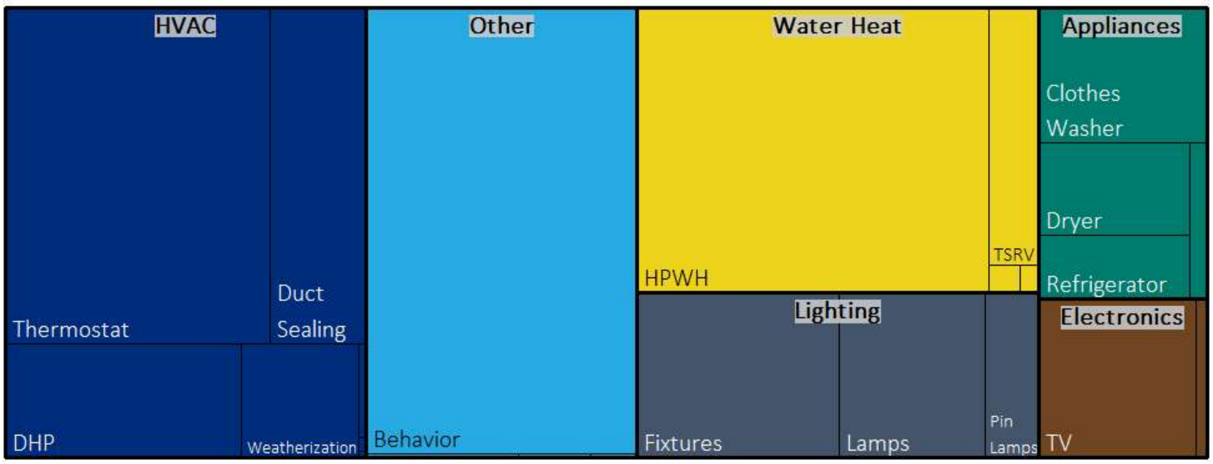


Figure 16 shows how the 10-year potential breaks down into end uses and measure categories. The area of each block represents the share of the total 10-year residential potential. Smart thermostats, ductless heat pumps, and duct sealing make up most of the potential in the HVAC end use, while heat pump water heaters (HPWH) and thermostatic restriction valves (TSRV) are the key measures within the water heating end use. As described earlier, measures like weatherization and air source heat pumps have been large components of residential efficiency programs in the past. In this CPA, due to low avoided costs and updated assumptions on measure costs and savings, many of these measures did not pass the cost-effectiveness test and they comprise a much smaller portion of the overall potential.

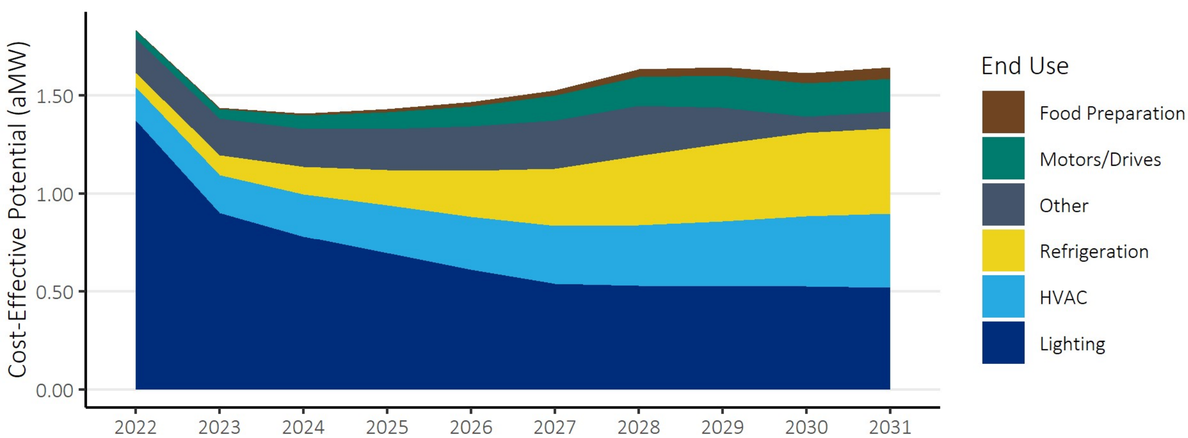
Figure 16: Residential Potential by End Use and Measure Category



Commercial

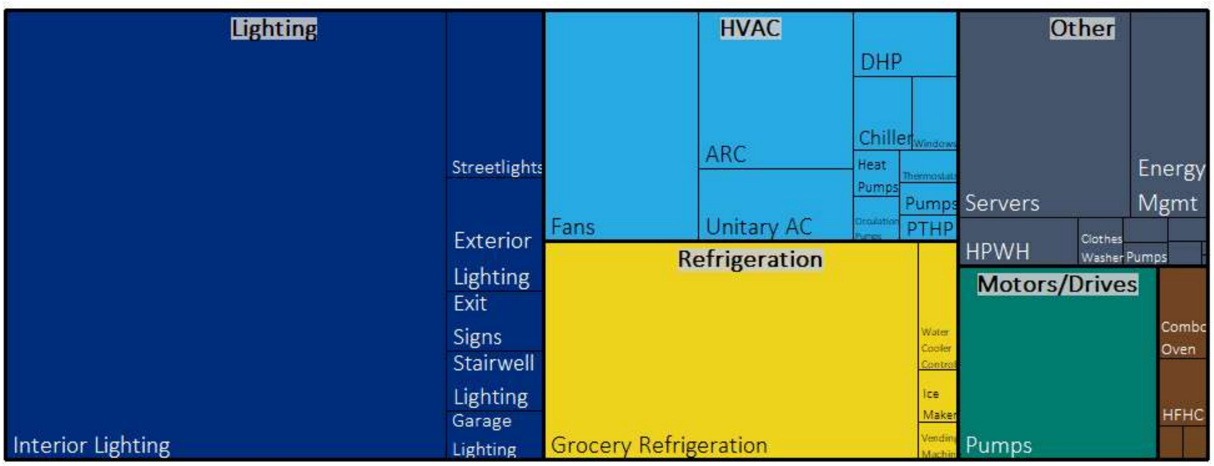
In the commercial sector, lighting, HVAC, and refrigeration measures are the end uses with the highest potential. The lighting end use includes measures applicable to both interior and exterior lighting. In Figure 17, the other category includes measures in the compressed air, electronics, energy management, and water heating end uses.

Figure 17: Annual Commercial Potential by End Use



The key end uses and measure categories within the commercial sector are shown in Figure 18. The area of each block is proportional to its share of the 10-year commercial potential. Most of the potential in the lighting end use is in interior lighting, while the potential in the HVAC end use is more evenly distributed across a range of equipment types. The commercial sector includes a variety of building types with different end uses and system types. This is apparent in the range of measures included in Figure 18.

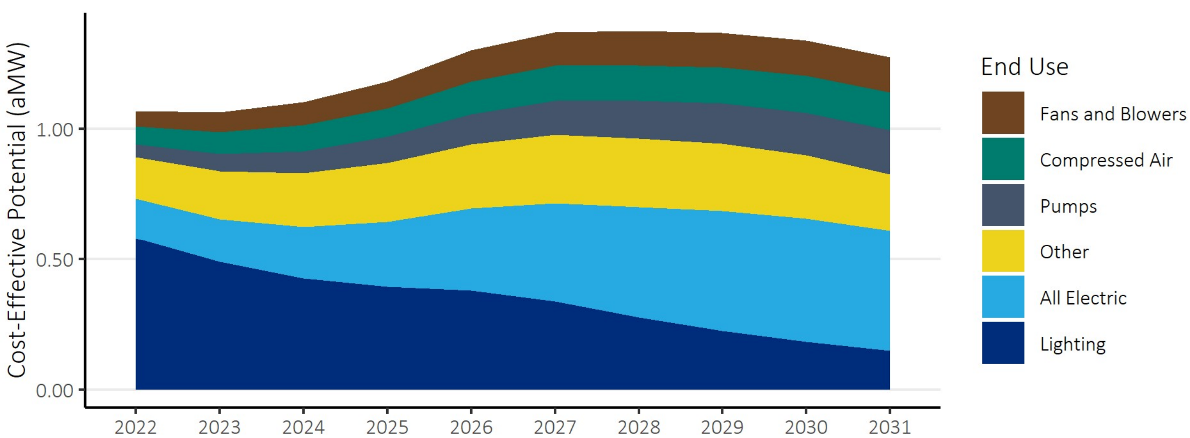
Figure 18: Commercial Potential by End Use and Measure Category



Industrial

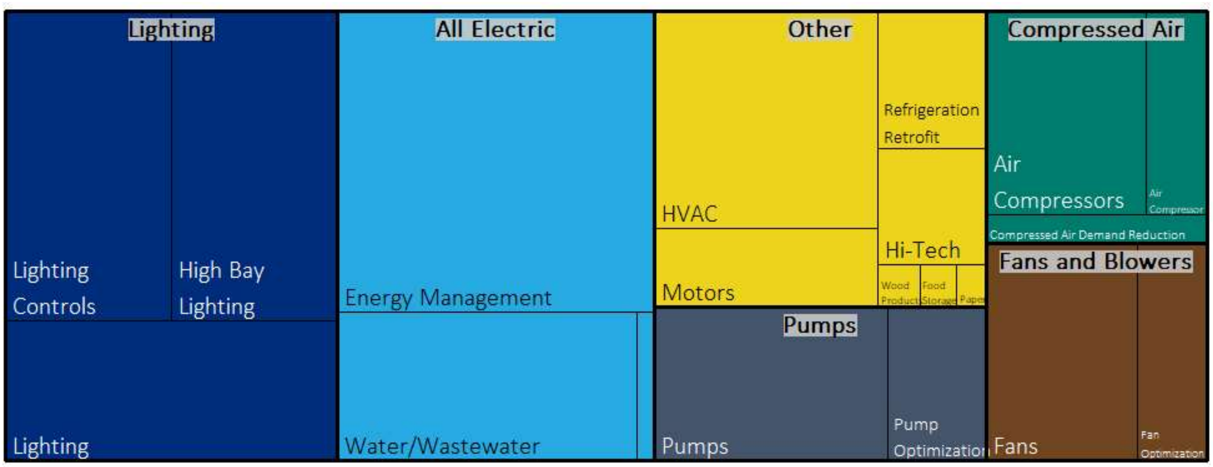
The annual industrial sector potential is shown in Figure 19. Significant amounts of potential are spread across the lighting and all electric end uses. The all electric end use includes measures applicable to all end uses, such as strategic energy management programs. Smaller amounts of potential are available through measures in the pumps, compressed air, and fans and blowers end uses. The other category in Figure 19 includes a variety of end uses, including material handling and processing, HVAC, refrigeration, and several other small end uses.

Figure 19: Annual Industrial Potential by End Use



The breakdown of 10-year industrial potential into end uses and measure categories is shown in Figure 20.

Figure 20: Industrial Potential by End Use and Measure Category

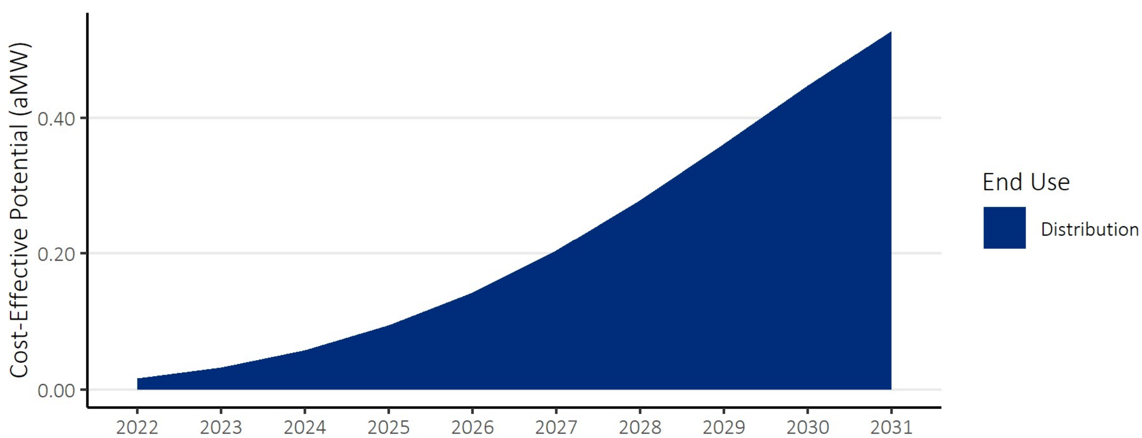


Utility

Measures in the utility sector involve the regulation of voltage to improve the efficiency of the distribution system. This analysis includes the measures characterized for the draft 2021 Power Plan, which are based on an estimate of the number of distribution substations and feeders for CPU.

The annual distribution system potential is shown in Figure 21. The Council characterized three measures in the draft 2021 Power Plan, which use increasingly sophisticated control systems. Note that the scale for this figure has changed relative to the figures above, as the potential in this sector is much smaller than those sectors.

Figure 21: Annual Distribution System Potential



Savings Shape

This section provides further details on the shape of the identified cost-effective potential, including breakdowns of energy savings by on- and off-peak periods and month, as well as further detail on the peak demand savings.

Methodology

Each of the measures included in this CPA have one or more savings components. While most measures have just a single savings component, numerous measures have more than one. Efficient heat pumps, for example, can provide both heating and cooling savings, each of which are quantified as a separate savings component. Water-saving measures often have two distinct savings components: the reduction of water heating loads in homes and the reduced loads at wastewater treatment plants through the reduction of wastewater influent. Each measure savings component was assigned a load profile and a ratio corresponding to the ratio of the total measure savings corresponding to that savings component. These ratios and load profiles were applied to the annual potential results, enabling the calculation of more detailed breakdowns in the savings potential. The load shapes used in this analysis were the ones developed by the Council for the draft 2021 Power Plan.

Results

Figure 22 shows the shape of monthly savings for on- and off-peak energy savings. Like the annual results discussed above, most of the savings in each period are in the residential sector. This sector also contributes a larger share of its savings during the winter months, while the savings from other sectors are more consistent across the months of the year.

Figure 22: On- and Off-Peak Savings by Month and Sector

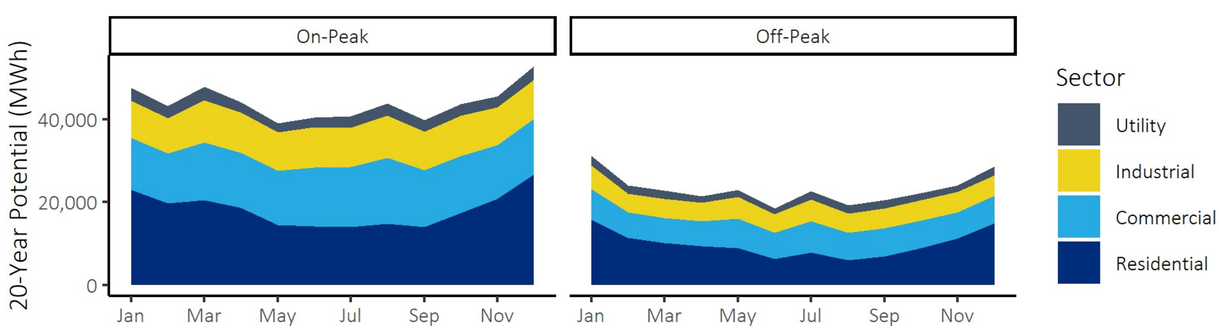


Figure 23 shows a similar breakdown as above, only by end use instead of sector. This figure shows that the HVAC, water heating, and lighting end uses are two of the key end uses for on-peak savings. As would be expected, the HVAC savings are more focused in the winter months while water heating and lighting savings are more evenly spread across the year.

Figure 23: On- and Off-Peak Savings by Month and End Use

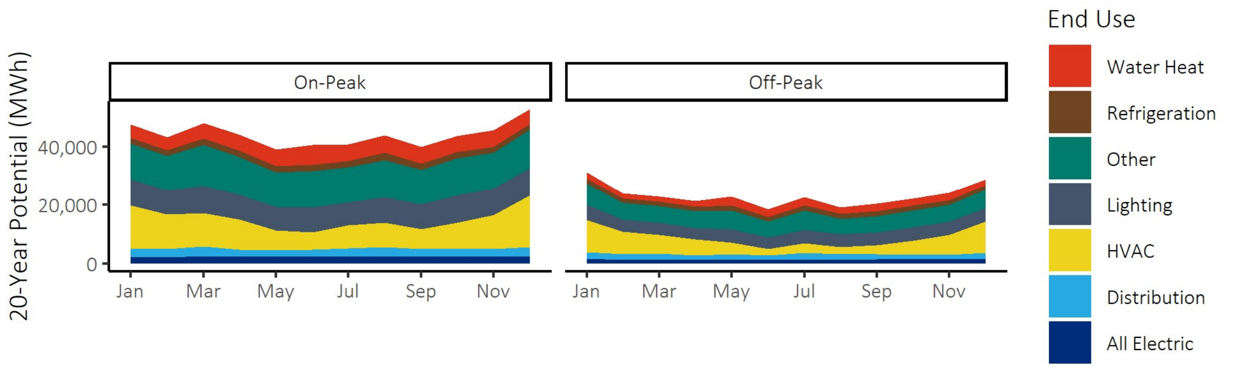


Figure 24 and Figure 25 show the monthly peak demand savings by sector and end use, respectively. Like above, the residential sector and HVAC end use contribute the most to reductions in peak demand. For this breakdown, Lighthouse used the same timing of monthly peak demand as was used in the 2019 CPA, which assumed morning peaks in the winter and shoulder season months with evening peaks in the summer.

Figure 24: Monthly Peak Savings by Sector

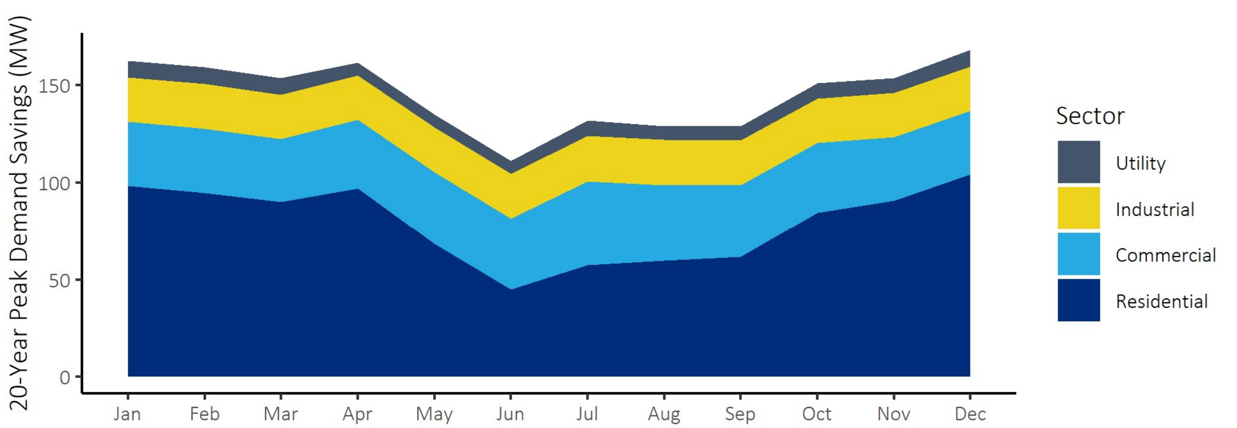


Figure 25: Monthly Peak Savings by End Use

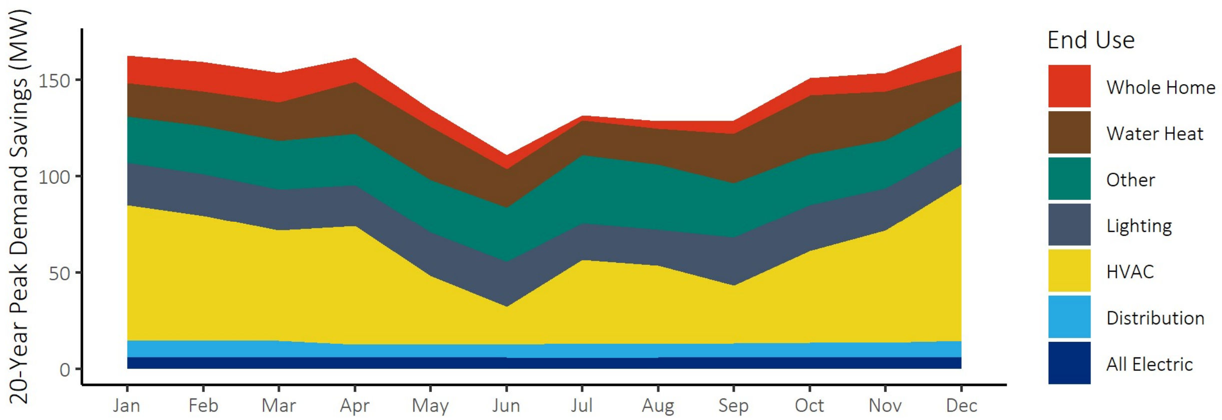
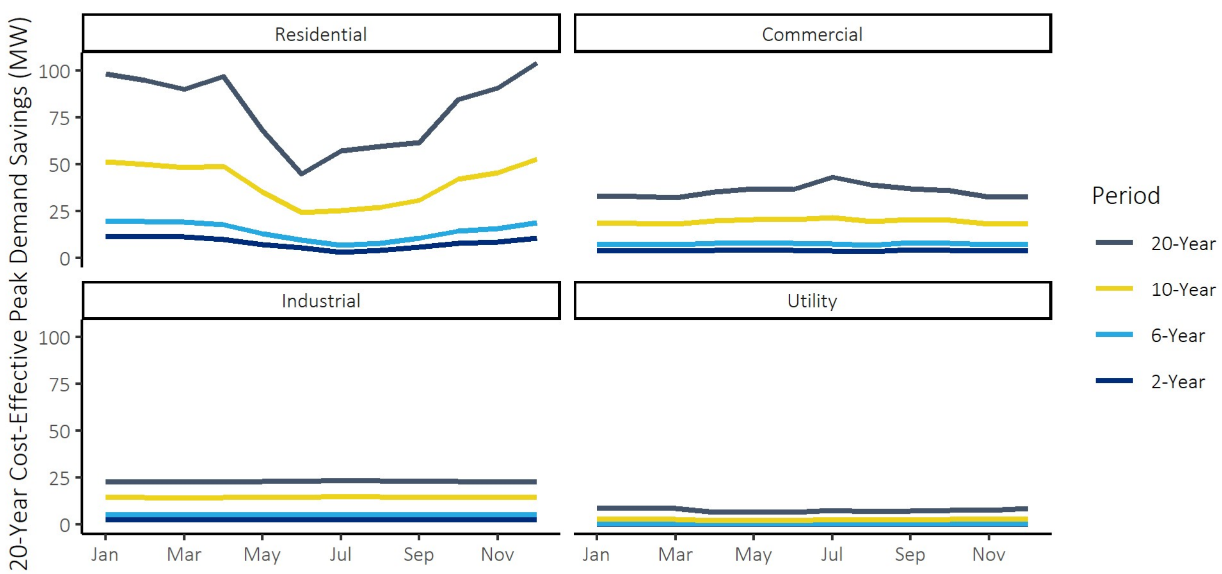


Figure 26 shows the monthly peak demand savings by sector, month, and CPA time period. Like the figures above, the residential sector shows the highest levels of peak demand savings, but the month-to-month shape of the residential begins fairly flat but takes on a more seasonal profile over time. This highlights the fact that much of the peak demand savings in the residential sector are in measures that were given slower ramp rates and are projected to be acquired more slowly. In the commercial sector, the savings take on a slightly more summer-oriented savings shape over time.

Figure 26: Monthly Peak Demand Savings by Sector, Month, and Time Period



Scenario Results

This section discusses the results of two additional scenarios that were considered in addition to the base case scenario covered in the previous section. These scenarios feature low and high variations in the avoided costs values, covering a range of possible outcomes to reflect uncertainty in future values. These scenarios allow CPU to understand the sensitivity of the cost-effective potential to variations in avoided cost. All other inputs were held constant.

Table 10 summarizes the avoided cost assumptions used in each scenario, which are discussed further in Appendix IV.

Table 10: Avoided Cost Assumptions by Scenario

		Low Scenario	Base Scenario	High Scenario
Energy Values	Avoided Energy Costs (20-Year Levelized Price, 2016$)	Market Forecast minus 20%-80% ($17)	Market Forecast ($32)	Market Forecast plus 20%-80% ($48)
	Social Cost CO_2	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
	RPS Compliance	WA EIA & CETA Requirements	WA EIA & CETA Requirements	WA EIA & CETA Requirements
Capacity Values	Distribution Capacity (2016$)	$6.85/kW-year	$6.85/kW-year	$6.85/kW-year
	Transmission Capacity (2016$)	$3.08/kW-year	$3.08/kW-year	$3.08/kW-year
	Generation Capacity (2016$)	$72/kW-year	$86/kW-year	$124/kW-year
	Implied Risk Adder (2016$)	-$15/MWh -$14/kW-year	N/A	$16/MWh $38/kW-year
	Northwest Power Act Credit	10%	10%	10%

Instead of using a single risk adder applied to each unit of energy, the two alternate scenarios consider potential futures with higher and lower values for the avoided cost inputs where some degree of uncertainty exists, including variations in the value of both energy and capacity. The final row calculates the implied risk adders for the low and high scenarios by totaling the differences in both energy and capacity-based values. Further discussion of these values is provided in Appendix IV.

Table 11 summarizes the cost-effective potential across each avoided cost scenario. As discussed above, the results show roughly equal sensitivities to both higher and lower avoided cost scenarios. This suggests equal risk in both under- and over-valuing energy efficiency. However, these results should also be considered with the relative likelihood of each scenario and the associated scale of risk as well. For example, given that we are already in an environment with low market prices, further declines in market prices and the low capacity value reflected in the low scenario may be less likely. In addition, pursuing only the energy efficiency quantified in the low scenario could lead to long-term contracts for other resources that, over the long term, may prove to be unneeded or uneconomic.

Table 11: Cost Effective Potential (aMW) by Avoided Cost Scenario

Scenario	2-Year	4-Year	10-Year	20-Year
Low Scenario	8.31	15.57	42.82	78.09
Base Case	9.37	17.91	50.07	92.20
High Scenario	10.15	19.40	54.33	99.75

Overall, energy efficiency remains a low-risk resource for CPU since it is purchased in small increments over time, making it unlikely that the significant amounts of the resource be acquired that were over-valued.

Summary

This report has summarized the results of the 2021 CPA conducted for CPU. The assessment provided estimates of the cost-effective energy savings potential for the 20-year period beginning in 2022, with details on the first ten years per the requirements of Washington State's EIA. The assessment considered a wide range of measures that are reliable and available during the study period.

Compared to CPU's 2019 CPA, the potential has increased slightly in the near term with larger increases in the longer term. Expectations of savings from a behavior program have offset other decreases, including the recent adoption of state product standards for lighting and water-saving measures, as well as the continued decline in avoided costs. Ramp rates were also adjusted to reflect recent program achievements.

In the longer term, this assessment found significantly higher amounts of cost-effective potential. This additional potential is in measures that currently see slower adoption rates, like heat pump water heaters and smart thermostats, but can gain traction in the future. In the commercial and industrial sectors, new measures for pumps and fans also add to the potential.

Compliance with State Requirements

The methodology used to estimate the cost-effective energy efficiency potential described in this report is consistent with the methodology used by the Council for determining the potential and cost-effectiveness of conservation resources in the draft 2021 Power Plan. Appendix III provides a list of Washington's EIA requirements and a description of how each was implemented. In addition to using a methodology consistent with the Council's draft 2021 Power Plan, the assessment used assumptions from the draft 2021 Power Plan where utility-specific inputs were not used. Utility-specific inputs covering customer characteristics, previous conservation achievements, and economic inputs were used. The assessment included the measures considered in the draft 2021 Power Plan materials, with additional RTF updates since its publication.

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Appendix I: Acronyms

aMW	Average Megawatt
BPA	Bonneville Power Administration
CEIP	Clean Energy Implementation Plan
CETA	Clean Energy Transformation Act
CFL	Compact Fluorescent Light
CPA	Conservation Potential Assessment
EIA	Energy Independence Act
EUI	Energy Use Intensity
HPWH	Heat Pump Water Heater
HVAC	Heating, Ventilation, and Air Conditioning
IRP	Integrated Resource Plan
kW	kilowatt
kWh	kilowatt-hour
LED	Light-Emitting Diode
MW	Megawatt
MWh	Megawatt-hour
NEEA	Northwest Energy Efficiency Alliance
O&M	Operations and Maintenance
RPS	Renewable Portfolio Standard
RTF	Regional Technical Forum
SEM	Strategic Energy Management
TRC	Total Resource Cost

Appendix II: Glossary

Achievable Technical Potential	Conservation potential that includes considerations of market barriers and programmatic constraints, but not cost effectiveness. This is a subset of technical potential.
Average Megawatt (aMW)	An average hourly usage of electricity, measured in megawatts, across the hours of a day, month, or year.
Avoided Cost	The costs avoided through the acquisition of energy efficiency.
Cost Effective	A measure is described as cost effective when the present value of its benefits exceeds the present value of its costs.
Economic Potential	Conservation potential that passes a cost-effectiveness test. This is a subset of achievable potential. Per the EIA, a Total Resource Cost (TRC) test is used.
Levelized Cost	A measure of costs when they are spread over the life of the measure, like a car payment. Levelized costs enable the comparison of resources with different useful lifetimes.
Megawatt (MW)	A unity of demand equal to 1,000 kilowatts (kW).
Renewable Portfolio Standard	A requirement that a certain percentage of a utility's portfolio come from renewable resources. In 2020, Washington utilities with more than 25,000 customers are required to source 15% of their energy from renewable resources.
Technical Potential	The set of possible conservation savings that includes all possible measures, regardless of market or cost barriers.
Total Resource Cost (TRC) Test	A test for cost-effectiveness that considers all costs and benefits, regardless of who they accrue to. A measure passes this test if the present value of all benefits exceeds the present value of all costs. The TRC test is required by Washington's Energy Independence Act and is the predominant cost effectiveness test used throughout the Northwest and U.S.

Appendix III: Compliance with State Requirements

This Appendix details the specific requirements for Conservation Potential Assessments listed in WAC 194-37-080. The table below lists the specific section and corresponding requirement along with a description of how the requirement is implemented in the model and where the implementation can be found.

Table 12: CPA Compliance with EIA Requirements

WAC 194-37-080 Section	Requirement	Implementation
(5)(a)	Technical potential. Determine the amount of conservation that is technically feasible, considering measures and the number of these measures that could physically be installed or implemented, without regard to achievability or cost.	The model calculates technical potential by multiplying the quantity of stock (number of homes, building floor area, industrial load) by the number of measures that could be installed per each unit of stock. The model further constrains the potential by the share of measures that have already been completed. See calculations in the "Units" tabs within each of the sector model files.
(5)(b)	Achievable technical potential. Determine the amount of the conservation technical potential that is available within the planning period, considering barriers to market penetration and the rate at which savings could be acquired.	The model applies maximum achievability factors based on the Council's 2021 Power Plan assumptions and ramp rates to identify how the potential can be acquired over the 20-year study period. See calculations in the "Units" tabs within each of the sector model files. The complete set of the ramp rates used is on the "Ramp Rates" tab.
(5)(c)	Economic achievable potential. Establish the economic achievable potential, which is the conservation potential that is cost-effective, reliable, and feasible, by comparing the total resource cost of conservation measures to the cost of other resources available to meet expected demand for electricity and capacity.	Lighthouse used the Council's ProCost model to calculate TRC benefit-cost ratios for each measure after updating ProCost with utility-specific inputs. The ProCost results are collected through an Excel macro in the "ProCost Measure Results-(scenario).xlsx" files and brought into the CPA models through Excel's Power Query. See Appendix IV for further discussion of the avoided cost assumptions.
(5)(d)	Total resource cost. In determining economic achievable potential as provided in (c) of this subsection, perform a life-cycle cost analysis of measures or programs to determine the net levelized cost, as described in this subsection.	A life-cycle cost analysis was performed using the Council's ProCost tool, which Lighthouse configured with utility-specific inputs. Costs and benefits were included consistent with the TRC test. The measure files within each sector folder are used to calculate the ProCost results. These

WAC 194-37-080 Section	Requirement	Implementation
		results are then rolled up into the ProCost Measure Results files, which are linked to each sector model file through Excel's Power Query functionality.
(5)(d)(i)	Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits.	The costs considered in the economic analysis included measure capital costs, O&M costs, periodic replacement costs, and any non-energy costs. Benefits included avoided energy, T&D capacity costs, avoided generation capacity costs, non-energy benefits, O&M savings, and periodic replacement costs. Measure costs and benefits can be found in the individual measure files as well as the "ProCost Measure Results" files.
(5)(d)(ii)	Include the incremental savings and incremental costs of measures and replacement measures where resources or measures have different measure lifetimes.	Assumed savings, cost, and measure lifetimes are based on draft 2021 Power Plan and subsequent RTF updates, where applicable. Measure costs and benefits can be found in the individual measure files as well as the "ProCost Measure Results" files.
(5)(d)(iii)	Calculate the value of the energy saved based on when it is saved. In performing this calculation, use time differentiated avoided costs to conduct the analysis that determines the financial value of energy saved through conservation.	Lighthouse used a 20-year forecast of monthly on- and off-peak market prices and the load shapes developed for the 2021 Power Plan as part of the economic analysis conducted in ProCost. The "MC and Loadshape" file contains both the market price forecast as well as the library of load shapes. Individual measure files contain the load shape assignments.
(5)(d)(iv)	Include the increase or decrease in annual or periodic operations and maintenance costs due to conservation measures.	Measure analyses include changes to O&M costs as well as periodic replacement costs, where applicable. These assumptions are based on the 2021 Plan and/or RTF. Measure assumptions can be found in the individual measure files.
(5)(d)(v)	Include avoided energy costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy	CPU provided a forecast of on- and off-peak market prices at the mid-Columbia trading hub, which Lighthouse extrapolated to cover the 20-year period evaluated by this CPA. Further discussion of this forecast can be found in

WAC 194-37-080 Section	Requirement	Implementation
	efficiency measures to which it is compared.	Appendix IV. See the “MC and Loadshape” file for the market prices. These prices include the value of avoided REC purchases as applicable.
(5)(d)(vi)	Include deferred capacity expansion benefits for transmission and distribution systems.	Deferred transmission and distribution system benefits are based on the values developed by the Council for the 2021 Power Plan. These values can be found on the “ProData” tab of the ProCost files, cells C50 and C54.
(5)(d)(vii)	Include deferred generation benefits consistent with the contribution to system peak capacity of the conservation measure.	Deferred generation capacity expansion benefits are based on BPA’s monthly demand charges, which are used as a proxy for the cost of capacity. The development of these values is discussed in Appendix IV. These values can be found on the “ProData” tab of the ProCost files, cells C60.
(5)(d)(viii)	Include the social cost of carbon emissions from avoided non-conservation resources.	This assessment uses the social cost of carbon values determined in 2016 by the federal Interagency Workgroup using a 2.5% discount rate, as required by the Clean Energy Transformation Act. The emissions intensity of energy savings is based on a Council analysis of the regional marginal emissions intensity developed for the 2021 Plan. Beginning in 2030, an emissions intensity of 0 lbs./kWh is assumed based on the CETA requirements for GHG neutral energy. The carbon costs and emissions intensities can be found in the MC and Loadshape file.
(5)(d)(ix)	Include a risk mitigation credit to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources.	This analysis uses a scenario analysis to consider risk. Avoided cost values with uncertain future values were varied across three different scenarios and the resulting sensitivity and risk were analyzed. The Scenario Results section of this report discusses the inputs used and the implicit risk adders used in the analysis.
(5)(d)(x)	Include all non-energy impacts that a	All quantifiable non-energy benefits were

WAC 194-37-080 Section	Requirement	Implementation
	resource or measure may provide that can be quantified and monetized.	included where appropriate, based on values from the Council's draft 2021 Plan materials and RTF. Measure assumptions can be found in the individual measure files.
(5)(d)(xi)	Include an estimate of program administrative costs.	This assessment uses the Council's assumption of administrative costs equal to 20% of measure capital costs. Program admin costs can be found in the "ProData" tab of the ProCost files, cell C29.
(5)(d)(xii)	Include the cost of financing measures using the capital costs of the entity that is expected to pay for the measure.	This assessment utilizes the financing cost assumptions from the draft 2021 Plan materials, including the sector-specific cost shares and cost of capital assumptions. Financing assumptions can be found in the ProData tab of the ProCost files, cells C37:F46.
(5)(d)(xiii)	Discount future costs and benefits at a discount rate equal to the discount rate used by the utility in evaluating non-conservation resources.	This assessment uses a real discount rate of 3.75% to determine the present value of all costs and benefits. This is the value developed for the 2021 Plan. The discount rate used in this analysis can be found in the ProCost files, on cell C27 of the ProData tab.
(5)(d)(xiv)	Include a ten percent bonus for the energy and capacity benefits of conservation measures as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act.	A 10% bonus is applied consistent with the Northwest Power Act. The 10% credit used in the measure analyses can be found in the ProCost files, on cell C29 of the ProData tab.

Appendix IV: Avoided Costs

The methodology used to conduct conservation potential assessments for electric utilities in the State of Washington is dictated by the requirements of the Energy Independence Act (EIA) and the Clean Energy Transformation Act (CETA). Specifically, WAC 194-37-070 requires utilities to determine the economic, or cost-effective, potential by "comparing the total resource cost of conservation measures to the total cost of other resources available to meet expected demand for electricity and capacity."[4] This CPA determined the cost-effectiveness of conservation measures through a benefit-cost ratio approach, which uses avoided costs to represent the costs avoided by acquiring efficiency instead of other resources. The EIA specifies that these avoided costs include the following components:

- Time-differentiated energy costs equal to a forecast of regional market prices
- Deferred capacity expansion costs for the transmission and distribution system
- Deferred generation capacity costs consistent with each measure's contribution to system peak capacity savings
- The social cost of carbon emissions from avoided non-conservation resources
- A risk mitigation credit to reflect the additional value of conservation not accounted for in other inputs
- A 10% bonus for energy and capacity benefits of conservation measures, as defined by the Pacific Northwest Electric Power Planning and Conservation Act

In addition to these requirements, Washington's CETA requires specific values be used for the social cost of carbon in item four above. Lighthouse has also included the value of avoided renewable portfolio standard compliance costs in the avoided costs.

This appendix discusses each of these inputs in detail in the following sections.

Avoided Energy Costs

Avoided energy costs are the energy costs avoided by CPU through the acquisition of energy efficiency instead of supply-side resources. For every megawatt-hour of conservation achieved, CPU avoids the purchase of one megawatt-hour of energy or can sell one megawatt-hour of excess energy.

For this CPA, CPU provided a forecast of avoided on- and off-peak energy prices at the Mid-Columbia trading hub from The Energy Authority (TEA). The forecast was provided on March 29, 2021 and includes prices by month for a seven-year period (2022-2028).

To benchmark this forecast, Lighthouse compared the TEA forecast to prices published by the CME Group[5] that were pulled on March 24, 2021. This comparison is shown in Figure 27 and Figure 28 below. While the prices available from the CME Group cover a more limited timeframe, the prices are nearly identical. Note that the prices in this memo are reported in real 2016 dollars for consistency with the dollar format used in the CPA model.

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[4] WAC 194-37-070. Accessed January 20, 2021. https://app.leg.wa.gov/wac/default.aspx?cite=194-37-070

[5] See https://www.cmegroup.com/trading/energy/electricity/mid-columbia-day-ahead-peak-calendar-month-5-mw-futures.html and https://www.cmegroup.com/trading/energy/electricity/mid-columbia-day-ahead-off-peak-calendar-month-5-mw-futures.html

Figure 27: Comparison of On-Peak Prices

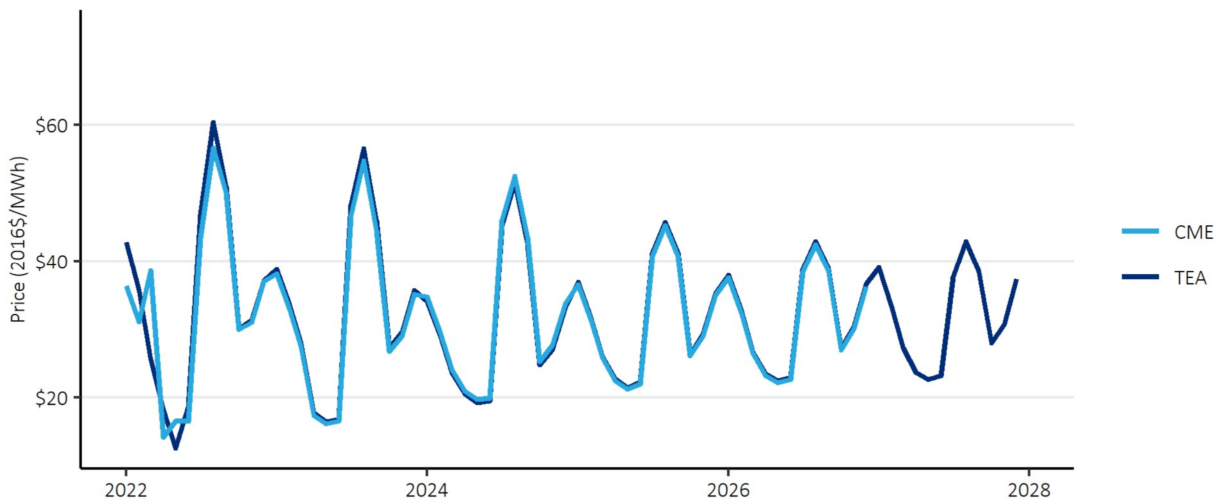
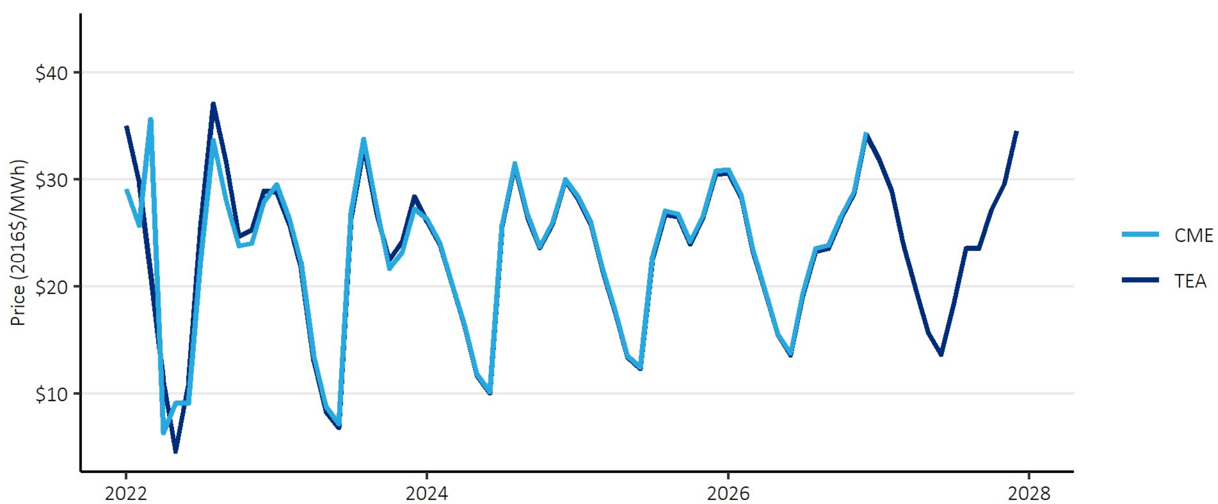
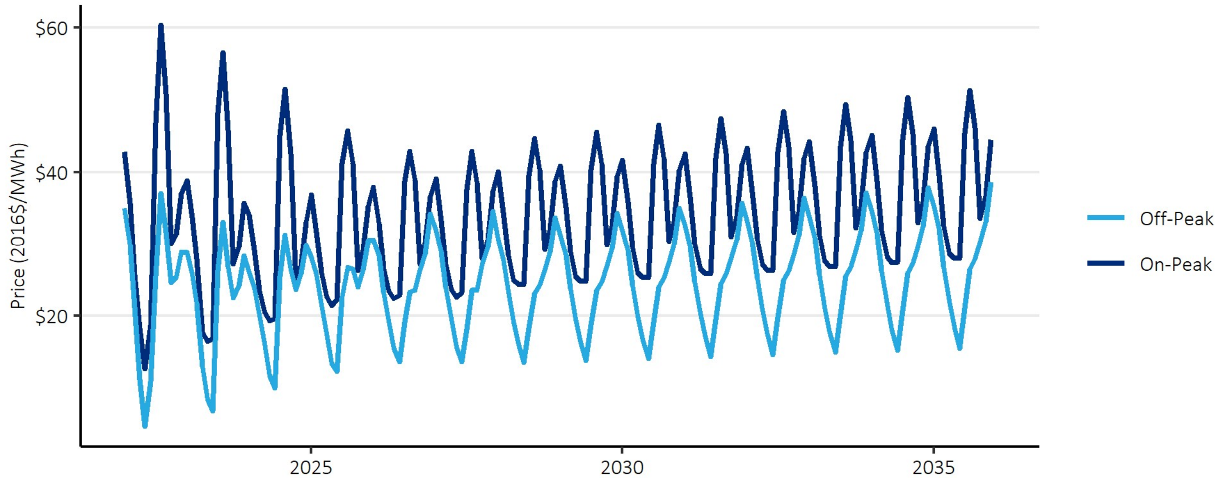


Figure 28: Comparison of Off-Peak Prices



To develop a forecast that would cover the 20-year study period of this CPA, Lighthouse applied an annual growth rate of 2% to the TEA forecast. The resulting on- and off-peak prices are shown in Figure 29, below. For clarity, only the years 2022 through 2035 are shown.

Figure 29: CPA Price Forecast



The levelized value of the 20-year price forecast is $32/MWh (2016$), a slight decrease from the price forecast used in the 2019 CPA, which also had a levelized value of $34/MWh (2016$).

Lighthouse also created high and low variations of this forecast to be used in the avoided cost scenarios, which are described more subsequently. To develop the forecast, Lighthouse examined the variation in the forecast developed by the Northwest Power and Conservation Council (Council) for the 2021 Plan and found that the highest and lowest forecasted prices varied by approximately 20% in the near term and 80% in the long term, relative to the average price forecast. Lighthouse applied this trend to forecast described above to create the high and low scenario forecasts. The resulting forecasts for on- and off-peak prices are shown in Figure 30 and Figure 31 below.

Figure 30: Comparison of On-Peak Price Scenarios

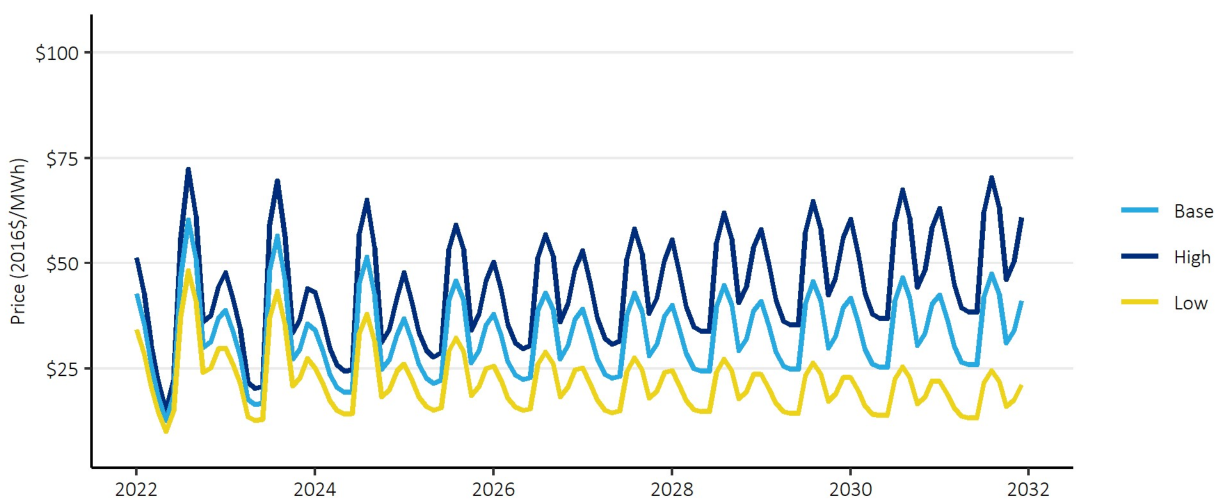
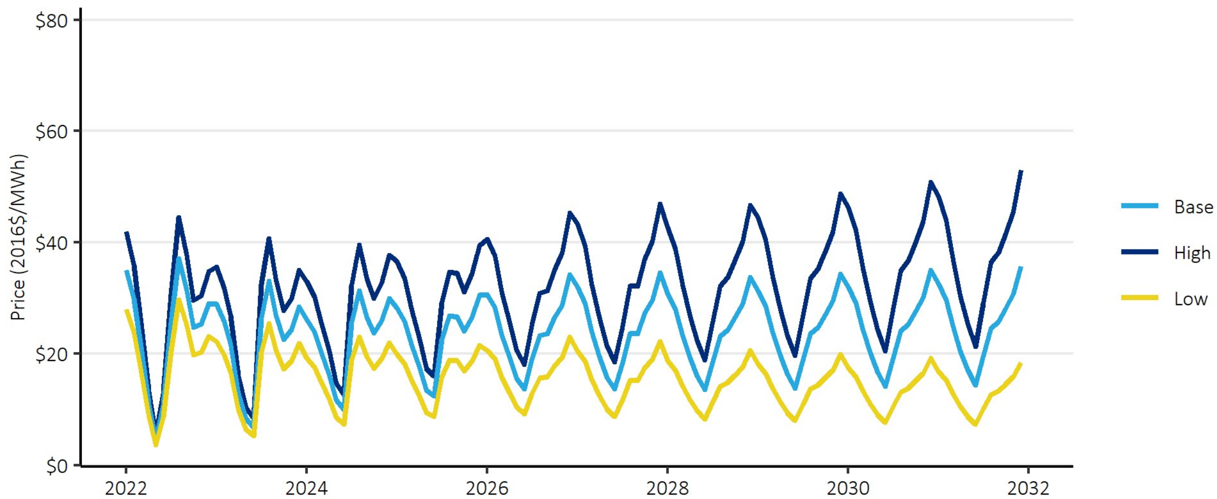


Figure 31: Comparison of Off-Peak Price Scenarios



Deferred Transmission and Distribution Capacity Costs

Unlike supply-side resources, energy efficiency does not require transmission and distribution infrastructure. Instead, it frees up capacity in these systems by reducing the peak demands and over time can help defer future capacity expansions and the associated capital costs.

In the development of the draft 2021 Power Plan, the Council developed a standardized methodology to calculate these values and surveyed Northwest utilities to update the values. The resulting values were $3.08/kW-year for transmission capacity and $6.85/kW-year for distribution capacity. CPU has used these values for all scenarios of this CPA, which were also used in the 2019 CPA.

The values for deferred transmission and distribution capacity are applied to demand savings coincident with the timing of the respective transmission and distribution system peaks.

Deferred Generation Capacity Costs

Similar to the transmission and distribution systems discussed above, acquiring energy efficiency resources can also help defer or eliminate the costs of new generation resources built or acquired to meet peak demands for electricity.

In CPU's previous CPA, BPA's monthly demand charges were used as proxy costs for the value of capacity. These charges are based on the cost of a gas turbine, which is CPU's likely resource for capacity needs over the timeframe of this study. While CETA places requirements on the sources of energy, even after 2030 it allows for up to 20% of energy sales to comply though alternate mechanisms, including the purchasing of Renewable Energy Credits (RECs). This is likely sufficient for CPU to meet any capacity needs with energy supplied by gas turbines accompanied by REC purchases.

Lighthouse assumed a shape of energy efficiency capacity contributions by month and applied those to BPA's 2020 monthly demand charges to calculate an annual value. Lighthouse reviewed historic trends in demand charges and found that, on average, the demand charges increased by approximately 2% each year, consistent with common assumptions about inflation. Lighthouse used this trend to calculate a 20-year series of annual generation capacity values and then levelized them to provide a single input required for the Council's ProCost model. This resulted in a base case value of $86/kW-year. For the low case, no price escalation was assumed, resulting in a value of $72/kW-year. In the high scenario, the Council's Seventh Plan value will be used, which is $124/kW-year when converted to 2016 dollars. Lighthouse and CPU considered the resource capacity value developed as part of the draft 2021 Plan but concluded that the approach described above better reflected the CPU's capacity needs.

Social Cost of Carbon

In addition to avoiding purchases of energy, energy efficiency measures avoid emissions of greenhouse gases like carbon dioxide. Washington's EIA requires that CPAs include the social cost of carbon, which the US EPA defines as a measure of the long-term damage done by a ton of carbon dioxide emissions in a given year. The EPA describes it as including, among other things, changes in agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, including increases in the costs of cooling and decreases in heating costs.[6] In addition to this requirement, Washington's CETA requires that utilities use the social cost of carbon values developed in 2016 by the federal Interagency workgroup using a 2.5% discount rate. After adjusting to 2016 dollars, these costs begin at approximately $76 per metric ton in 2022 and escalate to $102 per metric ton in 2041. These values were used in all scenarios of the CPA.

To implement a cost of carbon emissions, additional assumptions must be made about the intensity of carbon emissions. This assessment uses the market rate emissions factors developed for the 2021 Plan with modifications to reflect that CETA requires carbon-free energy beginning in 2030.

Renewable Portfolio Standard Compliance Costs

The renewable portfolio standard established under Washington's EIA currently requires CPU to source 15% of retail sales from renewable resources. The EIA also allows two alternate modes of compliance:

1. Utilities can comply by spending 4% or more of their annual retail revenue requirement on the incremental cost of renewable energy.
2. Utilities with no load growth can comply by spending 1% or more of their annual retail revenue requirement.

CPU's latest IRP projects small amount of load growth after accounting for future energy efficiency. Accordingly, this CPA considers the second alternate compliance mode where energy efficiency reduces the cost of compliance by reducing CPU's net retail revenue requirement. While each unit of energy includes a variety of costs, this CPA assumes that the only change to the revenue requirement is the cost of energy. Therefore, Lighthouse added 4% to the market price of energy to account for the value in reducing CPU's cost of EIA compliance.

The subsequently passed CETA furthers these requirements, mandating that 100% of sales be greenhouse gas neutral in 2030, with an allowance that up to 20% of the requirement can be achieved through other options, such as the purchase of RECs.

In 2030, it was assumed that marginal energy purchases would also include the purchase of a REC, thus the full price of a REC was added to the energy price after 2030.

Lighthouse developed a forecast of REC prices based on input from several clients.

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[6] https://www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf. Accessed January 21, 2021.

Risk Mitigation Credit

Any purchase of a resource involves risk. The decision to invest is based on uncertain forecasts of loads and market conditions. Investing in energy efficiency can reduce the risks that utilities face by the fact that it is made in small increments over time, rather than the large, singular sums required for generation resources. A decision not to invest in energy efficiency could result in exposure to higher market prices than forecast, an unneeded infrastructure investment, or one that cannot economically dispatch due to low market prices. While over-investments in energy efficiency are possible, the small and discrete amounts invested in energy efficiency limit the scale of any exposure to this risk.

In its power planning work, the Council develops a risk mitigation credit to account for this risk. This credit accounts for the value of energy efficiency not explicitly included in the other avoided cost values, ensuring that the level of cost-effective energy efficiency is consistent with the outcomes of the power planning process. The credit is determined by identifying the value that results in a level of cost-effective energy efficiency potential that is equivalent to the regional targets set by the Council.

In the Sixth Power Plan, the value of the risk adder varied by measure type and included values as large as $50/MWh for some measures. In the Seventh Plan draft 2021 Plan, the Council determined that no risk credit was necessary after including avoided carbon and generation/resource capacity costs.

This CPA follows the process used in CPU's 2019 CPA. A scenario analysis is used to account for uncertainty, where present, in avoided cost values. The variation in energy and capacity avoided cost inputs covers a range of possible outcomes and the sensitivity of the cost-effective energy efficiency potential is identified by comparing the outcomes of each scenario. In selecting its biennial target based on this range of outcomes, CPU is selecting its preferred risk strategy and the associated risk credit.

Northwest Power Act Credit

Finally, this CPA includes a 10% cost credit for energy efficiency. This credit is specified in the Pacific Northwest Electric Power Planning and Conservation Act for regional power planning work completed by the Council and by Washington's EIA for CPAs completed for Washington utilities. This credit is applied as a 10% bonus to the energy and capacity benefits described above.

Summary

Table 13 summarizes the avoided cost assumptions used in each of the scenarios in this CPA update.

Table 13: Avoided Cost Assumptions by Scenario

		Low Scenario	Base Scenario	High Scenario
Energy Values	Avoided Energy Costs (20-Year Levelized Price, 2016$)	Market Forecast minus 20%-80% ($17)	Market Forecast ($32)	Market Forecast plus 20%-80% ($48)
	Social Cost CO_2	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
	RPS Compliance	WA EIA & CETA Requirements	WA EIA & CETA Requirements	WA EIA & CETA Requirements

Capacity Values	Distribution Capacity (2016$)	$6.85/kW-year	$6.85/kW-year	$6.85/kW-year
	Transmission Capacity (2016$)	$3.08/kW-year	$3.08/kW-year	$3.08/kW-year
	Generation Capacity (2016$)	$72/kW-year	$86/kW-year	$124/kW-year
	Implied Risk Adder (2016$)	-$15/MWh -$14/kW-year	N/A	$16/MWh $38/kW-year
	Northwest Power Act Credit	10%	10%	10%

Appendix V: Measure List

This appendix provides a list of the measures that were included in this assessment and the data sources that were used for any measure characteristics. The assessment used all measures from the draft 2021 Power Plan that were applicable to CPU. Lighthouse customized these measures to make them specific to CPU's service territory and updated several with new information available from the RTF. The RTF continually updates estimates of measure savings and cost. This assessment used the most up to date information available when the CPA was developed.

This list is high-level and does not reflect the thousands of variations for each individual measure. Instead, it summarizes measures by category. Many measures include variations specific to different home or building types, efficiency level, or other characterization. For example, attic insulation measures are differentiated by home type (e.g., single family, multifamily, manufactured home), heating system (e.g., heat pump or furnace), baseline insulation level (e.g., R0, R11, etc.) and maximum insulation possible (e.g., R22, R30, R38, R49). This differentiation allows for savings and cost estimates to be more precise.

The measure list is grouped by sector and end use. Note that all measures may not be applicable to an individual utility service territory based on the characteristics of individual utilities and their customer sectors.

Table 14: Residential End Uses and Measures

End Use	Measure Category	Data Source
Appliances	Air Cleaner	Draft 2021 Plan
	Clothes Washer	Draft 2021 Plan
	Clothes Dryer	Draft 2021 Plan
	Freezer	Draft 2021 Plan
	Refrigerator	Draft 2021 Plan
Cooking	Electric Oven	Draft 2021 Plan
	Microwave	Draft 2021 Plan
Electronics	Advanced Power Strips	Draft 2021 Plan
	Desktop	Draft 2021 Plan
	Laptop	Draft 2021 Plan
	Monitor	Draft 2021 Plan
	TV	Draft 2021 Plan
EVSE	EVSE	Draft 2021 Plan
HVAC	Air Source Heat Pump	Draft 2021 Plan
	Central Air Conditioner	Draft 2021 Plan
	Cellular Shades	Draft 2021 Plan
	Circulator	Draft 2021 Plan
	Circulator Controls	Draft 2021 Plan
	Ductless Heat Pump	Draft 2021 Plan
	Duct Sealing	Draft 2021 Plan
	Ground Source Heat Pump	Draft 2021 Plan
	Heat Recovery Ventilator	Draft 2021 Plan
	Room Air Conditioner	Draft 2021 Plan
	Smart Thermostats	Draft 2021 Plan
	Weatherization	Draft 2021 Plan
	Whole House Fan	Draft 2021 Plan
Lighting	Fixtures	Draft 2021 Plan
	Lamps	Draft 2021 Plan
	Pin Lamps	Draft 2021 Plan
Motors	Well Pump	Draft 2021 Plan
Water Heat	Aerators	Draft 2021 Plan
	Circulator	Draft 2021 Plan
	Circulator Controls	Draft 2021 Plan
	Dishwasher	Draft 2021 Plan
	Gravity Film Heat Exchanger	Draft 2021 Plan
	Heat Pump Water Heater	Draft 2021 Plan, RTF
	Pipe Insulation	Draft 2021 Plan
	Showerhead	Draft 2021 Plan
	Thermostatic Restrictor Valve	Draft 2021 Plan, RTF
Whole Home	Behavior	Draft 2021 Plan

Table 15: Commercial End Uses and Measures

End Use	Measure Category	Data Source
Compressed Air	Air Compressor	Draft 2021 Plan
Electronics	Computers	Draft 2021 Plan
	Power Supplies	Draft 2021 Plan
	Smart Power Strips	Draft 2021 Plan
	Servers	Draft 2021 Plan
Food Preparation	Combination Ovens	Draft 2021 Plan
	Convection Ovens	Draft 2021 Plan
	Fryers	Draft 2021 Plan, RTF
	Griddle	Draft 2021 Plan
	Hot Food Holding Cabinet	Draft 2021 Plan
	Overwrapper	Draft 2021 Plan
	Steamer	Draft 2021 Plan
HVAC	Advanced Rooftop Controller	Draft 2021 Plan
	Chiller	Draft 2021 Plan
	Circulation Pumps	Draft 2021 Plan
	Ductless Heat Pump	Draft 2021 Plan
	Energy Management	Draft 2021 Plan
	Fans	Draft 2021 Plan
	Heat Pumps	Draft 2021 Plan
	Package Terminal Heat Pumps	Draft 2021 Plan
	Pumps	Draft 2021 Plan
	Smart Thermostats	Draft 2021 Plan
	Unitary Air Conditioners	Draft 2021 Plan
	Very High Efficiency Dedicated Outside Air System	Draft 2021 Plan
	Variable Refrigerant Flow Dedicated Outside Air System	Draft 2021 Plan
	Windows	Draft 2021 Plan
Lighting	Exit Signs	Draft 2021 Plan
	Exterior Lighting	Draft 2021 Plan
	Garage Lighting	Draft 2021 Plan
	Interior Lighting	Draft 2021 Plan
	Stairwell Lighting	Draft 2021 Plan
	Streetlights	Draft 2021 Plan
Motors & Drives	Pumps	Draft 2021 Plan
Process Loads	Elevators	Draft 2021 Plan
	Engine Block Heater	Draft 2021 Plan, RTF
Refrigeration	Freezer	Draft 2021 Plan
	Grocery Refrigeration	Draft 2021 Plan, RTF
	Ice Maker	Draft 2021 Plan, RTF
	Refrigerator	Draft 2021 Plan
	Vending Machine	Draft 2021 Plan, RTF
	Water Cooler Controls	Draft 2021 Plan
Water Heating	Commercial Clothes Washer	Draft 2021 Plan
	Heat Pump Water Heater	Draft 2021 Plan, RTF
	Pre-Rinse Spray Valve	Draft 2021 Plan
	Pumps	Draft 2021 Plan
	Showerheads	Draft 2021 Plan

Table 16: Industrial End Uses and Measures

End Use	Measure Category	Data Source
All Electric	Energy Management	Draft 2021 Plan
	Forklift Charger	Draft 2021 Plan
	Water/Wastewater	Draft 2021 Plan
Compressed Air	Air Compressor	Draft 2021 Plan
	Air Compressors	Draft 2021 Plan
	Compressed Air Demand Reduction	Draft 2021 Plan
Fans and Blowers	Fan Optimization	Draft 2021 Plan
	Fans	Draft 2021 Plan
HVAC	HVAC	Draft 2021 Plan
Lighting	High Bay Lighting	Draft 2021 Plan
	Lighting	Draft 2021 Plan
	Lighting Controls	Draft 2021 Plan
Low Temp Refer	Motors	Draft 2021 Plan
	Refrigeration Retrofit	Draft 2021 Plan
Material Handling	Motors	Draft 2021 Plan
	Paper	Draft 2021 Plan
	Wood Products	Draft 2021 Plan
Material Processing	Hi-Tech	Draft 2021 Plan
	Motors	Draft 2021 Plan
	Paper	Draft 2021 Plan
	Pulp	Draft 2021 Plan
	Wood Products	Draft 2021 Plan
Med Temp Refer	Food Storage	Draft 2021 Plan
	Motors	Draft 2021 Plan
	Refrigeration Retrofit	Draft 2021 Plan
Melting and Casting	Metals	Draft 2021 Plan
Other	Pulp	Draft 2021 Plan
Other Motors	Motors	Draft 2021 Plan
Pollution Control	Motors	Draft 2021 Plan
Pumps	Pulp	Draft 2021 Plan
	Pump Optimization	Draft 2021 Plan
	Pumps	Draft 2021 Plan

Table 17: Utility Distribution End Uses and Measures

End Use	Measure Category	Data Source
Distribution	Line Drop Control with no Voltage/VAR Optimization	Draft 2021 Plan
	Line Drop Control with Voltage Optimization & AMI	Draft 2021 Plan

Appendix VI: Energy Efficiency Potential by End Use

The tables in this appendix document the cost-effective energy efficiency savings potential by end use for each sector.

Table 18: Residential Potential by End Use (aMW)

End Use	2-Year	4-Year	10-Year	20-Year
Appliances	0.11	0.36	1.79	4.63
Cooking	0.00	0.00	0.03	0.25
Electronics	0.05	0.17	0.98	1.85
EV Supply Equipment	0.00	0.00	0.01	0.01
HVAC	0.62	1.46	5.94	13.05
Lighting	0.41	0.88	2.42	4.11
Motors	-	-	-	-
Water Heat	0.25	0.83	4.20	9.92
Whole Home	2.48	3.48	4.44	4.55
Total	3.91	7.17	19.81	38.37

Table 19: Commercial Potential by End Use (aMW)

End Use	2-Year	4-Year	10-Year	20-Year
Compressed Air	0.00	0.00	0.00	0.01
Electronics	0.15	0.42	1.10	1.24
Energy Mgmt	0.20	0.29	0.46	0.52
Food Preparation	0.01	0.03	0.28	0.76
HVAC	0.37	0.82	2.78	7.26
Lighting	2.28	3.76	7.01	10.00
Motors/Drives	0.09	0.24	1.12	2.05
Process Loads	-	-	-	-
Refrigeration	0.17	0.50	2.63	5.17
Water Heat	0.02	0.05	0.28	0.78
Total	3.28	6.12	15.66	27.78

Table 20: Industrial Potential by End Use (aMW)

End Use	2-Year	4-Year	10-Year	20-Year
All Electric	0.32	0.77	3.28	5.07
Compressed Air	0.15	0.36	1.18	2.33
Fans and Blowers	0.13	0.33	1.11	2.64
HVAC	0.13	0.31	1.12	1.34
Lighting	1.07	1.89	3.44	3.90
Low Temp Refrigeration	0.05	0.11	0.25	0.37
Material Handling	0.02	0.05	0.16	0.33
Material Processing	0.09	0.19	0.46	0.74
Med Temp Refrigeration	0.05	0.11	0.25	0.39
Melting and Casting	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Other Motors	0.00	0.00	0.01	0.05
Pollution Control	0.00	0.00	0.00	0.01
Pumps	0.12	0.30	1.18	2.50
Total	2.13	4.41	12.43	19.67

Table 21: Utility Distribution System Potential by End Use (aMW)

End Use	2-Year	4-Year	10-Year	20-Year
LDC with no VVO	0.01	0.05	0.50	1.49
LDC with VVO & AMI	0.04	0.15	1.66	4.90
Total	0.05	0.20	2.17	6.38

Appendix VII: Ramp Rate Alignment Documentation

This appendix documents how ramp rates were selected to ensure alignment between the near-term potential and the recent achievements of CPU's energy efficiency programs. Ramp rates are the annual values that describe the share of technical potential available in a given year that is achievable. Aligning the potential with recent achievements ensures that the near-term potential is feasible for CPU's programs as energy efficiency programs take time to ramp up and are subject to local market conditions, including the impacts of the COVID-19 pandemic.

Process

Achievement data for 2019-20 was provided by CPU and summarized by sector and end use. Residential program achievements were also summarized by high-level measure categories.

Savings from NEEA's market transformation initiatives were allocated to customer sectors based on the historical makeup of these savings but could not be allocated within end uses or measure categories. Lighthouse has a general sense of NEEA's initiatives, however, and can therefore identify the end uses or measures where NEEA's market transformation initiatives may contribute additional savings. That said, NEEA's market transformation savings are quantified relative to a baseline that is set to the baseline used in the most recent regional power plan. Accordingly, NEEA's baseline will reset in 2022 with the new 2021 Power Plan (2021 Plan), and it is currently unknown what level of savings will be achieved at this point. To account for this uncertainty, Lighthouse was conservative in the projecting the level of NEEA savings that may continue relative to past years.

Similarly, CPU has reported savings from new homes. The savings from these were allocated to the HVAC end use although the savings span space and water heating, as well as other end uses.

These recent achievements were compared with the cost-effective energy efficiency potential identified in the 2021 CPA.

Lighthouse started with the default ramp rates assigned to each measure in the draft 2021 Plan and compared the resulting cost-effective potential in the first few years of the assessment with CPU's recent program achievements. Changes to ramp rates were made to accelerate or decelerate the acquisition of potential to align with recent programmatic achievements.

The following tables show how CPU's previous achievements compare to the potential *after* ramp rates were adjusted. Color scaling has been applied to highlight the larger values. Discussion follows each table with additional detail.

Residential

The table below shows how residential potential was aligned with recent achievements by measure category.

Table 22: Alignment of Residential Program History and Potential by Measure Category (aMW)

		Program History		CPA Cost-Effective Potential		
End Use	Category	2019	2020	2022	2023	2024
Appliances	Clothes Washer			0.02	0.03	0.05
Appliances	Dryer			0.01	0.02	0.03
Appliances	Freezer	0.02	0.01	0.00	0.00	0.01
Appliances	Refrigerator	0.02	0.01	0.01	0.01	0.02
Cooking	Oven			0.00	0.00	0.00
Electronics	Advanced Power Strips	0.00	0.01	-	-	-
Electronics	Laptop			0.01	0.01	0.01
Electronics	TV			0.01	0.02	0.03
EVSE	EVSE			0.00	0.00	0.00
HVAC	ASHP	0.12	0.13	0.00	0.00	0.00
HVAC	Circulator			0.00	0.00	0.00
HVAC	Circulator Controls			0.00	0.00	0.00
HVAC	DHP	0.19	0.10	0.13	0.13	0.13
HVAC	Duct Sealing	0.00	0.00	0.01	0.01	0.03
HVAC	Thermostat	0.04	0.02	0.11	0.14	0.18
HVAC	Weatherization	0.05	0.05	0.04	0.05	0.05
Lighting	Lighting	1.03	0.32	0.19	0.22	0.23
Water Heat	Aerators	-	0.01	-	-	-
Water Heat	Circulator			0.00	0.00	0.00
Water Heat	Circulator Controls			0.00	0.00	0.00
Water Heat	HPWH	0.13	0.13	0.08	0.16	0.23
Water Heat	Showerhead	0.00	0.00	-	-	-
Water Heat	TSRV	-	0.00	0.00	0.01	0.01
Whole Home	Behavior	0.86	0.79	1.61	0.87	0.59
NEEA	NEEA	1.19	1.24	*n/a*	*n/a*	*n/a*
	Total	3.64	2.81	2.22	1.69	1.61

Note: For clarity, measure categories with no program achievements and no cost-effective potential have been removed. In addition, note that some measures have savings values that are small and cannot be shown at this level of resolution. These values show as 0 in this and following tables while a true zero value is shown as a dash.

The following sections discuss the alignment within each residential end use.

Appliances & Cooking

The potential in these categories is relatively small. While there are some measure categories with slightly higher potential than program achievements, this is one end use where NEEA's initiative may contribute additional savings. NEEA has a Retail Product Portfolio initiative that includes appliances and electronics.

Electronics

In this category, CPU has been providing incentives for advanced power strips. These measures, however, did not pass the cost-effectiveness test for this CPA. Additional potential is available through TVs and laptop computers, which could be achieved through NEEA's Retail Product Portfolio, similar to the appliance category discussed above.

Electric Vehicle Supply Equipment (EVSE)

There is a small amount of potential here, but too small to show up in the resolution provided by the table. CPU has recently started offering an incentive for qualifying EV chargers.

HVAC

In the HVAC category, only a limited number of applications of air-source heat pumps (ASHP) were cost-effective, limiting the ability to closely match program achievement and potential. The measures in this category were accelerated. The potential with ductless heat pumps (DHP) was accelerated to match recent program history. Weatherization measures were accelerated slightly while duct sealing measures were left at the 2021 Plan default ramp rates. The potential with smart thermostats was left slightly higher than recent program achievement, as this continues to be an area for growth and CPU could accelerate here, especially if ASHPs are not cost-effective in the future.

Lighting

Measures in the lighting category were given the fastest ramp rates available, but program potential is limited in this area due to Washington state standards that took effect in 2020 covering many screw-in lamps. There is potential that remains in fixtures and less common bulb types.

Water Heat

The program history in the water heating category consists mostly of savings from heat pump water heaters. The potential for heat pump water heaters was accelerated slightly above the 2021 Plan ramp rates. While this results in potential that is slightly higher than recent program achievement, this is an area where NEEA has a market transformation initiative which contributes additional savings. Washington's HB 1444 specifies standards for showerheads and aerators, so there is no potential in these categories. The initial potential for circulator pumps and controls was left at the default ramp rates, which results in limited early potential for these measures, which are new to the 2021 Power Plan and CPU's CPA. Similarly, no changes were made to the default 2021 Plan ramp rate for thermostatic restrictor valves.

Whole Home

This category includes a residential behavior program. The ramp rates were adjusted to roughly align with CPU's planned behavior program.

Table 23 below summarizes the residential measure category results in Table 22 by end use.

Table 23: Alignment of Residential Program History and Potential by End Use (aMW)

	Program History		CPA Cost-Effective Potential		
End Use	2019	2020	2022	2023	2024
Appliances	0.03	0.02	0.03	0.07	0.11
Cooking			0.00	0.00	0.00
Electronics	0.00	0.01	0.02	0.03	0.05
EVSE			0.00	0.00	0.00
HVAC	0.40	0.32	0.29	0.33	0.39
Lighting	1.03	0.32	0.19	0.22	0.23
Motors			-	-	-
Water Heat	0.13	0.13	0.08	0.17	0.25
Whole Home	0.86	0.79	1.61	0.87	0.59
NEEA	1.19	1.24	*n/a*	*n/a*	*n/a*
Total	**3.65**	**2.82**	**2.22**	**1.69**	**1.61**

Commercial

In the commercial sector, most of the potential is in the lighting end use which was given the fastest ramp rates available in the draft 2021 Plan. Using these default ramp rates resulted in potential that is still slightly less than recent program history in this end use.

Lighthouse applied slightly slower ramp rates to measures in the electronics and refrigeration categories. These end uses have smaller amounts of potential that ramp more slowly. Potential in the HVAC and energy management end uses was accelerated based on program history. These are end uses where NEEA's market transformation efforts may contribute additional savings.

Table 24 below shows the alignment of program history and potential in the commercial sector.

Table 24: Alignment of Commercial Program History and Potential by End Use (aMW)

	Program History		CPA Cost-Effective Potential		
End Use	2019	2020	2022	2023	2024
Compressed Air	0.00	-	0.00	0.00	0.00
Electronics			0.06	0.10	0.12
Energy Management	-	0.15	0.11	0.08	0.06
Food Preparation	-	0.00	0.00	0.01	0.01
HVAC	0.32	0.24	0.17	0.19	0.22
Lighting	1.51	1.83	1.37	0.90	0.78
Motors/Drives			0.04	0.05	0.07
Process Loads			-	-	-
Refrigeration	-	0.00	0.07	0.10	0.14
Water Heating			0.01	0.01	0.01
NEEA	0.32	0.33	*n/a*	*n/a*	*n/a*
Total	**2.16**	**2.55**	**1.83**	**1.44**	**1.41**

Industrial

Most of the potential in the industrial sector is in the lighting and energy management categories. Faster ramp rates were applied to some lighting measures to better align with CPU's recent program history. The ramp rates for energy management measures were slowed from the default 2021 Plan ramp rates. Potential in the HVAC end use was slowed while it was accelerated in the refrigeration and several industrial process categories.

Table 25 shows the alignment of industrial potential and recent program history by end use.

Table 25: Alignment of Industrial Program History and Potential by End Use (aMW)

	Program History		CPA Cost-Effective Potential		
End Use	2019	2020	2022	2023	2024
Energy Management	0.00	0.18	0.15	0.16	0.20
Compressed Air	0.15	0.09	0.07	0.08	0.10
Fans and Blowers	0.20	-	0.06	0.07	0.09
HVAC	-	-	0.06	0.07	0.09
Lighting	1.09	0.28	0.58	0.49	0.43
Motors	-	-	0.00	0.00	0.00
Refrigeration	-	0.39	0.05	0.05	0.06
Process	0.10	0.19	0.05	0.06	0.06
Pumps	0.02	0.14	0.05	0.07	0.08
Other	-	-	0.00	0.00	0.00
NEEA	0.01	0.01	*n/a*	*n/a*	*n/a*
Total	**1.57**	**1.29**	**1.07**	**1.06**	**1.10**

Utility Distribution System

The amount of potential in the utility distribution system is limited compared to other sectors. No changes were made to the default ramp rate assigned in the draft 2021 Plan.

Table 26: Alignment of Distribution System Program History and Potential by End Use (aMW)

	Program History		CPA Cost-Effective Potential		
End Use	2019	2020	2022	2023	2024
Distribution System	-	-	0.02	0.03	0.06