RESOLUTION NO. 2517

October 22, 2019

A RESOLUTION OF THE COMMISSION OF PUBLIC UTILITY DISTRICT NO. 1 OF BENTON COUNTY, WASHINGTON ESTABLISHING THE DISTRICT'S EIA 2020 - 2029 TEN-YEAR COST-EFFECTIVE RESOURCE CONSERVATION POTENTIAL AND 2020 - 2021 BIENNIAL TARGET

WHEREAS, Washington State Energy Independence Act, RCW 19.285, (Initiative 937) mandates that each qualifying utility pursue all available conservation that is cost-effective, reliable, and feasible; AND

WHEREAS, The District is a qualifying utility under the Act; AND

WHEREAS, The Commission wishes to assert its authority under Title 54 of the Revised Code of Washington in its implementation of the Washington State Energy Independence Act; AND

WHEREAS, Washington Administrative Code (WAC) provisions, adopted by the Department of Commerce, recognize that the individual public utility has the authority to establish the conservation targets that meet the requirements of the State's statute. WAC 194-37-070 (1) states, "Ten-year potential. By January 1st of each even-numbered year, each utility shall identify its achievable cost-effective conservation potential for the upcoming ten years"; AND

WHEREAS, WAC 194-37-070 (2) states, "Biennial target. By January 1st of each even-numbered year, each utility shall establish and make public a biennial conservation target. The utility's biennial target shall be no less than its pro rata share of the ten-year potential identified pursuant to subsection (1) of this section"; AND

WHEREAS, The District completed a Conservation Potential Assessment on September 25, 2019 that identifies the District's achievable cost-effective conservation potential and complies with provisions of WAC 194-37-070; AND

WHEREAS, Due notice was given of a public meeting to be held October 22, 2019 to make public the District's conservation resource potential and biennial conservation target; AND

WHEREAS, Said public meeting was held to gain public comment concerning the conservation potential and targets.

NOW, THEREFORE BE IT RESOLVED by the Commission of Public Utility District No. 1 of Benton County, that the District's 2020-2029 ten-year cost-effective conservation resource potential be established at 11.62 aMW and the District's 2020-2021 biennial target be established at 1.71 aMW based upon the District's September 25, 2019 Conservation Potential Assessment and in compliance with requirements of the Energy Independence Act.

APPROVED AND ADOPTED by the Commission of Public Utility District No. 1 of Benton County at an open meeting, with notice of such meeting being given as required by law, this 22nd day of October 2019.

Jeffrey D. Hall, President

ATTEST:

Barry Bush, Secretary

Benton County Public Utility District

Conservation Potential Assessment

Final Report

September 25, 2019

Prepared by:

EES Consulting

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EES Consulting

September 25, 2019

Mr. Chris Johnson
Benton PUD
P.O. Box 6270
2721 W. 10th Avenue
Kennewick, WA 99336

SUBJECT: 2019 Conservation Potential Assessment–Final Report

Dear Chris:

Please find attached the report summarizing the 2019 Benton Public Utility District Conservation Potential Assessment (CPA). This report covers the 20-year time period from 2020 through 2039.

The potential has decreased from the 2017 CPA, largely due to standards impacting many residential lighting measures and changes in the avoided cost assumptions.

We would like to acknowledge and thank you and your staff for the excellent support in developing and providing data for this project.

Best Regards,

Ted Light
Senior Project Manager

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Contents

Executive Summary

This report describes the methodology and results of the 2019 Conservation Potential Assessment (CPA) for Public Utility District No. 1 of Benton County (Benton PUD). This assessment provides estimates of energy savings by sector for the period 2020 to 2039. The assessment considers a wide range of conservation resources that are reliable, available and cost-effective within the 20-year planning period.

Background

Benton PUD provides electricity service to over 54,000 customers located in Benton County, Washington, excluding the City of Richland and Benton Rural Electric Association's service territory. Benton PUD's territory covers 939 square miles and includes 1,700 miles of transmission and distribution lines. In addition, Benton PUD's service territory includes an estimated 109,000 acres of irrigated agriculture.

Washington's Energy Independence Act (EIA), effective January 1, 2010, requires that utilities with more than 25,000 customers (known as qualifying utilities) pursue all cost-effective conservation resources and meet conservation targets set using a utility-specific conservation potential assessment methodology.

The EIA sets forth specific requirements for setting, pursuing and reporting on conservation targets. The methodology used in this assessment complies with RCW 19.285.040 and WAC 194-37-070 Section 5 parts (a) through (d) and is consistent with the methodology used by the Northwest Power and Conservation Council (Council) in developing the Seventh Power Plan. Thus, this Conservation Potential Assessment will support Benton PUD's compliance with EIA requirements.

This assessment was built on the same model used in the 2017 CPA, which was based on the completed Seventh Power Plan. The model was updated to reflect changes since the completion of the 2017 CPA. The primary model updates included the following:

- New Avoided Costs
  - Recent forecast of power market prices
  - Updated values for avoided generation capacity
  - New transmission and distribution capacity costs based on new values from the Council
  - New environmental costs due to legislation
- Updated Customer Characteristics Data
  - New residential home counts and characteristics
  - Updated commercial floor area
  - Updated industrial sector consumption
- Measure Updates

- Measure savings, costs, and lifetimes were updated based on the latest data available from the Regional Technical Forum (RTF)
- New measures not included in the Seventh Plan but subsequently reviewed by the RTF were added

- Accounting for Recent Achievements
  - Internal programs
  - NEEA programs

The first step of this assessment was to carefully define and update the planning assumptions using the new data. The Base Case conditions were defined as the most likely market conditions over the planning horizon, and the conservation potential was estimated based on these assumptions. Additional scenarios were also developed to test a range of conditions.

Results

Table ES-1 shows the high-level results of this assessment, the cost-effective potential by sector in 2, 6, 10, and 20-year increments. The total 20-year energy efficiency potential is 20.35 aMW. The most important numbers per the EIA are the 10-year potential of 11.62 aMW, and the two-year potential of 1.71 aMW.

These estimates include energy efficiency achieved through Benton PUD's own utility programs and through its share of the Northwest Energy Efficiency Alliance (NEEA) accomplishments. Some of the potential may be achieved through code and standards changes, especially in the later years. In some cases, the savings from those changes will be quantified by NEEA or through BPA's Momentum Savings work.

Table ES-1
Cost-Effective Potential (aMW)

	2-Year	6-Year	10-Year	20-Year
Residential	0.71	2.91	5.70	11.64
Commercial	0.40	1.32	2.09	3.13
Industrial	0.50	1.81	3.02	3.66
Distribution Efficiency	0.05	0.27	0.62	1.70
Agricultural	0.06	0.15	0.20	0.23
Total	**1.71**	**6.46**	**11.62**	**20.35**

Note: Numbers in this table and others throughout the report may not add to total due to rounding.

Energy efficiency also has the potential to reduce peak demands. Estimates of peak demand savings are calculated for each measure using the Council's ProCost tool, which uses hourly load profiles developed for the Seventh Power Plan and a Benton PUD-specific definition of when peak demand occurs. These unit-level estimates are then aggregated across sectors and years in the same way that energy efficiency measure savings potential is calculated. The reductions in peak demand provided by energy efficiency are summarized in Table ES-2 below.

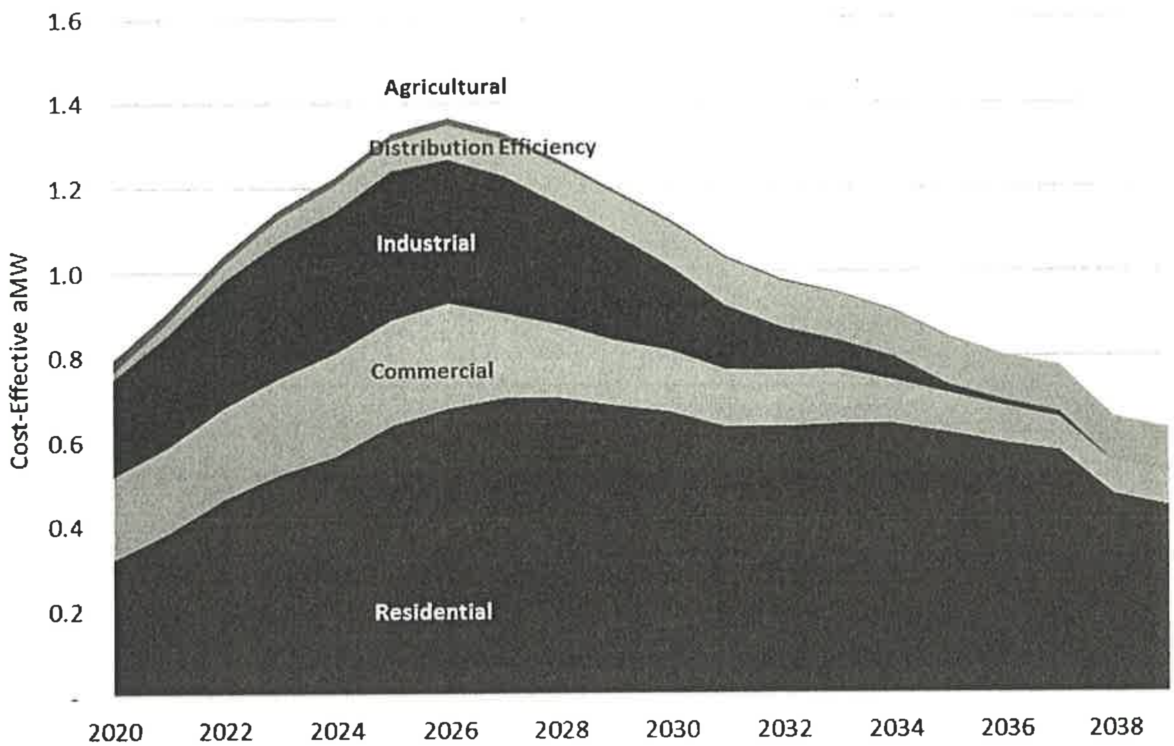
The savings from most energy efficiency measures is concentrated in those periods when energy is being used, and not evenly throughout the day. Thus, the peak demand reduction, measured in MW, is nearly double the annual average energy savings. Benton PUD's annual peak occurs most frequently in summer evenings, between 4 and 6 PM. In addition to these peak demand savings, demand savings would occur in varying amounts throughout the year.

Table ES-2
Cost-Effective Demand Savings (MW)

	2-Year	6-Year	10-Year	20-Year
Residential	1.20	5.00	10.09	22.39
Commercial	0.60	2.03	3.25	4.95
Industrial	0.64	2.33	3.91	4.78
Distribution Efficiency	0.10	0.29	0.40	0.46
Agricultural	0.04	0.27	0.61	1.68
Total	**2.58**	**9.92**	**18.27**	**34.26**

The 20-year energy efficiency potential is shown on an annual basis in Figure ES-1. This assessment shows potential starting around 0.8 aMW in 2020 and ramping up to a maximum of 1.37 aMW per year in 2026. Potential then gradually decreases through the remaining years of the planning period as the remaining retrofit measure opportunities diminish over time.

Figure ES-1
Annual Cost-Effective Energy Efficiency Potential Estimate



As Figure ES-1 shows, the majority of the potential is in the residential sector. Due to federal and state lighting product standards scheduled to take effect in 2020, much of the residential potential is in the end uses of HVAC (including weatherization) and water heating. Measures with notable potential in these end uses include:

- Weatherization measures like windows, insulation, and duct sealing
- Efficient heat pumps and heat pump commissioning
- Water Heating – including heat pump water heaters, clothes washers, and low-flow showerheads

A large share of conservation is also available in Benton PUD's commercial and industrial sectors. The potential in the commercial sector is lower compared with the potential estimated in the 2017 CPA. Changes in the value of transmission and distribution system capacity savings has resulted in a decrease in the cost effectiveness of some measures that contribute to reductions in peak demand, including many measures in the commercial sector. Benton PUD has also achieved significant savings in lighting measures in recent years, leaving limited remaining savings. Savings in the commercial sector are spread across numerous end uses, but the primary areas for opportunity are in the HVAC end use. Notable measures in this area include:

- Variable refrigerant flow HVAC systems
- Commercial energy management

- Ductless Heat Pumps in small commercial spaces
- Demand Control Ventilation

The 2019 CPA identified higher potential in the industrial sector relative to the 2017 CPA. Higher load forecasts as well as the addition of indoor agriculture contribute to this increase. Industrial sector savings also tend to have a profile that is flatter over time, so unlike savings from the other sectors, they were less impacted by changes to the transmission and distribution capacity values described above.

Comparison to Previous Assessment

Table ES-3 shows a comparison of the 2, 10, and 20-year Base Case conservation potential by customer sector for this assessment and the results of Benton PUD's 2017 CPA.

Table ES-3
Comparison of 2017 CPA and 2019 CPA Cost-Effective Potential

	2-Year			10-Year			20-Year		
	2017	2019	% Change	2017	2019	% Change	2017	2019	% Change
Residential	1.03	0.71	-31%	6.16	5.70	-8%	12.17	11.64	-4%
Commercial	0.52	0.40	-21%	4.26	2.09	-50%	9.20	3.13	-66%
Industrial	0.46	0.50	9%	2.18	3.02	38%	2.73	3.66	34%
Distribution Efficiency	0.03	0.05	51%	0.43	0.62	44%	1.19	1.70	43%
Agricultural	0.22	0.06	-75%	1.05	0.20	-81%	1.51	0.23	-85%
Total	**2.25**	**1.71**	**-24%**	**14.08**	**11.62**	**-17%**	**26.80**	**20.35**	**-24%**

*Note that the 2017 columns refer to the CPA completed in 2017 for the time period of 2018 through 2037. The 2019 assessment is for the timeframe: 2020 through 2039.

The change in conservation potential estimated since the 2017 study is the result of several changes to the input assumptions, including measure data and avoided cost assumptions. These are discussed below.

Measure Data

The above-mentioned federal lighting standard impacts many common screw-in bulbs and eliminated the consideration of many residential and some commercial lighting measures. The standard takes effect in 2020 and requires levels of efficiency found only in CFL and LED technologies. Studies of the lighting market show that CFL bulbs are quickly exiting the market, meaning that consumers will likely only be able to purchase LED bulbs beginning in 2020. This would leave little to no opportunities for utility programs to provide incentives.

Avoided Cost

There were both increases and decreases to the avoided cost inputs. The Council updated its assumptions on the value of deferred capital expenditures for transmission and distribution capacity, with the new values being significantly lower. At the same time, the market price forecast was higher and Washington state's new legislation increased the value of carbon emissions reductions and energy efficiency's ability to reduce Renewable Portfolio Standard costs. The extent to which each measure was impacted by these changes depends on its contribution to reducing peak demands; so measures in the agricultural, residential, and commercial sectors, which tend to contribute more to reducing Benton PUD's system peaks, were more impacted by the decrease in capacity values. Measures with flatter savings profiles, such as those in the industrial sector, were less impacted by the capacity value changes and may have benefited from the increase in energy-related values.

Customer Characteristics

As part of this study, EES performed a billing analysis of Benton PUD billing data. This data was used in conjunction with regional survey data to estimate the share of electric heating equipment in homes served by Benton PUD. The analysis showed a lower saturation of electric heat than was assumed in previous CPAs.

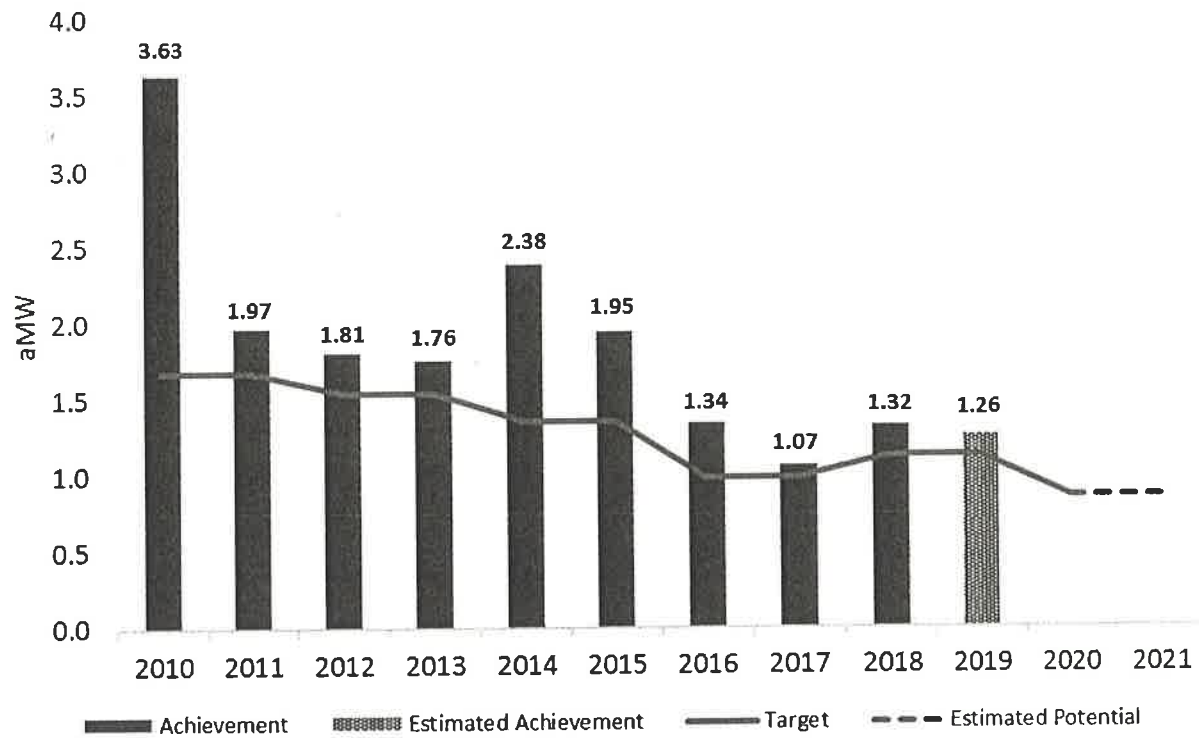
EES also added an additional industrial segment, indoor agriculture, that was not considered in the previous CPA.

In the agriculture sector, a new approach was used to estimate the level of agriculture in Benton PUD's service territory. This resulted in a 19% decrease in the number of irrigated acres.

Targets and Achievement

Figure ES-2 compares Benton PUD's historic achievement with its targets. The estimated potential for 2020 and 2021 is based on the Base Case scenario presented in this report and represents approximately a 24% decrease over the 2018-19 biennium. A decrease was expected given the likely changes to residential lighting programs, but the target is realistic as lighting savings were not considered when aligning potential with recent program history. The figure shows that Benton PUD has consistently met its biennial energy efficiency targets, and that the potential estimates presented in this report are achievable through Benton PUDs various programs and Benton PUD's share of NEEA savings.

Figure ES-2
Historic Achievement and Targets



Conclusion

This report summarizes the CPA conducted for Benton PUD for the 2020 to 2039 timeframe. Many components of the CPA are updated from previous CPA models including items such as energy market price forecast, code and standard changes, recent conservation achievements, revised savings values for RTF and Council measures, and multiple scenario analyses. Additionally, the state's new clean energy law required changes to the avoided cost assumptions.

The results of this assessment are lower than the previous assessment, primarily due to federal lighting standards decreasing savings opportunities for efficiency programs after 2020 as well as changes in the value of capacity savings occurring on the transmission and distribution systems. These changes result in a total 10-year cost effective potential of 11.62 aMW and a two-year potential of 1.71 aMW for the 2020-21 biennium, which is a 24% decrease over the target for the 2018-19 biennium.

Introduction

Objectives

The objective of this report is to describe the results of the Benton Public Utility District (Benton PUD) 2019 Electric Conservation Potential Assessment (CPA). This assessment provides estimates of energy savings by sector for the period 2020 to 2039, with the primary focus on the initial 10 years, 2020 to 2029. This analysis has been conducted in a manner consistent with requirements set forth in RCW 19.285 (EIA) and 194-37 WAC (EIA implementation) and is part of Benton PUD's compliance documentation. The results and guidance presented in this report will also assist Benton PUD in strategic planning for its conservation programs in the near future. Finally, the resulting conservation supply curves can be used in Benton PUD's Integrated Resource Plan (IRP).

The conservation measures used in this analysis are based on the measures that were included in the Council's Seventh Power Plan and were updated with subsequent changes and new measures approved by the Regional Technical Forum (RTF). The assessment considered a wide range of conservation resources that are reliable, available, and cost effective within the 20-year planning period.

Electric Utility Resource Plan Requirements

According to Chapter RCW 19.280, utilities with at least 25,000 customers are required to develop IRPs by September 2008 and biennially thereafter. The legislation mandates that these resource plans include assessments of commercially available conservation and efficiency measures. This CPA is designed to assist in meeting these requirements for conservation analyses. The results of this CPA may be used in the next IRP due to the state by September 2020. More background information is provided below.

Energy Independence Act

Chapter RCW 19.285, the Energy Independence Act, requires that, "each qualifying utility pursue all available conservation that is cost-effective, reliable and feasible." The timeline for requirements of the Energy Independence Act are detailed below:

- By January 1, 2010 – Identify achievable cost-effective conservation potential through 2019 using methodologies consistent with the Pacific Northwest Power and Conservation Council's (Council) latest power planning document.
- Beginning January 2010, each utility shall establish a biennial acquisition target for cost-effective conservation that is no lower than the utility's pro rata share for the two-year period of the cost-effective conservation potential for the subsequent ten years.

- On or before June 1, 2012, each utility shall submit an annual conservation report to the department (the Department of Commerce or its successor). The report shall document the utility's progress in meeting the targets established in RCW 19.285.040.
- Beginning on January 1, 2014, cost-effective conservation achieved by a qualifying utility in excess of its biennial acquisition target may be used to help meet the immediately subsequent two biennial acquisition targets, such that no more than twenty percent of any biennial target may be met with excess conservation savings.
- Beginning January 1, 2014, a qualifying utility may use conservation savings in excess of its biennial target from a single large facility to meet up to an additional five percent of the immediately subsequent two biennial acquisition targets.[1]

This report summarizes the preliminary results of a comprehensive CPA conducted following the requirements of the EIA. A checklist of how this analysis meets EIA requirements is included in Appendix III.

Other Legislative Considerations

Washington state recently enacted several laws that impact conservation planning. Washington HB 1444 enacts efficiency standards for a variety of appliances, some of which are included as measures in this CPA. This law takes effect on July 28, 2019 and applies to products manufactured after January 1, 2021. As the law applies to the manufacturing date, products not meeting the efficiency levels set forth in the law could continue to be sold in 2021 and a reasonable time of six months or more may be necessary for product inventories to turn over. As such, the standards contained in this law will be addressed in the 2021 CPA. HB 1444 also contains a duplicate requirement of the federal lighting standard scheduled to take effect in 2020. While there currently is some doubt about whether the federal standard will come into effect, HB 1444 ensures that the same standards will apply to lighting in Washington state and with the same timing as the federal standard.

Washington also recently enacted a clean energy law, SB 5116. The law contains two provisions that impact potential assessments: the use of a specific set of values for the social cost of carbon and the requirement that all sales be greenhouse gas free beginning in 2030. These provisions of the law have been incorporated into the assumptions of this CPA.

Study Uncertainties

The savings estimates presented in this study are subject to the uncertainties associated with the input data. This study utilized the best available data at the time of its development; however,

[1] The EIA requires that the savings must be cost effective and achieved within a single biennial period at a facility whose average annual load before conservation exceeded 5 aMW. In addition, the law requires that no more than 25% of a biennial target may be met with excess conservation savings, inclusive of provisions listed in this section.

the results of future studies will change as the planning environment evolves. Specific areas of uncertainty include the following:

- Customer characteristic data – Residential and commercial building data and appliance saturations are in many cases based on regional studies and surveys. There are uncertainties related to the extent that Benton PUD's service area is similar to that of the region, or that the regional survey data represents the population.
- Measure data – In particular, savings and cost estimates (when comparing to current market conditions), as prepared by the Council and RTF, will vary across the region. In some cases, measure applicability or other attributes have been estimated by the Council or the RTF based on professional judgment or limited market research.
- Market Price Forecasts – Market prices (and forecasts) are continually changing. The market price forecasts for electricity and natural gas utilized in this analysis represent a snapshot in time. Given a different snapshot in time, the results of the analysis would vary. However, different avoided cost scenarios are included in the analysis to consider the sensitivity of the results to fluctuating market prices over the study period.
- Utility System Assumptions – Credits have been included in this analysis to account for the avoided costs of transmission and distribution system expansion. Though potential transmission and distribution system cost savings are dependent on local conditions, the Council considers these credits to be representative estimates of these avoided costs. A value for generation capacity was also included but may change as the Northwest market continues to evolve.
- Discount Rate – The Council develops a real discount rate as well as a finance rate for each power plan. The finance rate is based on the relative share of the cost of conservation and the cost of capital for the various program sponsors. The Council has estimated these figures using the most current available information. This study reflects the current borrowing market although changes in borrowing rates will likely vary over the study period.
- Forecasted Load and Customer Growth – The CPA bases the 20-year potential estimates on forecasted loads and customer growth as approved by Resolution 2500. Each of these forecasts includes a level of uncertainty.
- Load Shape Data – The Council provides conservation load shapes for evaluating the timing of energy savings. In practice, load shapes will vary by utility based on weather, customer types, and other factors. This assessment uses the hourly load shapes used in the Seventh Plan to estimate peak demand savings over the planning period, based on shaped energy savings. Since the load shapes are a mix of older Northwest and California data, peak demand savings presented in this report may vary from actual peak demand savings.
- Frozen Efficiency – Consistent with the Council's methodology, the measure baseline efficiency levels and end-using devices do not change over the planning period. In addition, it is assumed that once an energy efficiency measure is installed, it will remain in place over the remainder of the study period.

Due to these uncertainties and the changing environment, under the EIA, qualifying utilities must update their CPAs every two years to reflect the best available information.

Report Organization

The main report is organized with the following main sections:

- Methodology – CPA methodology along with some of the overarching assumptions
- Recent Conservation Achievement – Benton PUD's recent achievements and current energy efficiency programs
- Customer Characteristics – Housing and commercial building data for updating the baseline conditions
- Results – Energy Savings and Costs – Primary base case results
- Scenario Results – Results of all scenarios
- Summary
- References & Appendices

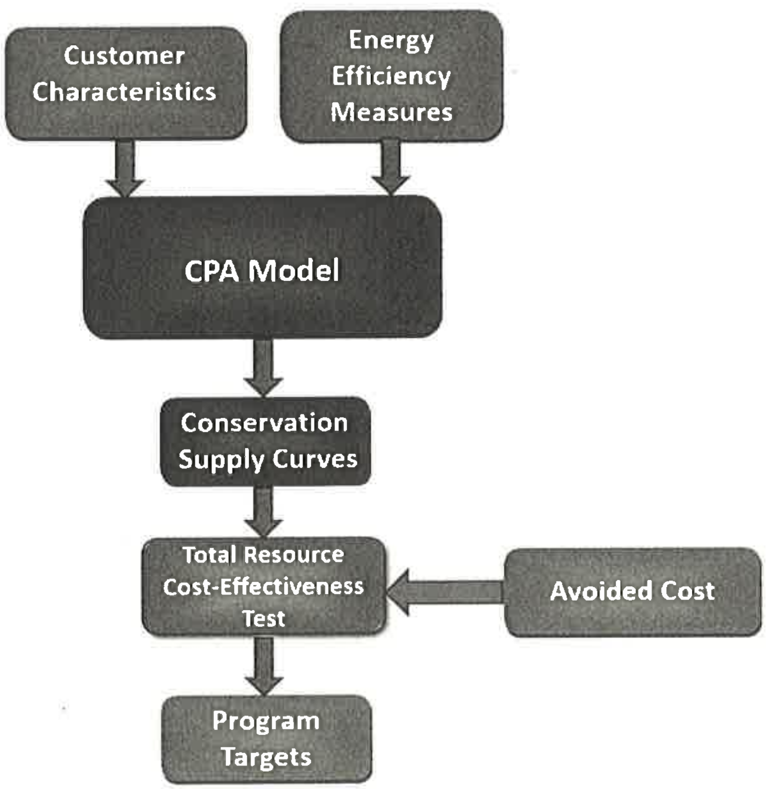
CPA Methodology

This study is a comprehensive assessment of the energy efficiency potential in Benton PUD's service area. The methodology complies with RCW 19.285.040 and WAC 194-37-070 Section 5 parts (a) through (d) and is consistent with the methodology used by the Northwest Power and Conservation Council (Council) in developing the Seventh Power Plan. This section provides a broad overview of the methodology used to develop Benton PUD's conservation potential target. Specific assumptions and methodology as it pertains to compliance with the EIA are provided in the Appendix III of this report.

Basic Modeling Methodology

The basic methodology used for this assessment is illustrated in Figure 1. A key factor is the kilowatt hours saved annually from the installation of an individual energy efficiency measure. The savings from each measure is multiplied by the total number of measures that could be installed over the life of the program. Savings from each individual measure are then aggregated to produce the total potential.

Figure 1
Conservation Potential Assessment Process



Customer Characteristic Data

Assessment of customer characteristics includes estimating both the number of locations where a measure could be feasibly installed as well as the share—or saturation—of measures that have already been installed. For this analysis, the characterization of Benton PUD's baseline was determined using data provided by Benton PUD, NEEA's commercial and residential building stock assessments, and census data. Details of data sources and assumptions are described for each sector later in the report.

This assessment primarily sourced baseline measure saturation data from the Council's Seventh Plan measure workbooks. The Council's data was developed from NEEA's Building Stock Assessments, studies, market research and other sources. This data was updated with NEEA's 2016 Residential Building Stock Assessment and Benton PUD's historic conservation achievement data, where applicable. Benton PUD's historic achievement is discussed in detail in the next section.

Energy Efficiency Measure Data

The characterization of efficiency measures includes measure savings, costs, and lifetime. Other features, such as measure load shape, operation and maintenance costs, and non-energy benefits are also important for measure definition. The Council's Seventh Power Plan is the primary source for conservation measure data. Where appropriate, the Council's Seventh Plan supply curve workbooks have been updated to include any subsequent updates from the RTF. New measures reviewed by the RTF were also added to the model.

The measure data include adjustments from raw savings data for several factors. The effects of space-heating interaction, for example, are included for all lighting and appliance measures, where appropriate. For example, if an electrically-heated house is retrofitted with efficient lighting, the heat that was originally provided by the inefficient lighting will have to be made up by the electric heating system. These interaction factors are included in measure savings data to produce net energy savings.

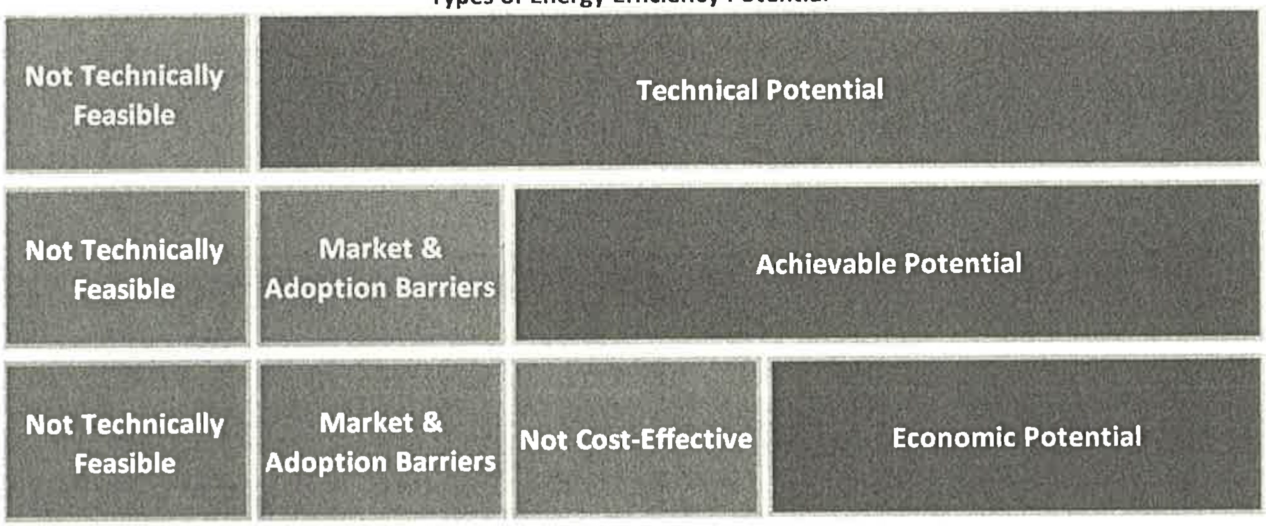
Other financial-related data needed for defining measure costs and benefits include: discount rate, line losses, and deferred capacity-expansion benefits.

A list of measures by end-use is included in this CPA in Appendix VI.

Types of Potential

Once the customer characteristics and energy efficiency measures are fully described, energy efficiency potential can be quantified. Three types of potential are used in this study: technical, achievable, and economic or cost-effective potential. Technical potential is the theoretical maximum efficiency available in the service territory if cost and market barriers are not considered. Market barriers and other consumer acceptance constraints reduce the total potential savings of an energy efficient measure. When these factors are applied, the remaining potential is called the achievable potential. Economic potential is a subset of the achievable potential that has been screened for cost effectiveness through a benefit-cost test. Figure 2 illustrates the four types of potential followed by more detailed explanations.

Figure 2
Types of Energy Efficiency Potential[2]



Technical – Technical potential is the amount of energy efficiency potential that is available, regardless of cost or other technological or market constraints, such as customer willingness to adopt a given measure. It represents the theoretical maximum amount of energy efficiency that is possible in a utility's service territory absent these constraints.

Estimating the technical potential begins with determining a value for the energy efficiency measure savings. Additionally, the number of applicable units must be estimated. Applicable units are the units across a service territory where the measure could feasibly be installed. This includes accounting for units that may have already been installed. The value is highly dependent on the measure and the housing stock. For example, a heat pump measure may only be applicable to single family homes with electric space heating equipment. A saturation factor accounts for measures that have already been completed.

In addition, technical potential considers the interaction and stacking effects of measures. For example, interaction occurs when a home installs energy efficient lighting and the demands on the heating system rise due to a reduction in heat emitted by the lights. If a home installs both insulation and a high-efficiency heat pump, the total savings of these stacked measures is less than if each measure were installed individually because the demands on the heating system are lower in a well-insulated home. Interaction is addressed by accounting for impacts on other energy uses. Stacked measures within the same end use are often addressed by considering the

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[2] Reproduced from U.S. Environmental Protection Agency. *Guide to Resource Planning with Energy Efficiency.* Figure 2-1, November 2007

savings of each measure as if it were installed after other measures that impact the same end use.

The total technical potential is often significantly more than the amount of achievable and economic potential. The difference between technical potential and achievable potential is a result of the number of measures assumed to be affected by market barriers. Economic potential is further limited due to the number of measures in the achievable potential that are not cost-effective.

Achievable Technical – Achievable technical potential, also referred to as achievable potential, is the amount of potential that can be achieved with a given set of market conditions. It takes into account many of the realistic barriers to adopting energy efficiency measures. These barriers include market availability of technology, consumer acceptance, non-measure costs, and the practical limitations of ramping up a program over time. The level of achievable potential can increase or decrease depending on the given incentive level of the measure. The Council assumes that 85% of technical potential can be achieved over the 20-year study period. This is a consequence of a pilot program offered in Hood River, Oregon where home weatherization measures were offered at no cost. The pilot was able to reach over 90% of homes. The Council also uses a variety of ramp rates to estimate the rate of achievement over time. This CPA follows the Council's methodology, including both the achievability and ramp rate assumptions.

Economic – Economic potential is the amount of potential that passes an economic benefit-cost test. In Washington State, EIA requirements stipulate that the total resource cost test (TRC) be used to determine economic potential. The TRC evaluates all costs and benefits of the measure regardless of who pays a cost or receives the benefit. Costs and benefits include the following: capital cost, O&M cost over the life of the measure, disposal costs, program administration costs, environmental benefits, distribution and transmission benefits, energy savings benefits, economic effects, and non-energy savings benefits. Non-energy costs and benefits can be difficult to enumerate, yet non-energy costs are quantified where feasible and realistic. Examples of non-quantifiable benefits might include: added comfort and reduced road noise from better insulation or increased real estate value from new windows. A quantifiable non-energy benefit might include reduced detergent costs or reduced water and sewer charges from energy efficient clothes washers.

For this potential assessment, the Council's ProCost model was used to determine cost effectiveness for each energy efficiency measure. The ProCost model values measure energy savings by time of day using conservation load shapes (by end-use) and segmented energy prices. The version of ProCost used in the 2019 CPA evaluates measure savings on an hourly basis, but ultimately values the energy savings during two segments covering high and low load hour time periods.

Avoided Cost

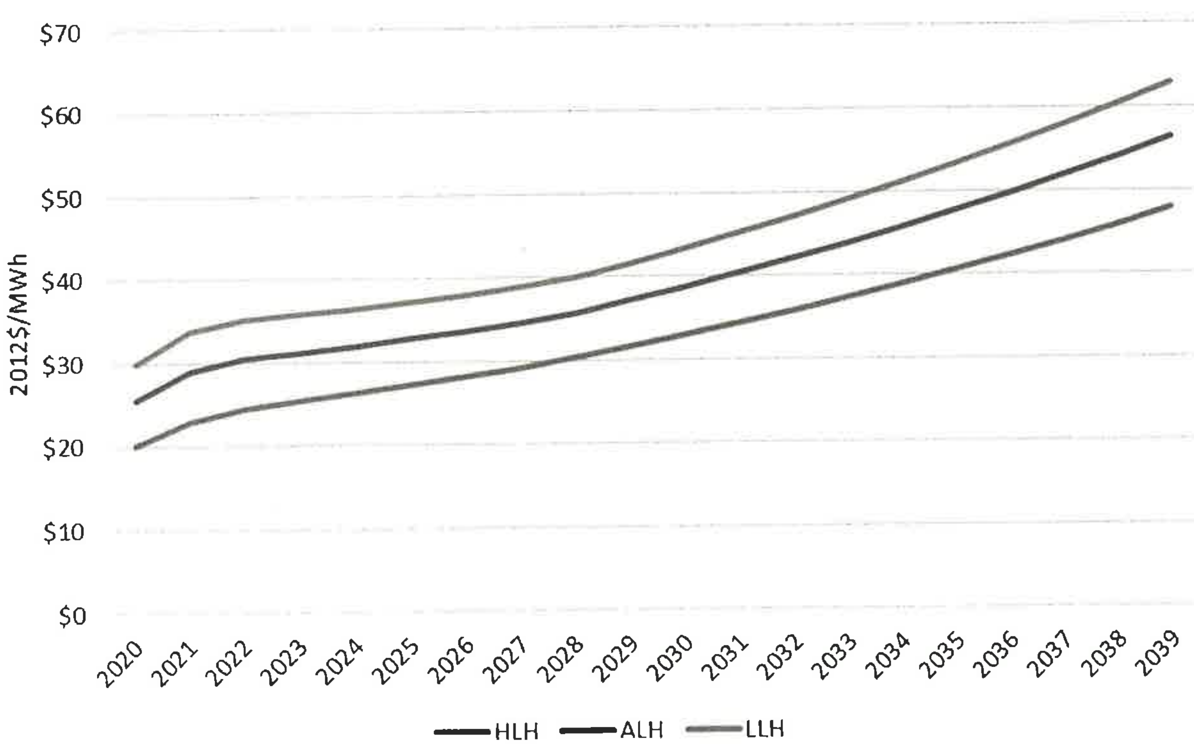
Each component of the avoided cost of energy efficiency measure savings is described below. Additional information regarding the avoided cost forecast is included in Appendix IV.

Energy

The avoided cost of energy is the cost that is avoided through the acquisition of energy efficiency in lieu of other resources. Avoided costs are used to value energy savings benefits when conducting cost effectiveness tests and are included in the numerator in a benefit-cost test. The avoided costs typically include energy-based values ($/MWh) and values associated with the demand savings ($/kW) provided by energy efficiency. These energy benefits are often based on the cost of a generating resource, a forecast of market prices, or the avoided resource identified in the IRP process.

Figure 3 shows the price forecast used as the primary avoided cost component for the planning period. The price forecast is shown for heavy load hours (HLH), light load hours (LLH), and average load hours (ALH).

Figure 3
20-Year Market Price Forecast (Mid-Columbia)



The EIA requires that utilities "...set avoided costs equal to a forecast of market prices" and as discussed in Appendix IV, Benton PUD relies on market purchases to meet peak energy demands.

Therefore, the market price forecast shown in Figure 3 is appropriate for modeling the value of avoided energy.

Social Cost of Carbon

In addition to the avoided cost of energy, energy efficiency provides the benefit of reducing carbon emissions. The revised EIA rules require the inclusion of the social cost of carbon, which is a cost that society incurs when fossil fuels are burned to generate electricity. Further, Washington state's recently enacted clean energy law (SB 5116) specified that utilities use the social cost of carbon developed by the federal Interagency workgroup using the 2.5 percent discount rate. These values were used in all scenarios of the CPA. The CPA also included assumptions about the carbon intensity of Benton PUD's marginal resource as well as the recently expanded Renewable Portfolio Standard (RPS) requirements, discussed below.

Renewable Portfolio Standard Cost

By reducing Benton PUD's overall load, energy efficiency provides a benefit of reducing the RPS requirement. Benton PUD currently purchases Renewable Energy Credits (RECs) to fulfill a requirement of sourcing 9% of its energy from renewable energy sources. In 2020, the requirement increases to 15% and Washington's clean energy law requires that 100% of sales be greenhouse gas neutral in 2030, effectively a 100% RPS requirement. Under a 15% RPS requirement, for every 100 units of conservation achieved, the RPS requirement is reduced by 15 units. After 2030, due to the increased requirement, the CPA assumes that the marginal cost of power includes the full price of a REC.

Transmission and Distribution System

The EIA requires that deferred capacity expansion benefits for transmission and distribution systems be included in the assessment of cost effectiveness. To account for the value of deferred transmission and distribution system expansion, a distribution system credit value of $6.33/kW-year and a transmission system credit of $2.85/kw-year were applied to peak savings from conservation measures, at the time of the regional transmission and Benton PUD's local distribution system peaks. These values were developed by Council staff in preparation for the 2021 Power Plan.

Generation Capacity

New to the Seventh Plan was the explicit calculation of a value for avoided generation capacity costs. The Council reasoned that in pursuing energy efficiency, in each year it was deferring the cost of a generation unit to meet the region's capacity needs. Based upon the cost savings of deferring this cost for 30 years, the Council estimated a generation capacity value of $115/kW-year.

Benton PUD's IRP concluded peak demands will be met through market purchases of energy. Thus, Benton PUD does not currently avoid any capital expenses associated with generation resources by reducing peak demands. The region may face capacity shortfalls in 2021 when several large coal plants in the Northwest are scheduled to be decommissioned. Further, Benton PUD's need for generation capacity will further increase when its Power Purchase Agreement with the Frederickson 1 Generating Station expires in 2022.

EES has included a value for generation capacity deferral in 2020-2022 based on the summer and winter months where a capacity need currently exists, and for all months in 2023 and thereafter. EES used BPA's monthly demand charges as a proxy value for the monthly value of generation capacity, as those charges are based upon the cost of a generating unit. EES also applied a monthly shape to Benton PUD's peak demand reductions due to conservation, based on early modeling results. With these two factors, the value of generation capacity was calculated to be $75/kW-year for the years 2020-2022 and $96/kW-year thereafter. For the base case, it was assumed the demand charges would increase in real terms by 3% annually. Over the 20-year analysis period, the resulting cost of avoided capacity is $102/kW-year (2012$) in levelized terms.

Risk

With the generation capacity value explicitly defined, the Council's analysis found that a risk credit did not need to be defined as part of its cost-effectiveness test. In this CPA, risk was modeled by varying the base case input assumptions. In doing so, this CPA addresses the uncertainty of the inputs and looks at the sensitivity of the results. The avoided cost components that were varied included the energy prices and generation capacity value. Through the variance of these components, implied risk credits of up to $18/MWh and $13/kW-year were included in the avoided cost.

Additional information regarding the avoided cost forecast and risk mitigation credit values is included in Appendix IV.

Power Planning Act Credit

Finally, a 10% benefit was added to the avoided cost as required by the Pacific Northwest Electric Power Planning and Conservation Act.

Discount and Finance Rate

The Council develops a real discount rate for each of its Power Plans. In preparation for the 2021 Power Plan, the Council proposed using a discount rate of 3.75%. This discount rate was used in this CPA. The discount rate is used to convert future costs and benefits into present values. The present values are then used to compare net benefits across measures that realize costs and benefits at different times and over different useful lives.

In addition, the Council uses a finance rate that is developed from two sets of assumptions. The first set of assumptions describes the relative shares of the cost of conservation distributed to various sponsors. Conservation is funded by the Bonneville Power Administration, utilities, and customers. The second set of assumptions looks at the financing parameters for each of these entities to establish the after-tax average cost of capital for each group. These figures are then weighted, based on each group's assumed share of project cost to arrive at a composite finance rate.

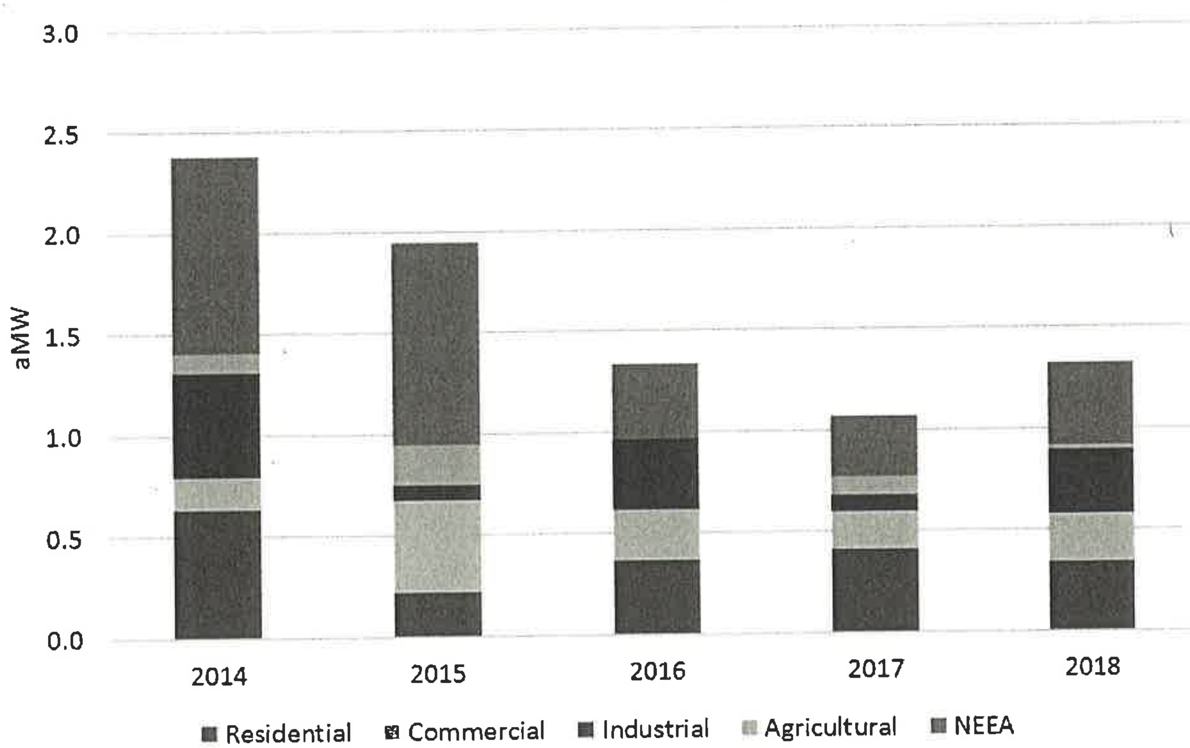
Recent Conservation Achievement

Benton PUD has pursued conservation and energy efficiency resources for many years. Currently, the utility offers a variety of programs for residential, commercial, industrial and agricultural customers. These include residential weatherization, Energy Star® appliance rebates, new construction programs for commercial customers, and energy-efficiency audits. In addition to utility programs, Benton PUD receives credit for market-transformation activities that are accomplished by the Northwest Energy Efficiency Alliance (NEEA) in its service territory.

Figure 4 shows the distribution of conservation among the District's customer sectors and through Northwest Energy Efficiency Alliance (NEEA) efforts over the past five years. Savings from NEEA decline significantly in 2016. The decline was caused by the adoption of the Seventh Power Plan, which resets the baseline against which NEEA's market transformation savings are claimed. As NEEA's work to transform markets continues and its initiatives continue to build market share of efficient products, the savings will continue to grow, as is apparent below. NEEA's work helps bring energy efficient emerging technologies, like ductless heat pumps and heat pump water heaters to the Northwest markets.

More detail for these savings is provided below for each sector.

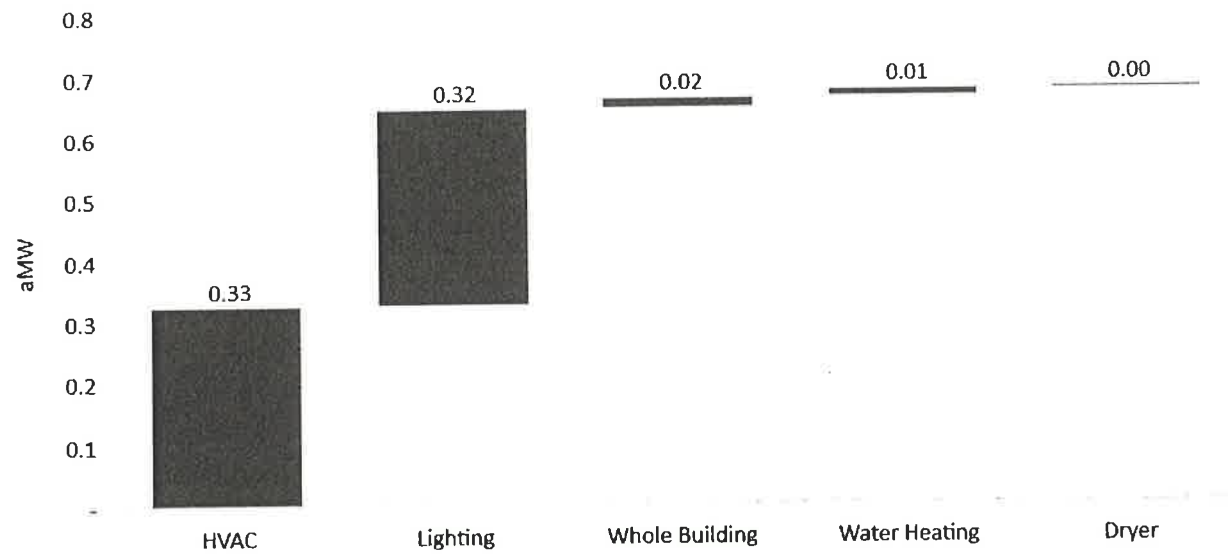
Figure 4
Recent Conservation History by Sector



Residential

Figure 5 shows historic conservation achievement by end use in the residential sector. Savings from HVAC and lighting measures account for the majority of the savings. As discussed above, residential lighting measures were largely excluded from the 2019 CPA due to product standards that take effect in 2020.

Figure 5
2017-2018 Residential Savings



Commercial & Industrial

Historic achievement in the commercial and industrial sectors is primarily due to lighting, Strategic Energy Management, and custom HVAC projects. Figures 6 and 7 show the breakdown of commercial and industrial savings, respectively, from 2017 and 2018.

Figure 6
2016-2017 Commercial Savings

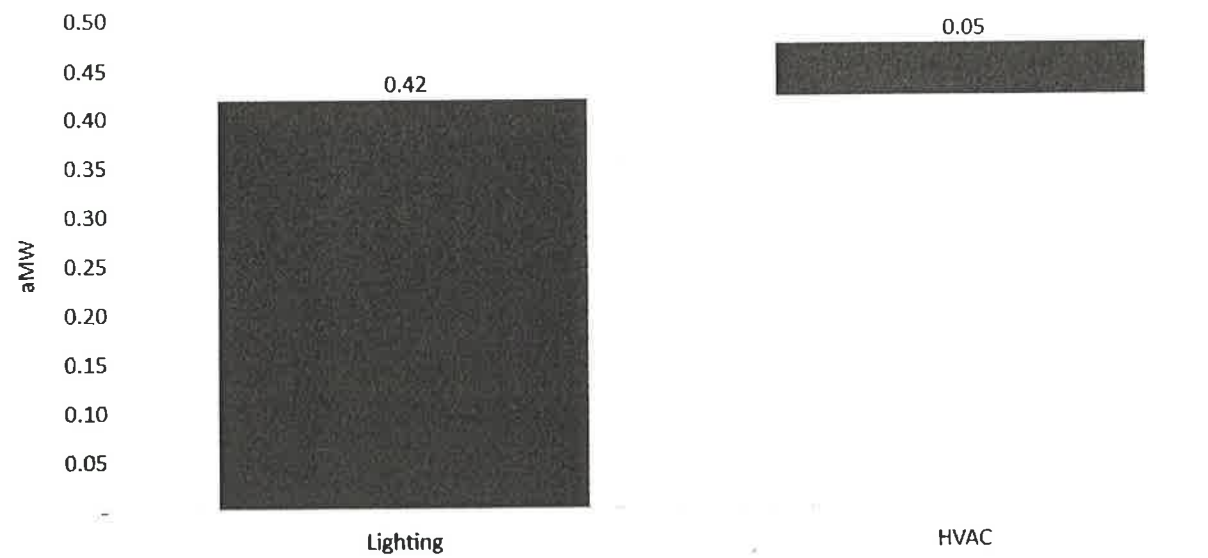
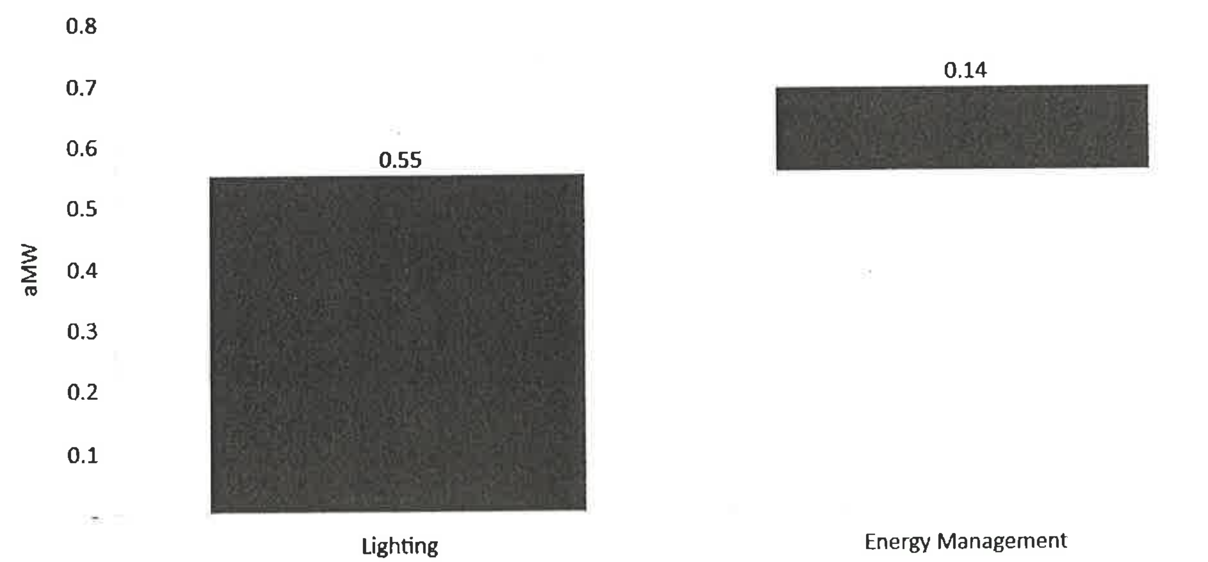


Figure 7
2017-2018 Industrial Savings



Agriculture

Savings in the agriculture sector have largely been due to scientific irrigation scheduling (SIS), irrigation hardware updates, and efficient pumps and motors. Benton PUD has helped farmers implement SIS on more than 55,000 acres annually. The RTF determined market transformation had occurred and therefore SIS is no longer available.

Current Conservation Programs

Benton PUD offers a wide range of conservation programs to its customers. These programs include many types of deemed conservation rebates, energy audits, net metering, and custom projects. The current programs offered by Benton PUD are detailed below and Benton PUD's board resolution detailing the utility's conservation rebate policy is included as Appendix VII.

Residential

- *Energy Star Rebates* – Benton PUD offers a number of rebates for Energy Star appliances. These include $30 for Energy Star clothes washers and $50 for clothes dryers
- *Heat Pump Water Heater* – Rebates are available for heat pump water heaters based on capacity. Rebates include $300 for Tier 1 tanks and $500 for tanks for Tier 2 tanks.
- *Weatherization* – This program provides insulation rebates from $0.02 to $0.70 per square foot, depending on location and home type. Benton PUD offers window replacement rebates of $3 per square foot. Finally, qualified energy efficient doors are eligible for a $40 rebate.
- *HVAC Rebates* – This program provides rebates for a variety of space conditioning upgrades including: a heat-pump and ductless heat-pump rebates ($500 to $1,100), duct sealing rebates up to $250, and up to $100 for qualifying smart thermostats.
- *Energy Star Homes and Manufactured Homes Program* – Benton PUD provides rebates of $1,200 to Northwest Energy Efficient Manufactured (NEEM) certified homes as well as incentives for site-built single family homes.

Commercial

- *Lighting Energy Efficiency Program (LEEP)* – Owners of commercial buildings can apply for a lighting energy audit. Applicable rebate amounts are determined upon completion of the audit.
- *Custom Projects Rebates* – Benton PUD offers rebates for special projects that improve efficiency or process related systems including, but not limited to, compressed air, variable frequency drives, industrial lighting interactive with HVAC systems, and refrigeration. Rebates for this program vary.
- *Deemed Rebates*- Supply fan VFDs, smart thermostats, and efficient rooftop units.

Agriculture

- *Agricultural Rebate Program* – This program offers incentives for irrigation sprinklers, nozzles, and regulators as well as replacement of 25 to 500 horsepower pump motors, and variable frequency drives installed in onion and potato sheds. Rebate amounts vary, and an application form must be completed to qualify.

Summary

Benton PUD plans to continue to invest in energy efficiency by offering incentives to all sectors. The results of this CPA will help Benton PUD program managers to structure energy efficiency program offerings, establish appropriate incentive levels, comply with the EIA requirements, and maintain Benton PUD's status as their customer's Trusted Energy Partner.

Customer Characteristics Data

Benton PUD serves over 53,000 electric customers in Benton County, Washington, with a service area population of approximately 114,283. A key component of an energy efficiency assessment is to understand the characteristics of these customers—primarily the building and end-use characteristics. These characteristics for each customer class are described below.

Residential

For the residential sector, the key characteristics include house type, space heating fuel, and water heating fuel. Tables 1, 2 and 3 show relevant residential data for single family, multi-family and manufactured homes in Benton PUD's service territory. The data is based on billing data provided by Benton PUD, which was used to estimate the share of homes with electric heating systems, as well as the 2016 Residential Building Stock Assessment (RBSA), developed by NEEA. The billing data analysis, summarized in Appendix IX, identified a lower share of electric heat than was assumed in previous CPAs. Within the portion of electrically heated homes, RBSA data was used to estimate the distribution of different types of electric heating equipment.

Table 1
Residential Building Characteristics

Heating Zone	Cooling Zone	Solar Zone	Residential Households	Total Population
1	3	3	44,002	114,283

Table 2
Home Heating & Cooling System Saturations

	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
Electric Forced Air Furnace	8%	16%	16%	56%
Heat Pump	61%	0%	0%	19%
Ductless Heat Pump	3%	0%	0%	0%
Electric Zonal/Baseboard	8%	67%	67%	0%
Central Air Conditioning	20%	12%	12%	44%
Room Air Conditioning	12%	63%	63%	13%

Table 3 Appliance Saturations				
	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
Electric Water Heat	79%	77%	77%	94%
Refrigerator	136%	105%	105%	119%
Freezer	45%	16%	16%	50%
Clothes Washer	96%	53%	53%	100%
Clothes Dryer	91%	49%	49%	100%
Dishwasher	87%	67%	67%	88%
Electric Oven	96%	100%	100%	100%
Desktop	49%	40%	40%	56%
Laptop	53%	35%	35%	38%
Monitor	51%	44%	44%	56%

Commercial

Building floor area is the key parameter in determining conservation potential for the commercial sector, as many of the measures are based on savings as a function of building area. The commercial building floor area used in the 2019 CPA started with the 2018 commercial load. This load was distributed among the different commercial business types based on the assumed distribution of load used in previous CPAs. The loads were then converted to floor areas using regional energy use intensity values from NEEA's Commercial Building Stock Assessment (CBSA).[3] The result was a 24% increase in floor area over the 2017 CPA. While this would lead to an increase in potential, other factors, such as changes in avoided cost assumptions resulted in a net decrease in potential.

Table 4 shows estimated 2020 commercial square footage in each of the 18 building categories.

Benton PUD provided a load forecast by rate class that was used to develop a sector-wide growth rate of 0.07% after embedded energy efficiency impacts were added back in. A regional demolition rate based on the Council's Seventh Plan assumptions is also used.

[3] Navigant Consulting. 2014. *Northwest Commercial Building Stock Assessment: Final Report.* Portland, OR: Northwest Energy Efficiency Alliance.

Table 4 Commercial Building Square Footage by Segment	
Segment	**Area (Square Feet)**
Large Office	408,591
Medium Office	3,515,557
Small Office	3,822,612
Extra Large Retail	1,574,841
Large Retail	2,652,703
Medium Retail	526,590
Small Retail	40,093
School (K-12)	138,531
University	268,843
Warehouse	7,453,394
Supermarket	1,059,412
Mini Mart	202,830
Restaurant	799,202
Lodging	2,075,772
Hospital	191,442
Residential Care	687,867
Assembly	971,563
Other Commercial	2,611,562
Total	**29,001,406**

The commercial square footage shown in Table 4 was used to estimate commercial potential for this assessment.

Industrial

The methodology for estimating industrial potential is different than the approaches used for the residential and commercial sectors primarily because most energy efficiency opportunities are unique to specific industrial segments. The Council and this study use a "top-down" methodology that utilizes annual consumption by industrial segment and then disaggregates total usage by end-use shares. Estimated measure savings are applied to each sector's end-use shares.

Benton PUD provided 2018 energy use for its industrial customers. Individual industrial customer usage is summed by industrial segment in Table 5. Similar to the commercial sector, the industrial growth rate used in Benton PUD's base case scenario was calculated from the industrial load forecast after accounting for embedded energy efficiency and applied across all sectors. The resulting load growth was 0.47%.

Table 5
Industrial Sector Load by Segment

Industrial Segment	2018 Sales (MWh)
Frozen Food	10,109
Other Food	92,299
Metal Fabrication	1,563
Equipment	3,379
Cold Storage	2,778
Refinery	1,530
Chemical	65,118
Miscellaneous Manufacturing	14,114
Total	**191,628**

In the 2019 CPA, Benton PUD also provided information on indoor agriculture operations in its service territory. The potential for this segment differed from the other industrial segments because it was based on the amount of untreated floor area of growing operations, rather than the overall load.

Benton PUD staff estimate that approximately 50,000 square feet of indoor growing rooms are present in their service territory. Approximately 18,000 square feet have already been converted to high efficiency lighting, so only 32,000 square feet remain. Based on previous projects, Benton PUD staff estimate that savings of approximately 100 kWh per square foot are possible. These estimates were used to estimate the potential for this segment.

Agriculture

To determine agriculture sector characteristics in Benton PUD's service territory, EES utilized data provided by the United States Department of Agriculture (USDA). The USDA conducts a census of farms and ranches in the U.S. every five years. The most recent available data for this analysis is from the 2012 census, which was published in 2014. This data was used in both the 2015 and 2017 CPAs.

Benton PUD provides electric service to agriculture customers in Benton County; however, Benton REA also provides electric service to agriculture customers in Benton County. Because the most recent data is published by county, EES adjusted county-wide totals by using zip code data from an earlier census.

Based on the adjusted data, irrigated acreage was estimated at 88,092 acres, a decrease of 19% from the 2017 CPA. Irrigated acreage is used to estimate savings from energy efficient irrigation hardware upgrades.

The updated data suggests that the number of farms in Benton PUD's service territory (914) is a 10% increase above the estimate used in the 2017 CPA. The number of farms is used to estimate potential for outdoor area lighting measures, as each farm is assumed to have several buildings, each with an outdoor area light. Finally, no dairy farms were estimated for Benton PUD's service territory.

Table 6 Agricultural Inputs	
Number of Dairy Farms	0
Total Irrigated Acreage	88,092
Total Number of Pumps	1,112
Total Number of Farms	914

Distribution Efficiency

For this analysis, EES developed an estimate of distribution system conservation potential using the Council's Seventh Plan approach. The Seventh Plan estimates distribution potential for five measures as a fraction of end system sales ranging from 0.1 to 3.9 kWh per MWh, depending on the measure.

Benton PUD provided a 10-year load forecast and a growth rate of 0.3% that was used to estimate the load through the 20-year study period. This growth rate is based on the compound average growth rate for the utility-provided forecast. Distribution system conservation is discussed in detail in the next section.

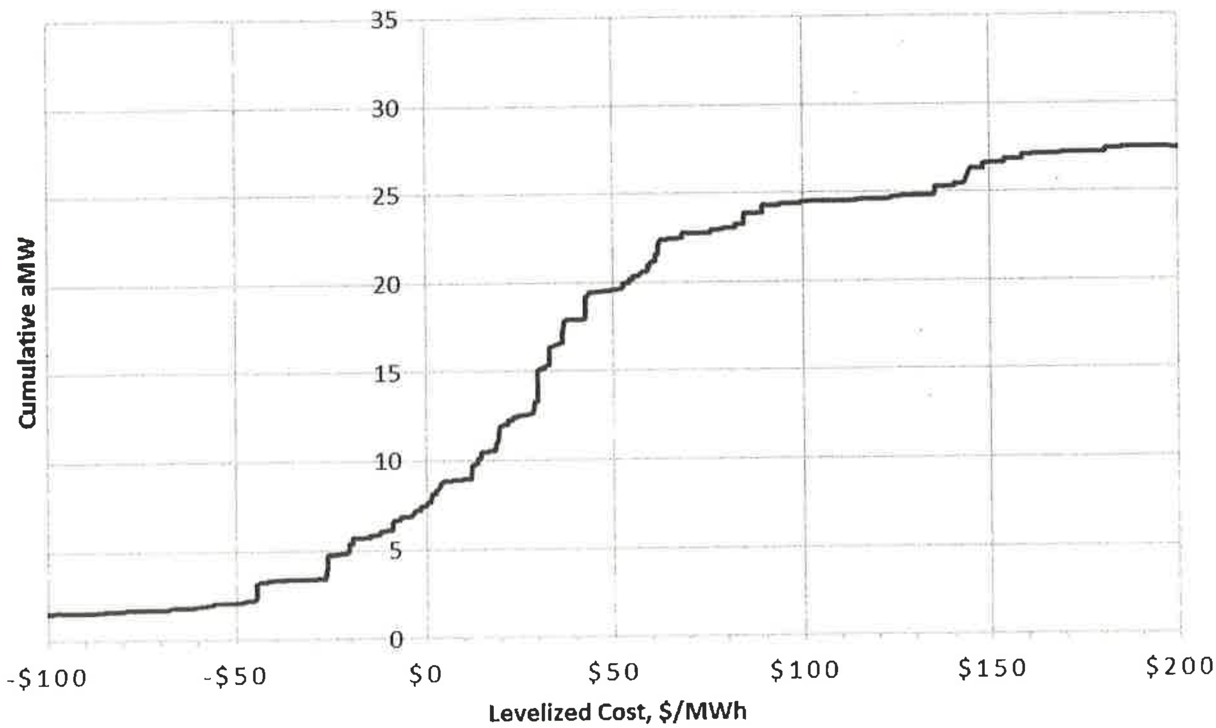
Results – Energy Savings and Costs

Achievable Conservation Potential

Achievable potential is the amount of energy efficiency potential that is available regardless of cost.

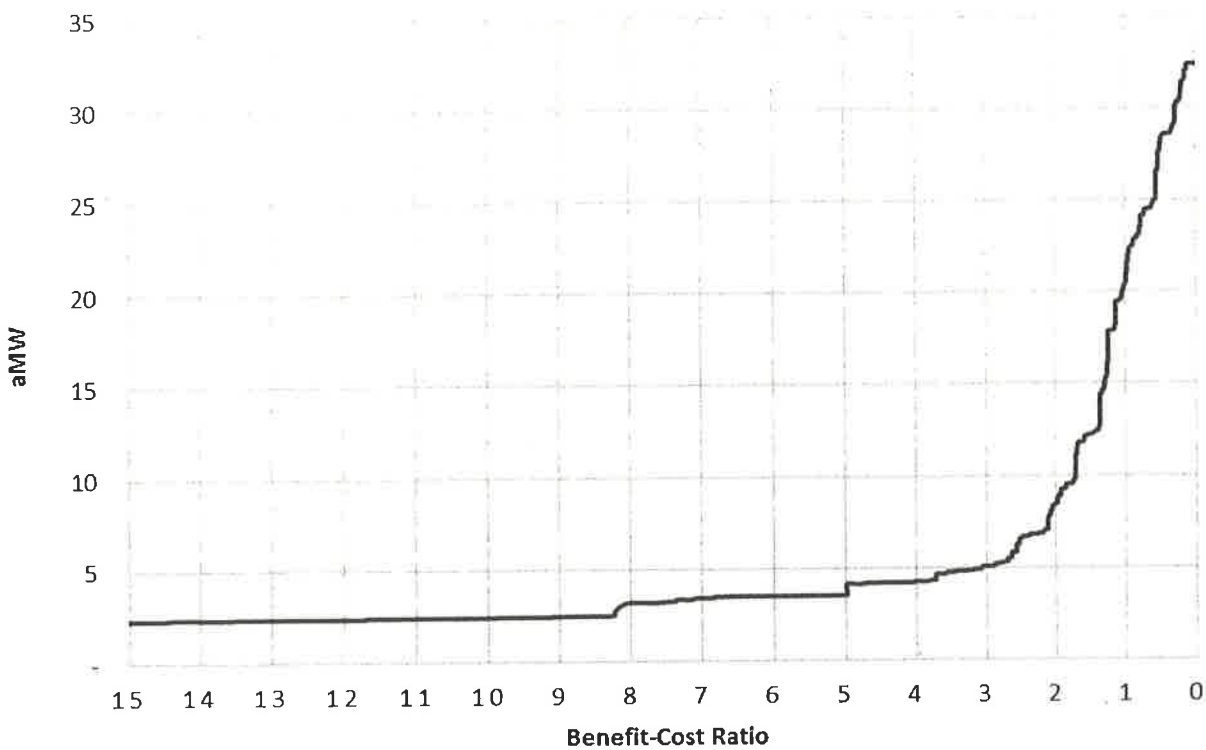
Figure 7, below, shows a supply curve of 20-year achievable potential. A supply curve is developed by plotting cumulative energy efficiency savings potential (aMW) against the levelized cost ($/MWh) of the savings, when measures are sorted in order of ascending cost. The potential shown in Figure 7 has not been screened for cost effectiveness. Costs are levelized, allowing for the comparison of measures with different lifetimes. The supply curve facilitates comparison of demand-side resources to supply-side resources and is often used in conjunction with integrated resource plans. Figure 7 shows that approximately 15 aMW of saving potential are available for less than $30/MWh and over 23 aMW are available for under $80/MWh. Total achievable potential for Benton PUD is approximately 32 aMW over the 20-year study period.

Figure 7
20-Year Achievable Potential Levelized Cost Supply Curve



While useful for considering the costs of conservation measures, supply curves based on levelized cost are limited in that not all energy savings are equally valued. Another way to depict a supply curve is based on the benefit-cost ratio, as shown in Figure 8 below. This figure repeats the overall finding that just over 20 aMW of potential is cost-effective with a benefit-cost ratio greater than or equal to 1.0. The line increases steeply at the point where the benefit-cost ratio is equal to 1.0, suggesting that small changes in avoided cost assumptions may lead to an additional 2 to 3 aMW of savings potential.

Figure 8
20-Year Potential Benefit-Cost Ratio Supply Curve



Economic Conservation Potential

Economic or cost-effective potential is the amount of potential that passes the Total Resource Cost (TRC) test. This means that the present value of the benefits attributed to the conservation measure exceeds the present value of the measure costs over its lifetime.

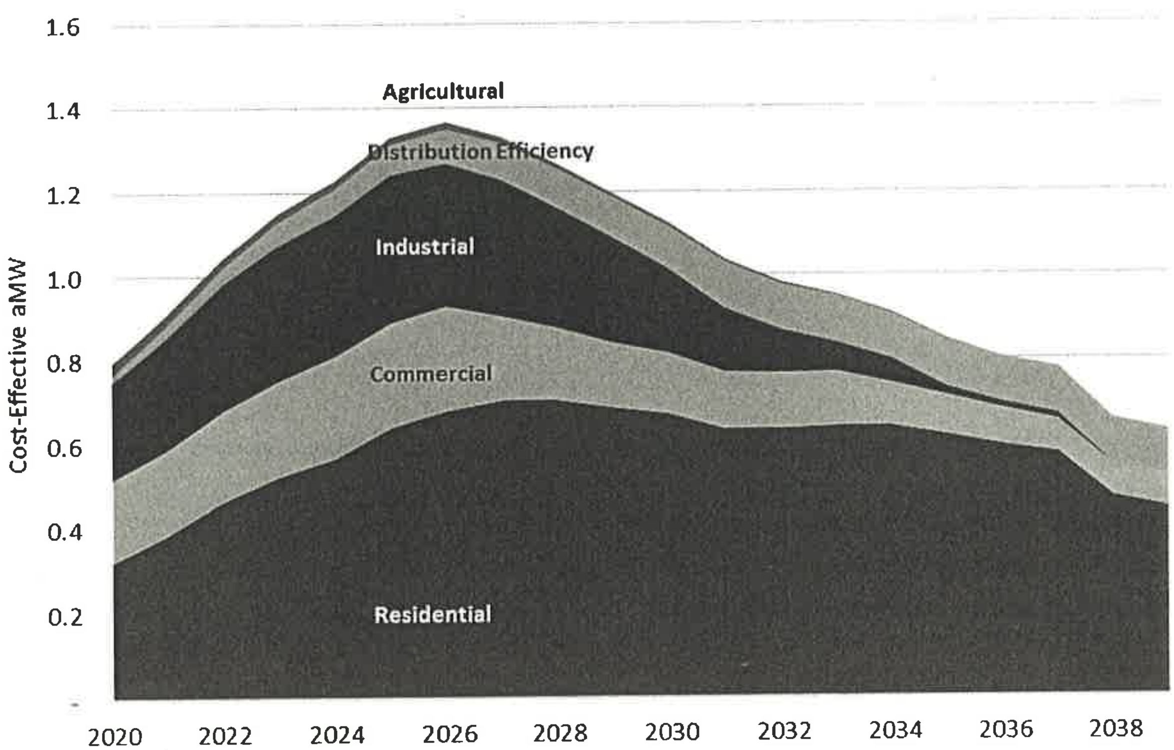
Table 7 shows the economic potential by sector in 2, 6, 10 and 20-year increments. Compared with the technical and achievable potential, it shows that 20.35 aMW of the total 32 aMW is cost effective for Benton PUD. The last section of this report discusses how these values could be used for setting targets.

Table 7 Cost Effective Achievable Potential - Base Case (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	0.71	2.91	5.70	11.64
Commercial	0.40	1.32	2.09	3.13
Industrial	0.50	1.81	3.02	3.66
Distribution Efficiency	0.05	0.27	0.62	1.70
Agricultural	0.06	0.15	0.20	0.23
Total	**1.71**	**6.46**	**11.62**	**20.35**

Sector Summary

Figure 9 shows economic potential by sector on an annual basis.

Figure 9
Annual Cost-Effective Potential by Sector



The largest share of the potential is in the residential sector followed by substantial savings potential in the commercial and industrial sectors. Ramp rates from the Seventh Power Plan were used to establish reasonable conservation achievement levels. Adjustments to these ramp rates were made to reflect the timeline of this CPA. Additionally, alternate ramp rates were assigned to reflect Benton PUD's current rate of program achievement. Achievement levels are affected by factors including timing of equipment turnover and new construction, program and technology maturity, market trends, and current utility staffing and funding.

Figure 9 shows that savings estimates are ramped up over the first half of the study period. The ramp rates reflect both resource availability and Benton PUD's current program levels and achievements.

Residential

Residential conservation potential is lower than what was identified in the 2017 assessment. Savings potential has been impacted by the expected impact of lighting standards scheduled to take effect in 2020 as well as changes to the value of capacity savings in the avoided cost.

Within the residential sector, water heating and HVAC (including weatherization) measures make up the largest share of savings (Figure 10). This is due, in part, to the fact that Benton PUD's residential customers rely mostly on electricity for space and water heating. Figure 10 shows increasing achievement in the water heating category through the adoption of heat pump water heaters, showerheads, and faucet aerators. Additional savings are available from heat pump dryers and other smaller measures such as smart power strips and food preparation equipment.

Some measures such as Wi-Fi enabled thermostats and water heaters can also provide additional benefits as demand response resources. These benefits were not included in this conservation potential assessment.

Figure 10
Annual Residential Cost-Effective Potential by End Use

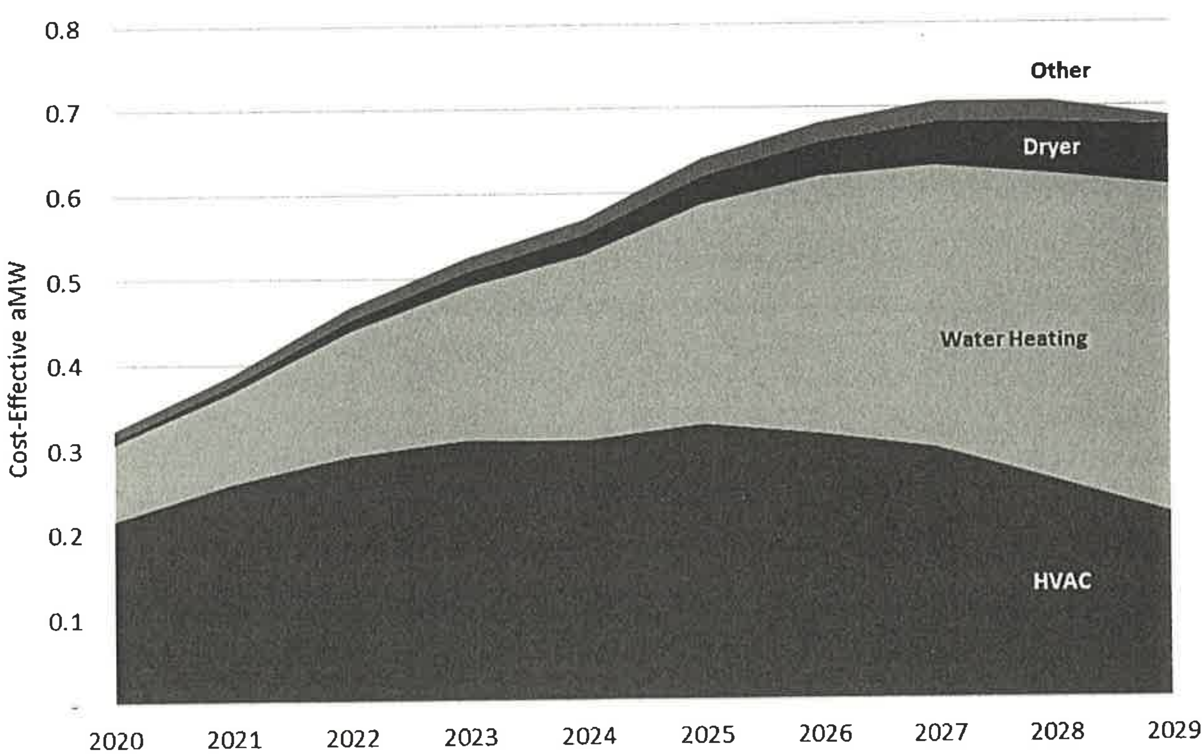
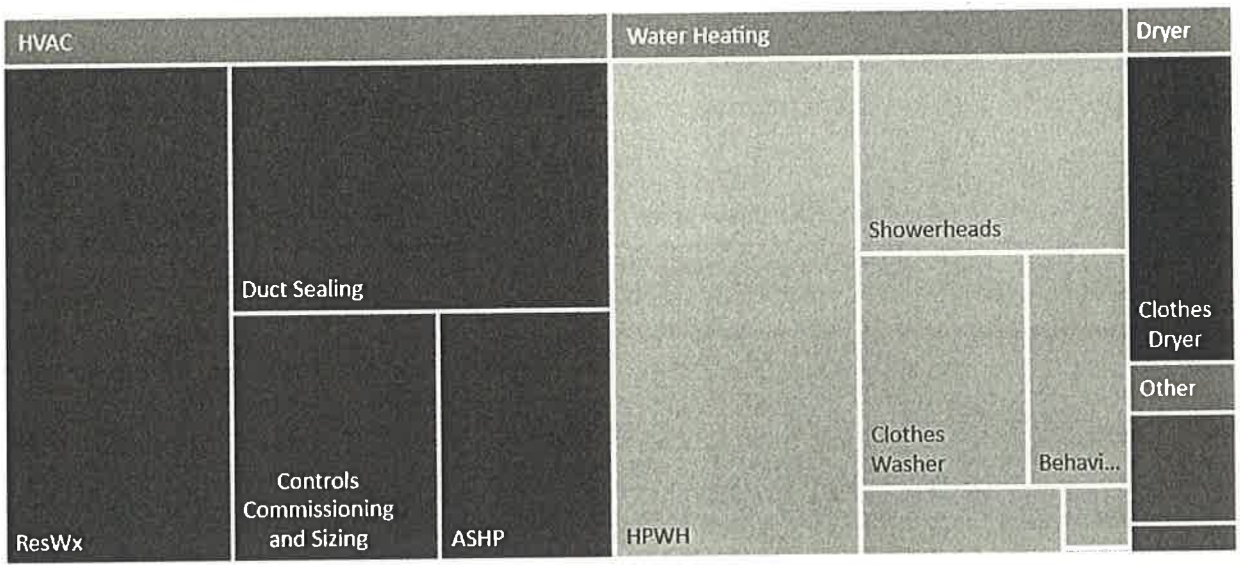


Figure 11 shows how the 10-year residential potential breaks down into end uses and key measure categories. The area of each block represents its share of the total 10-year residential potential.

Figure 11
Residential Cost-Effective Potential by End Use and Measure Category

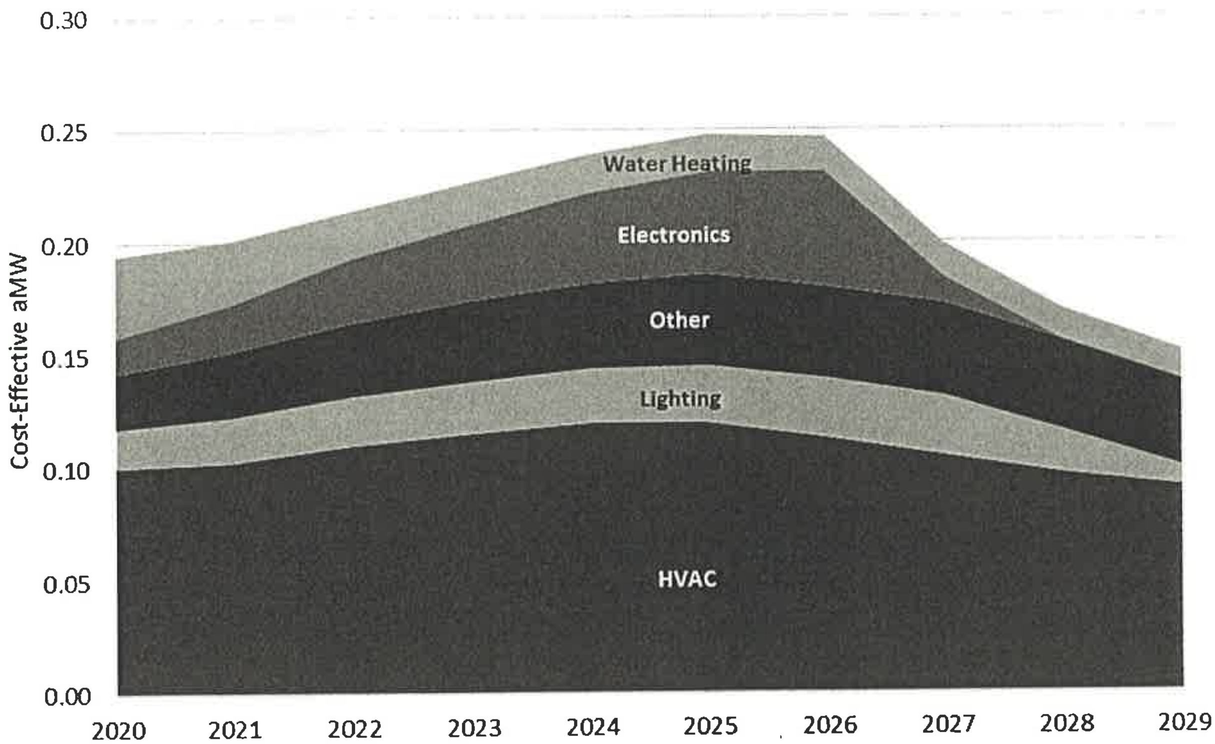


Commercial

Commercial HVAC measures make up the largest share of commercial conservation potential (Figure 12). The remaining lighting potential is projected to be limited after accounting for the achievements to date of Benton PUD's commercial lighting programs.

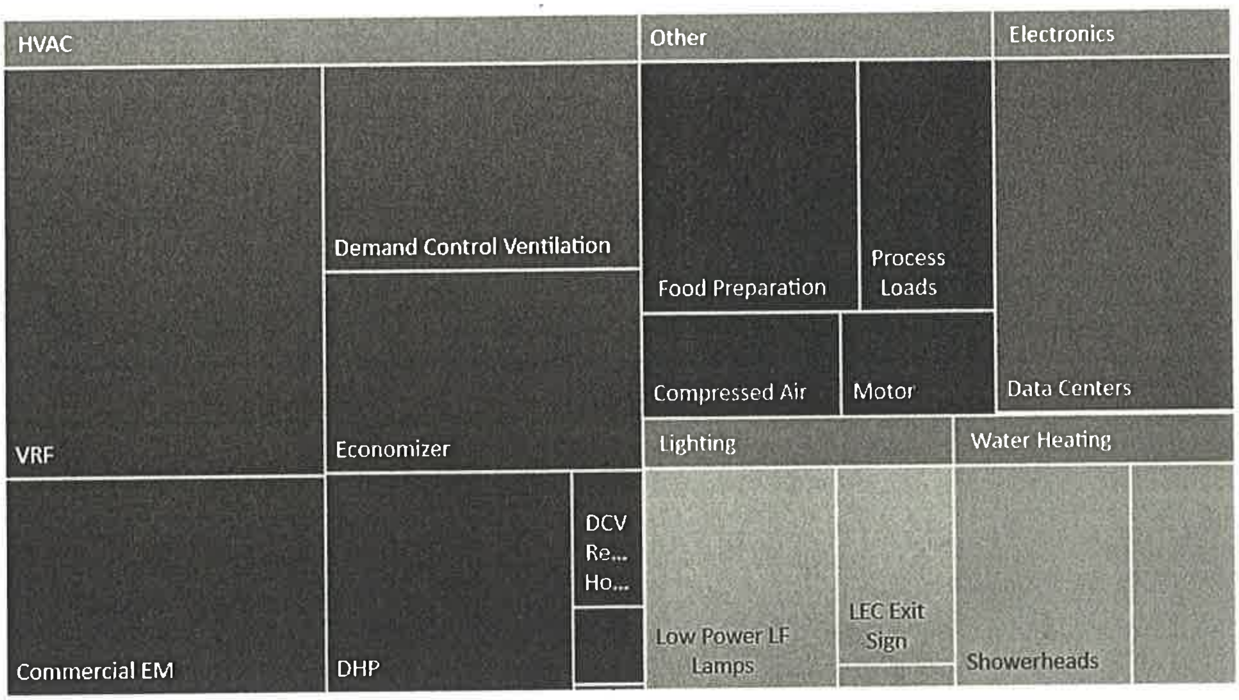
The diverse nature of commercial building energy efficiency is reflected in the variety of end-uses and corresponding measures. Beyond HVAC and lighting, additional sources of potential are available in water heating, electronics, compressed air, motors, food preparation and process loads.

Figure 12
Annual Commercial Cost-Effective Potential by End Use



The key end uses and measures within the commercial sector are shown in Figure 13. The area of each block represents its share of the 10-year commercial potential.

Figure 13
Commercial Cost-Effective Potential by End Use and Measure Category



Industrial

Much of Benton PUD's industrial load is composed of food processing and chemical facilities. These segments contribute significantly to end-use savings in the energy management measures (Figure 14). Energy management measures include both Strategic Energy Management and improved management of motor-driven systems.

As stated above, this CPA also evaluated the potential for indoor agriculture operations. EES used Benton PUD's work to date with this segment to estimate the potential, which is based on changing indoor growing rooms to efficient LED lights.

In Figure 14, the Other category is largely comprised of savings in refrigeration and fan systems, as well as smaller amounts of savings from compressed air and pump systems.

Figure 14
Annual Industrial Cost-Effective Potential by End Use

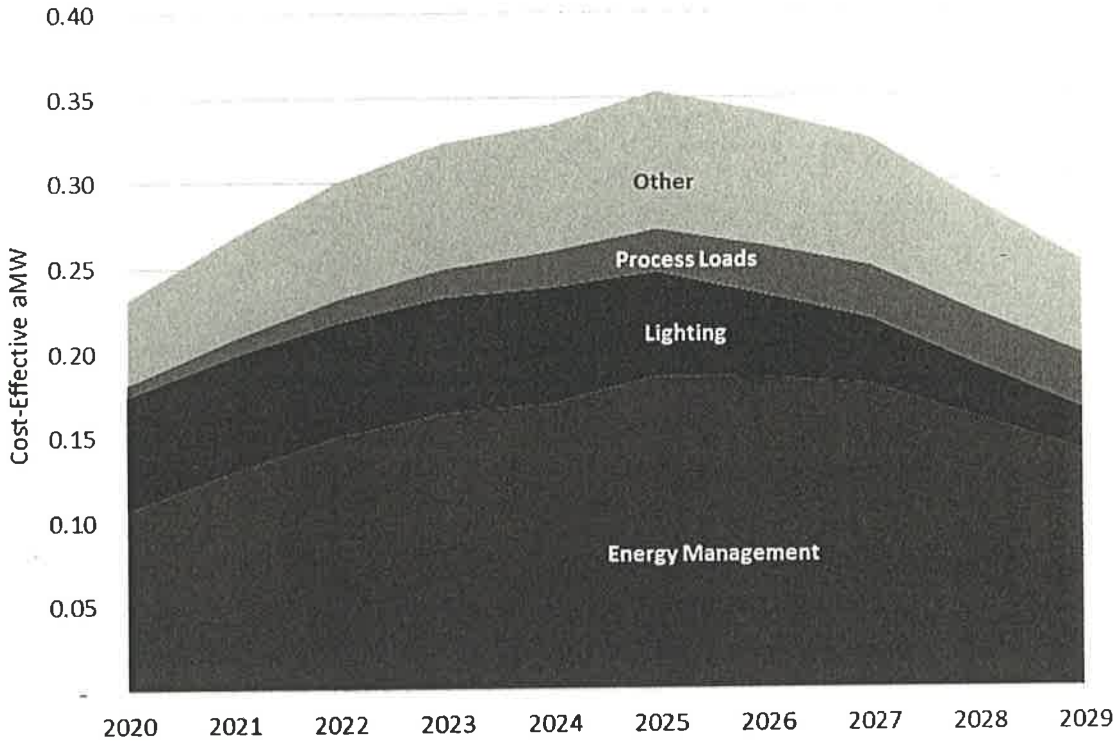
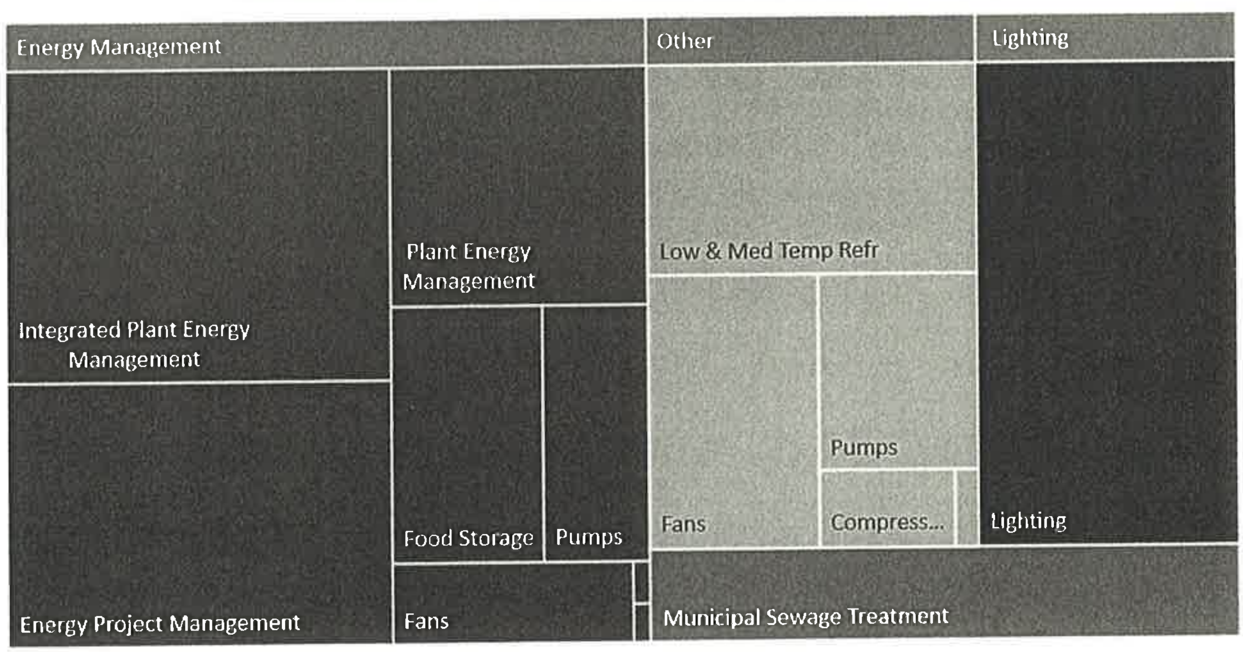


Figure 15 shows how the 10-year industrial potential breaks down by end use and measure categories.

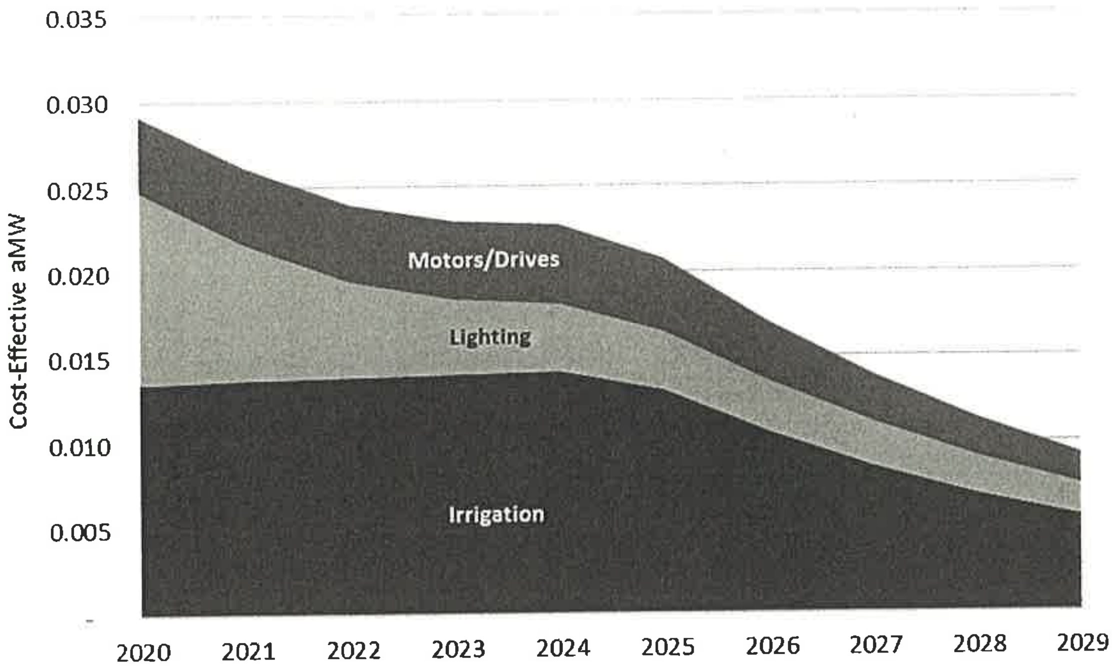
Figure 15
Industrial Cost-Effective Potential by End Use and Measure Category



Agriculture

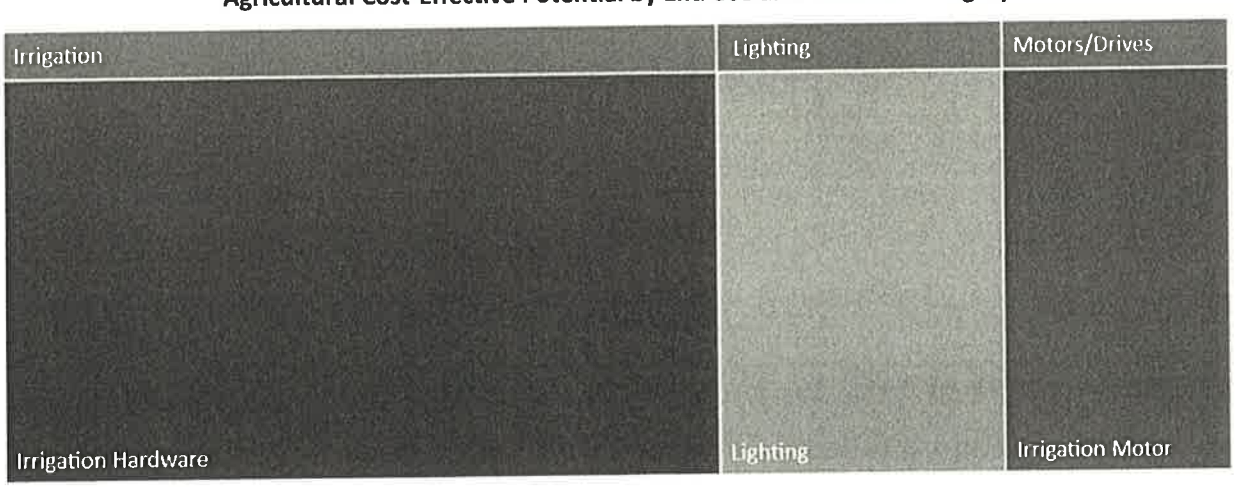
Potential in agriculture is a product of total acres under irrigation in Benton PUD's service territory, number of pumps, and the number of farms. As shown in Figure 16, most of the cost-effective conservation potential is due to irrigation measures, with additional savings from lighting and irrigation pump motors.

Figure 16
Annual Agriculture Cost-Effective Potential by End Use



The 10-year agricultural potential is shown in Figure 17, split by end use and measure categories.

Figure 17
Agricultural Cost-Effective Potential by End Use and Measure Category

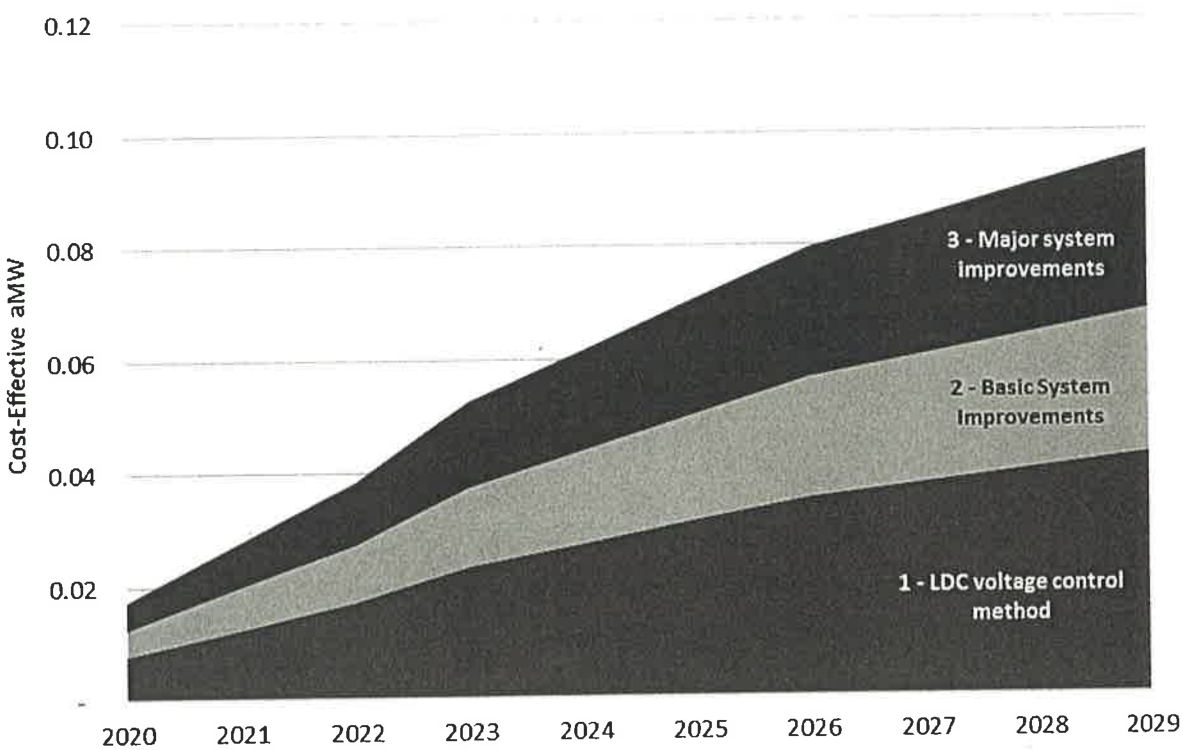


Distribution Efficiency

Distribution system energy efficiency measures regulate voltage and upgrade systems to improve the efficiency of utility distribution systems and reduce line losses. Distribution system potential was estimated using the Council's Seventh Plan methodology. The Seventh Plan estimates distribution system potential based on end of system energy sales.

Distribution system conservation potential is shown in Figure 18. Although five measures were considered in the analysis, only three measures were cost effective.

Figure 18
Annual Distribution System Cost-Effective Potential by End Use



Cost

Budget costs can be estimated at a high level based on the incremental cost of the measures (Table 8). The assumptions in this estimate include: 20 percent of measure cost for administrative costs and 35 percent of the incremental measure costs is assumed to be paid by the utility as incentives. A 20 percent allocation of measure costs to administrative expenses is a standard assumption for conservation programs. This figure was used in the Council's Seventh Power Plan. The 35 percent utility-share of measure costs is used in all sectors except in the utility distribution efficiency category, where Benton PUD is likely to pay the entire cost of any measures implemented and no incentives will be paid. These assumptions are consistent with Benton PUD's previous CPA.

This chart shows that Benton can expect to spend approximately $4.5 million to realize estimated savings over the next two years including program administration costs. The bottom row of Table 8 shows the cost per MWh of first year savings.

Table 8 Utility Program Costs (2019$)				
	2-Year	6-Year	10-Year	20-Year
Residential	$2,796,000	$10,923,000	$20,431,000	$39,505,000
Commercial	$866,000	$3,021,000	$5,009,000	$8,255,000
Industrial	$621,000	$2,201,000	$3,609,000	$4,366,000
Distribution Efficiency	$121,000	$718,000	$1,658,000	$4,546,000
Agricultural	$89,000	$232,000	$313,000	$359,000
Total	**$4,493,000**	**$17,095,000**	**$31,020,000**	**$57,031,000**
$/First Year MWh	$300	$302	$305	$320

The cost estimates presented in this report are conservative estimates for future expenditures since they are based on historic values. Future conservation achievement may be more costly than historic conservation achievement since utilities often choose to implement the lowest cost programs first. In addition, as energy efficiency markets become more saturated, it may require more effort from Benton PUD to acquire conservation through its programs. The additional effort may result in increased administrative costs.

Cost Scenarios

To provide a range of program costs over the planning period, EES tested a range of high and low cost assumptions, relative to the expected cost assumptions above. For the high cost scenario, administrative costs were increased from 20 to 30 percent. The high cost scenario reflects the case where program administration costs may increase in order for Benton PUD to connect with hard-to-reach customers.

For the low cost scenario, the utility share of measure capital cost is reduced from 35 to 30 percent. A situation where the utility is responsible for a lower share of measure capital cost may result from higher conservation achievement through programs for which the customer is responsible for a higher fraction of measure cost. An example of this would be if more conservation were achieved through commercial or industrial custom projects where lower incentives may be needed. Table 9 shows 2, 6, 10 and 20-year program costs for the expected, high and low cost scenarios. Table 10 shows the cost per average megawatt for each of the cost scenarios.

Table 9 Utility Cost Scenarios for Cost-Effective Potential (2019$)				
	2-Year	6-Year	10-Year	20-Year
Expected Case	$4,493,000	$17,095,000	$31,020,000	$57,031,000
Low Cost Case	$4,085,000	$15,541,000	$28,200,000	$51,846,000
High Cost Case	$5,310,000	$20,203,000	$36,660,000	$67,400,000

Table 10 Utility Cost Scenarios for Cost-Effective Potential (2019$/MWh)				
	2-Year	6-Year	10-Year	20-Year
Expected Case	$300	$302	$305	$320
Low Cost Case	$273	$274	$277	$291
High Cost Case	$355	$357	$360	$378

Table 10 costs are again presented as dollars per first year savings (MWh). These units do not consider the savings over the life of a measure, but they do provide an indication of the costs Benton PUD's programs could expect to incur in order to acquire conservation going forward. Annual conservation potential and cost is modeled using the Council's ramp rates. The Council applies ramp rates at the measure level to reflect the characteristics of a particular program (maturity, measure type, and availability etc.) The increasing costs are a result of the ramp rate choice across all measures, reflecting more high-cost measures later in the study period.

Over the next two years, conservation programs are expected to cost between $272 and $354/MWh (first year savings). Overall, Benton PUD can expect the biennium potential estimates presented in this report to cost between $4.1 and $5.3 million for utility incentives and administrative expenditures.

Besides looking at the utility cost, Benton PUD may also wish to consider the total resource cost (TRC) of energy efficiency. The total resource cost reflects the cost that the utility and ratepayer will together pay for conservation, similar to how the costs of other power resources are paid. The TRC costs are shown below (Table 11), levelized over the measure life of each measure. Distribution efficiency measures are by far the cheapest resource, with other measures costing approximately four to six cents per kilowatt-hour.

Table 11 TRC Levelized Cost (2019$/MWh)				
	2-Year	6-Year	10-Year	20-Year
Residential	$63	$64	$65	$69
Commercial	$55	$57	$58	$59
Industrial	$37	$36	$36	$35
Distribution Efficiency	$27	$27	$27	$27
Agricultural	$42	$43	$44	$44
Total	**$53**	**$54**	**$55**	**$59**

Scenario Results

The costs and savings discussed throughout the report thus far describe the Base Case avoided cost scenario. Under this scenario, annual potential for the planning period was estimated by applying assumptions that reflect Benton PUD's expected avoided costs. In addition, the Council's 20-year ramp rates were applied to each measure and then adjusted to more closely reflect Benton PUD's recent level of achievement.

Additional scenarios were developed to identify a range of possible outcomes that account for uncertainties over the planning period. In addition to the Base Case scenario, this assessment tested low and high scenarios to test the sensitivity of the results to different future avoided cost values. The avoided cost values in the low and high scenarios reflect values that are realistic and lower or higher, respectively, than the Base Case assumptions.

To understand the sensitivity of the identified savings potential to avoided cost values alone, all other inputs were held constant while varying avoided cost inputs.

Table 12 summarizes the Base, Low, and High avoided cost input values. Relative to the values used in the 2017 CPA, there are several energy-related values that are higher. The energy market prices are somewhat higher. Further, recently enacted legislation in Washington state requires the use of a specific social cost of carbon and also increases the state's renewable portfolio standard.

While the energy-based avoided cost values increased, the value of capacity decreased relative to the 2017 CPA. As part of the work leading to the 2021 Power Plan, the Council developed new estimates for the value of deferred expenditures for transmission and distribution system capacity.

Rather than using a single generic risk adder applied to each unit of energy, the Low and High avoided cost values consider lower and higher potential future values for each avoided cost input. These values reflect potential price risks based upon both the energy and capacity value of each measure. The final row tabulates the implied risk adders for the Low and High scenarios by summarizing all additions or subtractions relative to the Base Case values. Risk adders are provided in both energy and demand savings values. The first set of values is the maximum (or minimum in the case of negative values). The second set of risk adder values are the average values in energy terms. Further discussion of these values is provided in Appendix IV.

Table 12 Avoided Cost Assumptions by Scenario, $2012			
	Base	**Low**	**High**
Energy	Market Forecast	-50%-85% Confidence Interval*	+50%-85% Confidence Interval*
Social Cost of Carbon	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
Value of REC Compliance	Existing RPS	Existing RPS	Existing RPS
Distribution System Credit, $/kW-year	$6.85	$6.85	$6.85
Transmission System Credit, $/kW-year	$3.08	$3.08	$3.08
Deferred Generation Capacity Credit, $/kW-year	$102	$0	$115
Implied Risk Adder $/MWh $/kW-year	N/A	Up to -$18/MWh -$102/kW-year Average of -$10/MWh -$102/kW-year	Up to $18/MWh $13/kW-year Average of $10/MWh $13/kW-year

**Prediction intervals were used based on the last 10 years of data for high and low estimates.*

Table 13 summarizes results across each avoided input scenario, using Base Case load forecasts and measure acquisition rates.

Table 13 Cost-Effective Potential - Avoided Cost Scenario Comparison				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Base Case	1.7	6.5	11.6	20.3
Low Scenario	1.4	4.9	8.4	12.5
High Scenario	2.0	7.4	13.2	22.7

Table 13 shows that the savings potential does not vary considerably with either upward or downward changes in avoided costs during the early years of the study period. Over the 20-year study period, there is a more significant decrease in the low scenario, likely due to that scenario's exclusion of any credit for deferred generation capacity.

Overall, energy efficiency remains a low-risk resource for Benton PUD for several reasons. First, energy efficiency is purchased in small increments over time, meaning that buying too much energy efficiency is unlikely. Second, while the different avoided cost scenarios described above are all hypothetically possible, it is unlikely that energy prices will decrease further below their already historically low values.

Summary

This report summarizes the results of the 2019 CPA conducted for Benton Public Utility District. The assessment provides estimates of energy savings by sector for the period 2020 to 2039 with a focus on the first 10 years of the planning period, as required by the EIA. The assessment considered a wide range of conservation resources that are reliable, available, and cost effective within the 20-year planning period.

Federal lighting standards impacting many residential lighting measures and new, lower values for capacity savings has resulted in less cost-effective potential than was identified in the 2017 CPA. The cost-effective potential identified in this report remains the lowest cost and lowest risk resource and will serve to keep future electricity costs to a minimum.

Methodology and Compliance with State Mandates

The energy efficiency potential reported in this document is calculated using methodology consistent with the Council's methodology for assessing conservation resources. Appendix III lists each requirement and describes how each item was completed. In addition to using methodology consistent with the Council's Seventh Power Plan, this assessment utilized many of the measure assumptions that the Council developed for the Seventh Plan. Additional measure updates subsequent to the Seventh Plan were also incorporated. Utility-specific data regarding customer characteristics, service-area composition, and historic conservation achievements were used, in conjunction with the measures identified by the Council, to determine available energy-efficiency potential. This close connection with the Council methodology enables compliance with the Washington EIA.

Three types of energy-efficiency potential were calculated: technical, achievable, and economic. Most of the results shown in this report are the economic potential, or the potential that is cost effective in Benton PUD's service territory. The economic and achievable potential considers savings that will be captured through utility program efforts, market transformation and implementation of codes and standards. Often, realization of full savings from a measure will require efforts across all three areas. Historic efforts to measure the savings from codes and standards have been limited, but regional efforts to identify and track savings are increasing as they become an important component of the efforts to meet aggressive regional conservation targets.

Conservation Targets

The EIA states that utilities must establish a biennial target that is "no lower than the qualifying utility's pro rata share for that two-year period of its cost-effective conservation potential for the subsequent ten-year period."[4] However, the State Auditor's Office has stated that:

> The term pro-rata can be defined as equal portions but it can also be defined as a proportion of an "exactly calculable factor." For the purposes of the Energy Independence Act, a pro-rata share could be interpreted as an even 20 percent of a utility's 10-year assessment but state law does not require an even 20 percent.[5]

The State Auditor's Office expects that qualifying utilities have analysis to support targets that are more or less than the 20 percent of the ten-year assessments. This document serves as support for the target selected by Benton PUD and approved by its Commission.

Summary

This study shows a range of conservation target scenarios. These scenarios are estimates based on the set of assumptions detailed in this report and supporting documentation and models. Due to the uncertainties discussed in the Introduction section of this report, actual available and cost-effective conservation may vary from the estimates provided in this report.

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[4] RCW 19.285.040 Energy conservation and renewable energy targets.

[5] State Auditor's Office. Energy Independence Act Criteria Analysis. Pro-Rata Definition. CA No. 2011-03. https://www.sao.wa.gov/local/Documents/CA_No_2011_03_pro-rata.pdf

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Appendix I – Acronyms

ALH – Average Load Hours

aMW – Average Megawatt

BCR – Benefit-Cost Ratio

BPA – Bonneville Power Administration

CFL – Compact Fluorescent Light

CPA – Conservation Potential Assessment

EIA – Energy Independence Act

EUI – Energy Use Intensity

HLH – Heavy load hour energy

HPWH – Heat Pump Water Heater

HVAC – Heating, ventilation and air-conditioning

IRP – Integrated Resource Plan

kW – kilowatt

kWh – kilowatt-hour

LED – Light-emitting diode

LLH – Light load hour energy

MW – Megawatt

MWh – Megawatt-hour

NEEA – Northwest Energy Efficiency Alliance

NPV – Net Present Value

O&M – Operation and Maintenance

RPS – Renewable Portfolio Standard

RTF – Regional Technical Forum

TRC – Total Resource Cost

UC – Utility Cost

Appendix II – Glossary

7th Power Plan: Seventh Northwest Conservation and Electric Power Plan, Feb 2016. A regional resource plan produced by the Northwest Power and Conservation Council (Council).

Average Megawatt (aMW): Average hourly usage of electricity, as measured in megawatts, across all hours of a given day, month or year.

Avoided Cost: Refers to the cost of the next best alternative. For conservation, avoided costs are usually market prices.

Achievable Potential: Conservation potential that takes into account how many measures will actually be implemented after considering market barriers. For lost-opportunity measures, there is only a certain number of expired units or new construction available in a specified time frame. The Council assumes 85% of all measures are achievable. Sometimes achievable potential is a share of economic potential, and sometimes achievable potential is defined as a share of technical potential.

Cost Effective: A conservation measure is cost effective if the present value of its benefits is greater than the present value of its costs. The primary test is the Total Resource Cost test (TRC), in other words, the present value of all benefits is equal to or greater than the present value of all costs. All benefits and costs for the utility and its customers are included, regardless of who pays the costs or receives the benefits.

Economic Potential: Conservation potential that considers the cost and benefits and passes a cost-effectiveness test.

Levelized Cost: Resource costs are compared on a levelized-cost basis. Levelized cost is a measure of resource costs over the lifetime of the resource. Evaluating costs with consideration of the resource life standardizes costs and allows for a straightforward comparison.

Lost Opportunity: Lost-opportunity measures are those that are only available at a specific time, such as new construction or equipment at the end of its life. Examples include heat-pump upgrades, appliances, or premium HVAC in commercial buildings.

MW (megawatt): 1,000 kilowatts of electricity. The generating capacity of utility plants is expressed in megawatts.

Non-Lost Opportunity: Measures that can be acquired at any time, such installing low-flow shower heads.

Northwest Energy Efficiency Alliance (NEEA): The alliance is a unique partnership among the Northwest region's utilities, with the mission to drive the development and adoption of energy-efficient products and services.

Northwest Power and Conservation Council "The Council": The Council develops and maintains a regional power plan and a fish and wildlife program to balance the Northwest's environment and energy needs. Their three tasks are to: develop a 20-year electric power plan that will guarantee adequate and reliable energy at the lowest economic and environmental cost to the Northwest; develop a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin; and educate and involve the public in the Council's decision-making processes.

Regional Technical Forum (RTF): The Regional Technical Forum (RTF) is an advisory committee established in 1999 to develop standards to verify and evaluate conservation savings. Members are appointed by the Council and include individuals experienced in conservation program planning, implementation and evaluation.

Renewable Portfolio Standards: Washington state utilities with more than 25,000 customers are required to meet defined percentages of their load with eligible renewable resources by 2012, 2016, and 2020.

Retrofit (discretionary): Retrofit measures are those that can be replaced at any time during the unit's life. Examples include lighting, shower heads, pre-rinse spray heads, or refrigerator decommissioning.

Technical Potential: Technical potential includes all conservation potential, regardless of cost or achievability. Technical potential is conservation that is technically feasible.

Total Resource Cost Test (TRC): This test is used by the Council and nationally to determine whether or not conservation measures are cost effective. A measure passes the TRC if the ratio of the present value of all benefits (no matter who receives them) to the present value of all costs (no matter who incurs them) is equal to or greater than one.

Appendix III – Documenting Conservation Targets

References:

1) Report – "Benton Public Utilities 2019 Conservation Potential Assessment". Final Report – September 25, 2019.
2) Model – "EES CPA Model-v3.3.xlsm" and supporting files
    a. MC_and_Loadshape-Benton-Base.xlsm – referred to as "MC and Loadshape file" – contains price and load shape data

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
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 includes estimates for stock (e.g. number of homes, square feet of commercial floor area, industrial load) and the number of each measure that can be implemented per unit of stock. The technical potential is further constrained by the amount of stock that has already completed the measure.	Model – the technical potential is calculated as part of the achievable potential, described below.
b) **Achievable 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 assessment conducted for Benton PUD used ramp rate curves to identify the amount of achievable potential for each measure. Those assumptions are for the 20-year planning period. An additional factor of 85% was included to account for market barriers in the calculation of achievable potential. This factor comes from a study conducted in Hood River where home weatherization measures were offered for free and program administrators were able to reach more than 85% of home owners.	Model – the use of these factors can be found on the sector measure tabs, such as 'Residential Measures'. Additionally, the complete set of ramp rates used can be found on the 'Ramp Rates' tab.
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.	Benefits and costs were evaluated using multiple inputs; benefit was then divided by cost. Measures achieving a benefit-cost ratio greater than one were tallied. These measures are considered achievable and cost-effective (or economic).	Model – Benefit-Cost ratios are calculated at the individual level by ProCost and passed up to the model.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
d) **Total Resource Cost**: In determining economic achievable potential, perform a life-cycle cost analysis of measures or programs	The life-cycle cost analysis was performed using the Council's ProCost model. Incremental costs, savings, and lifetimes for each measure were the basis for this analysis. The Council and RTF assumptions were utilized.	Model – supporting files include all of the ProCost files used in the Seventh Plan. The life-cycle cost calculations and methods are identical to those used by the Council.
e) 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	Cost analysis was conducted per the Council's methodology. Capital cost, administrative cost, annual O&M cost and periodic replacement costs were all considered on the cost side. Energy, non-energy, O&M and all other quantifiable benefits were included on the benefits side. The Total Resource Cost (TRC) benefit cost ratio was used to screen measures for cost-effectiveness (I.e., those greater than one are cost-effective).	Model – the "Measure Info Rollup" files pull in all the results from each avoided cost scenario, including the BC ratios from the ProCost results. These results are then linked to by the Conservation Potential Assessment model. The TRC analysis is done at the lowest level of the model in the ProCost files.
f) Include the incremental savings and incremental costs of measures and replacement measures where resources or measures have different measure lifetimes	Savings, cost, and lifetime assumptions from the Council's 7th Plan and RTF were used.	Model – supporting files include all of the ProCost files used in the Seventh Plan, with later updates made by the RTF. The life-cycle cost calculations and methods are identical to those used by the Council.
g) Calculate the value of 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	The Council's Seventh Plan measure load shapes were used to calculate time of day of savings and measure values were weighted based upon peak and off-peak pricing. This was handled using the Council's ProCost tool, so it was handled in the same way as the Seventh Power Plan models.	Model – See MC_AND_LOADSHAPE files for load shapes. The ProCost files handle the calculations.
h) Include the increase or decrease in annual or periodic operations and maintenance costs due to conservation measures	Operations and maintenance costs for each measure were accounted for in the total resource cost per the Council's assumptions.	Model – the ProCost files contain the same assumptions for periodic O&M as the Council and RTF.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
i) 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 efficiency measures to which it is compared	A regional market price forecast for the planning period was created and provided by EES. A discussion of methodologies used to develop the avoided cost forecast is provided in Appendix IV.	Report –See Appendix IV. Model – See MC_AND_LOADSHAPE files ("Base Market Forecast" worksheet).
j) Include deferred capacity expansion benefits for transmission and distribution systems	Deferred transmission capacity expansion benefits were given a benefit of $2.85/kW-year in the cost-effectiveness analysis. A distribution system credit of $6.33/kW-year was also used. These values were developed by the Council in preparation for the 2021 Power Plan.	Model – this value can be found on the ProData page of each ProCost file.
k) Include deferred generation benefits consistent with the contribution to system peak capacity of the conservation measure	Deferred generation capacity expansion benefits were given a value of $ 102/kW-year in the cost effectiveness analysis for the Base Case Scenario. This is based upon Benton PUD's marginal cost for generation capacity. See Appendix IV for further discussion of this value.	Model – this value can be found on the ProData page of the ProCost Batch Runner file. The generation capacity value was not originally included as part of ProCost during the development of the 7th Plan, so there is no dedicated input cell for this value. Instead, the value has been combined with the distribution capacity benefit, since the timing of Benton PUD's distribution system peak and the regional transmission peak occur at different times.
l) Include the social cost of carbon emissions from avoided non-conservation resources	This CPA uses the social cost of carbon values specified in Washington's recently enacted clean energy law, SB 5116.	The MC_AND_LOADSHAPE files contain the carbon cost assumptions for each avoided cost scenario.
m) 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	In this analysis, risk was considered by varying avoided cost inputs and analyzing the variation in results. Rather than an individual and non-specific risk adder, our analysis included a range of possible values for each avoided cost input.	The scenarios section of the report documents the inputs used and the results associated. Appendix IV discusses the risk adders used in this analysis.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
n) Include all non-energy impacts that a resource or measure may provide that can be quantified and monetized	Quantifiable non-energy benefits were included where appropriate. Assumptions for non-energy benefits are the same as in the Council's Seventh Power Plan. Non-energy benefits include, for example, water savings from clothes washers.	Model – the ProCost files contain the same assumptions for non-power benefits as the Council and RTF. The calculations are handled in ProCost.
o) Include an estimate of program administrative costs	Total costs were tabulated and an estimated 20% of total was assigned as the administrative cost. This value is consistent with regional average and BPA programs. The 20% value was used in the Fifth, Sixth, and Seventh Power plans.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
p) Include the cost of financing measures using the capital costs of the entity that is expected to pay for the measure	Costs of financing measures were included utilizing the same assumptions from the Seventh Power Plan.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
q) Discount future costs and benefits at a discount rate equal to the discount rate used by the utility in evaluating non-conservation resources	Discount rates were applied to each measure based upon the Council's methodology. A real discount rate of 3.75% was used, based on the Council's most recent analyses in support of the Seventh Plan	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
r) 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 was added to all measures in the model parameters per the Conservation Act.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.

Appendix IV – Avoided Cost and Risk Exposure

EES Consulting (EES) has conducted a Conservation Potential Assessment (CPA) for Benton PUD (the District) for the period 2020 through 2039 as required under RCW 19.285 and WAC 194.37. According to WAC 197.37.070, the District must evaluate the cost-effectiveness of conservation by setting avoided energy costs equal to a forecast of regional market prices. In addition, several other components of the avoided cost of energy efficiency savings must be evaluated including generation capacity value, transmission and distribution costs, risk, and the social cost of carbon.

This appendix describes each of the avoided cost assumptions and provides a range of values that was evaluated in the 2019 CPA. The 2019 CPA considers three avoided cost scenarios: Base, Low, and High. Each of these is discussed below.

Avoided Energy Value

For the purposes of the 2019 CPA, EES has prepared a forecast of market prices for the Mid-Columbia trading hub. This section summarizes the methodology used to develop the forecast, benchmarks it against other forecasts, and compares the forecast to the market forecast used in the District's 2017 CPA.

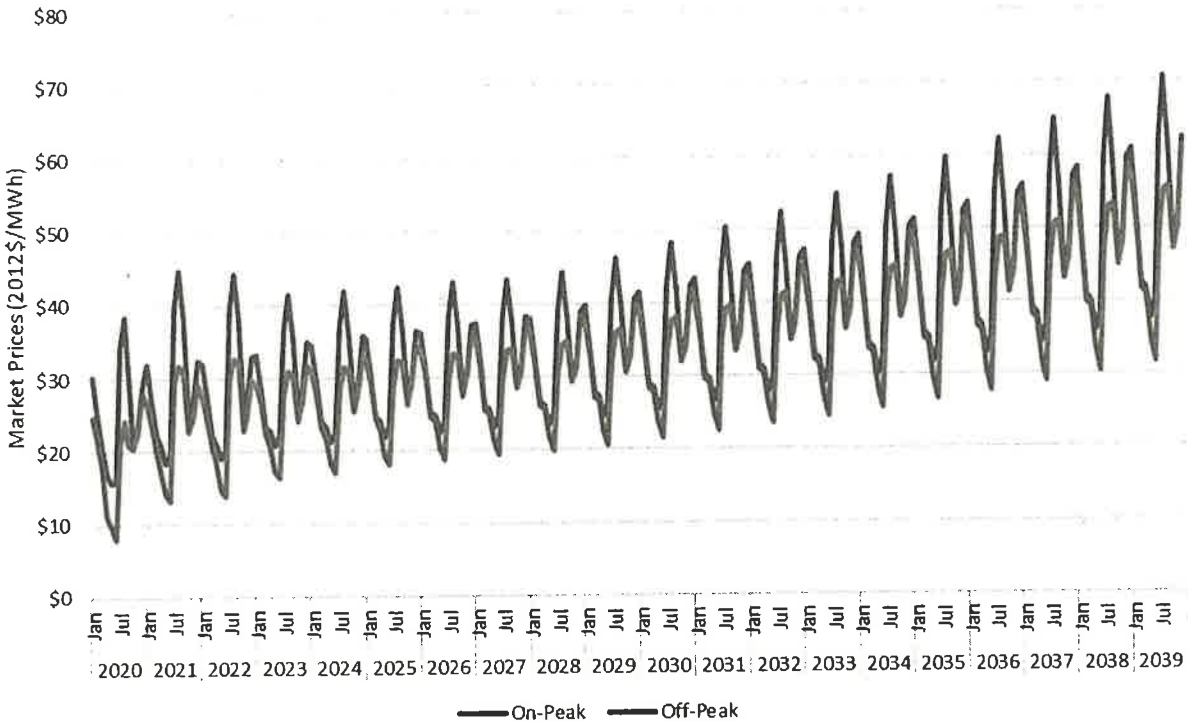
Methodology

For the period January 2020 to January 2029, projected monthly on- and off-peak market prices were provided through a subscription service. These market prices were sourced on April 15, 2019. The prices rise at an annual growth rate of 4.2 percent. This growth rate was used to extend the forecast for the remaining years of the 20-year study period.

Results

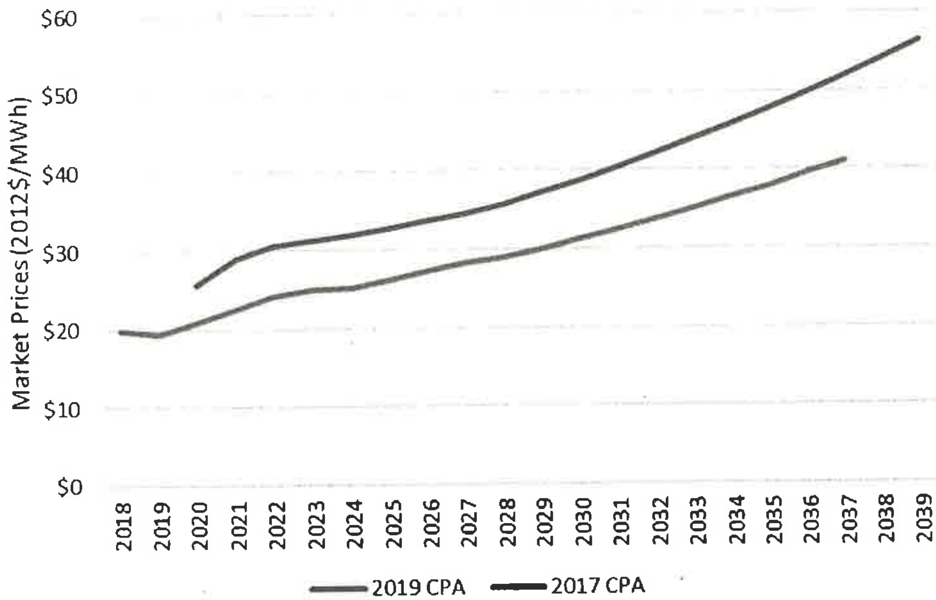
Figure IV-1 illustrates the resulting monthly, diurnal market price forecast. The levelized value of market prices over the study period is $37.81/MWh in 2012 dollars, assuming a 3.75 percent real discount rate.

Figure IV-1
Forecast Market Prices



This market price forecast is slightly higher than the market price forecast used in the District's previous CPA (the 2017 CPA). Figure IV-2 compares the average annual price of the two forecasts. The 2019 CPA's 20-year market price forecast begins approximately $5 higher, but then the difference increases to $10 in the later years.

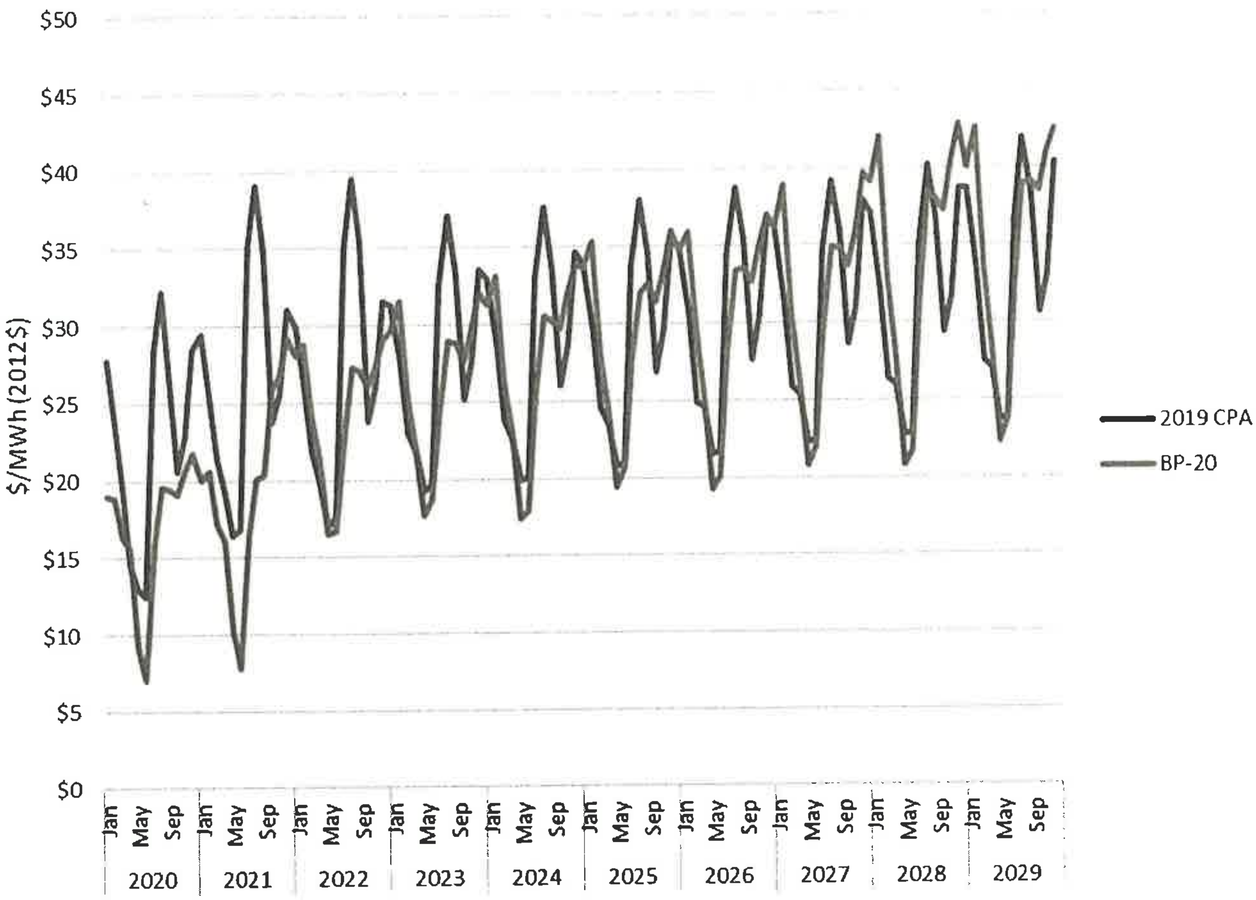
Figure IV-2
Forecast Market Prices in 2019 CPA and 2017 CPA



Benchmarking

Figure IV-4 compares the EES market forecast with the forecast included in BPA's Initial Proposal for FY20-21 rates over the years 2020-2029. The monthly shapes differ in the short term as the BPA market price forecast is lower through June 2021, likely due to lower power prices at the time it was prepared, near the end of 2018. The forecasts are similar from summer 2021 forward, noting the CPA forecast peaks higher in summer months and dips further in the fall.

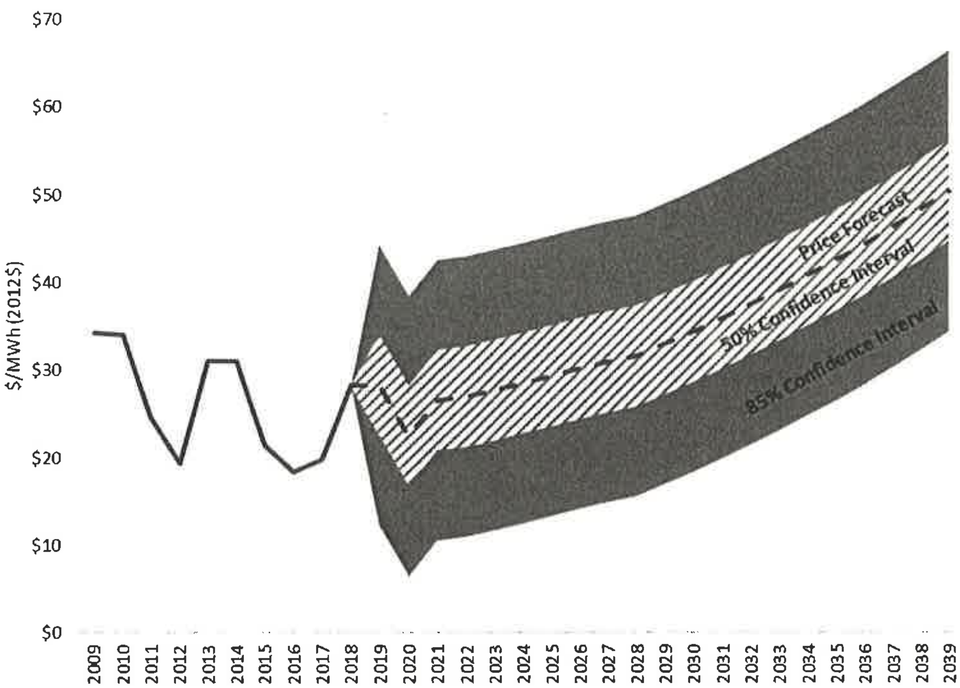
Figure IV-4
Forecast Market Prices compared to BPA's Market Price Forecast



High and Low Scenarios

To reflect a range of possible future outcomes, EES calculated high- and low-case market price forecasts. To do this, EES looked at a history of monthly mid-Columbia energy prices from the past ten years and fit a simple model controlling for monthly variation and a time trend. From this model a prediction interval was calculated moving from a 50% to 85% confidence interval over time to estimate the high and low market price forecasts. Figure IV-5 illustrates how the historic prices and price forecast were used to develop the confidence intervals used to develop the high and low forecasts.

Figure IV-5
Market Price History and Forecast with Confidence Intervals



Figures IV-6 and IV-7 compare the resulting price forecasts, for high and low load hours, respectively.

Figure IV-6
High Load Hour Market Price Forecast

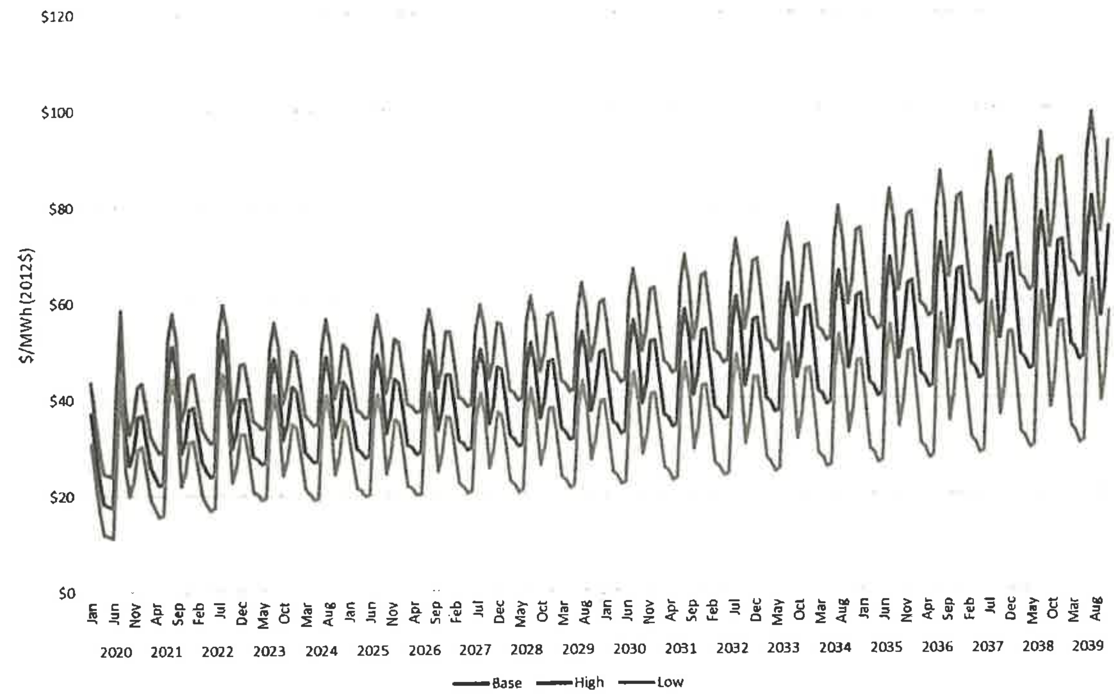
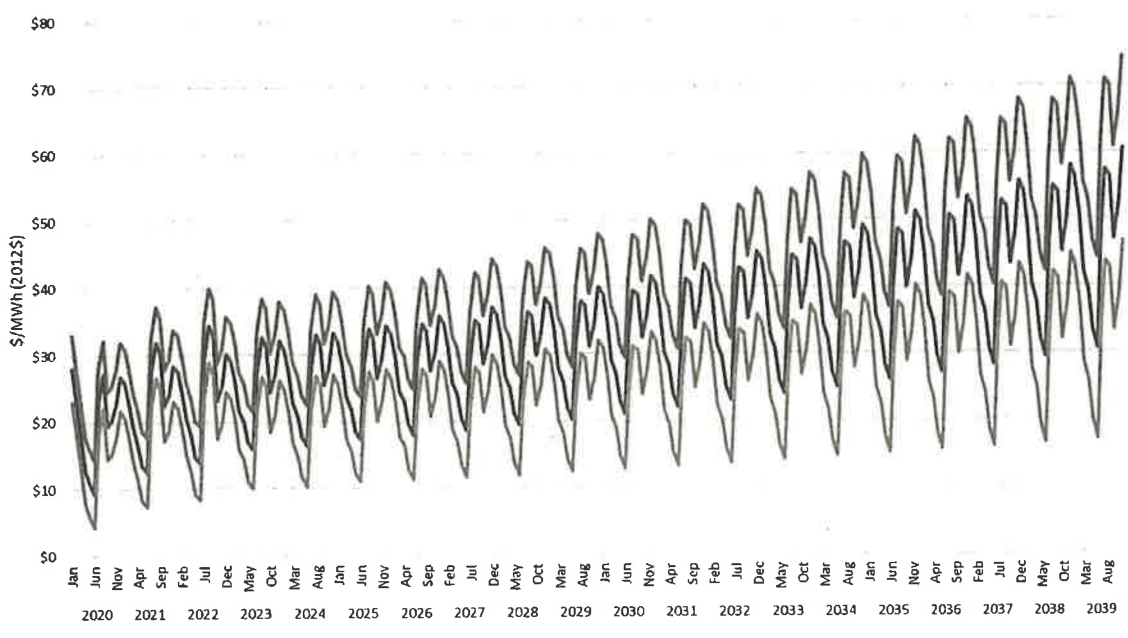


Figure IV-7: Low Load Hour Market Price Forecast



Avoided Cost Adders and Risk

From a total resource cost perspective, energy efficiency provides multiple benefits beyond the avoided cost of energy. These include deferred capital expenses on generation, transmission, and distribution capacity; as well as the reduction of required renewable energy credit (REC) purchases, avoided social costs of carbon emissions, and the reduction of utility resource portfolio risk exposure. Since energy efficiency measures provide both peak demand and energy savings, these other benefits are monetized as value per unit of either kWh or kW savings.

Energy-Based Avoided Cost Adders:

1. Social Cost of Carbon
2. Renewable Energy Credits
3. Risk Reduction Premium

Peak Demand-Based Adders:

1. Generation Capacity Deferral
2. Transmission Capacity Deferral
3. Distribution Capacity Deferral

The estimated values and associated uncertainties for these avoided cost components are provided below. EES evaluated the energy efficiency potential under a range of avoided cost adders and identified the sensitivity of the results to changes in these values.

Social Cost of Carbon

The social cost of carbon is a cost that society incurs when fossil fuels are burned to generate electricity. EIA rules require that CPAs include the social cost of carbon when evaluating cost effectiveness using the total resource cost test (TRC). Further, Washington state's clean energy bill (SB 5116), specified that utilities use the social cost of carbon developed by the federal Interagency Workgroup using the 2.5 percent discount rate.

In the 2017 CPA, the high avoided cost scenario used the 3 percent discount rate version of these values, which were also used in scenarios of the Seventh Power Plan. The 2.5 percent discount values are approximately 50% higher than these values, beginning at $62/ton in 2020 and rising to $93/ton over the 20-year study period.

These carbon costs were included in all avoided cost scenarios.

In addition to these carbon costs, the variation of the marginal generation resource over time also needs to be considered. In the spring runoff season, hydropower and wind are the likely the marginal resources, while gas turbines serve as the marginal resource at other times of the year. Accordingly, EES has assumed zero pounds of CO_2 production per kWh in April through July, and 0.84 lbs. of CO_2 per kWh in the other months.

Beginning in 2030, the clean energy bill requires that all energy be greenhouse gas neutral. As such, the CPA assumes that all energy will be carbon-free from 2030 through the end of the study period.

Value of Renewable Energy Credits

Related to the social cost of carbon is the value of renewable energy credits. Washington's Energy Independence Act established a Renewable Portfolio Standard (RPS) for utilities with 25,000 or more customers. Currently, utilities are required to source 9% of all electricity sold to retail customers from renewable energy resources. In 2020, the requirement increases to 15%. Washington's clean energy bill requires that 100% of sales be greenhouse gas neutral in 2030, although 20% can be achieved through alternate compliance options such as the purchase of Renewable Energy Credits. Due to these requirements, energy efficiency's value changes over time.

From 2020 to 2029, energy efficiency can reduce the cost of compliance associated with the 15% RPS requirement by reducing the District's overall load. Under a 15% RPS requirement, for every 100 units of energy efficiency acquired, the District's RPS spending requirement is reduced by 15 units. In effect, this adds 15 percent of the costs of RECs to the avoided costs of energy efficiency. EES has used a blend of several forecasts of REC prices and incorporated them into the avoided costs of energy efficiency accordingly.

As stated above, Washington's clean energy bill requires that, beginning in 2030, all energy sales be greenhouse gas neutral, allowing for 20% of the compliance to be achieved through purchases of RECs or other means. Accordingly, the CPA assumes that the marginal cost of power in 2030 would be the market price of power plus the full cost of a REC.

Risk Adder

In general, the risk that any utility faces is that energy efficiency will be undervalued, either in terms of the value per kWh or per kW of savings, leading to an under-investment in energy efficiency and exposure to higher market prices or preventable investments in infrastructure. The converse risk—an over-valuing of energy and subsequent over-investment in energy efficiency—is also possible, albeit less likely. For example, an over-investment would occur if an assumption is made that economies will remain basically the same as they are today, and subsequent sector shifts or economic downturns cause large industrial customers to close their operations. Energy efficiency investments in these facilities may not have been in place long enough to provide the anticipated low-cost resource.

In order to address risk, the Council develops a risk adder ($/MWh) for its cost-effectiveness analysis of energy efficiency measures. This adder represents the value of energy efficiency savings not explicitly accounted for in the avoided cost parameters. The risk adder is included to ensure an efficient level of investment in energy efficiency resources under current planning conditions. Specifically, in cases where the market price has been low compared to historic levels, the risk adder accounts for the likely possibility that market prices will increase above current forecasts.

The value of the risk adder has varied depending on the avoided cost input values. The adder is the result of stochastic modeling and represents the lower risk nature of energy efficiency resources. In the Sixth Power Plan the risk adder was significant (up to $50/MWh for some measures). In the Seventh Power Plan the risk adder was determined to be $0/MWh after the addition of the generation capacity deferral credit. While the Council uses stochastic portfolio modeling to value the risk credit, utilities conduct scenario and uncertainty analysis. The scenarios modeled in the District's CPA include an inherent value for the risk credit.

For the District's 2019 CPA, the avoided cost parameters have been estimated explicitly, and, a scenario analysis is performed. Therefore, no risk adder was used for the base case. Variation in other avoided cost inputs covers a range of reasonable outcomes and is sufficient to identify the sensitivity of the cost-effective energy efficiency potential to a range of outcomes. The scenario results present a range of cost-effective energy efficiency potential, and the identification of the District's biennial target based on the range modeled is effectively selecting the utility's preferred risk strategy and associated risk credit.

Deferred Transmission and Distribution System Investment

Energy efficiency measure savings reduce capacity requirements on both the transmission and distribution systems. The Council recently updated its estimates for these capacity savings, which were $31/kW-year and $26/kW-year for distribution and transmission systems, respectively ($2012). These values were used in the Seventh Plan. The new values, $3.08/kW-year and $6.85/kW-year for transmission and distribution systems, respectively will be used in the next Power Plan. These assumptions are used in all scenarios in the CPA.

Deferred Investment in Generation Capacity

The District's 2018 Integrated Resource Plan states that the District relies upon market purchases to meet peak demands. Thus, the District does not currently avoid any capital expenses associated with generation resources by reducing peak demands. There is no guarantee that the market will continue to be a reliable resource for peak capacity, however. The District's IRP shows current capacity needs in summer and winter months. These needs will be increase further when the District's Power Purchase Agreement with the Frederickson 1 Generating Station expires in 2022.

EES has included a value for generation capacity deferral in 2020-2022 based on the summer and winter months where a capacity need currently exists, and for all months in 2023 and after. EES used BPA's monthly demand charges as a proxy value for the monthly value of generation capacity, as those charges are based upon the cost of a generating unit. EES also applied a monthly shape to the District's peak demand reductions due to conservation, based on early modeling results. With these two factors, the value of generation capacity was calculated to be $75/kW-year for the years 2020-2022 and $96/kW-year thereafter. For the base case, it was assumed the demand charges would increase in real terms by 3% annually. Over the 20-year analysis period, the resulting cost of avoided capacity is $102/kW-year (2012$) in levelized terms.

In the low scenario, it is assumed that a market will continue to be available to meet the District's needs for peak demands, so no capacity value is included.

In the Council's Seventh Power Plan[6], a generation capacity value of $115/kW-year was explicitly calculated ($2012). This value will be used in the high scenario.

Summary of Scenario Assumptions

Table 1 summarizes the recommended scenario assumptions. The Base Case represents the most likely future.

Table 1

Avoided Cost Assumptions by Scenario, $2012

	Base	Low	High
Energy	Market Forecast	-50%-85% Confidence Interval*	+50%-85% Confidence Interval*
Social Cost of Carbon	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
Value of REC Compliance	Existing RPS	Existing RPS	Existing RPS
Distribution System Credit, $/kW-year	$6.85	$6.85	$6.85
Transmission System Credit, $/kW-year	$3.08	$3.08	$3.08
Deferred Generation Capacity Credit, $/kW-year	$102	$0	$115
Implied Risk Adder $/MWh $/kW-year	N/A	Up to -$18/MWh -$102/kW-year Average of -$10/MWh -$102/kW-year	Up to $18/MWh $13/kW-year Average of $10/MWh $13/kW-year

**As noted above prediction intervals were used based on the last 10 years of data for high and low estimates.*

[6] https://www.nwcouncil.org/energy/powerplan/7/home/

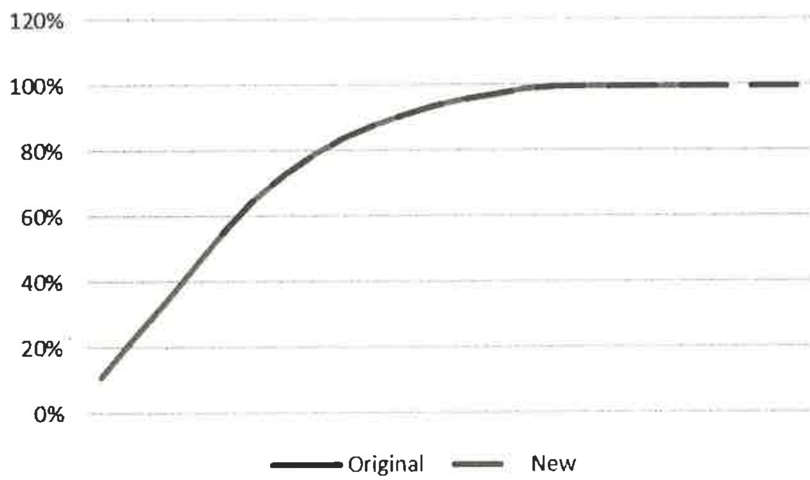
Appendix V – Ramp Rate Documentation

This section is intended to document how ramp rates were adjusted to align near term potential with recent achievements of Benton PUD programs.

Modelling work began with the Seventh Plan ramp rate assignments for each measure. For new measures added to the model, an appropriate ramp rate was selected based on the maturity of each measure. Seventh Plan ramp rates were also adjusted to fit the 2020-2039 timeline of this CPA. The adjustment made to each ramp rate varied depending on the type of ramp rate, since different types of ramp rates are applied to retrofit and lost opportunity measures.

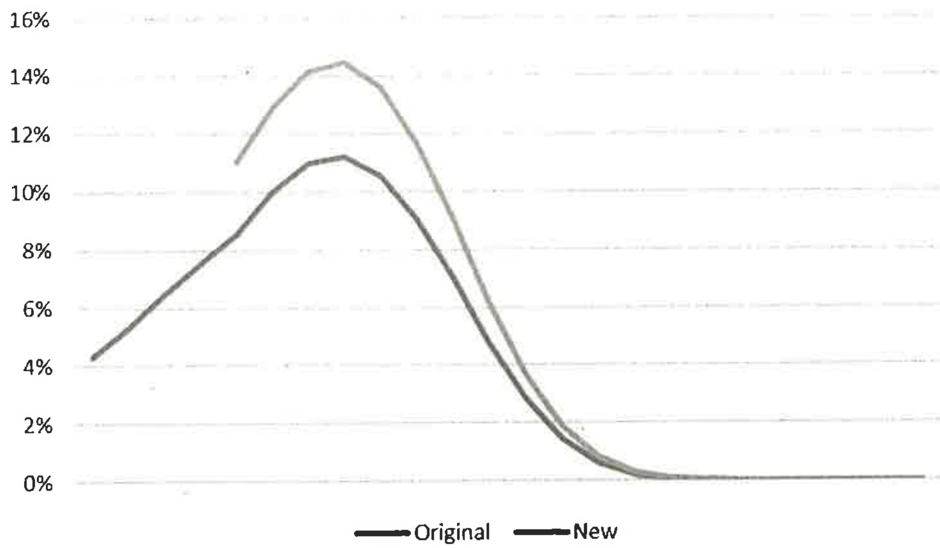
For lost opportunity measures, the ramp rates represent the share of equipment turning over in a given year that is achieved by efficiency programs. For these ramp rates, the only modification necessary was to extrapolate the final years to cover the time period relevant to the 2019 CPA. An example of this is shown in Figure V-1 below.

Figure V-1
Example Lost Opportunity Ramp Rate Modification



For retrofit ramp rates, a different adjustment was necessary. The ramp rates applied to retrofit measures describe the portion of the entire stock that is acquired in a given year. For these ramp rates, new values were calculated based on the original ramp rate values. The new value was set as the original ramp rate value for a given year, divided by the sum of original ramp rate values over the 2020-2039 timeframe. This approach reflects the fact that a portion of the stock has already been acquired and continuing with the pace projected by the Seventh Plan would mean acquiring a larger percentage of a smaller remaining stock. An example of this is shown below.

Figure V-2
Example Retrofit Ramp Rate Modification



With these modified ramp rates, Benton PUD's program achievements from 2017-2018 and estimates for 2019 were compared at a sector level with the first three years of the study period, 2020-2022. Savings from NEEA's market transformation initiatives were allocated to the appropriate sectors. This allowed for the identification of sectors where ramp rate adjustments may be necessary.

Table V-1 below shows the results of the comparison by sector after ramp rate adjustments were made.

Table V-1
Comparison of Sector-Level Program Achievement and Potential (aMW)

	Program History				Potential		
	2017	2018	2019	Average	2020	2021	2022
Residential	0.40	0.40	0.41	0.41	0.32	0.39	0.47
Commercial	0.29	0.28	0.20	0.26	0.20	0.21	0.22
Industrial	0.43	0.28	0.30	0.34	0.23	0.27	0.30
Agricultural	0.08	0.02	0.06	0.05	0.03	0.03	0.02
Distribution Efficiency	-	-	-	-	0.02	0.03	0.04
Total	**1.21**	**0.98**	**0.97**	**1.05**	**0.81**	**0.92**	**1.05**

When viewing the achievement and potential at the sector level, adjustments were found to be necessary in the residential and industrial sectors. The adjusted Seventh Plan ramp rates were found to be a good match for Benton PUD programs in the commercial, agricultural, and distribution system sectors.

Residential savings potential was compared with program history at the end use level, in Table V-2 below. In this table, NEEA savings are unable to be allocated to individual end uses. The text below discusses the comparison.

Table V-2
Comparison of Residential End Use Program Achievement and Potential (aMW)

	Program History			Potential		
	2017	**2018**	**Average**	**2020**	**2021**	**2022**
Dryer	0.00	0.00	0.00	0.01	0.01	0.01
Electronics	-	-	-	0.01	0.01	0.01
Food Preparation	-	-	-	0.00	0.00	0.00
HVAC	0.16	0.17	0.16	0.22	0.26	0.29
Lighting	0.21	0.11	0.16	-	-	-
Refrigeration	-	-	-	-	-	-
Water Heating	0.01	0.01	0.01	0.09	0.11	0.15
Whole Bldg/Meter Level	0.02	0.00	0.01	-	-	-
NEEA	0.22	0.22	0.22	-	-	-
Total	**0.40**	**0.40**	**0.40**	**0.32**	**0.39**	**0.47**

Dryers: This technology is still emerging and faces cost and consumer acceptance barriers. Slower ramp rates were assigned to the heat pump dryers in this end use.

Electronics: NEEA has an initiative in consumer electronics and other retail products, and smart power strips are an emerging measure opportunity still being piloted in the region. A small amount of savings growing slowly is appropriate here.

HVAC: While some amount of savings from NEEA count towards this category, ramp rates were decreased in this category to more closely align with program history.

Lighting: Savings in this end use were not counted in the totals, since product standards taking effect in 2020 will likely remove program opportunities.

Water Heating: Like the HVAC category, the potential in this category is higher than recent program accomplishments, but savings from NEEA count in this category as well since NEEA has worked to bring heat pump water heaters to the Northwest. The potential in this category includes heat pump water heaters as well as low-flow showerheads, aerators, and thermostatic restriction valves, which are measures that are easy to ramp up. Also included in this category are behavior-based programs.

In the industrial sector, measure ramp rates across several categories of measrues were adjusted until the acquisition of potential better aligned with program history. Savings in the industrial sector can sometimes vary with larger projects happening irregularly.

Appendix VI – Measure List

This appendix provides a high-level measure list of the energy efficiency measures evaluated in the 2019 CPA. The CPA evaluated thousands of measures; the measure list does not include each individual measure; rather it summarizes the measures at the category level, some of which are repeated across different units of stock, such as single family, multifamily, and manufactured homes. Specifically, utility conservation potential is modeled based on incremental costs and savings of individual measures. Individual measures are then combined into measure categories to more realistically reflect utility-conservation program organization and offerings. For example, single family attic insulation measures are modeled for a variety of upgrade increments: R-0 to R-38, R-0 to R-49, or R-19 to R-38. The increments make it possible to model measure savings and costs at a more precise level. Each of these individual measures are then bundled across all housing types to result in one measure group: attic insulation.

The measure list used in this CPA was developed based on information from the Regional Technical Forum (RTF) and the Northwest Power and Conservation Council (Council). The RTF and the Council continually maintain and update a list of regional conservation measures based on new data, changing market conditions, regulatory changes, and technological developments. The measure list provided in this appendix includes the most up-to date information available at the time this CPA was developed.

The following tables list the conservation measures (at the category level) that were used to model conservation potential presented in this report. Measure data was sourced from the Council's Seventh Plan workbooks and the RTF's Unit Energy Savings (UES) workbooks. Please note that some measures may not be applicable to an individual utility's service territory based on characteristics of the utility's customer sectors.

Table VI-1 Residential End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Dryer	Heat Pump Clothes Dryer	7th Plan
Electronics	Advanced Power Strips	7th Plan, RTF
	Energy Star Computers	7th Plan
	Energy Star Monitors	7th Plan
Food Preparation	Electric Oven	7th Plan
	Microwave	7th Plan
HVAC	Air Source Heat Pump	7th Plan, RTF
	Controls, Commissioning, and Sizing	7th Plan, RTF
	Ductless Heat Pump	7th Plan, RTF
	Ducted Ductless Heat Pump	7th Plan
	Duct Sealing	7th Plan, RTF
	Ground Source Heat Pump	7th Plan, RTF
	Heat Recovery Ventilation	7th Plan
	Attic Insulation	7th Plan, RTF
	Floor Insulation	7th Plan, RTF
	Wall Insulation	7th Plan, RTF
	Windows	7th Plan, RTF
	Wi-Fi Enabled Thermostats	7th Plan
Lighting	Linear Fluorescent Lighting	7th Plan, RTF
	LED General Purpose and Dimmable	7th Plan, RTF
	LED Decorative and Mini-Base	7th Plan, RTF
	LED Globe	7th Plan, RTF
	LED Reflectors and Outdoor	7th Plan, RTF
	LED Three-Way	7th Plan, RTF
Refrigeration	Freezer	7th Plan
	Refrigerator	7th Plan
Water Heating	Aerator	7th Plan
	Behavior Savings	7th Plan
	Clothes Washer	7th Plan
	Dishwasher	7th Plan
	Heat Pump Water Heater	7th Plan, RTF
	Showerheads	7th Plan, RTF
	Solar Water Heater	7th Plan
	Thermostatic Valve	RTF
	Wastewater Heat Recovery	7th Plan
Whole Building	EV Charging Equipment	7th Plan

Table VI-2 Commercial End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Compressed Air	Controls, Equipment, & Demand Reduction	7th Plan
Electronics	Energy Star Computers	7th Plan
	Energy Star Monitors	7th Plan
	Smart Plug Power Strips	7th Plan, RTF
	Data Center Measures	7th Plan
Food Preparation	Combination Ovens	7th Plan, RTF
	Convection Ovens	7th Plan, RTF
	Fryers	7th Plan, RTF
	Hot Food Holding Cabinet	7th Plan, RTF
	Steamer	7th Plan, RTF
	Pre-Rinse Spray Valve	7th Plan, RTF
HVAC	Advanced Rooftop Controller	7th Plan
	Commercial Energy Management	7th Plan
	Demand Control Ventilation	7th Plan
	Ductless Heat Pumps	7th Plan
	Economizers	7th Plan
	Secondary Glazing Systems	7th Plan
	Variable Refrigerant Flow	7th Plan
	Web-Enabled Programmable Thermostat	7th Plan
Lighting	Bi-Level Stairwell Lighting	7th Plan
	Exterior Building Lighting	7th Plan
	Exit Signs	7th Plan
	Lighting Controls	7th Plan
	Linear Fluorescent Lamps	7th Plan
	LED Lighting	7th Plan
	Street Lighting	7th Plan
Motors/Drives	ECM for Variable Air Volume	7th Plan
	Motor Rewinds	7th Plan
Process Loads	Municipal Water Supply	7th Plan
Refrigeration	Grocery Refrigeration Bundle	7th Plan, RTF
	Water Cooler Controls	7th Plan
Water Heating	Commercial Clothes Washer	7th Plan, RTF
	Showerheads	7th Plan
	Tank Water Heaters	7th Plan

Table VI-3 Industrial End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Compressed Air	Air Compressor Equipment	7th Plan
	Demand Reduction	7th Plan
Energy Management	Air Compressor Optimization	7th Plan
	Energy Project Management	7th Plan
	Fan Energy Management	7th Plan
	Fan System Optimization	7th Plan
	Cold Storage Tune-up	7th Plan
	Chiller Optimization	7th Plan
	Integrated Plant Energy Management	7th Plan
	Plant Energy Management	7th Plan
	Pump Energy Management	7th Plan
	Pump System Optimization	7th Plan
Fans	Efficient Centrifugal Fan	7th Plan
	Fan Equipment Upgrade	7th Plan
Hi-Tech	Clean Room Filter Strategy	7th Plan
	Clean Room HVAC	7th Plan
	Chip Fab: Eliminate Exhaust	7th Plan
	Chip Fab: Exhaust Injector	7th Plan
	Chip Fab: Reduce Gas Pressure	7th Plan
	Chip Fab: Solid State Chiller	7th Plan
Lighting	Efficient Lighting	7th Plan
	High-Bay Lighting	7th Plan
	Lighting Controls	7th Plan
Low & Medium Temp Refrigeration	Food: Cooling and Storage	7th Plan
	Cold Storage Retrofit	7th Plan
	Grocery Distribution Retrofit	7th Plan
Material Handling	Material Handling Equipment	7th Plan
	Material Handling VFD	7th Plan
Metals	New Arc Furnace	7th Plan
Misc.	Synchronous Belts	7th Plan
	Food Storage: CO2 Scrubber	7th Plan
	Food Storage: Membrane	7th Plan
Motors	Motor Rewinds	7th Plan
Paper	Efficient Pulp Screen	7th Plan
	Material Handling	7th Plan
	Premium Control	7th Plan
	Premium Fan	7th Plan
Process Loads	Municipal Sewage Treatment	7th Plan
Pulp	Efficient Agitator	7th Plan
	Effluent Treatment System	7th Plan
	Premium Process	7th Plan
	Refiner Plate Improvement	7th Plan
	Refiner Replacement	7th Plan
Pumps	Equipment Upgrade	7th Plan
Transformers	New/Retrofit Transformer	7th Plan
Wood	Hydraulic Press	7th Plan
	Pneumatic Conveyor	7th Plan

Table VI-3 Agriculture End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Dairy Efficiency	Efficient Lighting	7th Plan
	Milk Pre-Cooler	7th Plan
	Vacuum Pump	7th Plan
Irrigation	Low Energy Sprinkler Application	7th Plan
	Irrigation Hardware	7th Plan, RTF
	Scientific Irrigation Scheduling	7th Plan, BPA
Lighting	Agricultural Lighting	7th Plan
Motors/Drives	Motor Rewinds	7th Plan

Table VI-4 Distribution Efficiency End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Distribution Efficiency	LDC Voltage Control	7th Plan
	Light System Improvements	7th Plan
	Major System Improvements	7th Plan
	EOL Voltage Control Method	7th Plan
	SCL Implement EOL w/ Improvements	7th Plan

Appendix VII – Annual Energy Efficiency Potential by End-Use

Residential aMW

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Dryer	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10
Electronics	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food Preparation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HVAC	0.22	0.26	0.29	0.31	0.31	0.33	0.31	0.30	0.26	0.22	0.18	0.14	0.14	0.14	0.14	0.12	0.12	0.11	0.00	0.00
Lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating	0.09	0.10	0.14	0.17	0.21	0.24	0.29	0.31	0.34	0.37	0.39	0.39	0.39	0.40	0.40	0.40	0.37	0.37	0.37	0.34
Whole Bldg/Meter l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0.32	0.38	0.46	0.51	0.56	0.62	0.66	0.69	0.69	0.67	0.65	0.62	0.63	0.64	0.64	0.62	0.59	0.58	0.47	0.45

Commercial aMW

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Electronics	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Food Preparation	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
HVAC	0.10	0.10	0.11	0.12	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06
Lighting	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Motors/Drives	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Process Loads	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Total	0.20	0.21	0.22	0.24	0.25	0.25	0.25	0.20	0.17	0.15	0.14	0.13	0.13	0.13	0.10	0.09	0.08	0.08	0.07	0.07

Industrial aMW

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Energy Managemen	0.11	0.13	0.15	0.16	0.17	0.19	0.18	0.18	0.16	0.14	0.11	0.08	0.06	0.04	0.03	0.01	0.01	0.01	0.00	0.00
Fans	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	-	-
Hi-Tech	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-
Lighting	0.07	0.07	0.07	0.07	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Low & Med Temp Re	0.03	0.03	0.03	0.04	0.03	0.04	0.03	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Loads	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	-	-
Pulp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Transformers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0.23	0.27	0.30	0.32	0.33	0.35	0.34	0.33	0.29	0.25	0.20	0.15	0.10	0.07	0.06	0.02	0.02	0.02	0.00	0.00

Agricultural	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Dairy Efficiency	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Irrigation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lighting	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Motors/Drives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.03**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Distribution Efficienc	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
1 - LDC voltage control n	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
2 - Light system improve	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
3 - Major system improv	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
4 - EOL voltage control n	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A - SCL implement EOL w	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.09**	**0.10**	**0.10**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**

Appendix VIII – Board Resolution Adopting Conservation Rebate Policy

RESOLUTION NO. 2312

MARCH 24, 2015

**A RESOLUTION OF THE COMMISSION OF
PUBLIC UTILITY DISTRICT NO. 1 OF BENTON COUNTY
ADOPTING THE DISTRICT CONSERVATION REBATE POLICY**

WHEREAS, Resolution No. 2048 was passed on September 8, 2009 authorizing establishment of an Energy Conservation Plan; AND

WHEREAS, The General Manager is authorized to enter into Bonneville Power Administration's Conservation Programs and other District determined programs financially beneficial to our service area as a means to achieve energy savings; AND

WHEREAS, Washington State Energy Independence Act (EIA), RCW 19.285 (Initiative 937) mandates that each qualifying utility pursue all available conservation that is cost-effective, reliable and feasible; AND

WHEREAS, District Commissioners set a biennial target every two years to meet the requirements of the EIA; AND

WHEREAS, District staff establish biennial conservation budgets to assure the targets are met; AND

WHEREAS, Conservation program offerings are managed to meet the biennial budget and funding may not be adequate to provide rebates for all customer requests; AND

WHEREAS, The District wishes to outline the policy by which it will provide conservation rebates in an equitable manner.

NOW, THEREFORE BE IT HEREBY RESOLVED By the Commission of the Public Utility District No. 1 of Benton County that the attached Conservation Rebate Policy be adopted.

ADOPTED By the Commission of Public Utility District No. 1 of Benton County at an open meeting, with notice of such meeting being given as required by law, this 24th day of March, 2015.

Barry Bush, Vice-President

ATTEST:

Jeff Hall, Secretary

Benton PUD Conservation Rebate Policy

The District offers conservation rebates to all customers in a variety of diverse offerings with the primary purpose of saving energy that will count towards the Energy Independence Act requirements and providing customers opportunities to save energy on their electric bill.

The following outlines the District's Conservation Rebate Policy:

1. Every odd year the Benton PUD Commission approves an Energy Independence Act (EIA) Conservation Biennial Target in an open public meeting to establish a two year conservation target. The target is determined by the District's Conservation Potential Assessment (CPA) or other accepted target setting requirements of the EIA.
2. Following CPA approval by Commission, staff will prepare and present a two year Conservation Budget Plan that allocates the estimated necessary budget amounts to each customer class to achieve the EIA Conservation Biennial Target.
3. The District may budget a larger portion of the Commission approved target for the first year of each biennium to mitigate risk of postponed or cancelled projects and to ensure the biennial target is reached.
4. The District will consider using BPA funds first, when available, followed by District self-funding.
5. Conservation program rebate offerings and the unit energy savings (UES) per measure are calculated by the entity responsible (Northwest Power and Conservation Council, Bonneville Power Administration (BPA), District, etc.) for establishing the energy savings values, but can change throughout the biennial period.
6. The District may allow for Conservation Smoothing which allows banking of achieved savings that exceed the biennial target by up to 50% and spreads the excess over the next two bienniums beginning January 1, 2014.
7. Applications for conservation rebates will be reviewed on a first come first served basis and once approved by District staff, will be disbursed upon installation or project completion. When all funding is allocated, customers will be advised funds are no longer available and they may request rebates for the following year subject to item numbers 8 and 9 below.
8. Any potential rebate to a customer in excess of $100,000 must be presented to Commission for approval.
9. The Commission must approve any single customer request for a rebate that is greater than 50% of that customer class biennial budget or 50% of self-funding customer class biennial budget in the case of marijuana industry related rebate requests.

10. The Commission recognizes that large energy savings projects will be reviewed and discussed with District customers many months in advance to prepare for budgeting and project coordination and that some projects may take several years from beginning to end.
11. A baseline of energy consumption must be available for all customers requesting a rebate for new construction projects. If no baseline is available, supporting information will be required to satisfy documentation requirements for meeting EIA.
12. Any customer requesting conservation incentives related to the marijuana industry must be licensed with the State of Washington for legal marijuana activities. BPA conservation funds are not allowed for marijuana industry related rebates.
13. Distribution System Efficiency Savings programs may be funded via conservation funds from BPA, District Self-Funding, or through normal Engineering/Operations capital funding which is included in the District annual budget and approved by Commission as work orders.

Appendix IX – Billing Data Analysis

This memo documents the findings of EES' analysis of Benton PUD (the District) residential billing data. The District provided 2018 usage data, including energy and demand, for its complete set of residential customer accounts, with the goal of identifying the share of homes in the District's service territory that use electric heat.

Data Cleaning

The first step was to clean the data, filtering out residential accounts assigned to Schedule 12, which is for shops and pools, as well as accounts that did not have a complete year of 2018 billing data. This resulted in nearly 36,700 accounts that could be used for the analysis.

Initial Analysis

EES then looked broadly at the data, looking for factors that would differentiate homes with electric heat from homes that use other fuels. This included looking at the distribution of winter energy consumption, demand over the winter months, as well as the ratio of energy consumption and demand in the winter months relative to spring shoulder season months. The results are shown below.

Figure 1 – Distribution of Winter Month Energy

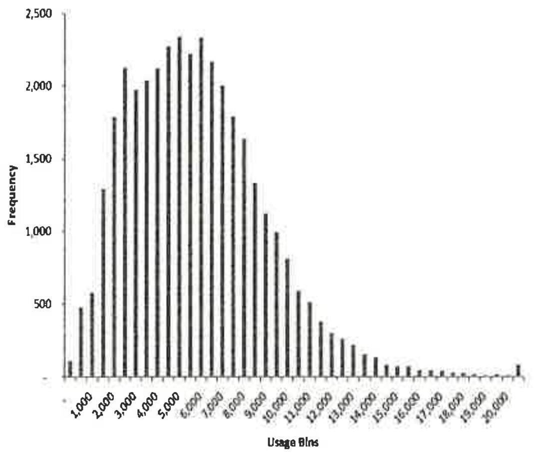


Figure 2 – Ratio of Winter to Spring Energy

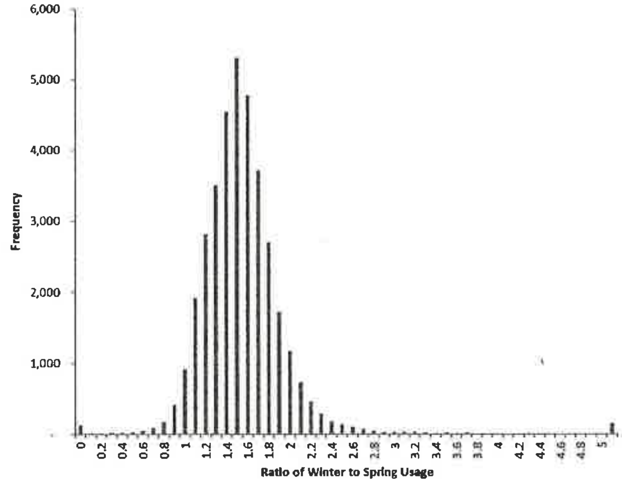


Figure 3 – Distribution of Winter Month Demand Demand

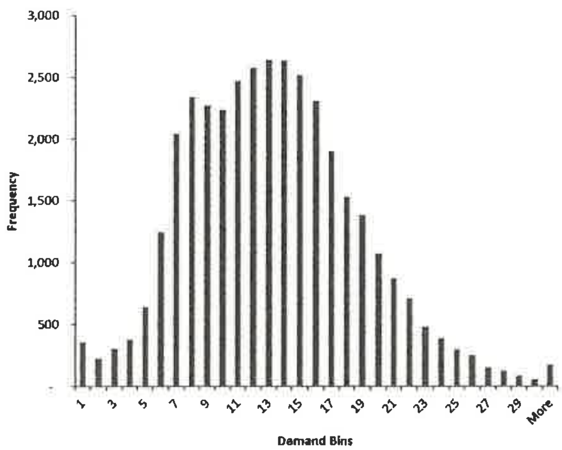
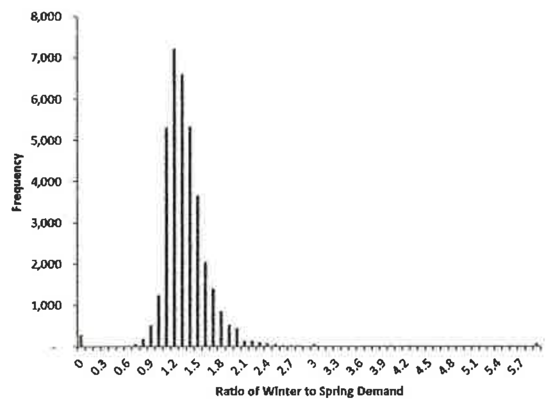


Figure 4 – Ratio of Winter to Spring



The lack of a clear differentiation between electric and non-electric heating fuel homes in the figures above indicates that there is likely a wide array in the amount of electric heating used in homes across the District's service territory. As such, EES developed two alternate approaches to identify the number of homes using electric heat.

Approach 1 – RBSA Data

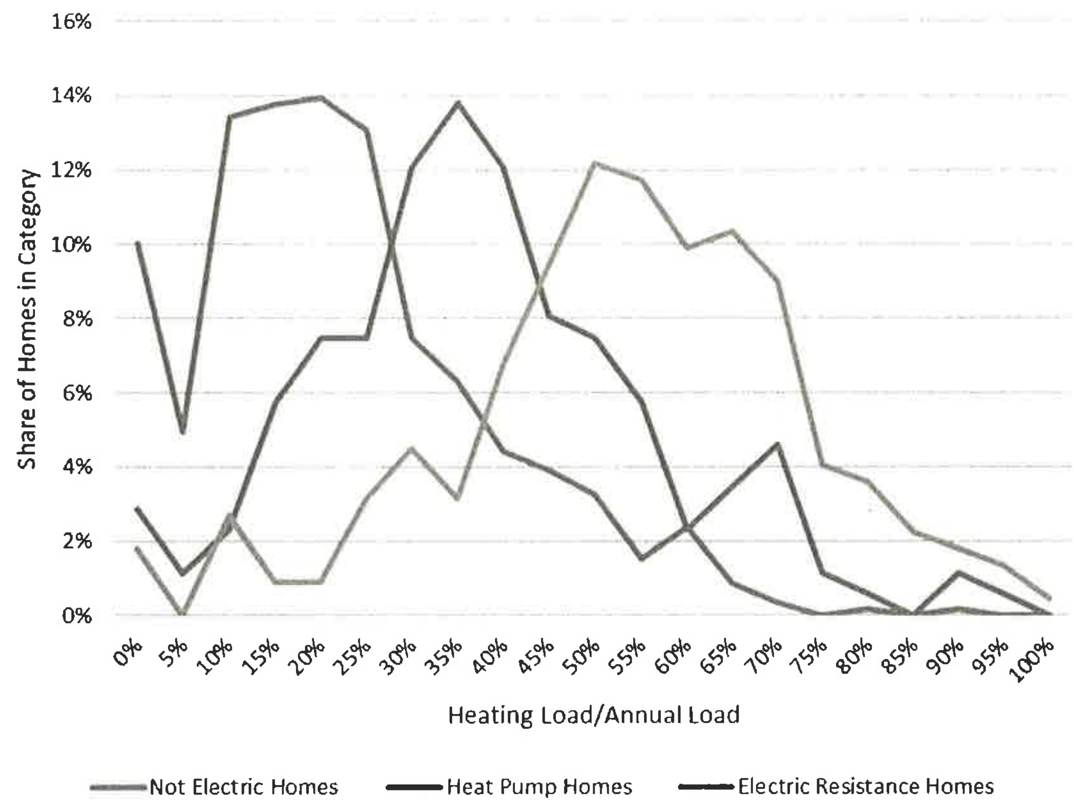
Data from the first Residential Building Stock Analysis (RBSA) contains weather-normalized annual energy consumption and estimates of the electric heating load for each home that was surveyed. This data could be combined with information on each home's primary heating system to identify typical usage patterns for different heating system types.

The RBSA data described above was queried for all single family homes in heating zone 1. Each home was then assigned to one of the following three groups:

1. **Not Electric**: Heating systems fueled by natural gas, propane, or wood
2. **Electric Resistance**: Heating systems fueled by electricity, using electric resistance technology, e.g. electric furnaces, baseboard heaters, etc.
3. **Electric Heat Pump**: Heating systems fueled by electricity, using heat pump technology, e.g. air-source heat pumps, ductless heat pumps, ground source heat pumps

The ratio of electric heating energy to annual usage was calculated for each of these three groups. Figure 5 shows the range of values for each system type.

Figure 5 – Share of Heating Load by Primary Heating Type in RBSA Homes

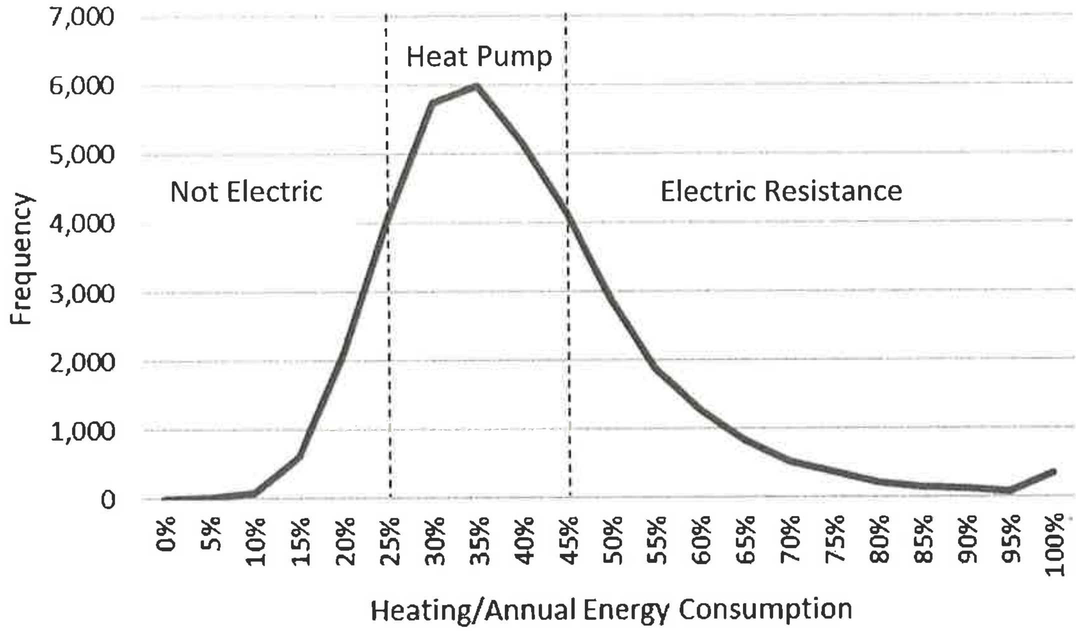


Based on these distributions, approximate ranges could be identified and applied to the District's billing data to identify whether the heating fuel was electric, as well as provide an estimate of the split between electric resistance and heat pump equipment. The ranges were identified as follows:

- Not Electric: Less than 25% heating/annual load
- Electric-Heat Pump: Between 25% and 45% heating/annual load
- Electric-Resistance: Greater than 45% heating/annual load

To apply these cutoff points to the District's billing data, it was necessary to estimate each home's electric heating consumption. This was done by assuming each home's second lowest bill was the home's base load. Any consumption above 12 times this amount was identified as heating consumption. Based on these calculations, Figure 6 below shows the distribution of heating load among District homes was used to estimate heating system types.

Figure 6 – Distribution of Heating Load and Estimated System Types



Based on this methodology, the heating systems of the District's homes breakdown as follows:

Not Electric			19%
Electric	81%	Heat Pump	57%
		Resistance	24%

Approach 2 – Regression Analysis

The District's billing data was analyzed by regression analysis to determine the share of accounts with electric heat. EES cleaned the District's data removing shop and pool accounts, accounts with zero annual consumption and extreme outliers totaling .02% of billing data. The following equation was estimated:

$$\frac{month\ kWh_{am}}{annual\ kWh_a} = heating\ degree\ days_m + cooling\ degree\ days_m + winter + summer + spring + fall + \varepsilon_{am}$$

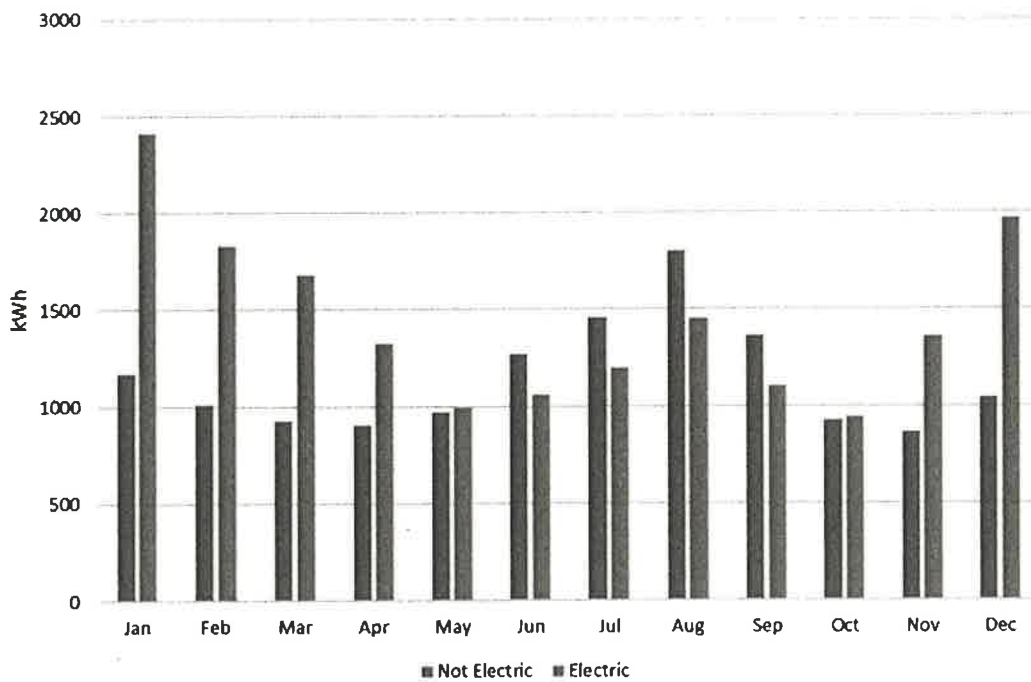
where the dependent variable represents the monthly share of annual consumption per account. Heating and cooling degree days are the sum degree days per month using a base temperature of 65°F. Winter, summer, spring and fall are dummy variables equal to 0 or 1 depending on season and are included to control for seasonal variation independent of temperature. Subscripts index account (a) and month (m) level variables.

From this estimated equation a linear prediction was computed for each billing account. Homes without electric heat were assumed to consume less than predicted monthly kWh in each of the coldest four months of the year, which in 2018 were January, February, November and December. Based on this methodology, the District's heating systems breakdown as:

Less than predicted consumption (not electric)	20.5%
Predicted consumption or greater (electric)	79.5%

Figure 7 below compares the average not electric account to the average electric account as identified by this strategy. Electric accounts peak in winter months while not electric show a flatter consumption through winter, spring and fall.

Figure 7 – Average Monthly Consumption by Estimated Type



Discussion of Results

The results above indicate that approximately 80% of homes in Benton PUD service territory have electric heat. This result, however, cannot be applied directly to single family homes, as the billing data analysis included all Schedule 11 residential accounts, regardless of the type of home.

To account for this, EES used data from the American Community Survey to estimate the breakdown of home types in Benton County, and data from the 2016 RBSA to estimate the share of electric heat in multifamily and manufactured homes, where natural gas heating is uncommon. With this data, EES was able to estimate the number of multifamily and manufactured homes within the billing data provided by the District, and then subtract those homes from the total number of accounts to find the total number of single family homes with electric heat. This math is illustrated in the table below.

			Electric Heat	
		Homes	%	Count
(a)	All Schedule 11 Accounts	44,002	80%	35,202
(b)	Multifamily Homes	9,680	84%	8,132
(c)	Manufactured Homes	4,840	75%	3,630
(a)-(b)-(c)	Single Family Homes	29,481		23,440

Because the overall number of multifamily and manufactured homes is small and the share of those homes with gas heat is close to the saturation of electric heat found for all residential accounts, the resulting share of single family homes with electric heat—23,440 out of 29,481—is unchanged, at 80%.

These results compare well with the data obtained from the 2016 RBSA, especially with the homes in Benton County, where a small sample size was a concern. Both the RBSA II data and the billing analysis described above indicate that approximately 80% of homes have electric heat, and 60% of the homes use heat pumps.

	Single Family 2016 RBSA	
HVAC System Saturations	E. WA/BPA Strata	Benton County
Electric Forced Air Furnace (FAF)	6%	8%
Heat Pump (HP)	49%	63%
Ductless HP (DHP)	2%	0%
Electric Zonal (Baseboard)	6%	8%
Central AC	23%	17%
Room AC	11%	13%
% Electric Heat	**64%**	**79%**