Public Utility District No. 1 of Cowlitz County

2017 Conservation Potential Assessment

Final Report

November 17, 2017

Prepared by:

EES Consulting

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November 17, 2017

Mr. Gary Huhta
Public Utility District No. 1 of Cowlitz County
961 12th Avenue
Longview, Washington 98632

SUBJECT: 2017 Conservation Potential Assessment – Final Report

Dear Mr. Huhta:

Please find attached the final report summarizing the 2017 Public Utility District No. 1 of Cowlitz County (Cowlitz PUD) Conservation Potential Assessment. This report covers the 20-year time period from 2018 through 2037.

The measures and information used to develop Cowlitz PUD's 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 additional components included in the avoided costs, improvements in LED technology, and the associated increased acceptance and adoption of LED technology 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 Cowlitz County (Cowlitz 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

Cowlitz PUD provides electricity service to more than 48,200 customers in Cowlitz County, Washington. 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 Cowlitz 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
  - Values for avoided generation capacity costs and the social cost of carbon, which were not previously explicitly valued
- Updated financial parameters – including a Cowlitz 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
  - Updated pulp and paper mill measures based on site visit discussions

- 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 define the planning assumptions based on the most up to date data. The Base Case conditions were defined as the most likely market conditions over the planning horizon, and conservation potential was estimated based on these assumptions. Additional scenarios were also developed to test a range of conditions and to model uncertainty regarding the input assumptions.

Results

Table ES-1 shows the high-level results of this assessment. The cost-effective potential by sector in 2, 6, 10, and 20-year increments is included. The total 20-year energy efficiency potential is 58.05 aMW. The most important numbers per the EIA are the 10-year potential of 37.25 aMW, and the 2-year potential of 6.98 aMW.

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

	2-Year*	6-Year	10-Year	20-Year
Residential	1.27	4.15	7.12	13.05
Commercial	0.78	2.54	4.55	9.08
Industrial	4.88	14.78	25.03	34.48
Agricultural	0.02	0.05	0.07	0.10
Distribution Efficiency	0.03	0.21	0.48	1.35
Total	**6.98**	**21.72**	**37.25**	**58.05**

**2018 and 2019*

These estimates include energy efficiency achieved through Cowlitz 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.

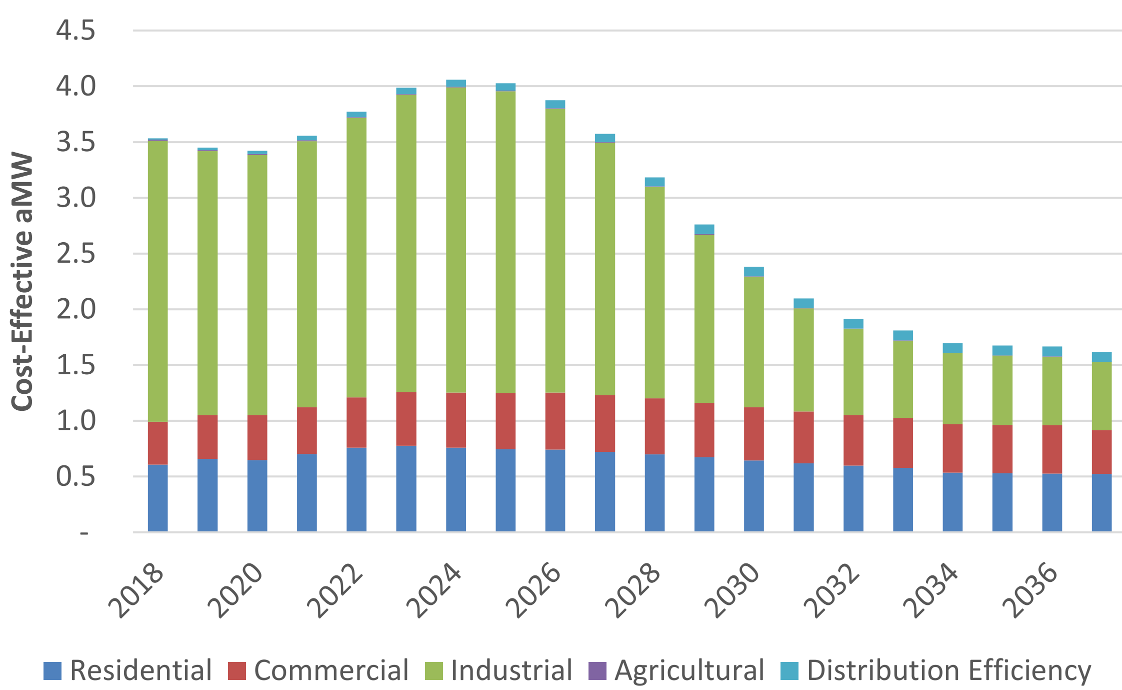
Energy efficiency also has the potential to reduce peak demands. Estimates of peak demand savings are calculated for each measure using the Council's ProCost tool, which uses hourly load profiles developed for the Seventh Power Plan and a Cowlitz PUD-specific definition of when peak demand occurs. These 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. Cowlitz PUD's annual peak occurs in winter mornings and evenings. 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	4.10	12.97	20.81	34.55
Commercial	1.29	4.26	7.78	15.52
Industrial	5.67	16.84	28.30	38.87
Agricultural	0.02	0.04	0.05	0.06
Distribution Efficiency	0.04	0.26	0.60	1.68
Total	**11.12**	**34.37**	**57.54**	**90.67**

The 20-year energy efficiency potential is shown on an annual basis in Figure ES-1. This assessment shows potential starting around 3.53 aMW in 2018, decreasing over the next two years due to decreasing industrial load and measure opportunities, and then ramping back up to 4.06 aMW per year in 2024 with increasing potential in the residential and commercial sectors. Potential is then gradually ramped down through the remaining years of the planning period as the remaining retrofit measure opportunities diminish over time.

Ramp rates from the Seventh Power Plan were used to develop the annual savings potential estimates over the 20-year study. Limited adjustments were made to the ramp rates applied to industrial energy management and commercial lighting measures to align annual potential with Cowlitz PUD’s current program savings levels. No other ramp rate adjustments were necessary.

Figure ES-1
Annual Economic Energy Efficiency Potential – Base Case Scenario



As shown in Figure ES-1, the majority of conservation potential for the 2017 CPA is in the industrial sector. The 20-year industrial sector potential primarily lies in the following segments, which aligns with Cowlitz PUD's industrial load:

- Paper
- Kraft Pulp

The savings estimates for the largest three industrial customers was informed through meetings with key PUD staff and customer staff. The customers indicated that the projects being planned over the near term are only those with quick paybacks. Therefore, the savings potential in the near-term is based on the most cost-effective measures only.

Second to industrial potential, conservation is available in Cowlitz PUD's residential sector. The conservation potential in this sector falls among the major end uses of lighting, HVAC, and water heating. The measures of notable potential in the residential sector include the following:

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

The updated avoided cost assumptions combined with continued improvements and cost declines in LED technologies resulted in LEDs passing the cost-effectiveness test as well as several additional HVAC measures (heat pumps). These changes significantly increase the savings potential as shown in the section below.

Comparison to Previous Assessment

Table ES-3 shows a comparison of the 10 and 20-year Base Case conservation potential by customer sector for this assessment and the results of Cowlitz PUD's 2016 CPA.

Table ES-3
Comparison of 2016 CPA Update and 2017 CPA Cost-Effective Potential

	10-Year			20-Year		
	2016	2017	% Change	2016	2017	% Change
Residential	1.75	7.12	307%	4.07	13.05	221%
Commercial	1.20	4.55	279%	2.30	9.08	295%
Industrial	17.47	25.03	43%	34.51	34.48	0%
Agricultural	0.06	0.07	12%	0.11	0.10	-11%
Distribution Efficiency	0.18	0.48	168%	0.51	1.35	165%
Total	**20.66**	**37.25**	**80%**	**41.50**	**58.05**	**40%**

*Note that the 2016 columns refer to the CPA completed in 2016 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 2016 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 2016 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 – Industrial potential was updated based on Cowlitz PUD's new load forecast, including a substantial reduction in the pulp and paper industries. Measure savings and saturations were also adjusted as part of the Seventh Plan, and additional adjustments were made based on work completed since then. Based on discussions with pulp and paper facility managers, measures with longer payback periods were excluded as the sites are not able to make investments of that scale. The increase in avoided costs, discussed below, resulted in four measures passing the cost-effectiveness screen that did not pass in the 2016 CPA. This resulted in a small increase in industrial potential over the 20-year study period.

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 inclusion of these values offset the decrease in market price forecasts used to value avoided energy use. Additional information regarding the avoided cost forecast is included in Appendix IV.

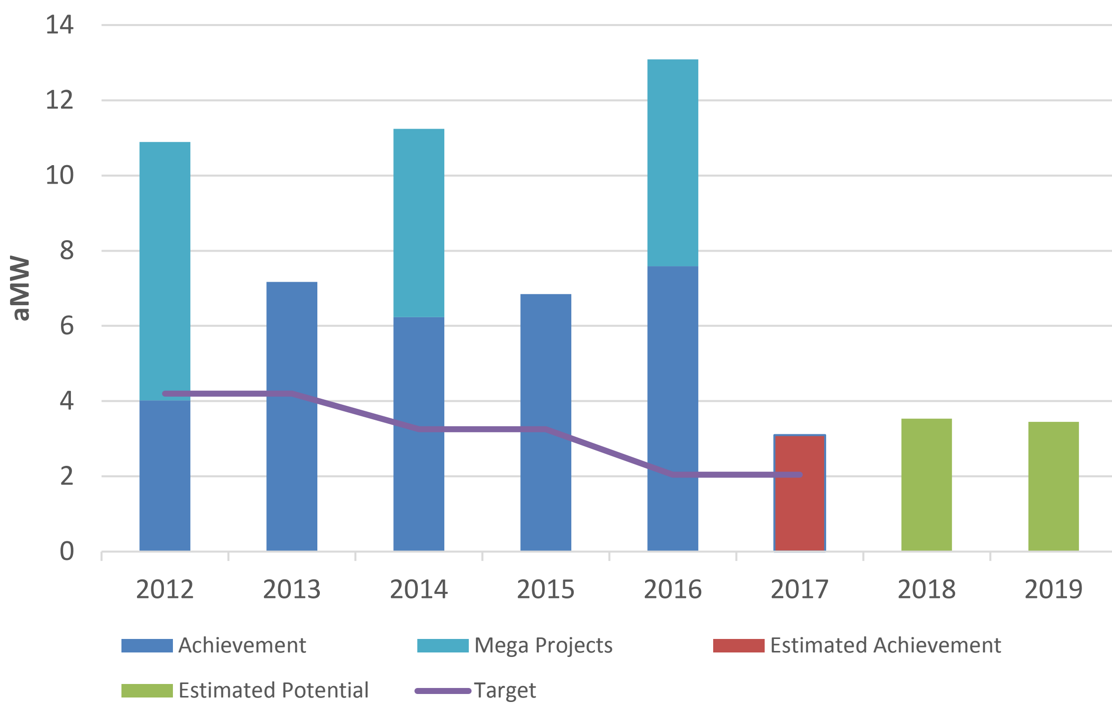
Modeling Methodology

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.

Targets and Achievement

Figure ES-2 compares Cowlitz PUD's historic conservation achievement with the 2017 CPA potential. Savings from single large projects called megaprojects are categorized separately, as these savings are not reliable and predictable sources of savings. The 2018 and 2019 targets are based on the Base Case scenario presented in this report. The Figure shows that Cowlitz PUD has consistently exceeded its energy efficiency targets and that the potential estimates presented in this report are achievable through Cowlitz PUD's conservation programs, the utility's share of NEEA savings and future Momentum savings.

Figure ES-2
Historic Achievement and Targets



Conclusion

This report summarizes the CPA conducted for Cowlitz PUD for the 2018 to 2037 timeframe. Based on the results of the Base Case scenario, the total 10-year economic achievable potential is 37.25 aMW and the 2-year potential is 6.98 aMW. The results of this assessment are higher than the previous assessment due to numerous factors, including changes in commercial and residential LED lighting technologies, new avoided cost adders, and updated industrial savings assumptions. Continued LED improvements have allowed the technology to be used in more applications, resulting in greater potential; and improvements in costs have led to broad market adoption and higher acquisition rates. The industrial sector also has a small increase in potential savings due to changes in measure saturation assumptions and avoided cost components, despite reductions in load and measure updates.

Introduction

Objectives

The objective of this report is to describe the results of the Public Utility District No. 1 of Cowlitz County (Cowlitz PUD) 2015 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 WAC 194-37 (EIA implementation) and is part of Cowlitz PUD's compliance documentation. The results and guidance presented in this report will also assist Cowlitz PUD in strategic planning for its conservation programs in the near future. Finally, the resulting conservation supply curves can be used in Cowlitz 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.

Energy Independence Act

RCW 19.285 the Energy Independence Act (EIA), requires that, "each qualifying utility pursue all available conservation that is cost-effective, reliable and feasible." The timeline for requirements of the EIA 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.
- By June 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.

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 Cowlitz 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, therefore risk credits are included in the analysis to mitigate the market price risk over the study period.
- Utility system assumptions – Credits have been included in this analysis to account for the avoided costs of transmission and distribution system expansion. Though potential transmission and distribution system cost savings are dependent on local conditions, the Council considers these credits to be representative estimates of these avoided costs.
- Discount and finance 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.
- Load and customer growth forecasts – The CPA bases the 20-year potential estimates on forecasted loads and customer growth. Each of these forecasts includes a level of uncertainty.
- Large loads – Individual large loads, such as large industrial customers, create additional uncertainty for utilities due to the reliance of conservation potential that applies to these customers. Loss of large loads due to facility closures, customers opting to purchase market power, and other factors can affect available conservation potential and the utility's ability to meet program targets. This consideration is particularly applicable to Cowlitz PUD. Three customers account for approximately 55 percent of total load; therefore, conservation potential relies heavily on projects at these facilities where the continued operation is uncertain.
- 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-use devices do not change over the planning period. In addition, it is assumed that once an energy efficiency measure is installed, it will remain in place over the remainder of the study period.

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

Report Organization

The main report is organized with the following main sections:

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

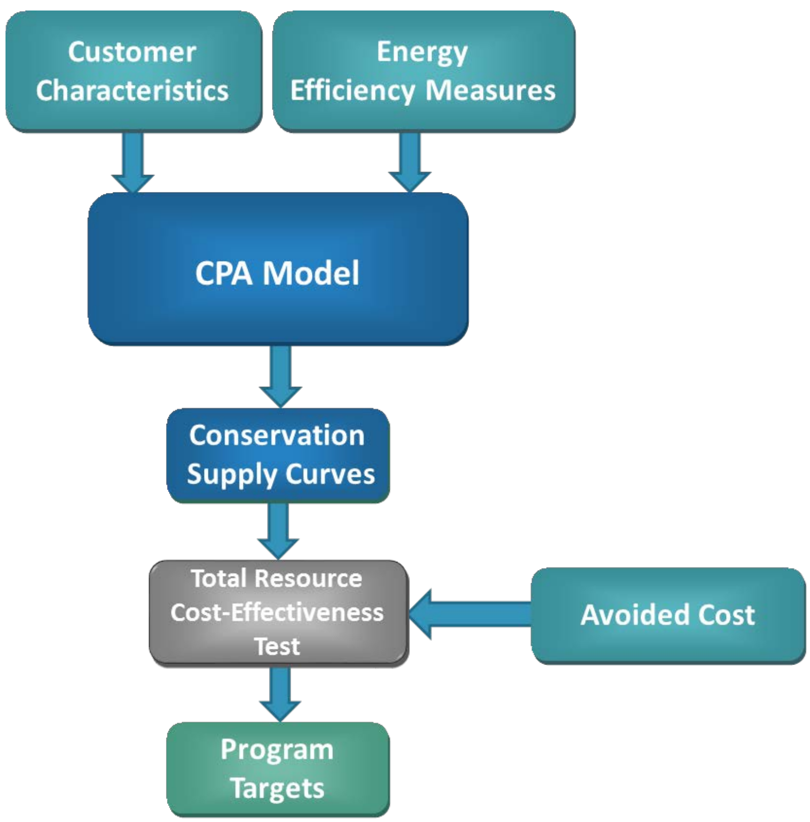
CPA Methodology

This study is a comprehensive assessment of the energy efficiency potential in Cowlitz 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 Cowlitz PUD's conservation potential target. Specific assumptions and methodology as it pertains to compliance with the EIA is provided in the appendices 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 Cowlitz PUD's baseline was determined based on information provided by Cowlitz PUD's staff, surveys of Cowlitz PUD's service area, and NEEA's commercial and residential building stock assessments. In 2014, Cowlitz PUD commissioned a survey of its residential customers to inform residential sector characteristics (e.g., space heating fuel type, home vintage, etc.) and to evaluate saturation of energy efficient equipment.[1] This assessment used findings from this survey to estimate applicability of residential refrigerator, dishwasher, clothes washer, showerhead, faucet aerator and heat pump water heater measures. 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 Cowlitz PUD's recent conservation achievements for measures baselines that have not been updated since the 2011 Residential Building Stock Assessment. Cowlitz 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.

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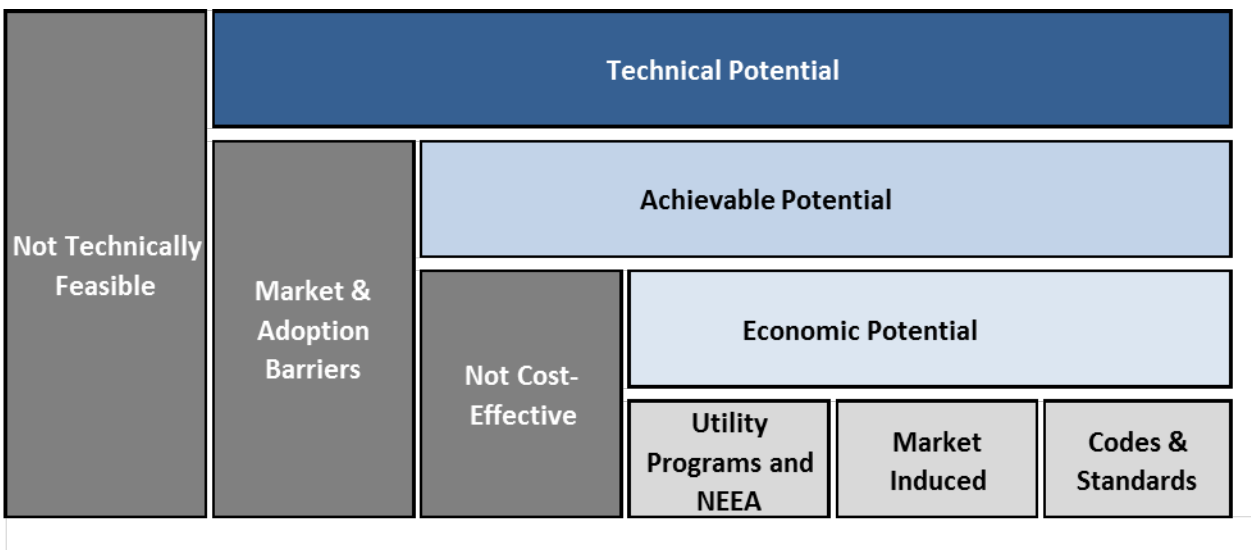
[1] Clearspring Energy Advisors. 2015. *2014 Residential Energy & Efficiency Survey Results.* Longview, WA: Public Utility District No. 1 of Cowlitz County.

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 efficiency measure. When these factors are applied, the remaining potential is called the achievable potential. Economic potential is a subset of the achievable potential that has been screened for cost effectiveness through a benefit-cost test.

Figure 2 illustrates the three types of potential followed by more detailed explanations. The 20-year economic achievable potential estimated in the CPA will be met through utility programs, NEEA accomplishments, code and standards not known at the time of this study and market induced savings.

Figure 2
Types of Energy Efficiency Potential[2]



Technical – Technical potential is the amount of energy efficiency potential that is available, regardless of cost or other technological or market constraints, such as customer willingness to adopt 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

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[2] Adapted from Northwest Power and Conservation Council. *Draft Seventh Northwest Conservation and Electric Power Plan*. October 20, 2015. Page 12-10.

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 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 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. The avoided costs used in the economic screening are discussed below.

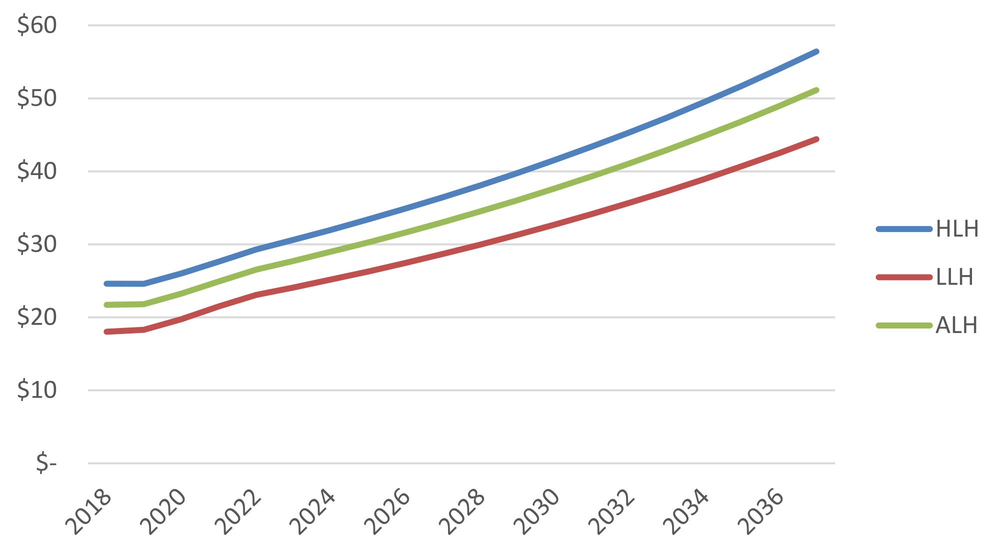
Avoided Cost

Each component of the avoided cost of energy efficiency measure savings is described below.

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

Social Cost of Carbon

In addition to the avoided cost of energy, energy efficiency provides the benefit of reducing carbon emissions. The revised EIA rules require the inclusion of the social cost of carbon. Because uncertainty exists around this value, a range of values was considered. These included a forecast of prices from the California cap and trade market, as well as the federal interagency workgroup values that were considered in the Seventh Plan.

Renewable Energy Portfolio Cost

By reducing Cowlitz PUD's overall load, energy efficiency provides a benefit of reducing the RPS requirement. Cowlitz 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. EES has used a forecast of REC prices and incorporated them into the avoided costs of energy efficiency accordingly.

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.

The District's 2016 IRP identified that the utility had sufficient resources for average annual energy requirements, but showed a need for new resources to meet peak demands. Since the Northwest does not have a capacity market, other resources must serve as proxy values for the value of generation capacity resources. For the 2017 CPA, demand response resources were modeled to determine the value of generation capacity.

EES scaled the NW Power Council's regional demand response potential from the Seventh Plan by the District's share of residential, commercial, and industrial loads, according to the sector of the demand response resource. The scaled supply curve of demand response resources was assessed to find the cost of the marginal resource that would meet the District's need for capacity, which was found to be approximately 20 MW. That marginal resource was found to cost $19.20/kW-yr. This value was used in the base case. In the low scenario, it was assumed that the market would continue to be able to serve capacity needs, and a value of $0/kW-yr was assumed. 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, and the social cost of carbon. Through the variance of these components, implied risk credits of up to $53/MWh and $95.80/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.

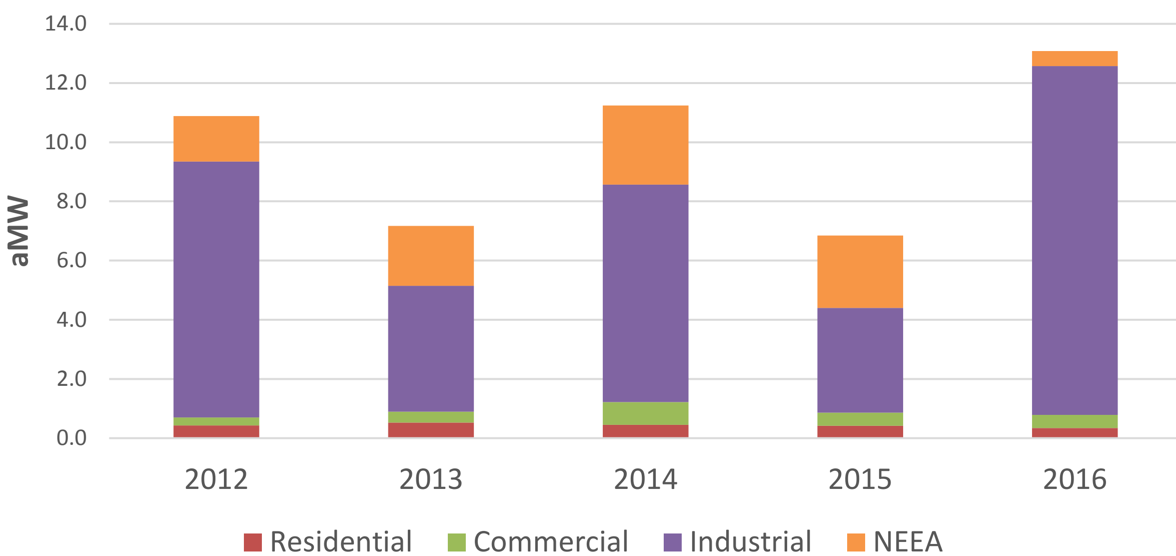
The finance rate is developed from two sets of assumptions. The first set of assumptions describes the relative shares of the cost of conservation distributed to various sponsors. Conservation is funded by the Bonneville Power Administration (BPA), utilities, and customers. The second set of assumptions 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

Cowlitz 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 incentives for weatherization upgrades, appliances, heat pumps and ductless heat pumps, motor rewinds and custom projects. In addition to utility programs, Cowlitz PUD receives credit for market-transformation activities accomplished by the Northwest Energy Efficiency Alliance (NEEA) in its service territory. While they have contributed more than 2.5 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 Cowlitz PUD's conservation achievement from 2012 through 2016.

Figure 4
Recent Conservation Achievement by Sector

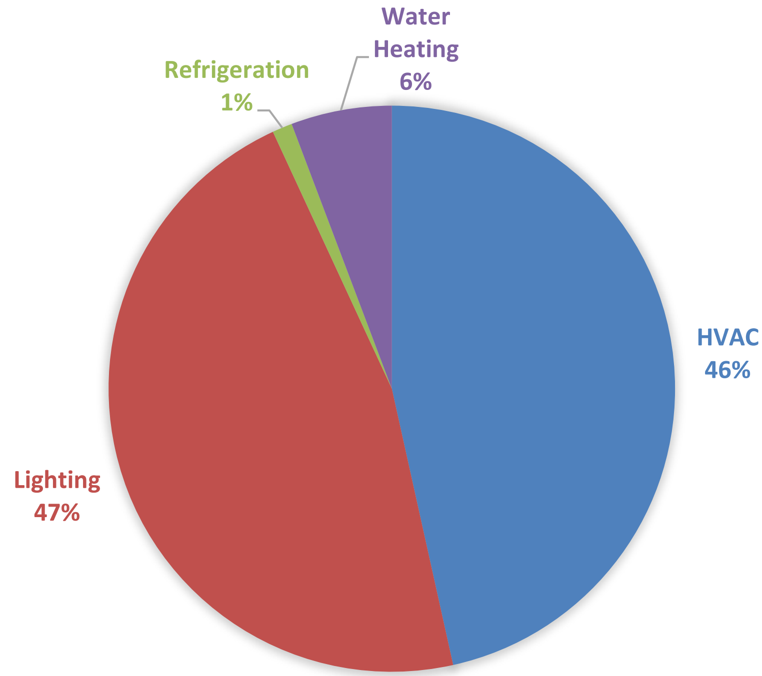


Cowlitz PUD has achieved an average of 9.85 aMW of conservation per year since 2012 through both utility program efforts and NEEA savings. More detail for these savings are provided below for each sector.

Residential

Figure 5 shows recent residential sector conservation achievement by measure category. HVAC and lighting measures are the largest areas of achievement in the residential sector. Within the HVAC category are both weatherization and heating system measures like heat pumps. Water heating represents the majority of the remaining savings.

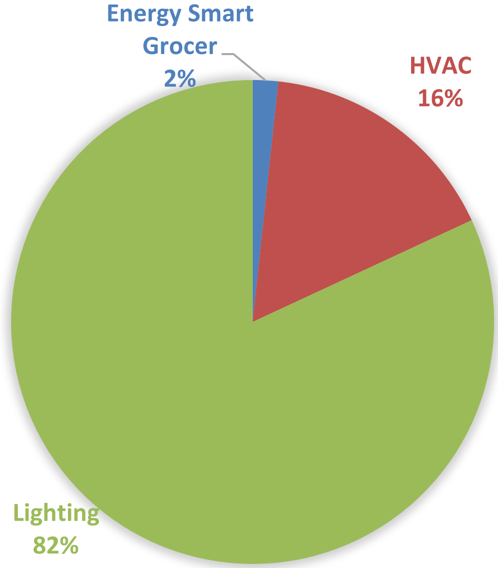
Figure 5
2015-2016 Residential Program Achievements by End-Use



Commercial

Cowlitz PUD has achieved the majority of recent commercial sector savings through lighting measures (Figure 6). The utility has also achieved notable savings through custom HVAC projects and the Energy Smart Grocer program.

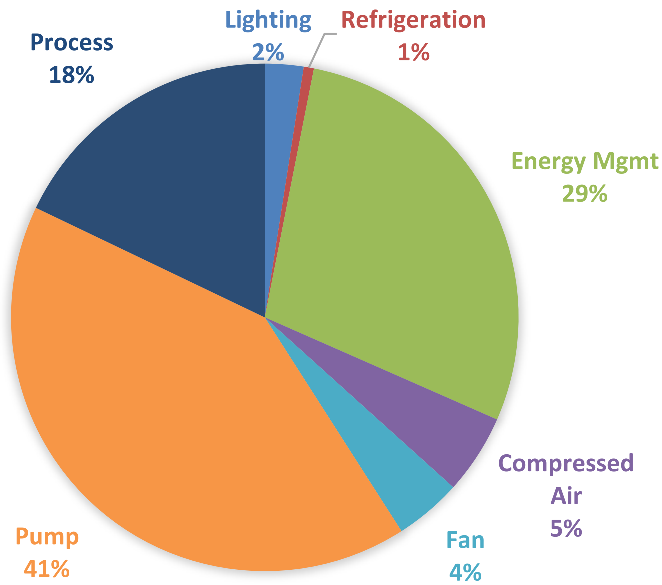
Figure 6
2015-2016 Commercial Program Achievements by End-Use



Industrial

Consistent with the large amount of industrial sector load in Cowlitz PUD's service territory, the utility has achieved considerable savings through energy efficiency projects at industrial facilities (Figure 7). Due to the custom nature of industrial sector energy usage, significant savings have been achieved through various custom projects and energy management efforts. Custom projects cover energy efficiency measures on a wide variety of industrial systems, including compressed air, fans, pumps, and other industrial process equipment.

Figure 7
2015-2016 Industrial Program Achievements by End-Use



Current Conservation Programs

Cowlitz PUD offers a wide range of conservation programs to its customers. These programs include several appliance rebates, weatherization incentives, heat pump rebates, and custom commercial and industrial projects. Some of Cowlitz PUD's current program offerings are detailed below.

Residential

- *Ductless Heat Pump Rebates – Ductless heat pumps are eligible for incentives ranging from $800 to $1200.*
- *Smart Thermostats* – For qualifying smart thermostats connected to in-home Wi-Fi, a rebate of up to $125 is available.
- *Heat Pump Rebates* – Air source heat pump conversions in homes with forced air furnaces are eligible for rebates of $1,400. $500 rebates are available for air source heat pump upgrades for homes with existing heat pumps or with zonal heating. These rebates are also available for new residential homes with electric heating.
- *Duct Sealing* – This program offers rebates of $200 and $250 for duct sealing in manufactured and site built homes, respectively, for Performance Tested Comfort System (PTCS) duct sealing.
- *Weatherization/Insulation Rebates* – This program provides rebates from $0.10 to $0.65 per square foot for ceiling, floor and wall insulation in homes with electric heat (depending on existing insulation levels). Rebates of up to $1 per square foot are available for low-income weatherization upgrades. Energy efficient window upgrades are eligible for rebates of $3 per square foot and rebates of up to $20 per square foot are available for low income window

upgrades. Cowlitz PUD also offers rebates of $0.02 per square foot for air-sealing measures ($0.10 for low income air sealing).

- *Clothes Washers* – Rebates of $30 are available for qualifying clothes washers.
- *Heat Pump Water Heater* – Rebates of $300 to $500 are available for heat pump water heaters, depending on capacity.
- *Refrigerator/Freezer Recycling* – Cowlitz PUD provides pick-up service and $30 rebates for recycling a qualifying refrigerator or freezer.
- *Simple Steps, Smart Savings* – Cowlitz PUD offers in-store discounts to customers for Energy Star qualified CFLs, LEDs, showerheads and light fixtures at participating retail locations.
- *Energy Audits* – Cowlitz PUD offers free energy audits for residential customers.

Commercial, Industrial, and Agriculture

- *Lighting* – Cowlitz PUD offers a wide variety of incentives for installing or upgrading indoor and outdoor lighting at new or existing commercial and industrial sites. Rebates range from $3 to $500, depending on existing and efficient equipment and wattage reduction. Additional requirements and restrictions apply.
- *Motor Rewind* – Incentives of $1 per horsepower (HP) are available for rewinds of each qualifying motor from 1 HP to 5,000 HP.
- *Energy Smart Industrial* – Cowlitz PUD participates in BPA's Energy Smart Industrial program which provides incentives Strategic Energy Management (SEM), including Track and Tune and High-Performance Energy Management (HPEM). Track and Tune helps facilities improve O&M efficiencies while HPEM provides training and technical support to help upper management and process engineers implement energy management in their core business practices.
- *Custom Industrial Projects* – Through the Energy Savings Plan Industrial Conservation Effort (EnergySPICE) Program, Cowlitz PUD offers incentives of up to $0.25 per kilowatt hour of verified annual energy savings or 70 percent of incremental project costs for custom industrial projects.
- *Custom Commercial Projects* – Through the Commercial Energy Efficiency Program (CEEP), Cowlitz PUD provides incentives of up to $0.20 per kilowatt hour of verified annual energy savings or 70 percent of incremental project costs for custom commercial projects, whichever is less.

Summary

Cowlitz PUD plans to continue offering incentives for energy efficiency investments. The results of this study will assist Cowlitz PUD program managers in strategic planning for energy efficiency program offerings, incentive levels, and program evaluation.

Customer Characteristics Data

Cowlitz PUD serves over 48,200 electric customers in Cowlitz County, Washington, with a service area population of approximately 102,080. A key component of an energy efficiency assessment is understanding 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 and vintage distribution, space-heating fuel, and water heating fuel. Tables 1, 2, and 3 show relevant residential data for single family, multi-family and manufactured homes in Cowlitz PUD's service territory. Residential characteristics are based on utility service area data collected from Cowlitz PUD's 2014 residential energy and efficiency survey.[3] These data provide estimates of the current residential characteristics in Cowlitz PUD's service territory and are utilized as the baseline in this study.

This assessment assumes an average annual residential growth rate of 0.5 percent. Residential demolition rates are based on regional assumptions.

Table 1
Residential Building Characteristics

Heating Zone	Cooling Zone	Solar Zone	Residential Households	Total Population
1	1	2	43,354	102,080

Table 2
Existing Homes - Heating / Cooling System Saturations

	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
New & Existing Homes				
Electric Forced Air Furnace (FAF)	21%	2%	2%	54%
Heat Pump (HP)	39%	1%	1%	15%
Ductless HP (DHP)	1%	2%	2%	1%
Electric Zonal (Baseboard)	24%	81%	81%	3%
Central AC	5%	4%	4%	16%
Room AC	20%	8%	8%	19%

[3] Clearspring Energy Advisors. 2015. *2014 Residential Energy & Efficiency Survey Results.* Longview, WA: Public Utility District No. 1 of Cowlitz County.

Table 3 Appliance Saturations				
	Single Family	Multifamily - Low Rise	Multifamily - High Rise	Manufactured
New & Existing Homes				
Electric WH	93%	95%	95%	89%
Refrigerator	138%	102%	102%	120%
Freezer	89%	5%	5%	44%
Clothes Washer	95%	46%	46%	95%
Clothes Dryer	94%	46%	46%	88%
Dishwasher	87%	78%	78%	76%
Electric Oven	94%	97%	97%	90%
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 per square foot). Commercial building square footage for the 2017 assessment was estimated based on an escalation of the 2016 floor area estimate from Cowlitz PUD's 2015 CPA, which was based on 2014 commercial sector load (MWh) and commercial building data from Cowlitz PUD's 2013 CPA.

Table 4 shows estimated 2018 commercial square footage in each of the 18 building segments. This assessment assumes a sector-wide growth rate of 1.0 percent.

Table 4 Commercial Building Square Footage by Segment	
Large Office	1,071,469
Medium Office	-
Small Office	1,096,560
Extra Large Retail	401,162
Large Retail	1,068,065
Medium Retail	2,050,911
Small Retail	-
School (K-12)	3,311,683
University	63,520
Warehouse	8,062,120
Supermarket	103,849
Mini Mart	599,548
Restaurant	504,210
Lodging	751,341
Hospital	485,466
Residential Care	377,278
Assembly	-
Other Commercial	4,492,870
Total	**24,440,052**

Industrial

The methodology for estimating industrial potential is different from the approach used for the residential and commercial sectors primarily because industrial energy efficiency opportunities are based on the distribution of electricity use among processes at industrial facilities. Industrial potential for this assessment was estimated based on the Council's "top-down" methodology that utilizes annual consumption by industrial segment and then disaggregates total electricity usage by process shares to create an end-use profile for each segment. Estimated measure savings are applied to each sector's process shares.

Cowlitz PUD provided a year of energy use for its industrial customers, as well as forecasts for the three largest Schedule 50 pulp and paper customers. Individual industrial customer usage is summed by industrial segment in Table 5. The industrial sector consumption totaled 2,909,969 MWh after factoring in plans for reductions in operation at once facility. Regional growth rates were applied to the sectors other than the pulp and paper industry, whose growth rates were calculated based on their individual forecasts.

Table 5
Adjusted 2016 Industrial Sector Load by Segment[4]

Segment	MWh	Growth Rate
Mechanical Pulp	-	-
Kraft Pulp	830,651	0.4%
Paper	1,331,702	-0.5%
Foundries	724	1.0%
Frozen Food	9,157	1.0%
Other Food	24,154	1.0%
Sugar	-	-
Lumber	67,066	1.0%
Panel	-	-
Wood	9,370	1.0%
Electric Fabrication	-	-
Silicon	-	-
Metal Fabrication	1,680	1.0%
Equipment	2,825	1.0%
Cold Storage	8,855	-4.0%
Fruit Storage	-	-
Refinery	-	-
Chemical	322,830	1.0%
Miscellaneous Manufacturing	300,955	1.0%
Total	**2,909,969**	**0.13%**

Agriculture

To determine agriculture sector characteristics in Cowlitz 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.[5]

The Census estimates 7,199 irrigated acres in Cowlitz PUD's service territory. Irrigated acreage is used to estimate savings from energy efficient irrigation hardware upgrades and low energy spray application (LESA) measures. However, based on information provided by Cowlitz PUD, measures for center pivot irrigation systems are not applicable to the utility's service area and have thus been removed from the 2017 CPA potential.

In addition to irrigated acreage, the service area has 492 farms and 674 head of dairy cattle. These data are used to estimate area lighting and dairy measure potential, respectively. Table 6 shows key agriculture sector characteristics and applicable data sourced from the 2012 Census.

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[4] 2016 actual loads were adjusted to account for a planned load reduction at one of the large facilities.

[5] United States Department of Agriculture. (2014). 2012 Census of Agriculture. Retrieved from: http://www.agcensus.usda.gov/Publications/2012/

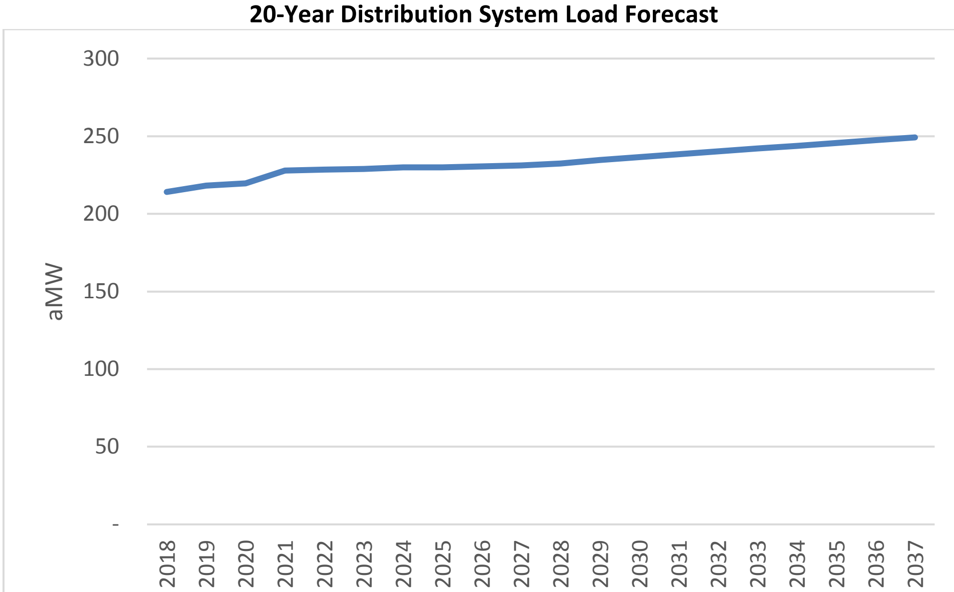
Table 6 Agriculture Sector Inputs		
Agriculture Data	**Count**	**2012 Census Data Point**
Number of Farms	492	Total number of farms
Irrigated Acres	7,199	Irrigated land
Dairy Cows	674	Milk Cows

Distribution Efficiency (DEI)

For this analysis, EES developed an estimate of distribution system conservation potential using the Council's Seventh Power Plan approach and measures. 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.

Cowlitz PUD provided a forecast for the first half of the 2017 CPA planning period, which was extended to 20 years based on the compound average growth rate of 0.2%. Distribution system potential is estimated for this assessment based on Cowlitz PUD's distribution level loads, which excludes industrial load served at the transmission level. The distribution load forecast is graphed in Figure 8 and distribution system conservation is discussed in detail in the next section.

Figure 8
20-Year Distribution System Load Forecast



Results – Energy Savings

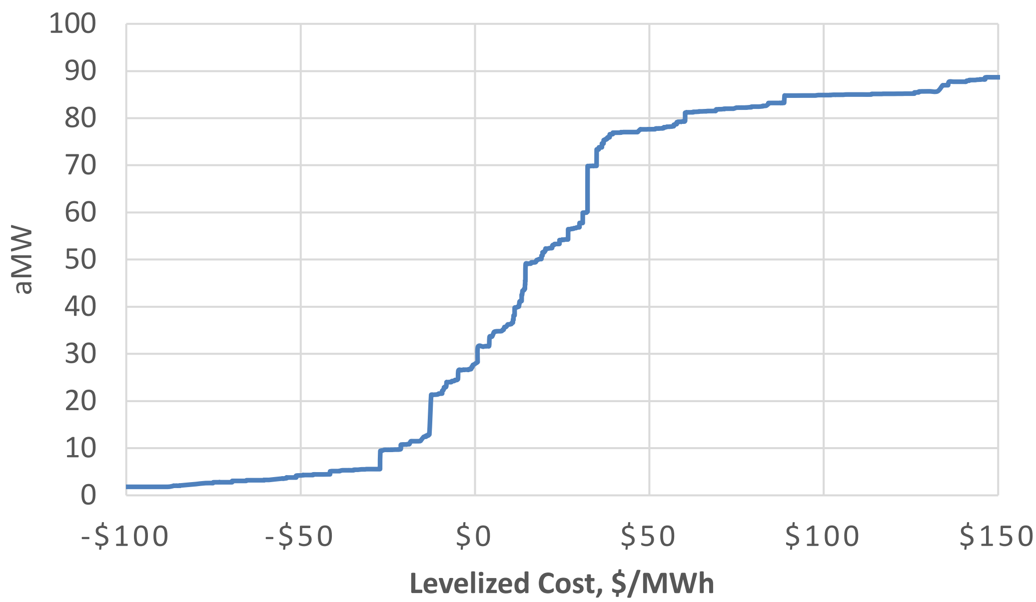
Achievable Conservation Potential

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 9, below, shows a supply curve of the 20-year 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 IRPs. The cost used is the net levelized cost, and includes credits for deferred transmission and distribution system costs, avoided periodic replacements, non-energy impacts, etc. As such, some measures with non-energy savings like clothes washers and showerheads, measures that avoid future equipment costs like long-lasting LED lighting, and measures that provide significant reductions in peak demand have a negative net levelized cost. This net levelized cost facilitates a more direct comparison to other supply-side options.

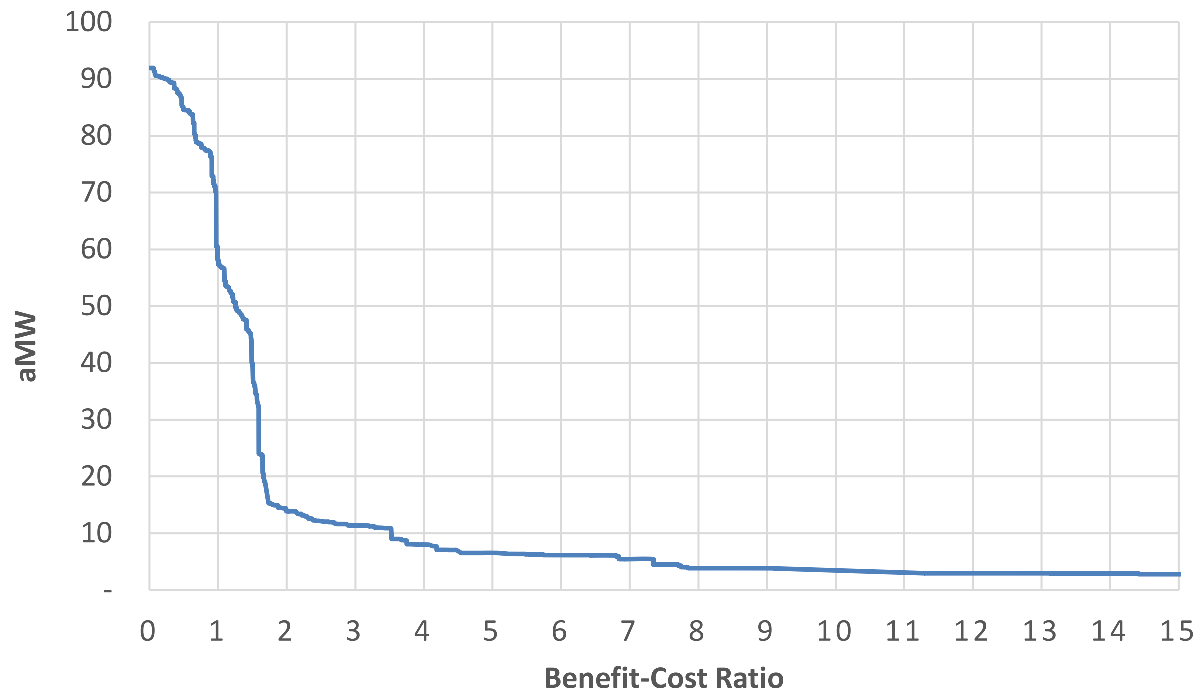
Figure 9 shows that approximately 57 aMW of savings potential is available for less than $30/MWh and nearly 82 aMW is available for under $80/MWh. Total technical-achievable potential for Cowlitz PUD is 91.93 aMW over the 20-year study period.

Figure 9
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 10 below. This figure repeats the overall finding that approximately 58 aMW of potential is cost-effective with a benefit-cost ratio greater than or equal to 1.0. The line is very 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 10
20-Year Technical-Achievable Potential Benefit-Cost Ratio Supply Curve



Economic Achievable Conservation Potential

Economic achievable 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.

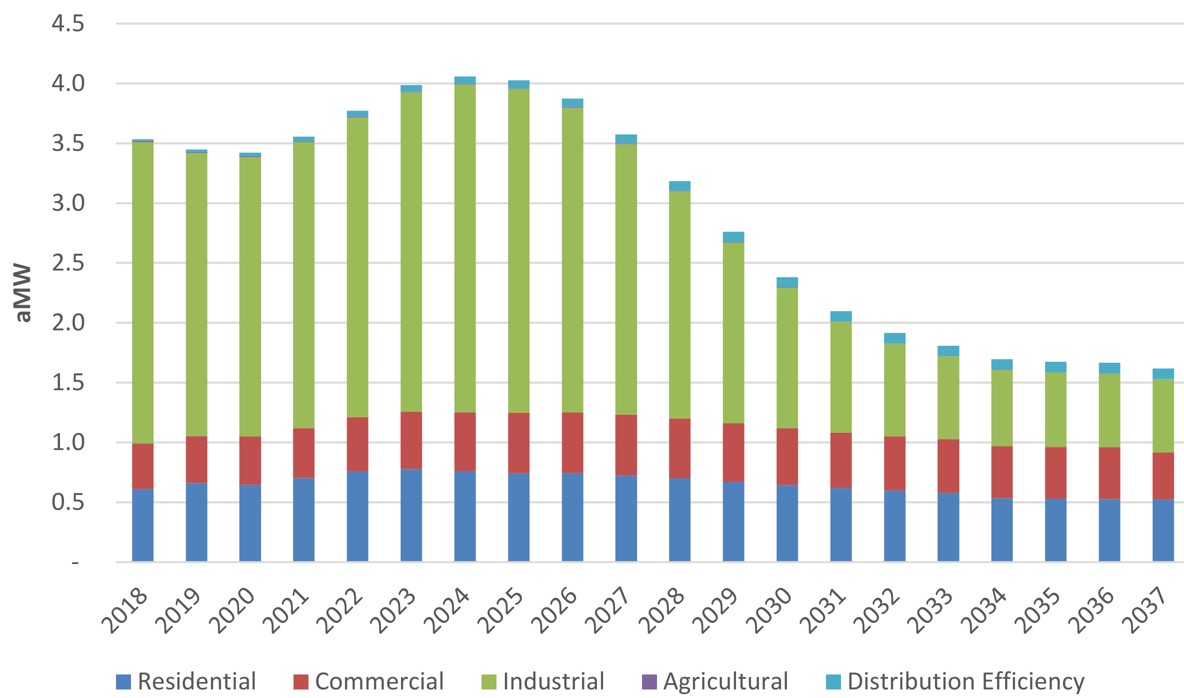
Table 7 shows aMW of economic achievable potential by sector in 2, 6, 10 and 20-year increments. Compared with the technical achievable potential, it shows that 58.05 aMW of the total 91.93 aMW is cost effective for Cowlitz PUD.

Table 7 Cost Effective Achievable Potential - Base Case (aMW)				
	2-Year	6-Year	10-Year	20-Year
Residential	1.27	4.15	7.12	13.05
Commercial	0.78	2.54	4.55	9.08
Industrial	4.88	14.78	25.03	34.48
Agricultural	0.02	0.05	0.07	0.10
Distribution Efficiency	0.03	0.21	0.48	1.35
Total	**6.98**	**21.72**	**37.25**	**58.05**

Sector Summary

Figure 11 shows economic achievable potential by sector on an annual basis.

Figure 11
Annual Economic Achievable Potential by Sector

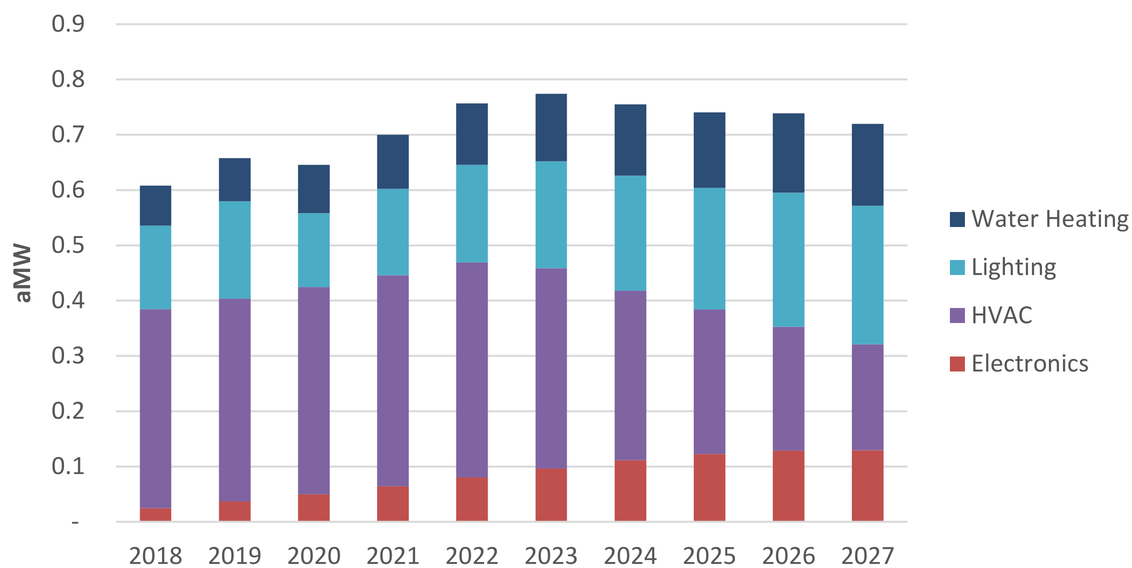


The largest share of the potential is in the industrial sector, followed by potential in the residential sector and commercial sector. Ramp rates from the Seventh Power Plan were used to establish reasonable conservation availability. The ramp rates for commercial lighting measures were adjusted to reflect both resource availability and Cowlitz PUD's current program levels and achievements. The ramp rate adjustment resulted in an increase in near-term potential for commercial lighting compared with the potential calculated using the Seventh Plan ramp rates as-is. No other ramp rate adjustments were necessary in order to develop potential estimates the align with both program achievement and remaining future potential. Appendix VII has more detail on ramp rates.

Residential

Within the residential sector, lighting measures account for a significant share of cost-effective conservation (Figure 12). 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. Another significant area for residential savings is water heating, including heat pump water heaters, low-flow showerheads, and faucet aerator measures. Smart power strip measures make up the majority of potential in the electronics category.

Figure 12
Annual Residential Cost-Effective Potential by End Use

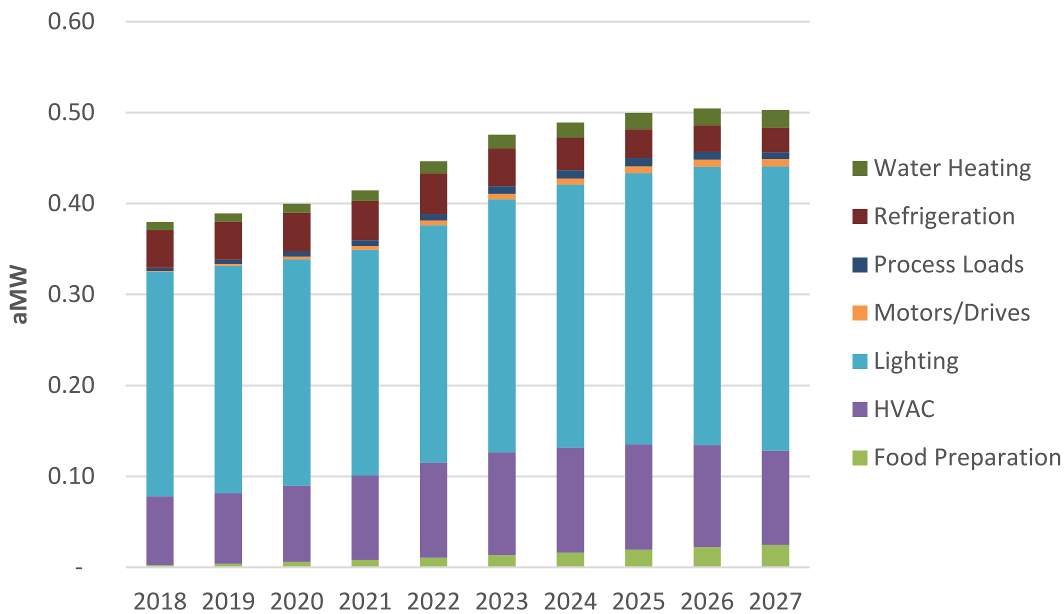


Commercial

Commercial lighting measures remain the largest contributors to commercial conservation potential (Figure 13). 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 13
Annual Commercial Cost-Effective Potential by End Use

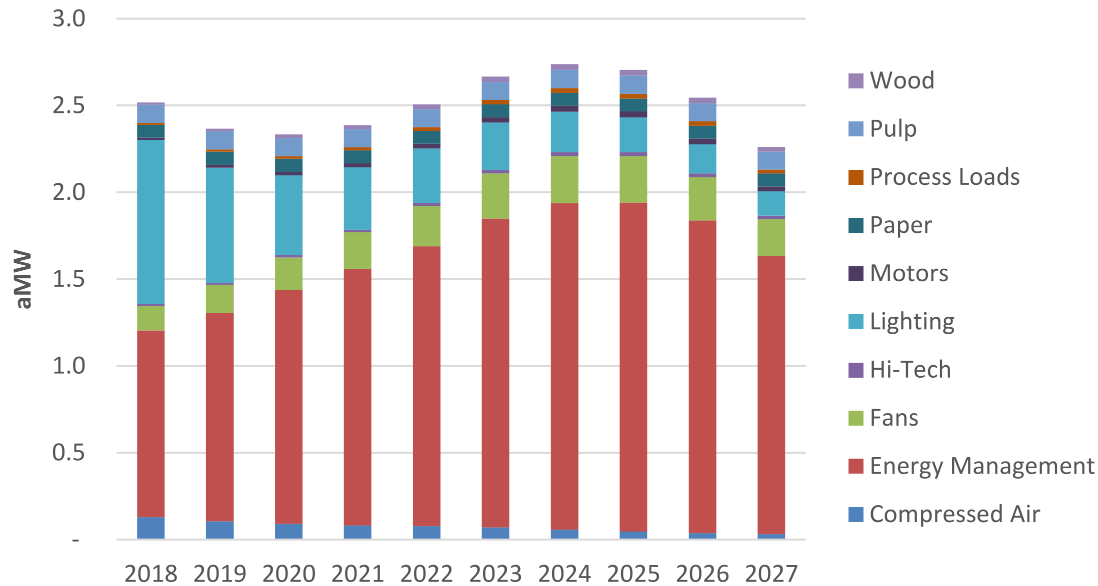


Industrial

Figure 14 shows annual industrial sector potential by industrial end use. 85 percent of industrial potential is attributed to the kraft pulp and paper segments. The majority of the industrial potential is in energy management measures. Energy management measures include both Strategic Energy Management programs and improved management of motor-driven systems.

Industrial potential was adjusted for Cowlitz PUD's historic industrial sector achievement since the Seventh Plan. A portion of these savings were removed, however, due to the planned reduction in operation at a large industrial facility, which was included in the load forecast. EES also accompanied Cowlitz PUD staff on visits to three large pulp and paper mills to discuss historic and planned energy efficiency work. In each of these discussions, mill staff stated that they could only get approvals for projects with short paybacks and projects requiring large investments were not being considered. As such, the most expensive process measures applicable to these industries were not included.

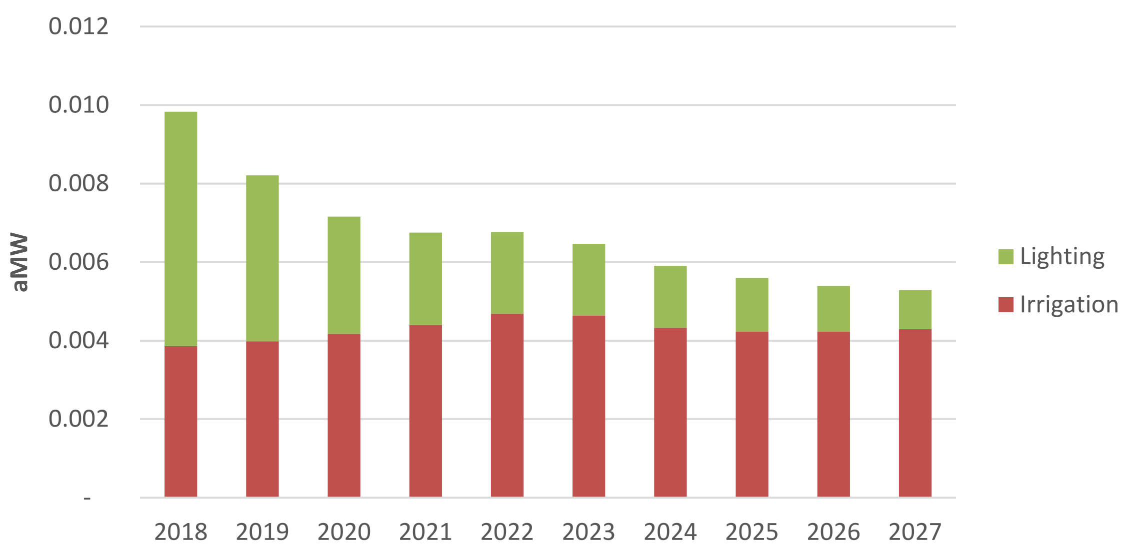
Figure 14
Annual Industrial Cost-Effective Potential by End Use



Agriculture

Agriculture sector potential is a product of total acres under irrigation in Cowlitz PUD's service territory, number of pumps, annual dairy production, and the number of farms. As shown in Figure 15, irrigation measures account for the largest area of conservation potential in the agriculture sector. This category includes irrigation hardware 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. The overall savings potential within the agriculture sector is small compared with residential and commercial opportunities.

Figure 15
Annual Agriculture Cost-Effective Potential by End Use

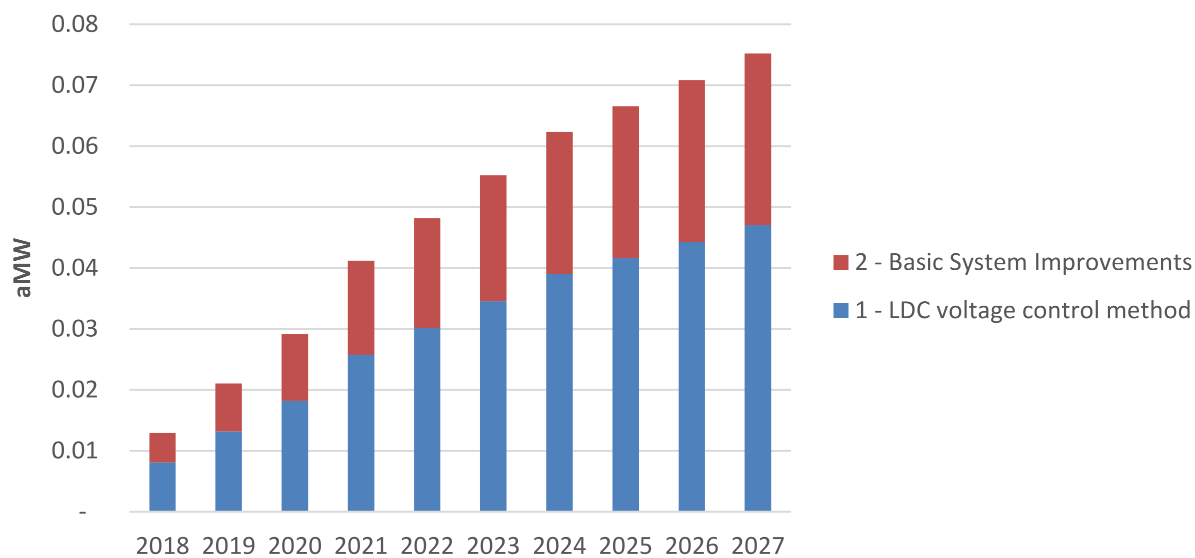


Distribution Efficiency

Distribution system energy efficiency measures regulate voltage and upgrade systems to improve the efficiency of utility distribution systems and reduce line losses. The Seventh Plan estimates distribution system potential based on end system energy sales. 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. As such, future energy efficiency was included in the load forecast used to estimate the potential. Retail sales to transmission voltage customers were excluded from the distribution efficiency analysis.

Distribution system conservation potential is shown in Figure 16. Although five measures were considered in the analysis, only two measures were cost effective.

Figure 16
Annual Distribution System Cost-Effective Potential by End Use



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 Cowlitz PUD's expected avoided costs and sector growth rates. 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.

Avoided Cost 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. The High and Low load growth scenarios are relative to the Base Case load growth assumptions. 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 8 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 8 Avoided Cost Assumptions by Scenario, $2012			
	Base	**Low**	**High**
Energy, 20-yr levelized $/MWh	Market Forecast	-1.25σ*	+1.25σ*
Social Cost of Carbon, $/MWh	California Carbon Market	$0	Federal/7th Power Plan Values
Value of REC Compliance	Existing RPS	Existing RPS	Existing RPS
Distribution System Credit, $/kW-yr	$31	$31	$31
Transmission System Credit, $/kW-yr	$26	$26	$26
Deferred Generation Capacity Credit, $/kW-yr	$19.20	$0	$115
Implied Risk Adder $/MWh $/kW-yr	N/A	Up to: -$52/MWh -$19.20/kW-yr Average of: -$19/MWh -$19.20/kW-yr	Up to: $53/MWh $95.80/kW-yr Average of: $24/MWh $95.80/kW-yr

***The standard deviation of historical prices was calculated and applied to the base market energy price forecast.*

Table 9 summarizes results across each avoided input scenario, using Base Case load forecasts and measure acquisition rates.

Table 9 Cost-Effective Potential -Avoided Cost Comparison				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Base Case	6.98	21.72	37.25	58.05
Low Avoided Costs	4.63	13.78	23.51	39.46
High Avoided Costs	9.31	30.56	53.75	83.54

Table 9 shows a wide range of results to both lower and higher avoided costs relative to the base case. Over the 20-year period, there is a higher sensitivity to the high avoided cost scenario.

Overall, energy efficiency remains a low-risk resource for Cowlitz PUD. Energy efficiency is purchased in small increments over time, meaning that buying too much energy efficiency is unlikely.

Growth Scenarios

Described below are the results for the scenarios that combine these low and high avoided costs with low and high growth rate assumptions.

For reference, the key growth assumptions for each scenario are summarized in Table 10 below.

Table 10 Growth Rate Assumptions			
	Residential	Commercial	Industrial
Base Case	0.50%	1.00%	0.13%
Low Growth	0.10%	0.70%	0.00%
High Growth	0.90%	1.30%	1.00%

Low Scenario

The Low conservation scenario evaluates energy efficiency cost effectiveness under a low growth scenario with the low avoided cost assumptions described above. Under the Low scenario, residential growth is 0.4 percentage points lower compared with the Base Case, commercial growth is reduced by 0.3 percentage points, and industrial sector growth eliminated for any segments with positive growth in the Base Case. Results of the Low scenario analysis are shown in Table 11.

Table 11 Cost-Effective Potential - Low Avoided Costs & Growth (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	0.64	2.06	3.83	8.01
Commercial	0.44	1.41	2.48	5.16
Industrial	3.29	9.41	15.51	22.94
Agricultural	0.01	0.03	0.04	0.07
Distribution Efficiency	0.03	0.21	0.48	1.35
Total	**4.41**	**13.12**	**22.35**	**37.54**

High Scenario

Under the High scenario, growth rates are increased to model a high growth future. The high avoided cost assumptions from Table 8 are also used. Growth parameters for the High scenario include:

Table 12 shows economic achievable potential by sector for the High scenario.

Table 12 Cost Effective Potential - High Avoided Costs & Growth (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	1.41	4.97	9.35	20.83
Commercial	0.98	3.21	5.79	11.79
Industrial	8.76	28.21	48.58	63.84
Agricultural	0.02	0.05	0.08	0.11
Distribution Efficiency	0.05	0.29	0.68	1.91
Total	**11.22**	**36.74**	**64.48**	**98.49**

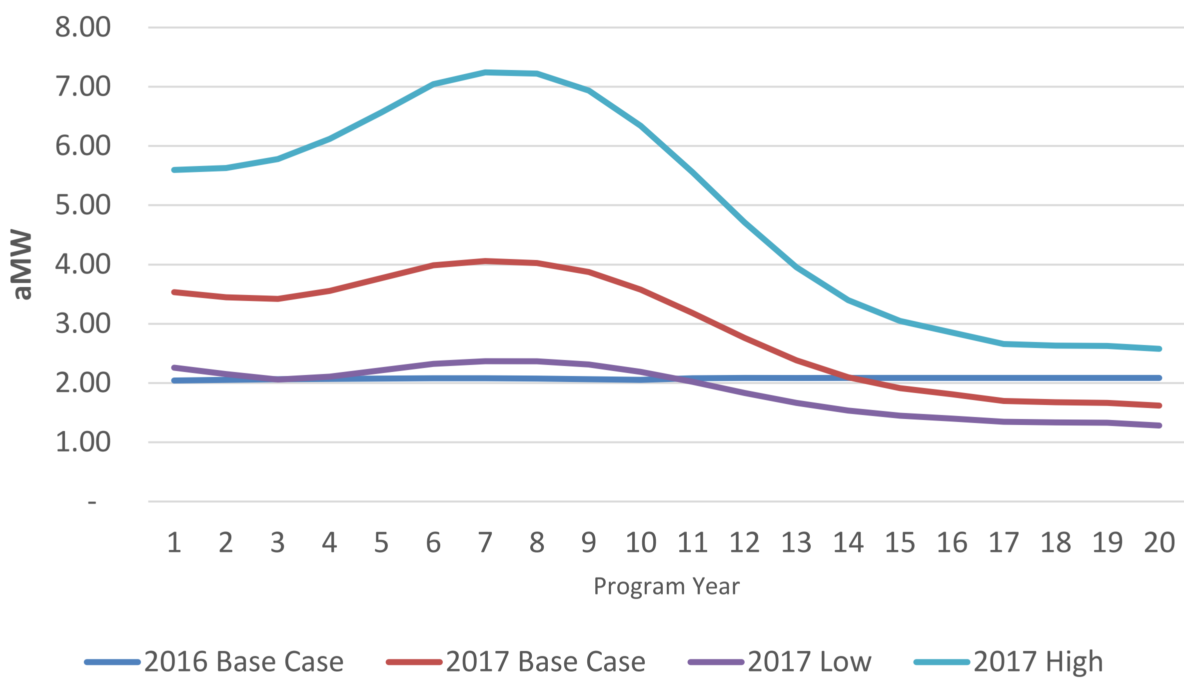
Scenario Summary

The 2, 6 and 10 and 20-year savings estimates for the four scenarios tested in this analysis are shown in Table 13, and Figure 17 graphs the Base Case, Low and High Growth scenarios.

Table 13
Economic Achievable Potential – Scenario Comparison (aMW)

	2 Year	5 Year	10 Year	20 Year
Base Case	6.98	21.72	37.25	58.05
Low Case	4.41	13.12	22.35	37.54
High Case	11.22	36.74	64.48	98.49

Figure 17
Conservation Scenarios – Annual Potential (aMW)



The Low scenario biennium potential is 37 percent lower than the Base Case biennium potential, and 35 percent lower over the 20-year study period. The High Scenario biennium potential is 61 percent higher than the Base Case, and 70 percent higher when considering the 20-year potential.

While the 2017 Base Case is higher than the 2016 Base Case, measure ramp rates were carefully considered to reasonably align with recent Cowlitz PUD achievement levels. Ramp rates are discussed further in Appendix VII.

Summary

This report summarizes the results of the 2017 CPA conducted for Public Utility District No. 1 of Cowlitz County. 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 and reduced baseline load, 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 for the Seventh Regional Power Plans. 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 Cowlitz 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."[6] 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.[7]

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 Cowlitz 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.

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

[7] 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

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

7^{th} 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 %ages 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 – "Public Utility District No. 1 of Cowlitz County – Conservation Potential Assessment". Draft Report – October 16, 2017.
2) Model – "EES CPA Model-v2.1b.xlsm" and supporting files
   a. MC_and_Loadshape_v3.0_24segment-Cowlitz-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 Cowlitz 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 to determine the net levelized cost, as described in this subsection:	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) i. Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits	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) ii. 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)	iii. 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 file for load shapes. The ProCost files handle the calculations.
h)	iv. 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)	v. Include avoided energy costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy 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 File ("Base Market Forecast" worksheet).
j)	vi. 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.
k)	vii. 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 $ 19.20/kW-yr in the cost effectiveness analysis for the Base Case Scenario. This is based upon Cowlitz 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 transmission capacity benefit.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option			
	NWPCC Methodology	**EES Consulting Procedure**	**Reference**
l)	viii. 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 files contain the carbon cost assumptions for each avoided cost scenario.
m)	ix. Include a risk mitigation credit to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources	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)	x. 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)	xi. Include an estimate of program administrative costs	Total costs were tabulated and an estimated 20% of total was assigned as the administrative cost. This value is consistent with regional average and BPA programs. The 20% value was used in the Fifth, Sixth, and Seventh Power plans.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
p)	xii. 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)	xiii. 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.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
r) xiii. 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 Cowlitz 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 uses three different avoided cost scenarios: Base, Low, and High. Each of these is discussed below.

Avoided Energy Value

For the purposes of the 2017 CPA, Cowlitz PUD provided a 45-day rolling average forecast of market prices for the Mid-Columbia trading hub covering the years 2018 through 2022. This forecast was then extended to cover the full 20 years of the study period. This section describes the methodology used to extend the forecast and compares the forecast to the market forecast used for the District's 2016 CPA, which was done as an update to the 2015 CPA.

Methodology

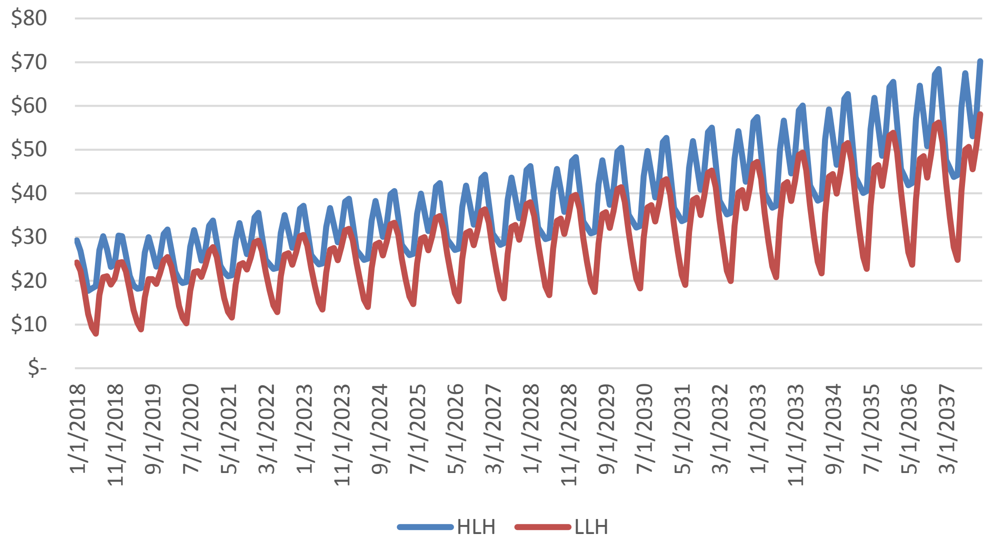
For the period January 2018 through December 2022, projected monthly on- and off-peak market prices were provided by the District in the form of a 45-day rolling average forecast. Using a rolling average forecast eliminates some of the daily volatility in price forecasts. The forward market prices upon which the avoided costs are based were provided on August 3, 2017. The compound annual growth rate over the five forecasted years was calculated to be 4.5% and 6.4% for on- and off-peak prices, respectively.

EES escalated prices using a growth rate of 4.5% for the remaining years of the 20-year study period, 2023 to 2037.

Results

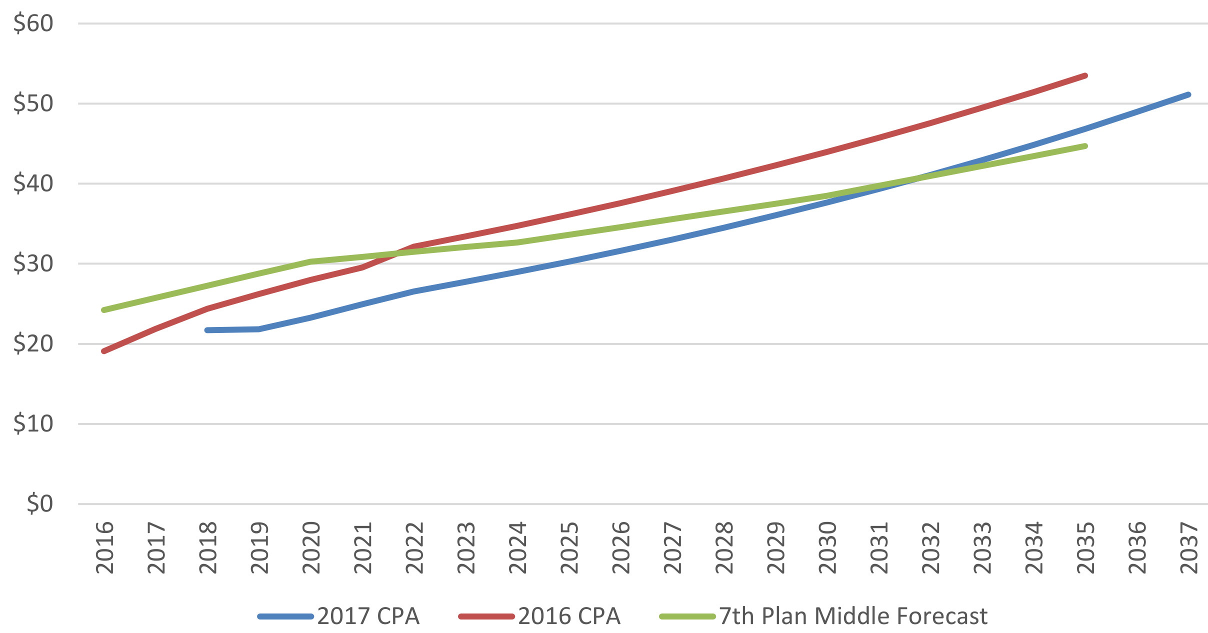
Figure IV-1 illustrates the resulting monthly, diurnal market price forecast. The levelized value of market prices over the study period is $34/MWh assuming a 4 percent real discount rate.

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



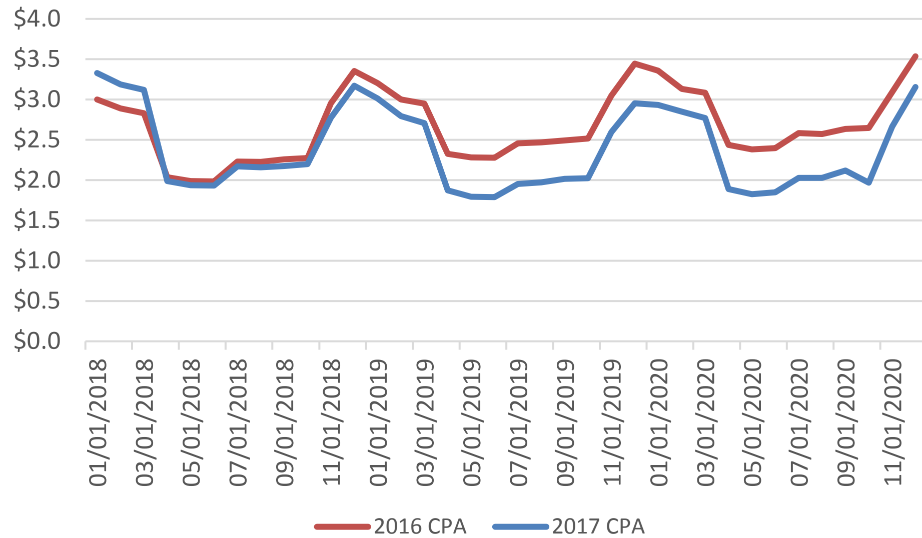
This market price forecast is lower than the market price forecast used in the District's most recent CPA (the 2016 CPA). It is also lower in the near term than the Northwest Power Council's Seventh Plan middle forecast. Figure IV-2 compares the forecasts.

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



The 2017 CPA's market price forecast for the period 2018 through 2035 is 12 percent lower compared with the 2016 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 2016 and 2017 CPAs. The projected average 2018-2020 Sumas natural gas price included in the 2017 CPA ($2.38/MMBtu) is 11 percent less than the projected average 2018-2020 Sumas natural gas price included in the 2016 CPA ($2.68/MMBtu).

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

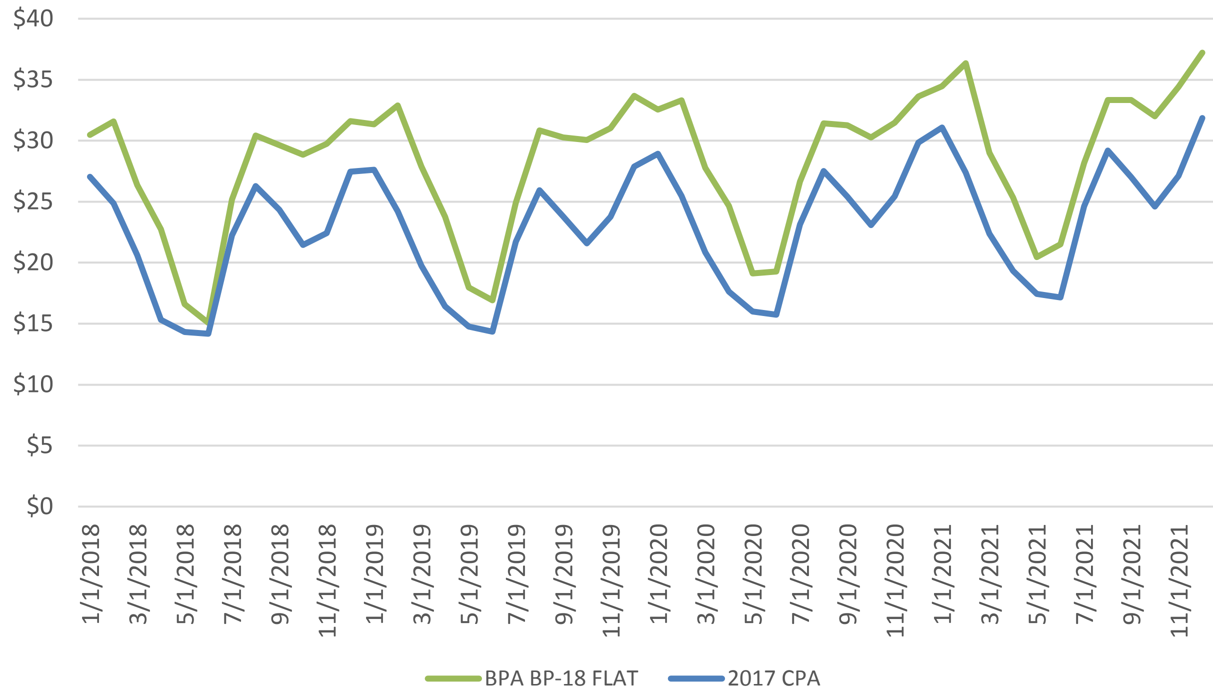


* Source: Henry Hub and Sumas Basis Differential Futures quotes as provided by CME Group

Benchmarking

Figure IV-4 compares the 2017 CPA forecast with the forecast included in BPA's Initial Proposal for FY18-19 rates for the first two years of the study. The monthly shapes are similar although there are some differences. 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 the date of the 45-day rolling average price forecast.

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 high- and low-case market price forecasts. To do this, EES looked at a history of Mid-Columbia 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
High Load Hour Market Price Forecast Comparison (2012$/MWh)

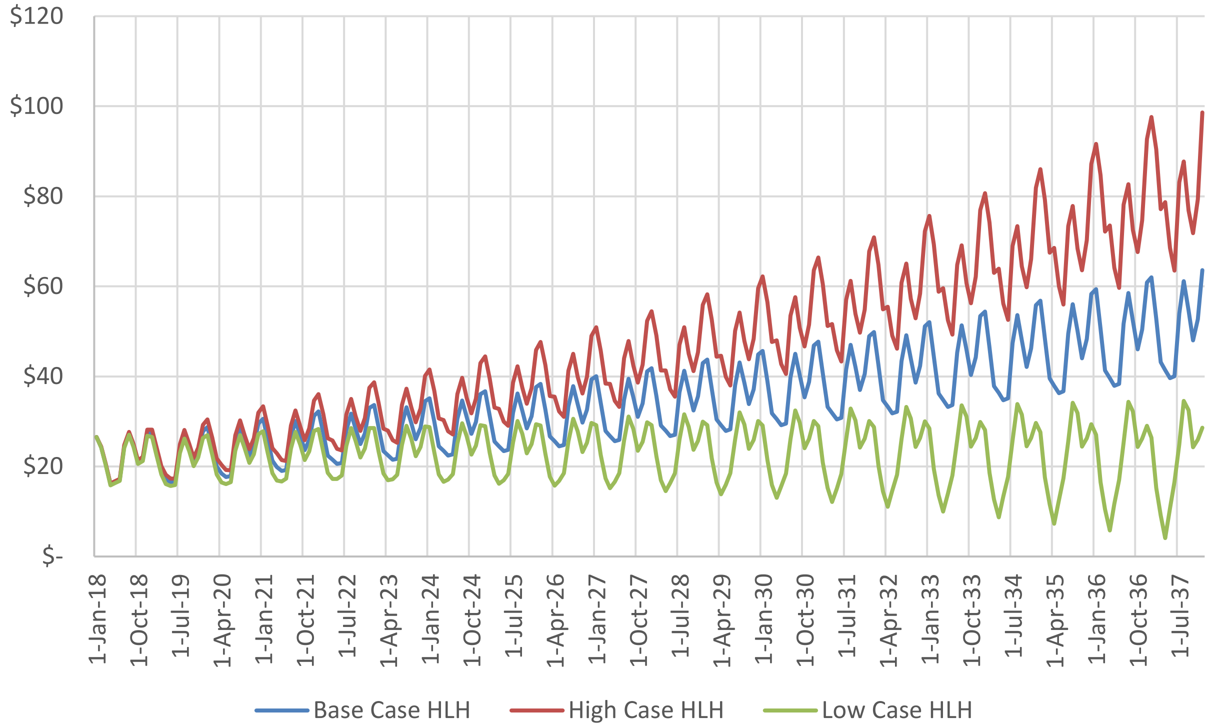
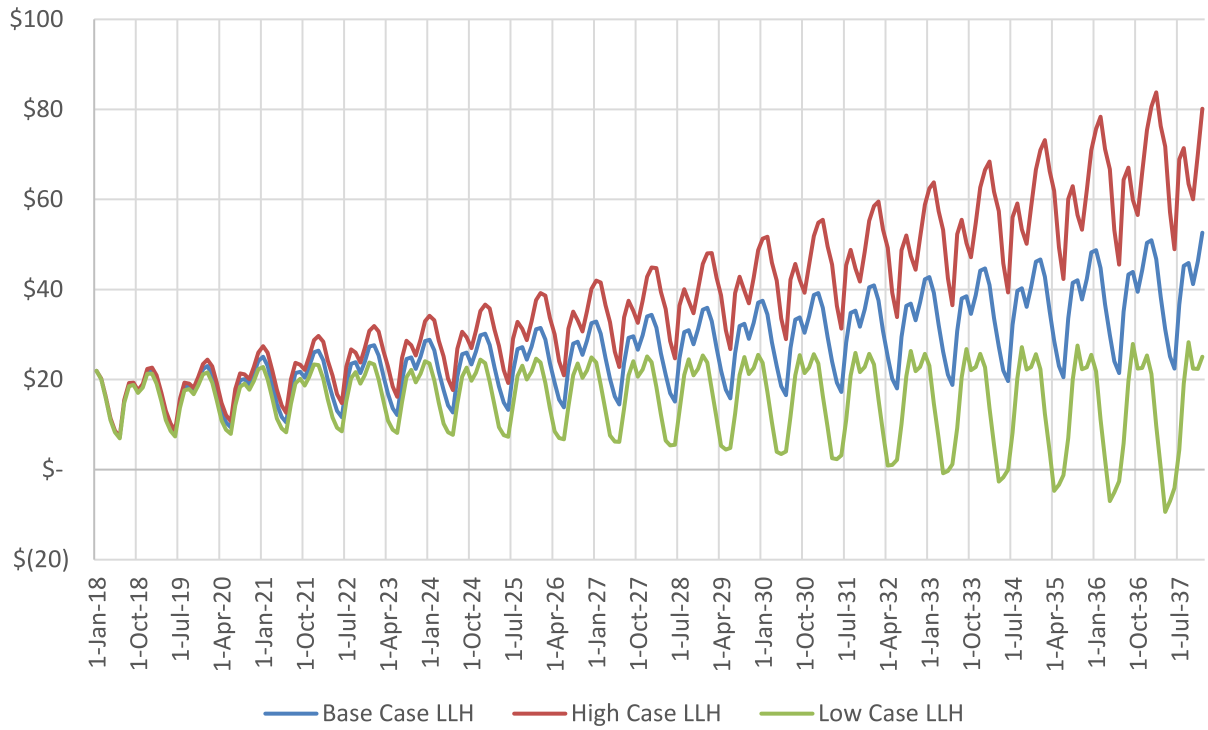


Figure IV-6
Low Load Hour Market Price Forecast Comparison (2012$/MWh)



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 value 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. The scenarios modeled include the value of the social cost of carbon from various resources. In the Base scenario, carbon pricing from California's cap and trade were used (currently around $13/ton). The Power Council used the federal interagency estimate of a social cost of carbon in scenarios of the Seventh Power Plan. The federal carbon cost estimates range from $44 to $63 (2012$) over the 20-year planning period. These values were used in the set of high avoided cost assumptions. Finally, a value of zero is included in the low avoided cost assumptions. The zero value reflects that carbon costs are not likely to be borne by only utility ratepayers.

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, in addition to sourcing a portion of its energy needs 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 forecast of REC prices and incorporated them into the avoided costs of energy efficiency accordingly. The resulting value of energy efficiency in the District meeting state RPS requirements ranges from $0.24 to $0.64 per MWh. Future potential increases in the stringency of Washington's RPS requirements are assumed to be covered under the energy market price scenarios. This is reasonable given that the value of energy efficiency in avoiding REC purchases is a nominal amount.

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.

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 adequate 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 possibility that market prices will increase above current forecasts.

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

For the District's 2017 CPA, the base case avoided cost parameters represent the most likely values. Where there may be uncertainty about the future value of an avoided cost input component, high and low values were determined to represent potential values that are higher and lower than the base case values. These variations in input values represent implied risk adders. The 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. Accordingly, no risk adder is used in the base case. 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 IRP identified that the utility had sufficient resources for average annual energy requirements, but showed a need for new resources to meet peak demands. Since the Northwest does not have a capacity market, other resources must serve as proxy values for the value of generation capacity resources. For the 2017 CPA, demand response resources were modeled to determine the value of generation capacity.

EES scaled the NW Power Council's regional demand response potential from the Seventh Plan by the District's share of residential, commercial, and industrial loads, according to the sector of the demand response resource. The scaled supply curve of demand response resources was assessed to find the cost of the marginal resource that would meet the District's need for capacity, which was found to be approximately 20 MW. That marginal resource was found to cost $19.20/kW-yr. This value was used in the base case. In the low scenario, it was assumed that the market would continue to be able to serve capacity needs, and a value of $0/kW-yr was assumed.

In the Council's Seventh Power Plan[8], a generation capacity value of $115/kW-year was explicitly calculated ($2012). This value was used in the high scenario.

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

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 Assumptions by Scenario, $2012			
	Base	**Low**	**High**
Energy, 20-yr levelized $/MWh	Market Forecast	-1.25σ*	+1.25σ*
Social Cost of Carbon, $/MWh	California Carbon Market	$0	Federal/7th Power Plan Values
Value of REC Compliance	Existing RPS	Existing RPS	Existing RPS
Distribution System Credit, $/kW-yr	$31	$31	$31
Transmission System Credit, $/kW-yr	$26	$26	$26
Deferred Generation Capacity Credit, $/kW-yr	$19.20	$0	$115
Implied Risk Adder $/MWh $/kW-yr	N/A	Up to: -$52/MWh -$19.20/kW-yr Average of: -$19/MWh -$19.20/kW-yr	Up to: $53/MWh $95.80/kW-yr Average of: $24/MWh $95.80/kW-yr

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

Appendix V – 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 draft 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 V-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 V-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 V-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 V-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 V-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 VI – Energy Efficiency Potential by End-Use

Table VI-1 Residential Economic Potential (aMW)				
	2 Year	**6 Year**	**10 Year**	**20 Year**
Dryer	-	-	-	-
Electronics	0.06	0.35	0.84	1.66
Food Preparation	0.00	0.01	0.02	0.07
HVAC	0.73	2.24	3.22	4.14
Lighting	0.33	0.99	1.91	4.61
Refrigeration	-	-	-	-
Water Heating	0.15	0.57	1.13	2.57
Whole Bldg/Meter Level	-	-	-	-
Total	**1.27**	**4.15**	**7.12**	**13.05**

Table VI-2 Commercial Economic Potential (aMW)				
	2 Year	**6 Year**	**10 Year**	**20 Year**
Compressed Air	0.01	0.03	0.05	0.10
Electronics	0.00	0.00	0.00	0.01
Food Preparation	0.01	0.04	0.13	0.41
HVAC	0.15	0.55	0.99	1.39
Lighting	0.50	1.53	2.74	5.96
Motors/Drives	0.00	0.02	0.05	0.14
Process Loads	0.01	0.04	0.07	0.08
Refrigeration	0.08	0.26	0.38	0.64
Water Heating	0.02	0.07	0.14	0.35
Total	**0.78**	**2.54**	**4.55**	**9.08**

Table VI-3 Industrial Economic Potential (aMW)				
	2 Year	**6 Year**	**10 Year**	**20 Year**
Compressed Air	0.23	0.55	0.73	0.82
Energy Management	2.27	8.49	15.66	22.14
Fans	0.30	1.19	2.19	2.61
Hi-Tech	0.02	0.09	0.18	0.22
Lighting	1.61	3.01	3.75	4.23
Low & Med Temp Refr	-	-	-	-
Material Handling	-	-	-	-
Metals	0.00	0.00	0.00	0.00
Misc	-	-	-	-
Motors	0.03	0.13	0.26	0.32
Paper	0.15	0.45	0.74	1.49
Process Loads	0.02	0.11	0.21	0.25
Pulp	0.21	0.63	1.04	2.09
Pumps	-	-	-	-
Transformers	-	-	-	-
Wood	0.03	0.13	0.26	0.31
Total	**4.88**	**14.78**	**25.03**	**34.48**

Table VI-4 Agricultural Economic Potential (aMW)				
	2 Year	**6 Year**	**10 Year**	**20 Year**
Dairy Efficiency	0.00	0.00	0.00	0.00
Irrigation	0.01	0.03	0.04	0.07
Lighting	0.01	0.02	0.02	0.03
Motors/Drives	-	-	-	-
Total	**0.02**	**0.05**	**0.07**	**0.10**

Table VI-5 Distribution Efficiency Economic Potential (aMW)				
	2 Year	**6 Year**	**10 Year**	**20 Year**
1 - LDC voltage control method	0.02	0.13	0.30	0.84
2 - Light system improvements	0.01	0.08	0.18	0.51
3 - Major system improvements	-	-	-	-
4 - EOL voltage control method	-	-	-	-
A - SCL implement EOL w/ major system improvements	-	-	-	-
Total	**0.03**	**0.21**	**0.48**	**1.35**

Appendix VII – 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 Cowlitz PUD's programs.

Cowlitz PUD's sector-level program achievements from 2012-2016 and estimates for 2017 were compared with the potential identified in this CPA, 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 to determine total sector savings. 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. Ultimately, only the ramp rates for commercial lighting and several industrial energy management measures were adjusted to better match recent program history.

Figure VII-1 below compares recent industrial achievement with the potential identified in this assessment. Large industrial mega projects, which are unreliable as a source of savings have been omitted from this figure. Due to a large reduction in operations at a paper mill and the accompanying reduction in load, as well as the continuing challenges facing the pulp and paper industry, attaining the large saving as were achieved in recent history may be more challenging.

Figure VII-1
Comparison of Industrial Program History and Potential

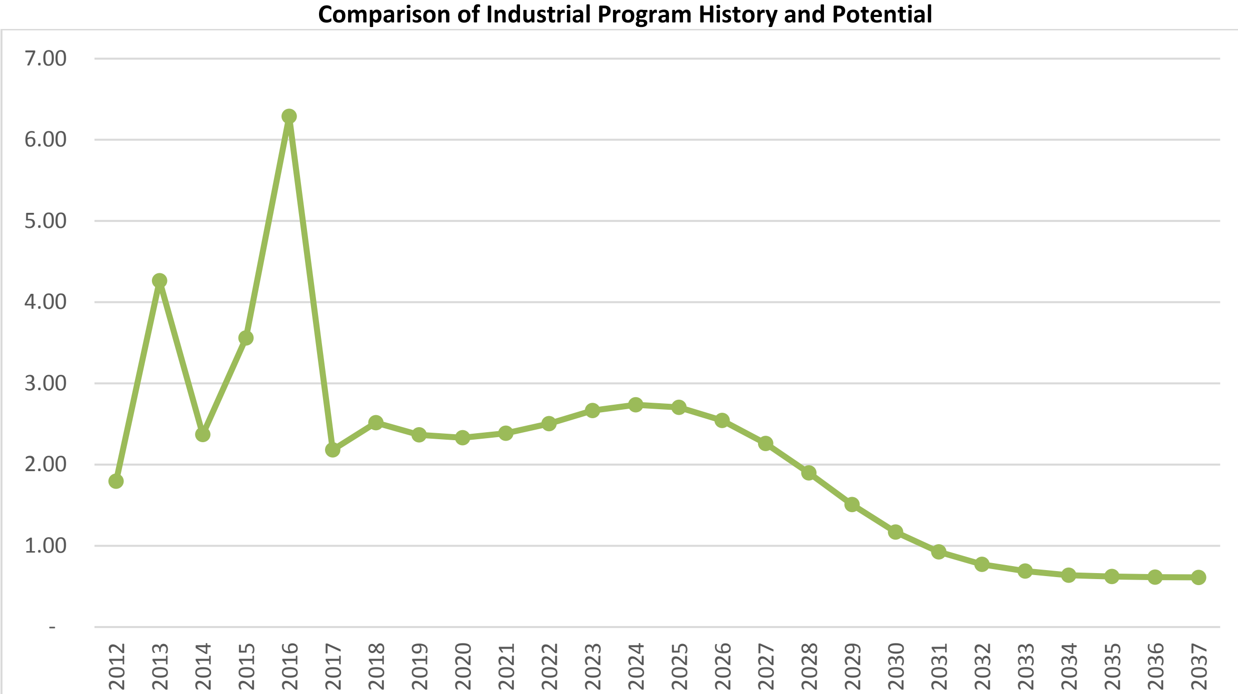


Figure VII-2 shows recent program achievements and estimated potential for the remaining sectors. Recent program achievements include savings allocated from NEEA market transformation initiatives. As stated above, the large declines in 2016 are attributable to NEEA's reset of the market baselines they use to estimate the savings of their market transformation initiatives. Savings levels will likely improve, but the NEEA savings for 2017 was estimated based on the 2016 result.

Figure VII-2
Comparison of Non-Industrial Program History and Potential