Benton County Public Utility District

Conservation Potential Assessment

Final Report

October 7, 2017

Prepared by:

EES Consulting

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October 7, 2017

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

SUBJECT: 2017 Conservation Potential Assessment –Final Report

Dear Chris:

Please find attached the report summarizing the 2017 Benton Public Utility District Conservation Potential Assessment (CPA). This report covers the 20-year time period from 2018 through 2037. The measures and information used to develop Benton PUD's preliminary conservation potential incorporate the most current information available for Energy Independence Act (EIA) reporting. The potential has increased from the 2015 CPA, largely due to increased avoided costs and improvements in LED technology and its increasing acceptance and adoption in the market.

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

Best Regards,

Amber Nyquist
Senior Project Manager

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Contents

Executive Summary

This report describes the methodology and results of the 2017 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 2018 to 2037. 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 53,000 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 a new model based on the completed Seventh Power Plan, but utilizes the same methodology as previous Conservation Potential Assessments. However, the model was further updated to reflect changes and developments since the completion of the Seventh Power Plan. These model updates included the following:

- Updated avoided cost – recent forecast of power market prices, a value for avoided generation capacity costs, and a social cost of carbon
- Updated financial parameters – including a Benton PUD-specific peak hour definition
- Updated customer characteristics data
  - New residential home counts
  - Updated commercial floor area
  - Updated industrial sector consumption

- Measure updates
    - Updated approximately 20 measures based on updates from the Regional Technical Forum (RTF) subsequent to the development of the Seventh Power Plan. Examples include heat pump water heaters, duct sealing, advanced power strips, and others.
    - Updated measure saturation data from the Council
- Improved modeling methodology that allows for measure opportunities not captured early in the study period to be achieved in subsequent replacement cycles
- 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 economically achievable potential by sector in 2, 6, 10, and 20-year increments is included. The total 20-year energy efficiency potential is 26.8 aMW. The most important numbers per the EIA are the 10-year potential of 14.08 aMW, and the two-year potential of 2.25 aMW.

Table ES-1
Cost Effective Potential - Base Case (aMW)

	2-Year*	6-Year	10-Year	20-Year
Residential	1.03	3.43	6.16	12.17
Commercial	0.52	2.17	4.26	9.20
Industrial	0.46	1.35	2.18	2.73
Agricultural	0.22	0.69	1.05	1.51
Distribution Efficiency	0.03	0.19	0.43	1.19
Total	**2.25**	**7.83**	**14.08**	**26.80**

**2018 and 2019*

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

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. While not quantified at a utility-specific level, the Momentum Savings quantified by BPA will also be claimed against the Seventh Plan conservation targets.

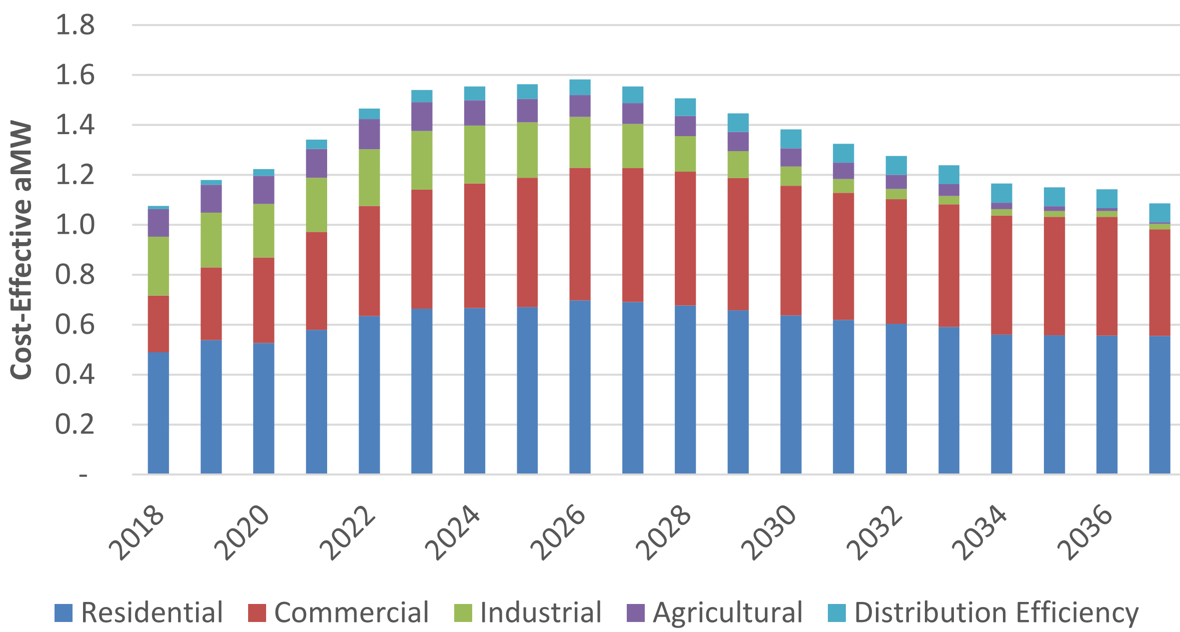
Energy efficiency also has the potential to reduce peak demands. Estimates of peak demand savings are calculated for each measure using the Council's ProCost tool, which uses hourly load profiles developed for the Seventh Power Plan and a Benton PUD-specific definition of when peak demand occurs. These 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. 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 throughout the year.

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

	2-Year	6-Year	10-Year	20-Year
Residential	1.33	4.49	7.94	15.34
Commercial	0.56	2.33	4.66	9.65
Industrial	0.61	1.83	2.99	3.71
Agricultural	0.56	1.76	2.72	3.93
Distribution Efficiency	0.03	0.18	0.43	1.17
Total	**3.09**	**10.60**	**18.74**	**33.81**

The 20-year energy efficiency potential is shown on an annual basis in Figure ES-1. This assessment shows potential starting around 1.08 aMW in 2018 and ramping up to 1.58 aMW per year in 2026. Potential is gradually ramped down through the remaining years of the planning period as the remaining retrofit measure opportunities diminish over time based on the ramp rate assumptions.

Figure ES-1
Annual Cost-Effective Energy Efficiency Potential Estimates – Base Case Scenario



As Figure ES-1 shows, the majority of the potential is in the residential sector. The conservation potential in this sector falls among the major end uses of lighting, HVAC, and water heating. The areas of notable potential include:

- LED lighting
- Weatherization measures like windows and insulation
- Water Heating – including heat pump water heaters and low-flow showerheads
- Consumer electronics such as advanced power strips

Second to the residential sector, a large share of conservation is available in Benton PUD's commercial sector. The potential in this sector is higher compared with the potential estimated in the 2015 CPA. With the 2017 CPA, acquisition rates for commercial lighting were updated to more accurately reflect the success of commercial lighting programs and the broad market acceptance of LED products. Outside of lighting, there were smaller changes to the potential in several end uses. Measures relating to food preparation and water heating increased, while the potential from HVAC measures decreased. Notable areas of commercial sector potential include:

- Lighting – including interior and exterior LED lighting, controls, and street lighting
- Commercial energy management
- HVAC measures like rooftop equipment controls and economizer retrofits
- Refrigeration – including grocery refrigeration measures

Another significant area of consideration for Benton PUD is the agriculture sector. Based on the most recent census of agriculture, it is estimated that Benton PUD has 109,000 irrigated acres in its service area.[1] While Scientific Irrigation Scheduling (SIS) has long been an important conservation area for the utility, a recent study conducted by BPA has called the energy savings of SIS into question and SIS will likely no longer be offered as a BPA measure. As such, SIS has been excluded from this CPA. There remain conservation opportunities in irrigation hardware and Low Elevation Spray Application (LESA).

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 2015 CPA.

[1] Based on updated figures from the US Department of Agriculture's 2012 Census of Agriculture.

Table ES-3 Comparison of 2015 CPA and 2017 CPA Cost-Effective Potential									
	2-Year			10-Year			20-Year		
	2015	2017	% Change	2015	2017	% Change	2015	2017	% Change
Residential	1.07	1.03	-4%	5.75	6.16	7%	10.06	12.17	21%
Commercial	0.41	0.52	27%	2.13	4.26	100%	3.37	9.20	173%
Industrial	0.26	0.46	75%	1.17	2.18	86%	1.58	2.73	73%
Agricultural	0.19	0.22	17%	1.49	1.05	-29%	2.53	1.51	-40%
Distribution Efficiency	0.03	0.03	5%	0.46	0.43	-6%	2.53	1.19	-53%
Total	**1.97**	**2.25**	**15%**	**11.00**	**14.08**	**28%**	**20.07**	**26.80**	**34%**

*Note that the 2015 columns refer to the CPA completed in 2015 for the time period of 2016 through 2035. The 2017 assessment is for the timeframe: 2018 through 2037.

The change in conservation potential estimated since the 2015 study is the result of several changes to the input assumptions, including measure data and avoided cost assumptions. These are discussed below.

Measure Data

Substantial changes were made to energy efficiency measures which significantly affected overall conservation potential:

- Commercial LED Lighting – Due to the program success and broad market acceptance of LED fixtures of all types, the projected annual acquisition rate of LED lighting has increased from the 2015 CPA. LED prices have declined and product availability has increased for a variety of applications. The current projections are in line with recent program accomplishments.
- Residential Lighting Measures – The total possible savings per home increased in 2017 by 40%, due in large part to the continued evolution of LED performance and cost. To account for the federal EISA standard, a set of measures in the model account for savings that are only available through the end of 2019.
- Industrial Potential – Updated potential based upon new load forecast and growth rate
- Agricultural Measures – As previously discussed, the removal of SIS measures from the potential resulted in a decline in agricultural potential.

Avoided Cost

In addition to measure changes, changes in the financial assumptions used to model cost-effective conservation potential impacted the amount of economic achievable potential estimated in this assessment. Revised EIA rules required the inclusion a social cost of carbon as well as a generation capacity value, which were not explicitly included as avoided cost inputs in previous CPAs. The higher avoided costs increased the cost-effectiveness of the energy efficiency measures resulting in greater estimated potential over the study period.

Modeling Methodology

New to the Seventh Power Plan was some additional modelling that allowed for lost opportunity conservation measures not acquired at the first opportunity to be acquired later in the study period. For example, the model assumes that approximately 4 percent of all heat pumps being replaced in 2018 will be replaced with an efficient model. The remaining 96 percent now become available again 15 years later, when it is assumed that the heat pump will be replaced again. At that point in the study period, nearly all of the heat pumps being replaced are assumed to be replaced with an efficient model.

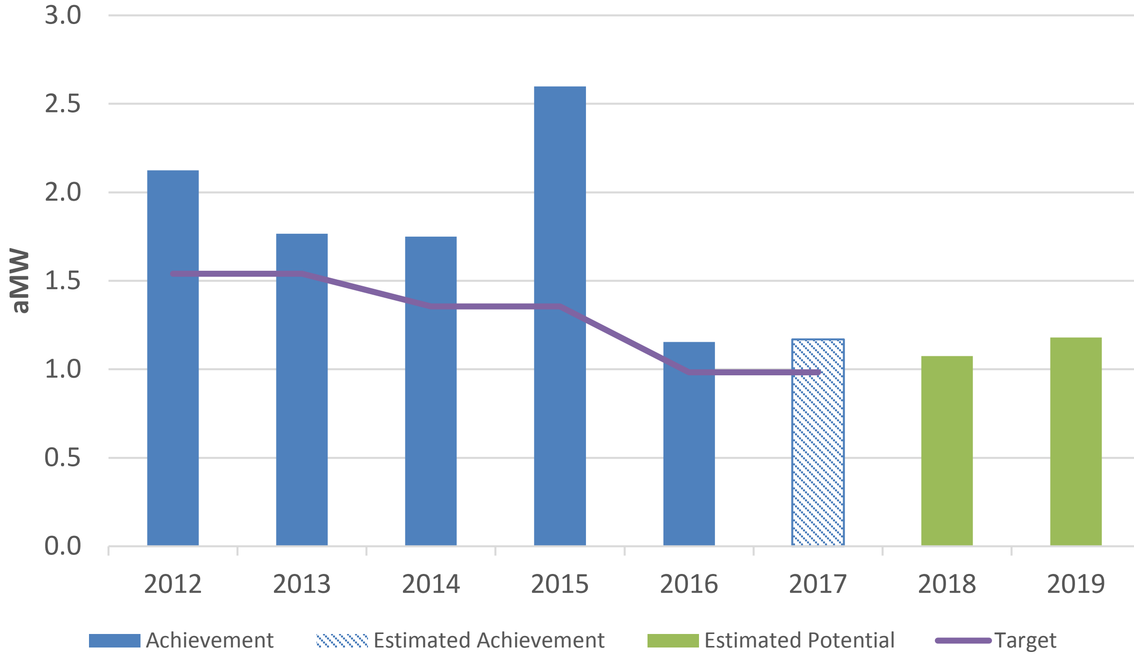
Market Prices

The EIA requires that utilities use a forecast of market prices in the Conservation Potential Assessment cost-effectiveness test for energy efficiency measures. The 2017 price forecast is 26 percent lower compared with the forecast used in Benton PUD's 2015 CPA due to changes in market conditions. This lower electricity price forecast is a result of multiple factors including an abundance of renewable wind energy and low natural gas prices. The effect of using a lower market price forecast is that fewer measures are considered cost-effective when compared with the alternative resource–market power purchases, although this was offset to some extent by the inclusion of values for the social cost of carbon and generation capacity described above. Additional information regarding the avoided cost forecast is included in Appendix IV.

Targets and Achievement

Figure ES-2 compares historic achievement with Benton PUD's targets. The figure shows that Benton PUD has consistently met its 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 2018 to 2037 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, new requirements from EIA November 2016 rulemaking changes to WAC 194-37-070 require inclusion of deferred generation benefits and social cost of carbon.

The results of this assessment are higher than the previous assessment due to both changes in commercial and residential LED lighting technology, as well as increases to the avoided cost estimates. First, continued improvements have allowed LED technology to be used in more applications, resulting in greater potential savings. Further, improvements in LED costs have led to broad market adoption and higher acquisition rates. Second, while market prices for wholesale electricity have decreased, the decrease in energy value was offset by the addition of the following two avoided cost adders that were defined explicitly in this study: the social cost of carbon and the value of deferred generation capacity investments. These changes result in a total 10-year cost effective potential of 14.08 aMW and a two-year potential of 2.25 aMW for the 2018-19 biennium, which is a 15% increase over the target for the 2016-17 biennium.

Introduction

Objectives

The objective of this report is to describe the results of the Benton Public Utility District (Benton PUD) 2017 Electric Conservation Potential Assessment (CPA). This assessment provides estimates of energy savings by sector for the period 2018 to 2037, with the primary focus on 2018 to 2027 (10 years). 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 used in the Council's Seventh Power Plan, along with any subsequent updates 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 2018. 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.[2]

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

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, 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 bulk transmission and distribution system expansion and local distribution system expansion. Though potential transmission and distribution system

[2] 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.

cost savings are dependent on local conditions, the Council considers these credits to be representative estimates of these avoided costs.

- 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 2410. 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. The Seventh Plan did, however, include the effects of a highly impactful lighting standard set to take effect in 2020. This assessment also includes that consideration. 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
- Appendices

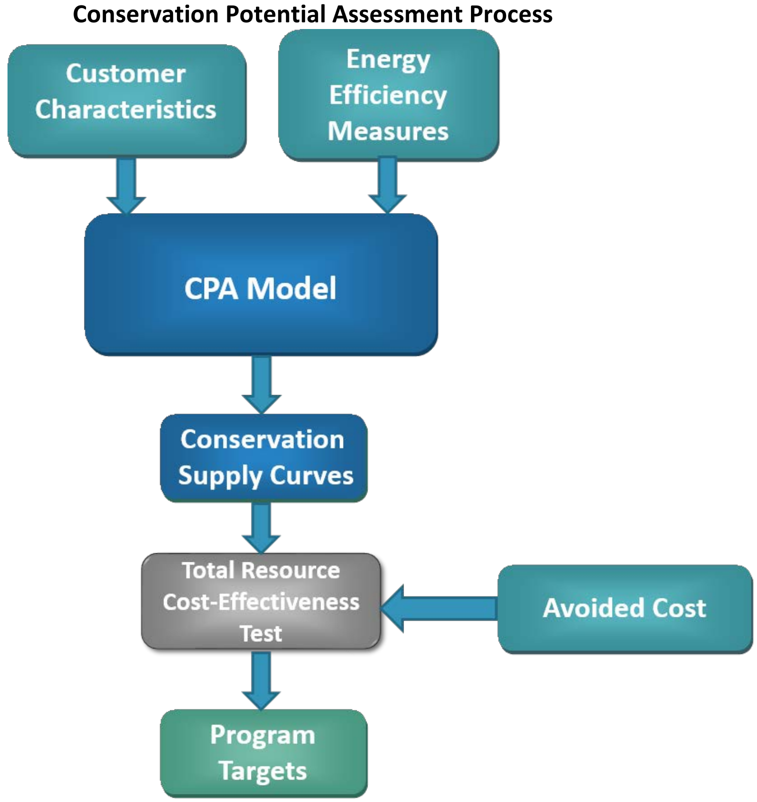
CPA Methodology

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 is 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

The quantification of energy efficiency begins with compiling customer characteristics, baseline measure saturation data, and appliance saturation. For this analysis, the characterization of Benton PUD's baseline was determined using data provided by Benton PUD customer surveys, NEEA's commercial and residential building stock assessments, and county assessor 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, and the Council has updated baselines for regional conservation achievement as part of the Seventh Power Plan. Historic conservation achievement data are often used to update measure saturation levels when current market data is unavailable. EES adjusted measure baselines using Benton PUD's customer surveys. For measures not accounted for in the customer surveys, conservation achievement was used to adjust baselines that have not been updated since the 2011 Residential Building Stock Assessment. 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 (kWh), demand savings (kW), measure costs ($), and measure life (years). Other features, such as measure savings shape, operation and maintenance costs, and non-energy benefits are also important components of the measures. 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.

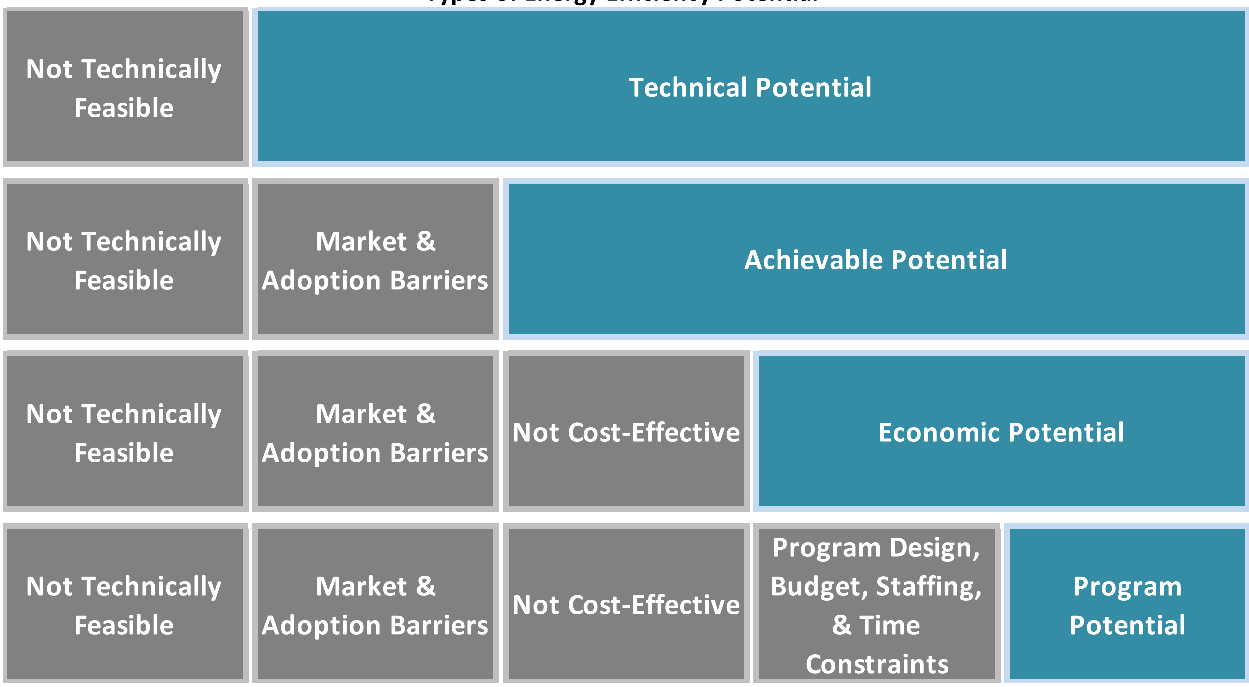
The measure data include adjustments from raw savings data for several factors. The effects of space-heating interaction, for example, are included for all lighting and appliance measures, where appropriate. For example, if an electrically-heated house is retrofitted with efficient lighting, the heat 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.

A list of measures by end-use is included in this CPA is included 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 potential. Technical potential is the theoretical maximum efficiency in the service territory if cost and achievability barriers are excluded. There are physical barriers, market conditions, and other consumer acceptance constraints that 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 technical-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[3]



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 measures. It represents the theoretical maximum amount of energy efficiency absent these constraints in a utility's service territory.

Estimating the technical potential begins with determining a value for the energy efficiency measure savings. Then, the number of "applicable units" must be estimated. "Applicable units" refers to the number of units that could technically be installed in a service territory. This includes accounting for units that may already be in place. The "applicability" value is highly dependent on the measure and the housing stock. For example, a duct sealing measure can only be completed in homes with ducts as part of the HVAC system. 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, if a home installs energy efficient lighting, the demands on the heating system will rise, due to a reduction in heat emitted by the lights (interaction). If a home installs both insulation and a high-efficiency heat pump, the total savings in the home is less than if each measure were

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

installed individually (stacking). Interaction is addressed by accounting for impacts on other energy uses. Stacking is often addressed by considering the 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 unaffected by market barriers. Economic potential is further limited due to the number of measures in the achievable potential that are not cost-effective.

Achievable – 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. Achievable potential 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 uses achievability rates equal to 85% for all measures 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 the both the achievability and ramp rate assumptions. Note that the achievability factors are applied to the technical potential before the economic screening.

Economic – Economic potential is the amount of potential that passes an economic benefit-cost test. In Washington State, the total resource cost test (TRC) is used to determine economic potential (per EIA requirements). This means that the present value of the benefits exceeds the present value of the costs over the lifetime of the measure. TRC costs include the incremental 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.

For this potential assessment, the Council's ProCost models are 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 2017 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.

Program – Program potential is the amount of potential that can be achieved through utility administered programs. The program achievable potential excludes savings estimates that are achieved through future code changes and market transformation. The program potential is not the emphasis of this assessment, but understanding the sources of achievement is an important reporting requirement.

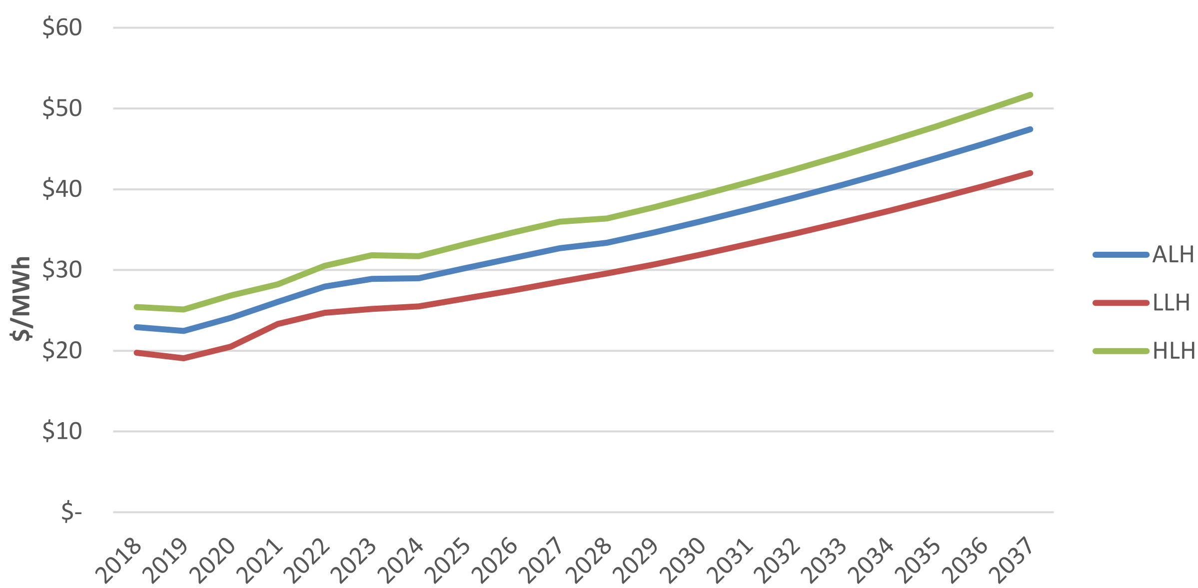
Avoided Cost

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 represented as a dollar value per MWh of conservation. 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. 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." 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 and lowering Benton PUD's Renewable Portfolio Standard (RPS) requirements. The revised EIA rules require the inclusion of the social cost of carbon. Because uncertainty exists around this value, a range of values was considered. These included a forecast of prices from Benton PUD's most recent IRP, as well as the federal interagency workgroup values that were considered in the Seventh Plan.

Renewable Energy Portfolio Cost

By reducing Benton PUD's overall load, energy efficiency provides a benefit of reducing the RPS requirement. Benton PUD purchases Renewable Energy Credits (RECs) to fulfill a requirement of sourcing 9% of its energy from renewable energy sources. Therefore, for every 100 units of conservation achieved, the RPS requirement is reduced by 9 units. A RPS with higher requirements was considered in the high-case, to account for the possibility of higher RPS requirements or higher Renewable Energy Certificate (REC) prices.

Transmission and Distribution System

The EIA also requires that deferred capacity expansion benefits for transmission and distribution systems be included in the cost-effectiveness analysis. To account for the value of deferred bulk transmission and local distribution system expansion, a distribution system credit value of $31/kW-year and a transmission system credit of $26/kw-year were applied to peak savings from conservation measures, at the time of the regional transmission and local distribution system peaks. These credits are taken from the Council's Seventh Plan supporting documents.

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, the District 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, the District's need for generation capacity will further increase when its Power Purchase Agreement with the Frederickson 1 Generating Station expires in 2022.

To be conservative, EES has included a value for generation capacity deferral beginning in 2021. EES used BPA's monthly demand charges as a proxy value for the monthly value of generation capacity, as those charges were based upon the cost of a generating unit. By assuming a monthly shape to the Benton PUD's peak demand reductions due to conservation, the generation capacity costs were converted into a value of $86.26/kW-year. For the base case, it was assumed that this cost would increase in real terms by 3% annually. In the low avoided cost scenario, it was assumed that market purchases would continue to be available to meet peak demands. The Council's value of $115 was used in the high scenario.

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, generation capacity value, REC prices, and the social cost of carbon. Through the variance of these components, implied risk credits of up to $71/MWh and $32/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

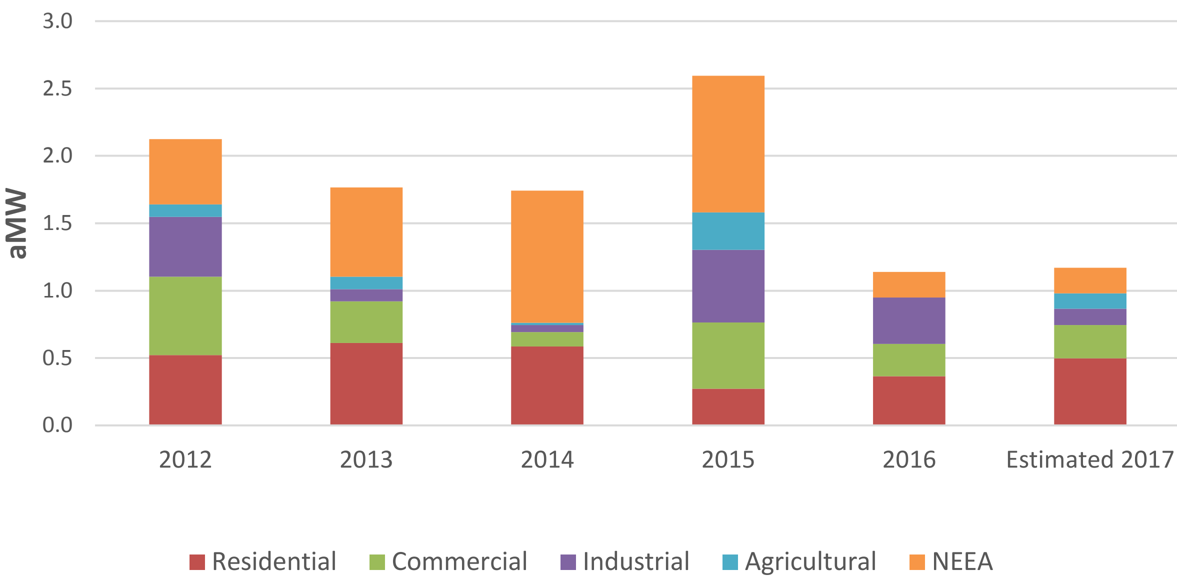
The Council develops a real discount rate and finance rate for each of its Power Plans. The most recent real discount rate assumption developed by the Council is 4%. The 4% discount rate was developed to model conservation potential for the Seventh Power Plan. The discount rate is used to convert future cost and benefit streams 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. The Council's 4% discount rate is used in this analysis.

The finance rate 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 (BPA), 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 several rebate programs for both residential and non-residential applications. 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. While they have contributed as much as 1 aMW in recent years, recent savings and near term savings projections have decreased significantly due to a change in baselines related to the adoption of the Seventh Power Plan. Figure 4 shows Benton PUD's conservation achievement from 2012 through projections for 2017. More detail for these savings are provided below for each sector.

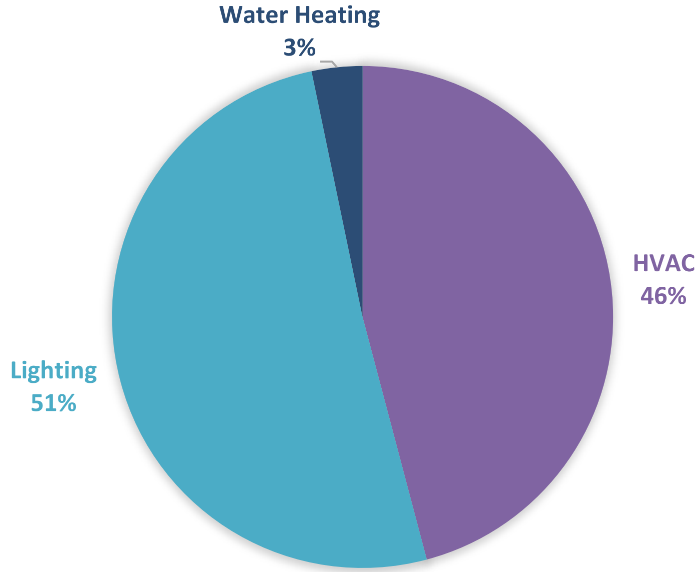
Figure 4
Benton PUD's Recent Conservation History by Sector



Residential

Figure 5 shows historic conservation achievement by end use in the residential sector. Savings from lighting measures account for just over half of the total. Due to the large share of electric heat in Benton PUD's service area, heat pumps and weatherization measures also make up a significant share of savings (HVAC).

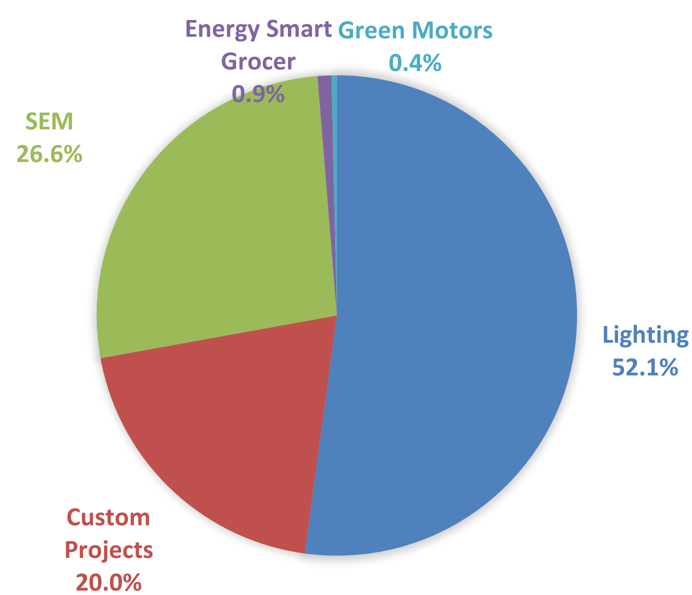
Figure 5
2015-2016 Residential Savings



Commercial & Industrial

Historic achievement in the commercial and industrial sectors is primarily due to lighting, SEM, and custom projects. Figure 6 shows the breakdown of total savings from 2016 and projections for 2017.

Figure 6
2016-2017 Commercial & 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.

Current Conservation Programs

Benton PUD offers a wide range of diverse conservation programs to its customers. These programs include many types of deemed conservation rebates, energy audits, net metering, commercial custom projects, and agricultural 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 $20 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 50-75 gallon tanks and $500 for tanks over 75 gallons.
- *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 $1,000), and duct- sealing rebates up to $250.
- *Energy Star Homes and Manufactured Homes Program* – Benton PUD provides rebates of $1,000 to Northwest Energy Efficient Manufactured (NEEM) certified 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.

Agriculture

- *Agricultural Rebate Program* – This program offers incentives for sprinklers, nozzles, 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 the District's status as our customer's Trusted Energy Partner.

Customer Characteristics Data

Benton PUD serves over 50,000 electric customers in Benton County, Washington, with a service area population of approximately 123,299. 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, heat fuel type, and water heating. 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 surveys conducted by Benton PUD as well as the 2011 Residential Building Stock Assessment (RBSA), developed by NEEA. The surveys were conducted by Robinson Research for the 2015 CPA, but are still considered relevant and useful information.

Table 1
Residential Building Characteristics

Heating Zone	Cooling Zone	Solar Zone	Residential Households	Total Population
1	3	3	41,862	123,299

Table 2
Existing Homes - Heating / Cooling System Saturations

	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
Existing Homes				
Electric Forced Air Furnace (FAF)	45%	36%	36%	56%
Heat Pump (HP)	42%	5%	5%	40%
Ductless HP (DHP)	0%	0%	0%	0%
Electric Zonal (Baseboard)	11%	57%	57%	4%
Central AC	42%	43%	43%	52%
Room AC	16%	38%	38%	6%
New Homes				
Electric Forced Air Furnace (FAF)	45%	36%	36%	56%
Heat Pump (HP)	42%	5%	5%	40%
Ductless HP (DHP)	0%	0%	0%	0%
Electric Zonal (Baseboard)	11%	57%	57%	4%
Central AC	42%	43%	43%	52%
Room AC	16%	38%	38%	6%

Table 3 Appliance Saturations				
	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
Existing Homes				
Electric WH	80%	88%	88%	100%
Refrigerator	140%	102%	102%	121%
Freezer	61%	61%	61%	61%
Clothes Washer	94%	94%	94%	94%
Clothes Dryer	91%	91%	91%	91%
Dishwasher	79%	79%	79%	79%
Electric Oven	95%	95%	95%	95%
Desktop	96%	44%	44%	71%
Laptop	68%	26%	26%	42%
Monitor	102%	45%	45%	72%
New Homes				
Electric WH	80%	88%	88%	100%
Refrigerator	140%	102%	102%	121%
Freezer	61%	61%	61%	61%
Clothes Washer	94%	94%	94%	94%
Clothes Dryer	91%	91%	91%	91%
Dishwasher	79%	79%	79%	79%
Electric Oven	95%	95%	95%	95%
Desktop	96%	44%	44%	71%
Laptop	68%	26%	26%	42%
Monitor	102%	45%	45%	72%

Commercial

Building square footage 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 (kWh/sf). Commercial building floor area data in the 2017 CPA is based upon the data developed for the 2015 CPA, with the addition of new service orders provided by Benton PUD. The 2015 data was based on 2011 county assessor data and average building size (square feet) from Benton PUD's commercial customer surveys. Benton PUD conducted commercial customer surveys both in 2010 and 2015 and requested that customers submit commercial building square footage. The building sizes for commercial building types are then averaged between the two surveys. The result is average building sizes that represent a larger sample size (800 buildings in total between the two surveys). The number of buildings was estimated based on county assessor data (2011 data) escalated using a 0.6 percent growth rate. Total commercial square footage by building type is the product of the number of buildings and average building size calculated from the surveys.

Table 4 shows estimated 2016 commercial square footage in each of the 18 building categories. Estimates of commercial floor area by building type are slightly higher than 2015 CPA estimates (22,523,065 square feet).

Benton PUD provided a load forecast by rate class that was used to develop a sector-wide growth rate of 0.73% after embedded energy efficiency impacts were added back in. The growth rates by segment from the 2015 CPA were then scaled to match this overall growth rate. A regional demolition rate, based on the Council's Seventh Plan assumptions is also used. Energy use intensity (EUI) values from the most recent Commercial Building Stock Assessment (CBSA)[4] were used for comparison purposes and are provided in Table 4.

Table 4
Commercial Building Square Footage by Segment

Segment	EUI[1]	Area (Square Feet)	Growth Rate
Large Office	15.6	327,870	0.64%
Medium Office	20.2	2,825,184	0.64%
Small Office	14.1	3,071,940	0.64%
Extra Large Retail	13.9	1,265,579	0.63%
Large Retail	13	2,131,774	0.63%
Medium Retail	14.4	423,180	0.63%
Small Retail	13.9	32220	0.63%
School (K-12)	9	111,327	0.63%
University	16.9	216,049	0.66%
Warehouse	7.3	5,989,721	0.91%
Supermarket	53.4	851,368	0.88%
Mini Mart	80.9	162,999	0.67%
Restaurant	50.7	642,258	0.71%
Lodging	14.6	1,668,139	0.44%
Hospital	27.4	153,847	0.50%
Residential Care	14.9	552,786	0.64%
Assembly	10.5	780,771	0.73%
Other Commercial	12.5	2,098,712	0.88%
Total		**23,305,723**	**0.73%**

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

To benchmark the estimated commercial square footage for this assessment, EES took the resulting floor area for each commercial segment described above and applied energy use intensity numbers from NEEA's 2014 Commercial Building Stock Assessment to develop an estimated commercial load. Doing this resulted in an estimated load of approximately 339 GWh.

This value was compared with an estimate of Benton PUD's actual commercial load, which was approximately 381 GWh. The actual commercial load is somewhat difficult to determine as load forecasting is done by rate class, which does not align with the sector definitions used in this assessment. The difference between the floor area based load forecast and rate class based forecast is 11%, which is considered to be reasonable given the uncertainties of rate classes aligning to the sector definitions and the fact that regional EUI numbers may not accurately represent Benton PUD's commercial building stock. The saturation of natural gas is lower in

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

Benton PUD’s service area, which would mean that Benton PUD’s commercial EUI values would be higher as more buildings are heated with electricity.

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 that of 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 2016 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 medium load growth scenario was calculated from the industrial load forecast after accounting for embedded energy efficiency and applied across all sectors. The 2016 industrial consumption totaled 189,697 MWh.

Table 5
Industrial Sector Load by Segment

Industrial Segment	2016 Sales (MWh)	Annual Growth Rate
Frozen Food	4,321	0.1%
Other Food	88,650	0.1%
Metal Fabrication	1,247	0.1%
Equipment	894.24	0.1%
Cold Storage	9,024	0.1%
Fruit Storage	489	0.1%
Refinery	1,275	0.1%
Chemical	67,660	0.1%
Miscellaneous Manufacturing	16,137	0.1%
Total	**189,697**	**0.1%**

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 and the City of Richland also provide electric service to agriculture customers in

Benton County. Because the USDA reports census data by county, the 2012 data for Benton County was adjusted to reflect Benton PUD's service area. Irrigated acreage and the number of farms were taken from the 2012 census, then weighted based on Benton PUD's service area size (square miles) and the total area of Benton County.

Irrigated acreage is estimated at 108,982 acres, based on 2012 census data. Irrigated acreage is used to estimate savings from energy efficient irrigation hardware upgrades.

The number of farms in Benton PUD's service territory (834) is estimated based on 2012 USDA census data for Benton County and has been adjusted to reflect Benton PUD's service area. The number of farms is used to estimate agriculture sector area lighting potential. Finally, Benton PUD provided the number of dairy farms and head of dairy cattle. This data is summarized in Table 6 below and was used to estimate dairy measure potential.

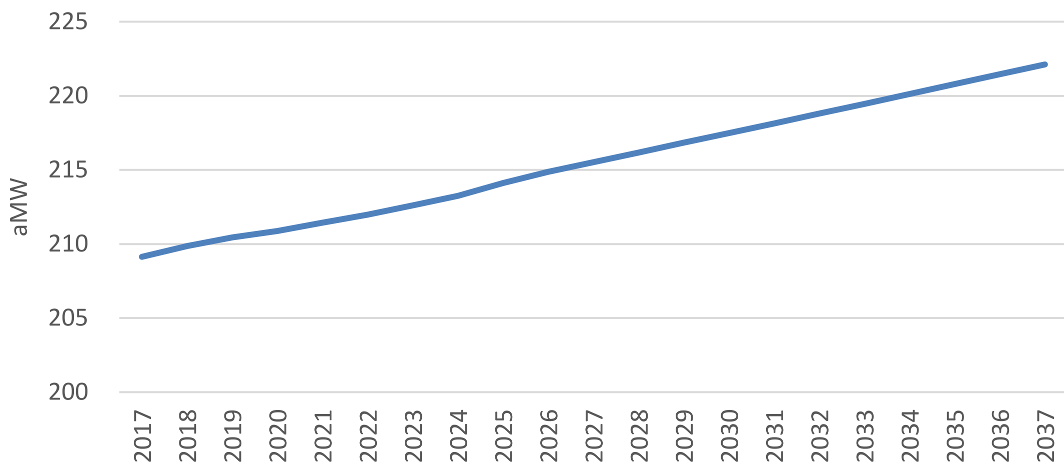
Table 6
Agricultural Inputs

Number of Dairy Farms	17
Total Irrigated Acreage	108,982
Total Number of Pumps	1,076
Total Number of Farms	834

Distribution Efficiency (DE)

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. Benton PUD provided a load forecast through 2026. The forecast is extended through 2037, assuming a 0.3 percent annual growth rate. This growth rate is based on compound average growth rate for the utility-provided forecast. Benton PUD's load forecast is graphed in Figure 7 and distribution system conservation is discussed in detail in the next section.

Figure 7
20-year End System Load Forecast



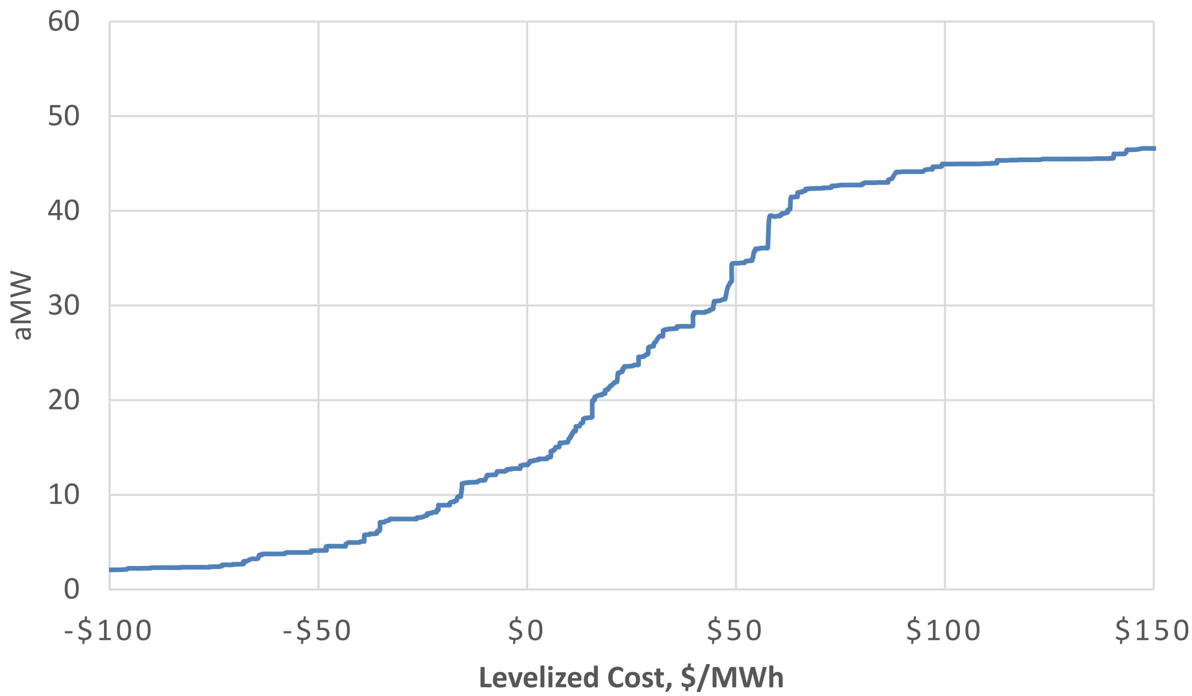
Results – Energy Savings and Costs

Technical Achievable Conservation Potential

Technical-achievable potential is the amount of energy efficiency potential that is available regardless of cost. It represents the theoretical maximum amount of achievable energy efficiency savings.

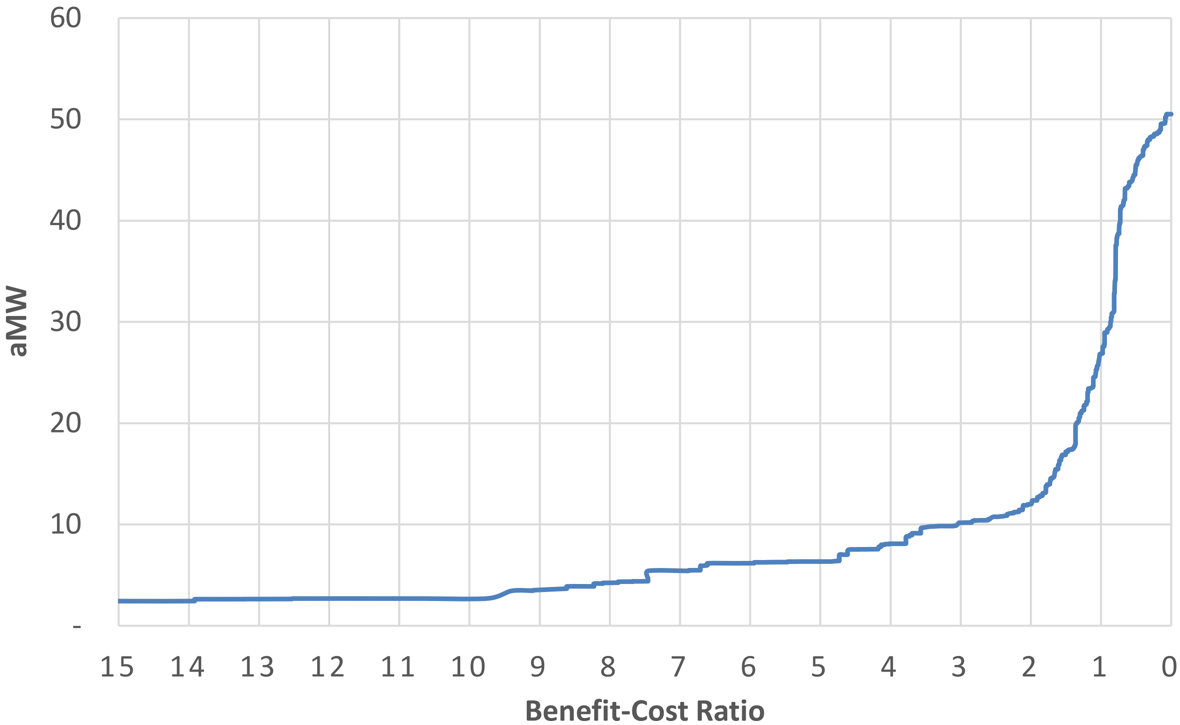
Figure 8, below, shows a supply curve of 20-year, technical-achievable potential. A supply curve is developed by plotting energy efficiency savings potential (aMW) against the levelized cost ($/MWh) of the conservation. The technical potential has not been screened for cost effectiveness. Costs are standardized (levelized), allowing for the comparison of measures with different lives. The supply curve facilitates comparison of demand-side resources to supply-side resources and is often used in conjunction with integrated resource plans (IRPs). Figure 8 shows that approximately 25 aMW of saving potential are available for less than $30/MWh and over 42 aMW are available for under $80/MWh. Total technical-achievable potential for Benton PUD is approximately 50 aMW over the 20-year study period.

Figure 8
20-Year Technical-Achievable Potential 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 9 below. This figure repeats the overall finding that 26.8 aMW of potential is cost-effective with a benefit-cost ratio greater than or equal to 1.0. The line is steep at the point where the benefit-cost ratio is equal to 1.0, suggesting that small changes in avoided cost assumptions would lead to large changes in potential.

Figure 9
20-Year Technical-Achievable Potential Benefit-Cost Ratio Supply Curve



Economic Achievable Conservation Potential

Economic 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.

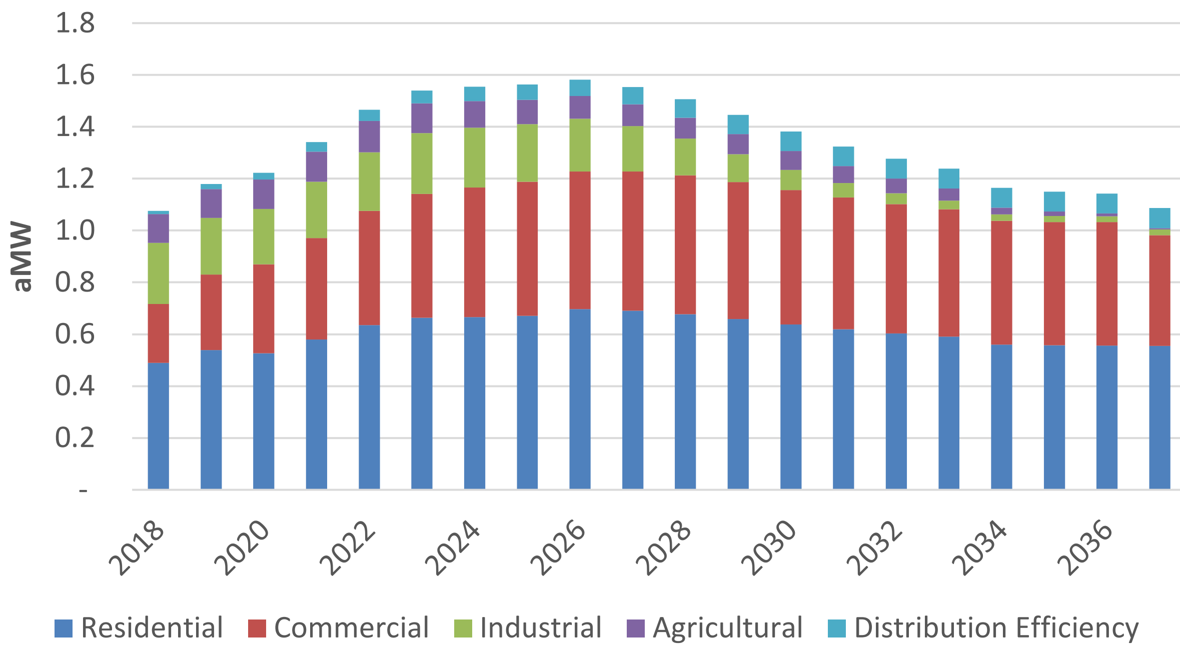
Table 7 shows aMW of economically achievable potential by sector in 2, 6, 10 and 20-year increments. Compared with the technical and achievable potential, it shows that 26.8 aMW of the total 50.5 aMW is cost effective for Benton PUD. The last section of this report discusses how these values could be used for setting targets.

Table 7 Cost Effective Achievable Potential - Base Case (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	1.03	3.43	6.16	12.17
Commercial	0.52	2.17	4.26	9.20
Industrial	0.46	1.35	2.18	2.73
Agricultural	0.22	0.69	1.05	1.51
Distribution Efficiency	0.03	0.19	0.43	1.19
Total	**2.25**	**7.83**	**14.08**	**26.80**

Sector Summary

Figure 10 shows economic achievable potential by sector on an annual basis.

Figure 10
Annual Achievable Potential by Sector

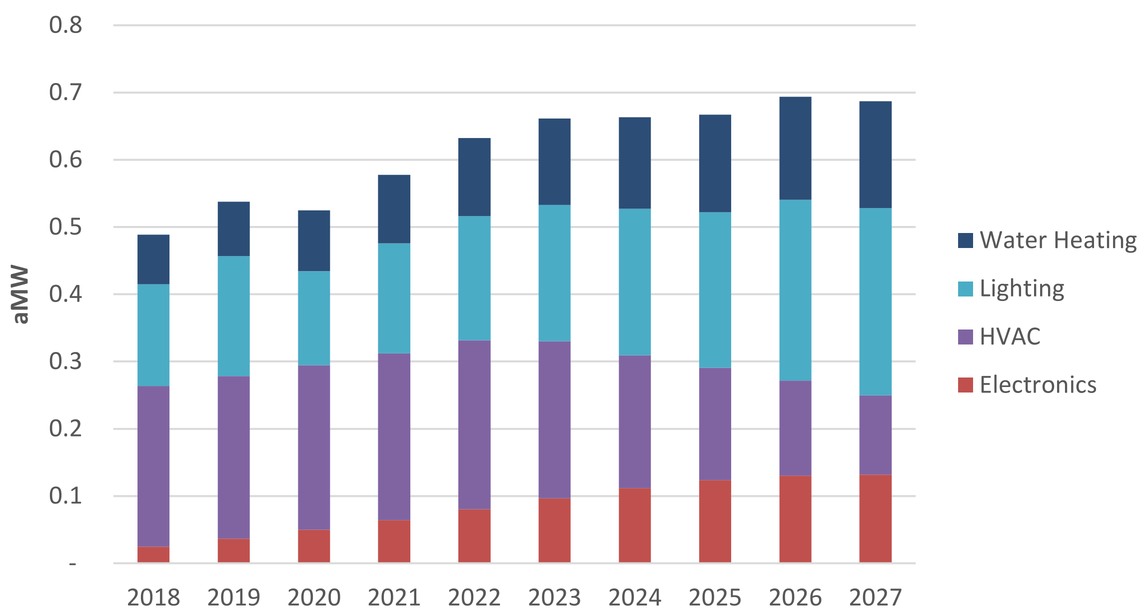


The largest share of the potential is in the residential sector followed by substantial savings potential in the commercial sector. Ramp rates are used to establish reasonable conservation achievement levels. Achievement levels are affected by factors including timing and availability of measure installation (lost opportunity), program (technological) maturity, non-programmatic savings, and current utility staffing and funding. In this analysis, the ramp rates used in the Seventh Plan were found to be a good fit for Benton PUD's current level of achievement. Figure 10 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

Within the residential sector, lighting measures make up the largest share of savings. The availability of a broad array of LED products and their widespread adoption has led to an increase in lighting savings potential. Weatherization measures—included in the HVAC category—also account for a significant amount of cost-effective conservation. This is due, in part, to the fact that Benton PUD's residential customers rely mostly on electricity for heating (Figure 11). Similar to weatherization measures, the large amount of electric water heating in Benton PUD's service area provides significant potential savings through heat pump water heaters, showerheads, and faucet aerators.

Figure 11
Annual Residential Potential by End Use

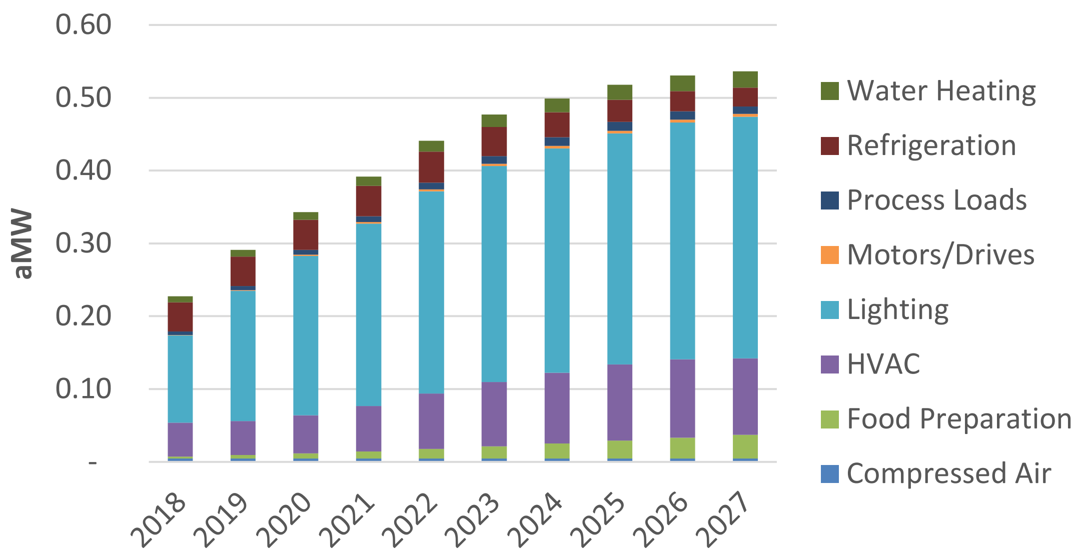


Commercial

Commercial lighting measures remain the largest contributors to commercial conservation potential (Figure 12). Lighting savings are higher in this assessment after ramp rates were adjusted to account for the success of commercial lighting programs and the broad acceptance of new LED products for a variety of applications and fixture types. These products have been easy to adopt in existing commercial lighting programs and trade ally networks, which are already well established. As a result, savings from lighting have been and will continue to be a foundation of commercial efficiency programs.

After lighting, commercial HVAC is the next largest source of potential for this assessment. The measures driving savings in this category include advanced rooftop controllers, ductless heat pumps, and commercial energy management. The custom nature of commercial building energy efficiency is reflected in the variety of end-uses and corresponding measures.

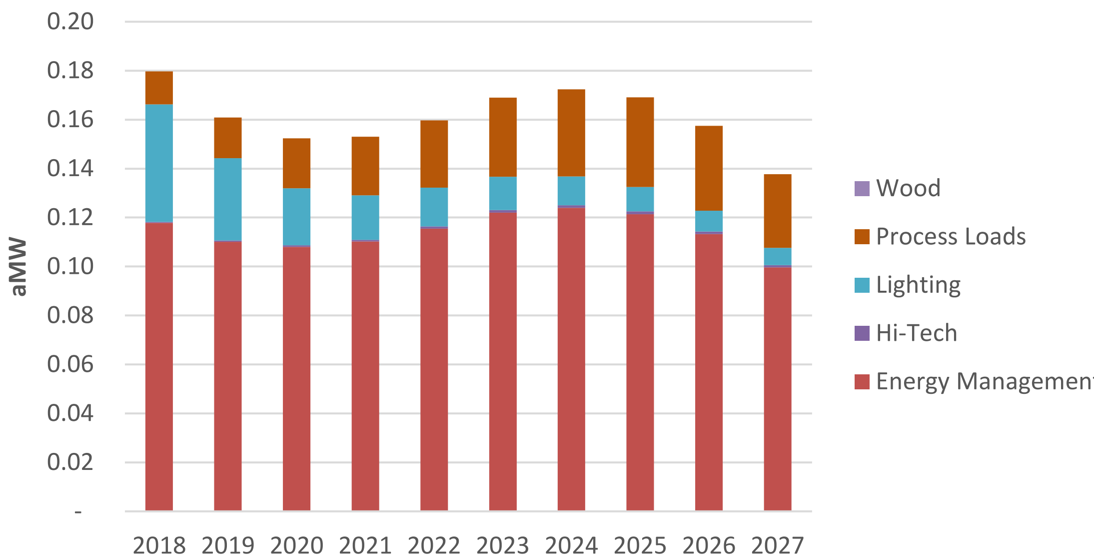
Figure 12
Annual Commercial Potential by End Use



Industrial

Much of Benton PUD's industrial load is composed of food and chemical facilities. Refrigerated storage and fruit storage load is also substantial. These segments contribute significantly to end-use savings in the energy management measures (Figure 13). Energy management measures include both Strategic Energy Management and improved management of motor-driven systems. Benton PUD's recent industrial sector achievement was used to adjust the 20-year technical industrial sector potential to estimate the remaining applicable potential available for future conservation programs. Because most industrial measures are thought to be retrofit measures, they are considered to be available from the beginning of the study period and generally decline over time as they are acquired.

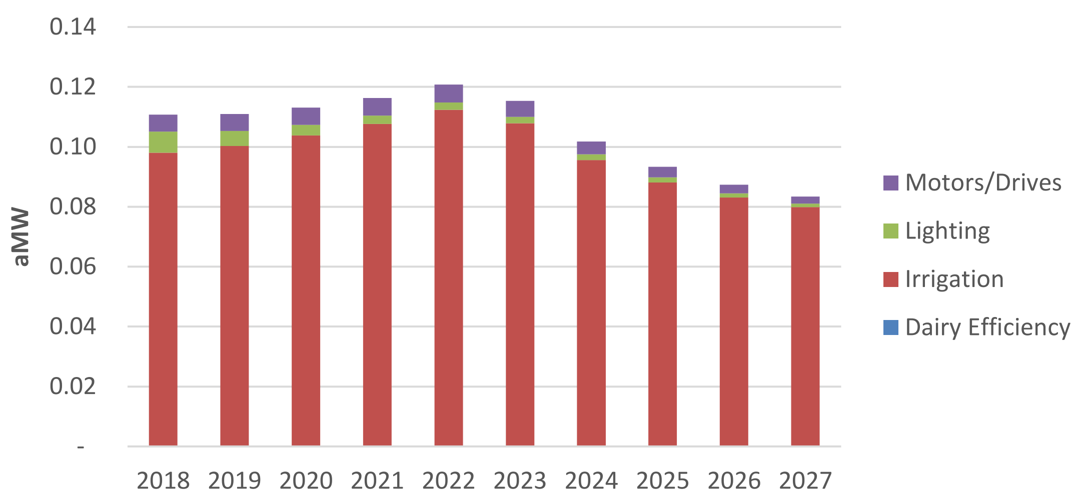
Figure 13
Annual Industrial Potential by End Use



Agriculture

Potential in agriculture is a product of total acres under irrigation in Benton PUD's service territory, number of pumps (well or river), and the number of farms (applied to lighting measures and dairy). As mentioned above, SIS measures were not considered in this assessment, as a study recently completed by BPA indicates that SIS may no longer result in energy savings. While Benton PUD may continue to offer SIS for other reasons, it will likely no longer provide energy savings. As shown in Figure 14, nearly all of cost-effective conservation potential is due to irrigation hardware measures and Low Elevation Spray Application (LESA) measures. LESA measures are part of an initiative under development by NEEA and are new for the Seventh Plan.

Figure 14
Annual Agriculture Potential by End Use

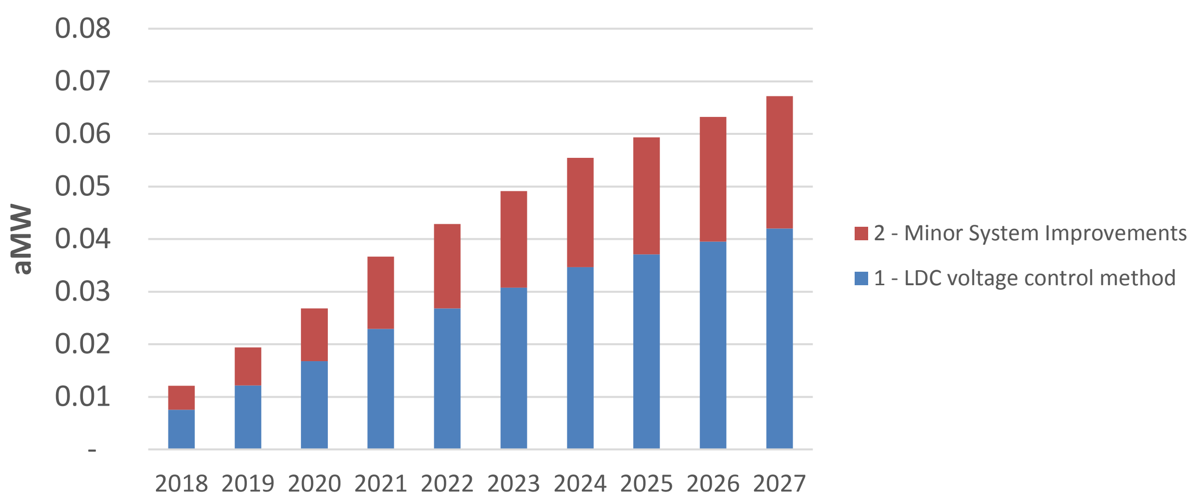


Distribution Efficiency

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 methodology. The Seventh Plan estimates distribution system potential based on end system energy sales. Systems sales were held constant to be consistent with the "last measure in" methodology, where each measure is assumed to be installed last to prevent the double-counting of savings where multiple measures may impact the same end-use. In the case of distribution system efficiency, any energy efficiency measure installed would reduce the overall load, and decrease the savings potential of utility distribution efficiency measures.

Distribution system conservation potential is shown in Figure 15. Although five measures were considered in the analysis, only two measures were cost effective.

Figure 15
Annual Distribution System 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 cost for incentives is assumed to be paid by the utility. 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. Table 8 costs are calculated based on a 35 percent utility-share, except in the utility distribution efficiency category, where Benton PUD is likely to pay the entire cost of any measures implemented. The 35 percent cost share assumption is consistent with Benton PUD's previous CPA.

This chart shows that Benton can expect to spend approximately $3.6 million to realize estimated savings over the next two years including program administration costs. The bottom row of Table 8 shows the cost per first year MWh.

Table 8 Utility Program Costs (2017$)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	$1,980,000	$6,635,000	$10,646,000	$18,172,000
Commercial	$903,000	$3,743,000	$7,213,000	$15,509,000
Industrial	$524,000	$1,554,000	$2,532,000	$3,205,000
Agricultural	$186,000	$563,000	$847,000	$1,183,000
Distribution Efficiency	$22,000	$130,000	$300,000	$825,000
Total	**$3,615,000**	**$12,625,000**	**$21,538,000**	**$38,894,000**
$/First Year MWh	$183	$184	$175	$166

The cost estimates above are conservative estimates for costs going forward since they are based on historic values. Future conservation achievement may be more costly or difficult since the lowest cost, easiest programs are usually implemented first. The next section provides a range of cost estimates for the planning period.

Cost Scenarios

To provide a range of program costs over the planning period, EES tested a High and Low cost scenario, relative to the Base Case conservation potential scenario. 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 scenario, the utility share of measure capital cost is reduced 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 Base Case Cost-Effective Potential (2017$)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Expected Case	$3,615,000	$12,625,000	$21,538,000	$38,894,000
Low Cost Case	$3,286,000	$11,477,000	$19,580,000	$35,358,000
High Cost Case	$4,272,000	$14,920,000	$25,454,000	$45,966,000

Table 10 Utility Cost Scenarios for Base Case Cost-Effective Potential (2017$/MWh)				
	2-Year	6-Year	10-Year	20-Year
Expected Case	$183	$184	$175	$166
Low Cost Case	$166	$167	$159	$151
High Cost Case	$216	$218	$206	$196

Table 9 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 could expect to incur in order to acquire conservation going forward. Utility conservation costs ($/MWh) are higher in the earlier years of the planning period and decrease in later years. 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 decreasing first year costs are a result of the ramp rate choice across all measures.

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 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 increase administrative costs.

Over the next two years, conservation programs are expected to cost between $151 and $218/MWh (first year savings). Overall, Benton PUD can expect the biennium potential estimates presented in this report to cost between $3.6 and $4.3 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) cost 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 cents per kilowatt-hour.

Table 11 TRC Levelized Cost (2017$/kWh)				
	2-Year	6-Year	10-Year	20-Year
Residential	$0.037	$0.038	$0.037	$0.035
Commercial	$0.045	$0.044	$0.043	$0.042
Industrial	$0.034	$0.034	$0.034	$0.035
Agricultural	$0.035	$0.034	$0.032	$0.030
Distribution Efficiency	$0.007	$0.007	$0.007	$0.007
Total	**$0.034**	**$0.034**	**$0.033**	**$0.033**

Scenario Results

The costs and savings discussed up to this point describe the Base Case scenario. Under this scenario, annual potential for the planning period was estimated using Benton PUD's expected avoided costs and by applying the Council's 20-year ramp rates to each measure, which were found to be a reasonable match for Benton PUD's current level of achievement. Additional scenarios were then tested to identify the change in cost-effective potential when key input parameters, such as avoided cost and load growth assumptions, were changed.

For reference, the load growth assumptions of the Base Case are listed below. Load growth estimates were based on frozen efficiency levels, and therefore do not include planned energy efficiency savings.

Base Case

- Base market price forecast and avoided cost assumptions
- Residential growth = 1.37%
- Commercial growth = 0.73%
- Industrial growth = 0.1%

Scenarios

Additional scenarios were developed to identify a range of possible outcomes and to account for uncertainties over the planning period. In addition to the Base Case scenario, this analysis first tested the sensitivity of different avoided cost assumptions under Base Case load growth assumptions. Also tested were Low and High load growth scenarios, as well as an Accelerated Base Case scenario. The High and Low load growth scenarios are relative to the Base Case load growth assumptions. The Accelerated Scenario retains the Base Case avoided cost and load growth assumptions, but changes ramp rates to acquire savings early. These additional scenarios are described in the following subsections.

To understand the sensitivity of the identified savings potential to avoided cost values alone, the Base Case growth rates were held constant while varying avoided cost inputs.

Table 12 summarizes the Base, Low, and High avoided cost input values. 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, 20-yr levelized $/MWh	Market Forecast	-1.25s*	+1.25s*
Social Cost of Carbon, $/MWh	$2.65/MWh	$0	Federal/7th Power Plan Values
Value of REC Compliance	Existing RPS	Existing RPS	25% RPS
Distribution System Credit, $/kW-yr	$31	$31	$31
Transmission System Credit, $/kW-yr	$26	$26	$26
Deferred Generation Capacity Credit, $/kW-yr	$81.95	$0	$115
Implied Risk Adder $/MWh $/kW-yr	N/A	Up to: -$51/MWh -$81.95/kW-yr Average of: -$14/MWh -$81.95/kW-yr	Up to: $71/MWh $33.05/kW-yr Average of: $30/MWh $33.05/kW-yr

**As noted above, the standard deviation of historical prices was calculated and applied to the base market energy price forecast.*

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	2.25	7.83	14.08	26.80
Low Scenario	1.08	3.75	7.09	14.90
High Scenario	2.79	10.04	18.79	39.39

Table 13 shows that the savings potential has a high degree of sensitivity to both upward and downward changes in avoided costs. Specifically, the cost-effective achievable potential of all low and high scenarios differ by more than 100%. This result is evident from the Benefit-Cost Ratio supply curve presented earlier in the report in Figure 9. The curve has a steep slope on both sides of the line where the BCR equals 1.0.

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. Detailed scenario results are provided below.

Low Scenario

The Low Conservation scenario evaluates energy efficiency cost effectiveness under a low market price forecast and with low load growth in Benton PUD's service territory. The Base Case market price forecast and other avoided cost assumptions were adjusted downward as outlined in Table 11 above.

Under the Low scenario, load growth in Benton PUD's residential sector is 0.47 percentage points lower compared with the Base Case scenario. Commercial sector growth rate is both 0.3 percentage points lower than the Base Case scenario, while the industrial load growth remains unchanged. Results of the Low scenario analysis are shown in Table 14. Under this scenario, 48.7 aMW of technically-achievable potential is available over the 20-year planning period, although only 14.4 aMW is cost effective.

Key parameters for the Low scenario include:

- Low market price and avoided cost assumptions
- Residential growth = 0.9%
- Commercial growth = 0.4%
- Industrial growth = 0.1%

Table 14
Cost Effective Potential - Low Scenario (aMW)

	2-Year*	6-Year	10-Year	20-Year
Residential	0.49	1.54	2.96	6.50
Commercial	0.32	1.28	2.42	4.88
Industrial	0.12	0.35	0.57	0.84
Agricultural	0.11	0.35	0.59	0.98
Distribution Efficiency	0.03	0.19	0.43	1.19
Total	**1.08**	**3.70**	**6.96**	**14.39**

High Scenario

Benton PUD's High Conservation scenario makes use of the high avoided cost assumptions described above in Table 11.

Under the High scenario, residential growth was increased to 1.8%, 0.43 percentage points higher than the base case. Commercial growth was assumed to be 1.1%, a similar increase above the base case. Industrial load growth was again left unchanged. Results of the High scenario are shown in Table 15. Under this scenario, 52.4 aMW of technically-achievable potential is available over the 20-year planning period, and 40.6 aMW is cost effective.

Key parameters for the High scenario include:

- High market price forecast and avoided cost assumptions
- Residential growth = 1.8%
- Commercial growth = 1.1%
- Industrial growth = 0.1%

Table 15
Cost Effective Achievable Potential - High Scenario (aMW)

	2-Year	6-Year	10-Year	20-Year
Residential	1.42	5.14	10.01	23.54
Commercial	0.66	2.69	5.21	11.14
Industrial	0.46	1.35	2.18	2.73
Agricultural	0.23	0.71	1.08	1.54
Distribution Efficiency	0.04	0.26	0.61	1.68
Total	**2.80**	**10.14**	**19.09**	**40.63**

Accelerated Scenario

The Accelerated Base scenario where Benton PUD ramps up programs to target reducing the summer peak demand. In this scenario, a subset of measures was modeled with more aggressive ramp rates, to acquire savings more quickly than what is presented in the Base Case. The measures chosen include:

- Commercial Energy Management
- Commercial Interior Lighting
- Industrial Lighting
- Industrial Energy Management

In the Accelerated Scenario, avoided cost and customer growth assumptions were kept the same as in the Base Case Scenario. Table 16 shows the results of the Accelerated Base Scenario. Note that since only commercial and industrial measures were accelerated, only these rows are different from the Base Case Scenario. This scenario acquires approximately 20 and 10 percent more energy savings in the first two and six years of the study period, respectively. Those additional energy savings translate to

Table 16
Cost Effective Achievable Potential – Accelerated Base Scenario (aMW)

	2-Year	6-Year	10-Year	20-Year
Residential	1.03	3.43	6.16	12.17
Commercial	0.68	2.48	4.46	9.63
Industrial	0.74	1.78	2.42	2.72
Agricultural	0.22	0.69	1.05	1.51
Distribution Efficiency	0.03	0.19	0.43	1.19
Total	**2.71**	**8.57**	**14.71**	**27.23**

Since this scenario was considered as a means to reduce peak demand, Table 17 below shows the estimated reductions in peak demand associated with this scenario. The pace of the incremental peak demand savings is similar to the incremental energy savings described above, or 20 percent in the first two years and 10 percent over the first six years.

Table 17
Cost Effective Peak Demand Savings – Accelerated Base Scenario (MW)

	2-Year	6-Year	10-Year	20-Year
Residential	1.33	4.49	7.94	15.34
Commercial	0.79	2.76	5.19	10.25
Industrial	0.97	2.36	3.27	3.70
Agricultural	0.56	1.76	2.72	3.93
Distribution Efficiency	0.03	0.18	0.43	1.17
Total	**3.68**	**11.56**	**19.56**	**34.40**

Scenario Summary

A comparison of the 20-year cost-effective potential for the scenarios outlined above is shown in Table 18 below. Based on the results of this table, it is evident that the results of the analysis are more sensitive to changes in avoided cost than load growth. Changes to load growth changed the results very little beyond the impact of the avoided cost assumptions.

Table 18
Scenario Comparison - 20-Year Cost-Effective Potential (aMW)

		Load Growth		
		Low	Base	High
Avoided Costs	Low	14.4	14.9	
	Base		26.8	
	High		39.4	40.5

Table 19 compares the 2, 6, 10, and 20-year potential from each scenario.

Table 19
Cost-Effective Potential - Scenario Comparison

	2-Year	6-Year	10-Year	20-Year
Base Case	2.25	7.83	14.08	26.80
Accelerated Base	2.71	8.57	14.71	27.23
High Avoided Cost	2.79	10.04	18.79	39.39
High Avoided Cost & Growth	2.80	10.14	19.09	40.63
Low Avoided Cost	1.08	3.75	7.09	14.90
Low Avoided Cost & Growth	1.08	3.70	6.96	14.39

Figure 16 graphs the annual potential for each scenario. The Base Case from the 2015 CPA is provided for comparison.

Figure 16
Benton PUD Conservation Scenarios – Annual Potential (aMW)

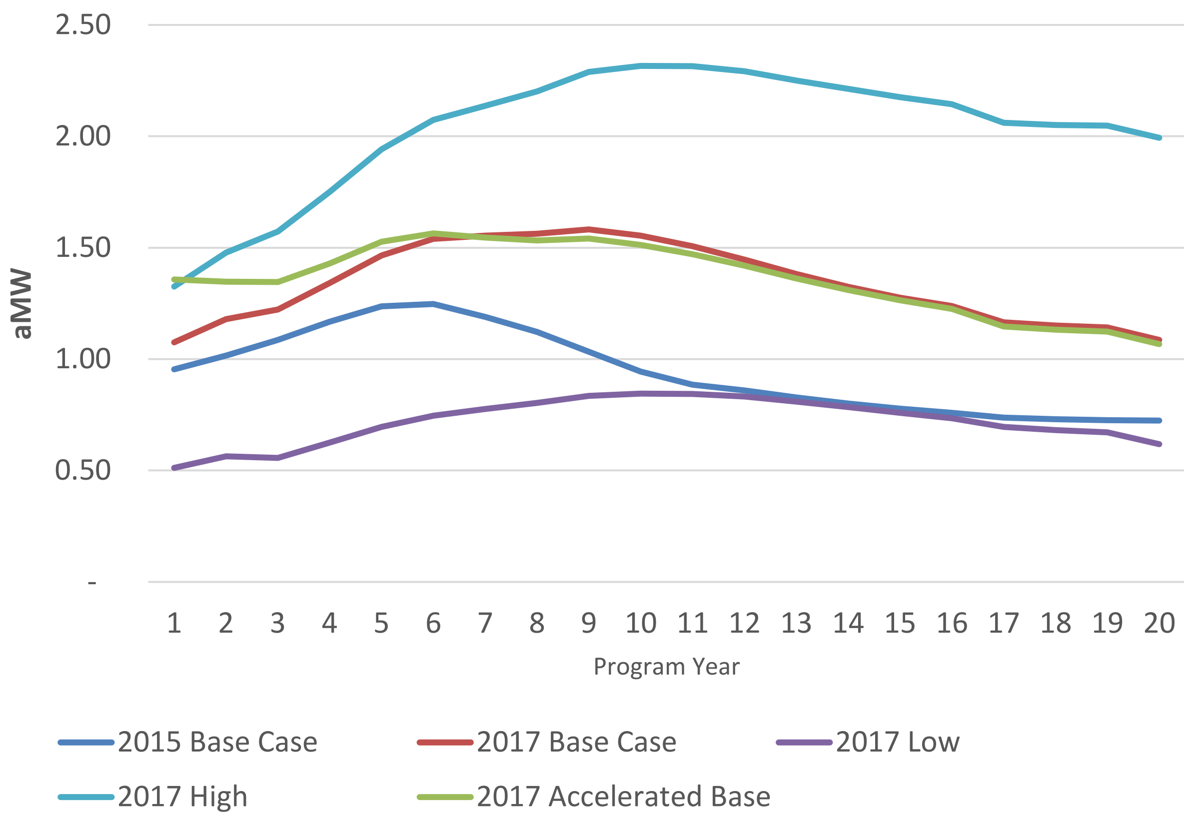


Figure 16 shows that the near-term projections of the 2017 Base Case are higher than the 2015 Base Case. The projections for year one (2018) in the 2017 Base Case start at approximately the same level as the projections for year three (also 2018) from the 2015 CPA. This shows that Benton PUD has met the targets set from the 2015 CPA as well as the fact that the ramp rates used in this CPA are a good fit for Benton PUD's current level of achievement.

Because 2017 CPA identified more cost-effective potential, the annual potential increases through the first nine years of study period, whereas in 2015, the annual potential only increased for the first six years. Later in the study period, the annual cost-effective potential remains higher to capture all cost-effective potential over the twenty-year study period.

Summary

This report summarizes the results of the 2017 CPA conducted for Benton Public Utility District. The assessment provides estimates of energy savings by sector for the period 2018 to 2037, with a focus on the first 10 years of the planning period, as per EIA requirements. The assessment considered a wide range of conservation resources that are reliable, available, and cost effective within the 20-year planning period.

Despite lower market prices, additional cost-effective potential from advancements in LED technologies, the inclusion of a social cost of carbon per the updated EIA rules, as well as improvements in quantifying the capacity value of measures has resulted in an increase in conservation potential. Conservation 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 as well. 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 the Benton PUD 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."[5] 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.[6]

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.

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

[6] 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

aMW –Average Megawatt

BPA – Bonneville Power Administration

CFL – Compact Fluorescent Light Bulb

Benton PUD – Benton Public Utility District

EIA – Energy Independence Act

EES – EES Consulting

EUI – Energy use intensity

HLH – Heavy load hour energy

HVAC – Heating, ventilation and air-conditioning

kW – kilowatt

kWh – kilowatt-hour

LED – Light-emitting diode

LLH – Light load hour energy

MF –Multi-Family

MH –Manufactured Home

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

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 2017 Conservation Potential Assessment". Final Report – October 3, 2017.
2) Model – "EES CPA Model-v2.1a-Base.xlsm" and supporting files
   a. MC_and_Loadshape_v3.0_24segment-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.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
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 (BC) ratio greater than one were tallied. These measures are considered achievable and cost-effective (or "economic").	Model – BC Ratios are calculated at the individual level by ProCost and passed up to the model.
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.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
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 program so it was handled in the same way as the Seventh Power Plan models.	Model – See MC_AND_LOADSHAPE_v3.0_24segment Excel 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.
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_v3.0_24segment Excel Files ("Base Market Forecast" worksheet).
j) Include deferred capacity expansion benefits for transmission and distribution systems	Deferred transmission and distribution capacity expansion benefits were given a benefit of $26/kW for bulk transmission in the cost-effectiveness analysis. The high case evaluates a local distribution system credit of $31/kW-yr. These are the same assumptions used by the Council in the Seventh Power Plan.	Model – this value can be found on the ProData page of each ProCost file.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
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 $ 81.95/kW-yr 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	The avoided cost data include estimates of future high, medium, and low CO_2 costs. For the base case, EES has used assumptions that mirror modeling for the District's IRP.	Multiple scenarios were analyzed and these scenarios include different levels of estimated costs and risk. There are MC_AND_LOADSHAPE_v3.0_24segment Excel 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.
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.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
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 4% 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, Inc. (EES) has conducted a Conservation Potential Assessment (CPA) for Benton PUD (the District) for the period 2018 through 2037 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, local distribution and regional transmission 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 2017 CPA. The 2017 CPA presents 4 avoided cost scenarios: Base, Accelerated, Low, and High avoided cost scenarios. Each of these is discussed below.

Avoided Energy Value

For the purposes of the 2017 CPA, EES has prepared a forecast of market prices for the Mid-Columbia (Mid-C) trading hub. This section summarizes the methodology and results of the market price forecast and compares the forecast to the market forecast used for the District's 2015 CPA (2016-17 biennium).

Methodology

Merchant natural gas-fired power plants operate on the margin in the Northwest. As the market price of electricity is usually set by the cost of the marginal unit, EES developed the market price forecast using a forecast of natural gas prices and projected market-implied heat rates or sparks spread. The projected market-implied heat rates reflect the average efficiency of gas-fired power plants in the Pacific Northwest. Projections are based on historic market-implied heat rates which are calculated by dividing historic Mid-C wholesale market prices by historic Sumas natural gas prices. EES developed a natural gas price forecast based on NYMEX forward gas prices for the Henry Hub trading hub, Sumas basis differentials, and projected market heat rates. The following steps were taken to produce the wholesale electric load forecast for the 2017 CPA:

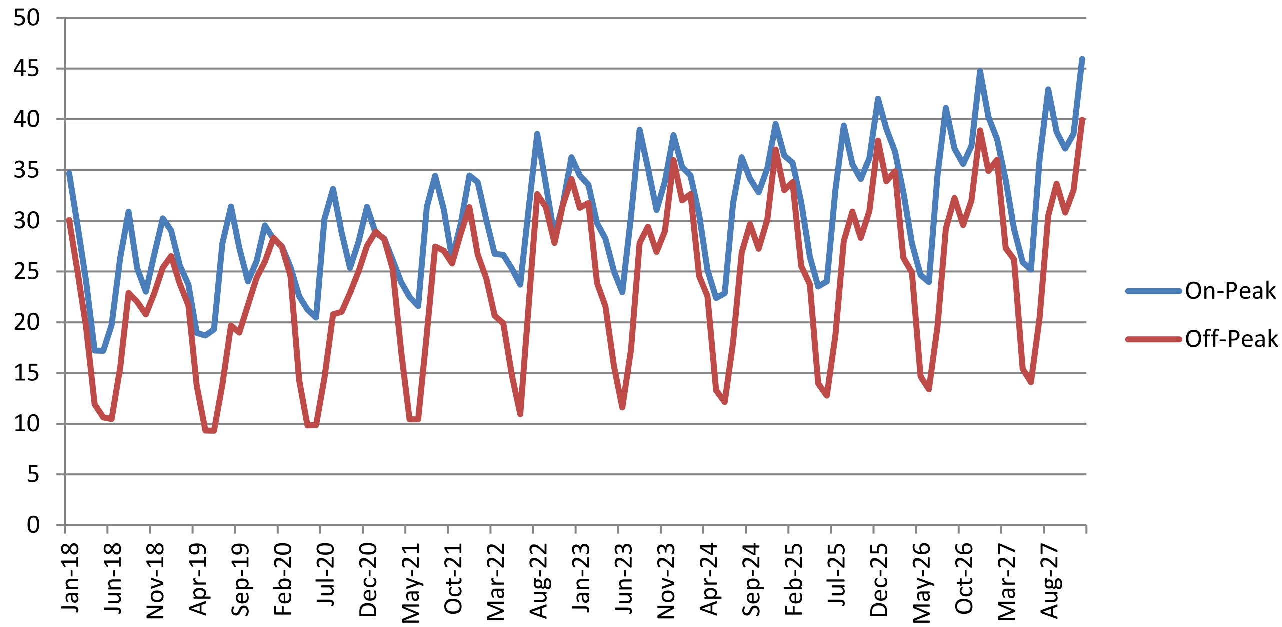
1. Forward prices for natural gas at Henry Hub are available through December 2029. A 4 percent annual growth rate is assumed after December 2029.
2. The Sumas basis differential is used to adjust the Henry Hub forward prices to Northwest prices. Sumas forward gas prices are equal to NYMEX forward prices (Henry Hub) plus the Sumas basis.
3. Projected monthly market-implied heat rates are applied to the Sumas forward gas price forecast to result in a forecast of Mid-C prices. Or, Mid-C prices are equal to Sumas forward prices multiplied by forecast heat rates.
4. Projected heat rates are based on historic heat rates (Mid-C wholesale electricity prices divided by Sumas natural gas prices).

5. Monthly heat rates are shaped to better match up with BPA's Mid-C price forecast in its Initial Proposal for FY18-19 power rates (BP-18).
6. Forecast Mid-C prices are benchmarked against other market price forecasts.

Results

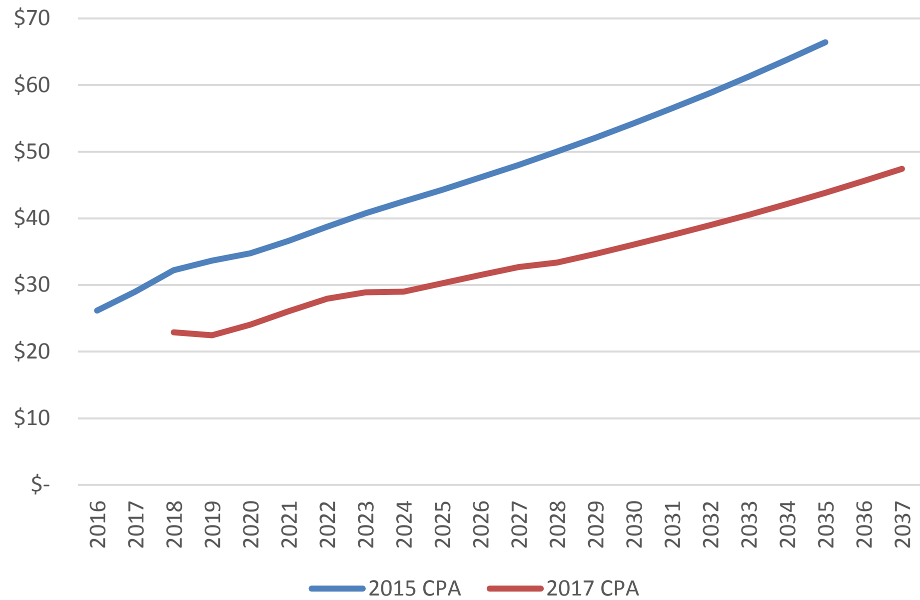
Figure IV-1 illustrates the resulting monthly, diurnal market price forecast. The levelized value of market prices over the study period is $32.16/MWh assuming a 4 percent real discount rate.

Figure IV-1
Forecast Market Prices ($/MWh)



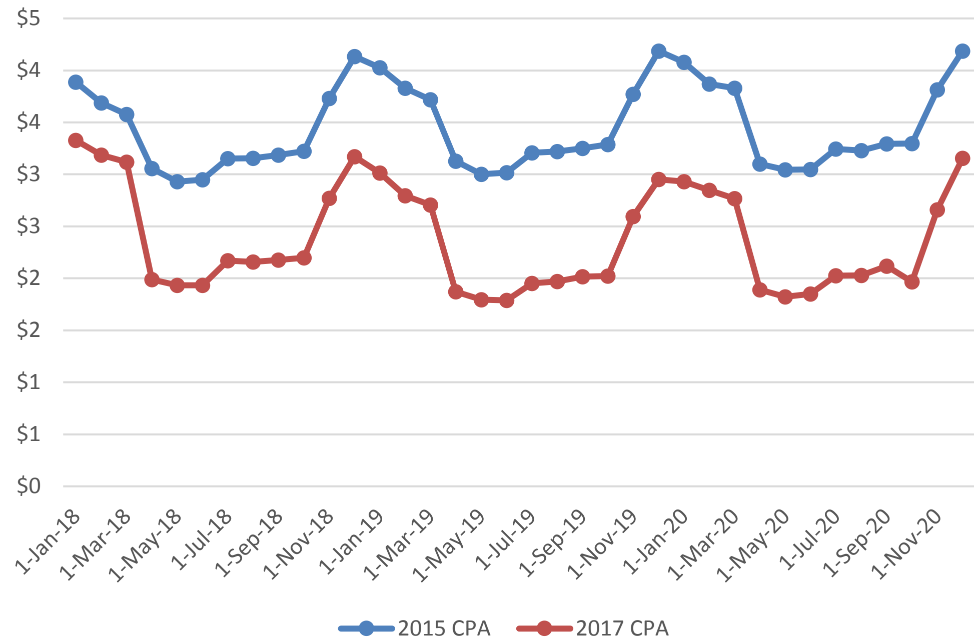
The 2017 market price forecast (April 6, 2017) is lower than the market price forecast used in the District's most recent CPA (the 2015 CPA). Figure IV-2 compares the two forecasts.

Figure IV-2
Forecast Market Prices in 2015 CPA and 2017 CPA ($/MWh)



The 2017 CPA's 20-year market price forecast is 26 percent lower compared with the 2015 CPA's market price forecast due to changes in market conditions mainly due to decreases in natural gas prices. Figure IV-3 illustrates decrease in forward natural gas prices between the 2015 and 2017 CPAs. The projected average 2018 Sumas natural gas price included in the 2017 CPA ($2.51/MMBtu) is 26 percent less than the projected average 2018 Sumas natural gas price included in the 2015 CPA ($3.39/MMBtu).

Figure IV-3
Forward Sumas Natural Gas Prices ($/MMBtu)

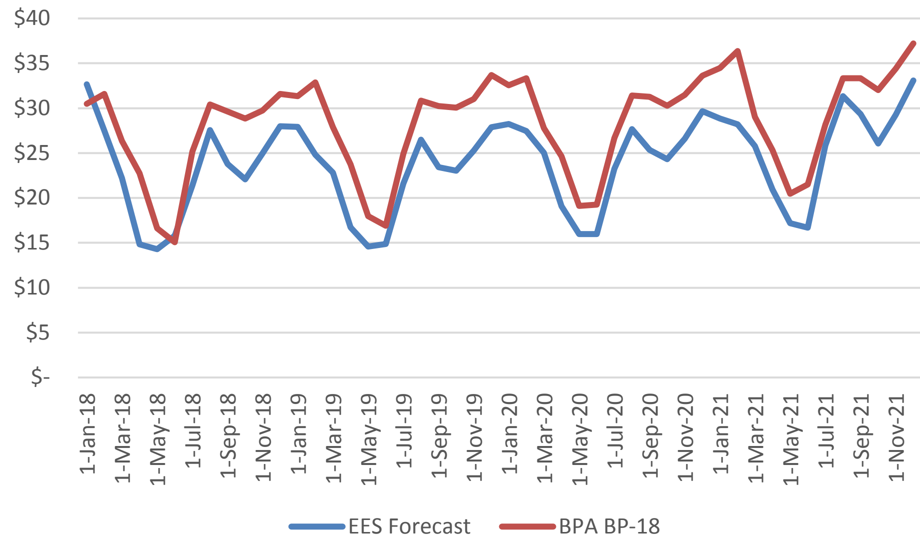


* Source: Henry Hub and Sumas Basis Differential Futures quotes as provided by CME Group

Benchmarking

Figure IV-4 compares the January 2018 through December 2021 EES market forecast with the forecast included in BPA's Initial Proposal for FY18-19 rates. The difference in overall price levels is due to the fact that natural gas prices decreased between the time that BPA developed its forecast in the fall of 2016 and when EES developed its price forecast in April 2017.

Figure IV-4
Forecast Market Prices compared to BPA's Market Price Forecast ($/MWh)



* BPA's market price forecast is per the market price forecast included in BPA's November 2016 initial rate proposal for FY18-19 power rates.

High and Low Scenarios

To reflect a range of possible future outcomes, EES calculated a high- and low-case market price forecasts. To do this, EES looked at a history of Mid-C energy prices from the past ten years and, after adjusting for inflation, calculated the standard deviation as a percentage of the mean price for each month over the 10-year period, for both high and low load hours. One and a quarter standard deviations were added or subtracted to our base market prices to calculate the high and low market price forecasts, respectively. Figures IV-5 and IV-6 compare the resulting price forecasts, for high and low load hours, respectively.

Figure IV-5
Low, Base, and High Case Price Forecast of HLH Prices (2012$/MWh)

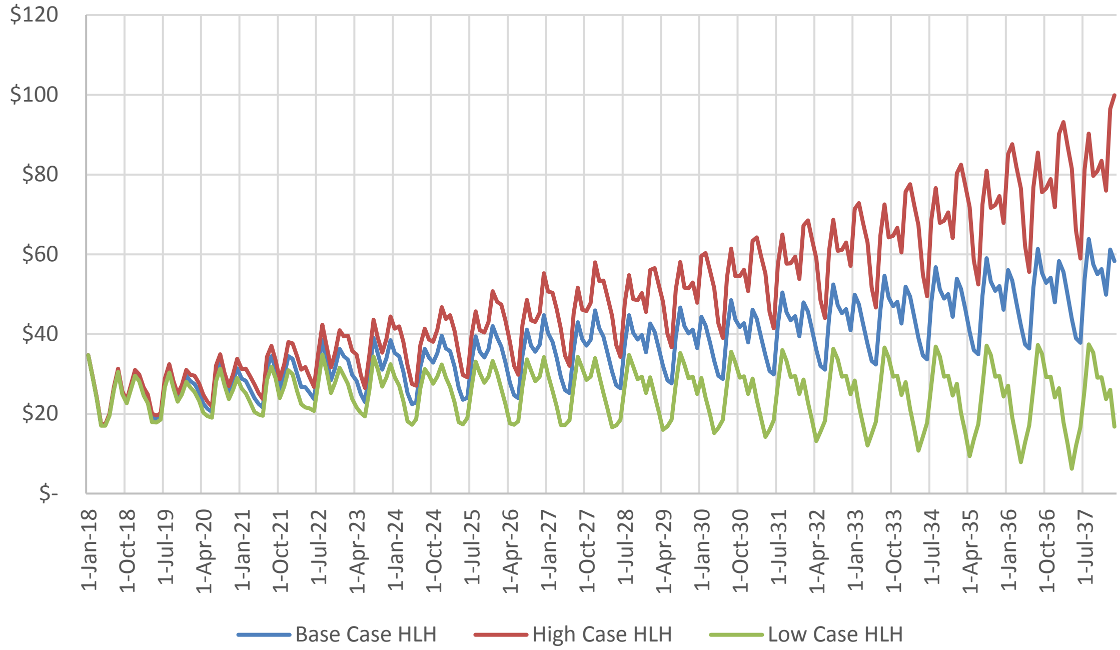
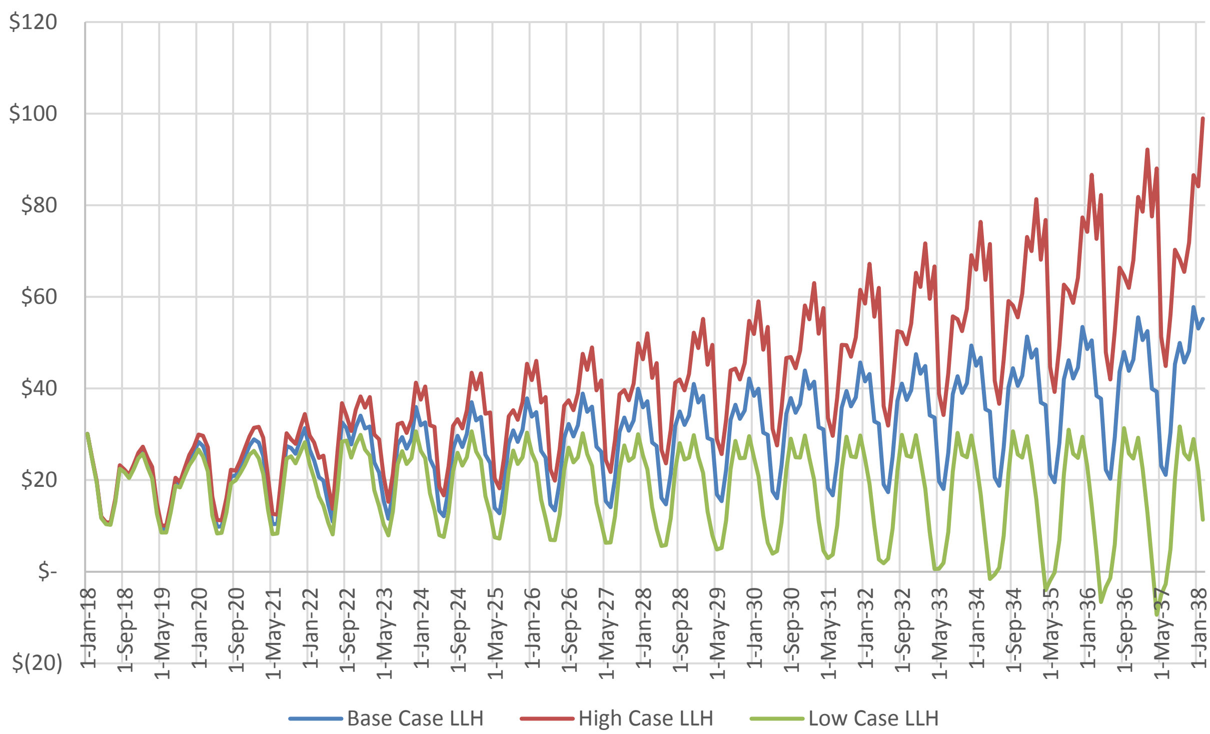


Figure IV-6
Low, Base, and High Case Price Forecast of LLH Prices (2012$/MWh)



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 (kW) and energy savings (kWh), 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 will evaluate the energy efficiency potential under a range of avoided cost adders, identifying 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 the social cost of carbon be included in the total resource cost test (TRC). The value of the social cost of carbon is not defined by markets; therefore, the CPA includes the social cost of carbon in an uncertainty analysis through scenario modeling. For the base case, EES has used assumptions that mirror modeling for the District's IRP. The IRP assumed a $25 per ton carbon tax and concluded that market prices would rise an average of $2.65/MWh.

In addition, a value of zero is used in the low case of the scenario analysis. The zero value reflects that carbon costs are not likely to be borne by only utility ratepayers directly in the near future and are not included in the modeling of other resources in the District's IRP.

The Power Council used the federal Interagency Workgroup estimate of a social cost of carbon in scenarios of the Seventh Power Plan. The federal carbon cost estimates range from $44 to $63 (2012$) per metric ton over the 20-year planning period. These values were used for the high cost scenario. For the high case, 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 a 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.

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%.

The EIA allows for alternate modes of compliance. Utilities can comply by spending four percent or more of the annual retail revenue requirement on the incremental cost of renewable energy—essentially a four percent cost cap. Utilities with no load growth can comply by spending one percent or more of the retail revenue requirement.

In 2016, the District purchased Renewable Energy Credits (RECs) to fulfill its requirement of sourcing 9% of its energy from renewable sources. Energy savings from conservation measures reduces this expense by reducing the net retail revenue requirement.

Under a 9% RPS requirement, for every 100 units of energy efficiency acquired, the District's RPS spending requirement is reduced by 9 units. In effect, this adds nine 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. In the high scenario, this value was increased to 25% of REC value to account for potential increases in the cost of RECs or potential increases in the stringency of Washington's RPS requirements.

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 includes a risk adder (\$/MWh) in 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 Council's 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. 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 2017 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 Local Distribution and Bulk Transmission System Investment

Energy efficiency measure savings reduce capacity requirements on both the local distribution system and the regional transmission system. The value of these capacity savings have been estimated in the Seventh Power Plan at $31/kW-year and $26/kW-year for distribution and transmission systems, respectively ($2012). These assumptions are used in all scenarios in the CPA.

Deferred Investment in Generation Capacity

The District's 2016 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. The region may face capacity shortfalls in 2021 when several large coal plants in the Northwest are scheduled to be decommissioned. Further, the District's need for generation capacity will increase when its Power Purchase Agreement with the Frederickson 1 Generating Station expires in 2022.

To be conservative, EES has included a value for generation capacity deferral beginning in 2021. EES used BPA's monthly demand charges as a proxy value for the monthly value of generation capacity, as those charges were based upon the cost of a generating unit. By assuming a monthly shape to the District's peak demand reductions due to conservation, the generation capacity costs were converted into a value of $85.24/kW-year. 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 $81.95/kW-year (2012$) 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[7], 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 IV-1 summarizes the recommended scenario assumptions. The Base Case represents the most likely future.

Table IV-1
Avoided Cost Scenario Assumptions, $2012

	Base	Low	High
Energy, 20-yr levelized $/MWh	Market Forecast	-1.25s*	+1.25s*
Social Cost of Carbon, $/MWh	$2.65/MWh	$0	Federal/7th Power Plan Values
Value of REC Compliance	Existing RPS	Existing RPS	25% RPS
Distribution System Credit, $/kW-yr	$31	$31	$31
Transmission System Credit, $/kW-yr	$26	$26	$26
Deferred Generation Capacity Credit, $/kW-yr	$82.93	$0	$115
Implied Risk Adder $/MWh $/kW-yr	N/A	Up to: -$51/MWh -$82.93/kW-yr Average of: -$14/MWh -$82.93/kW-yr	Up to: $71/MWh $32.07/kW-yr Average of: $30/MWh $32.07/kW-yr

**As noted above, the standard deviation of historical prices was calculated and applied to the base market energy price forecast.*

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

Appendix V – Ramp Rate Documentation

This section is intended to document how ramp rates were reviewed for alignment between the near-term potential and recent achievements of Benton PUD's programs.

Benton PUD's sector-level program achievements from 2015-2016 and estimates for 2017 were compared with the first three years of the study period, 2018-2020, using the ramp rates assigned to each measure in the Seventh Power Plan. Savings from NEEA's market transformation initiatives were allocated to the appropriate sectors. It was decided that savings from 2016-17 provided the best basis for comparison, since NEEA savings declined significantly in 2016 when baselines were reset with the release of the Seventh Power Plan.

Table V-1 below shows the results of the comparison by sector.

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

	Program History				Potential		
	2015	**2016**	**2017**	**'16-'17 Avg**	**2018**	**2019**	**2020**
Residential	1.01	0.51	0.65	0.58	0.49	0.54	0.53
Commercial	0.75	0.27	0.28	0.28	0.23	0.29	0.34
Industrial	0.55	0.35	0.13	0.24	0.24	0.22	0.21
Agricultural	0.28	-	0.11	0.06	0.11	0.11	0.11
Utility DE	-	-	-	-	0.01	0.02	0.03
Total	**2.59**	**1.14**	**1.17**	**1.15**	1.08	1.18	1.22

This table shows that the default Seventh Power Plan ramp rates provide a good match for Benton PUD's current level of achievement.

The residential sector makes up the largest portion of the potential, so this sector was reviewed at the end use level, in Table V-2 below. Note that the program history excludes measures for which there is no comparable measure in the potential model. 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 Program Achievement and Potential (aMW)							
	Program History				Potential		
End Use	**2015**	**2016**	**2017**	**'16-'17Avg**	**2018**	**2019**	**2020**
Dryer	-	-	-	-	-	-	-
Electronics	-	-	-	-	0.02	0.04	0.05
Food Preparation	-	-	-	-	0.00	0.00	0.00
HVAC	0.12	0.15	0.07	0.11	0.24	0.24	0.24
Lighting	0.16	0.14	0.29	0.21	0.15	0.18	0.14
Refrigeration	-	-	-	-	-	-	-
Water Heating	0.01	0.00	0.00	0.00	0.07	0.08	0.09
Whole Bldg/Meter Level	0.01	0.02	0.00	0.01	-	-	-
NEEA	0.73	0.10	0.10	0.10			
Total	**1.03**	**0.41**	**0.46**	**0.43**	**0.49**	**0.54**	**0.53**

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: The potential in this end use appears to be higher, but some savings from NEEA count towards this category.

Lighting: The potential in this category aligns well with program history. Although 2017 is predicted to be a high year, the savings opportunities in this end use are affected by a standard that takes effect soon and programs may not continue to operate in this market.

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. The potential in this category includes heat pump water heaters, an emerging technology, as well as low-flow showerheads, which are a measure that is easy to ramp up.

Appendix VI – Measure List

This appendix provides a high-level measure list of the energy efficiency measures evaluated in the 2017 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
	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 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 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-5
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

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Dryer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electronics	0.02	0.04	0.05	0.06	0.08	0.10	0.11	0.12	0.13	0.13	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.07	0.06
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	0.24	0.24	0.24	0.25	0.25	0.23	0.20	0.17	0.14	0.12	0.10	0.08	0.06	0.05	0.04	0.04	0.01	0.01	0.01	0.01
Lighting	0.15	0.18	0.14	0.16	0.18	0.20	0.22	0.23	0.27	0.28	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.31
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating	0.07	0.08	0.09	0.10	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Whole Bldg/Meter Level	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.49**	**0.54**	**0.53**	**0.58**	**0.63**	**0.66**	**0.67**	**0.67**	**0.70**	**0.69**	**0.68**	**0.66**	**0.64**	**0.62**	**0.60**	**0.59**	**0.56**	**0.56**	**0.56**	**0.56**

Commercial aMW

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Compressed Air	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	0.01	0.01	0.01	0.01
Electronics	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
Food Preparation	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
HVAC	0.05	0.05	0.05	0.06	0.08	0.09	0.10	0.10	0.11	0.11	0.10	0.09	0.08	0.06	0.05	0.04	0.03	0.03	0.03	0.02
Lighting	0.12	0.18	0.22	0.25	0.28	0.30	0.31	0.32	0.33	0.33	0.34	0.34	0.34	0.34	0.35	0.35	0.34	0.35	0.35	0.30
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
Process Loads	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Water Heating	0.01	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	0.02	0.02	0.02	0.02	0.02
Total	**0.23**	**0.29**	**0.34**	**0.39**	**0.44**	**0.48**	**0.50**	**0.52**	**0.53**	**0.54**	**0.54**	**0.53**	**0.52**	**0.51**	**0.50**	**0.49**	**0.48**	**0.47**	**0.47**	**0.43**

Industrial aMW

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Compressed Air	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
Energy Management	0.12	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.11	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02
Fans	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	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	0.00	0.00
Lighting	0.05	0.03	0.02	0.02	0.02	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
Low & Med Temp Refr	0.03	0.03	0.03	0.03	0.03	0.03	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
Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Loads	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Pulp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps	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	0.00
Transformers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.24**	**0.22**	**0.21**	**0.22**	**0.23**	**0.23**	**0.23**	**0.22**	**0.20**	**0.18**	**0.14**	**0.11**	**0.08**	**0.06**	**0.04**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**

Agricultural aMW

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Dairy Efficiency	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
Irrigation	0.10	0.10	0.10	0.11	0.11	0.11	0.10	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.03	0.02	0.01	0.01
Lighting	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	0.00	0.00
Motors/Drives	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	0.00	0.00	0.00	0.00
Total	**0.11**	**0.11**	**0.11**	**0.12**	**0.12**	**0.12**	**0.10**	**0.09**	**0.09**	**0.08**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**	**0.05**	**0.03**	**0.02**	**0.01**	**0.01**

Distribution Efficiency aMW

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
1 - LDC voltage control method	0.01	0.01	0.02	0.02	0.03	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
2 - Light system improvements	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 improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - EOL voltage control method	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A - SCL implement EOL w/ major system impro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.01**	**0.02**	**0.03**	**0.04**	**0.04**	**0.05**	**0.06**	**0.06**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**

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.