Richland Energy Services

2019 Conservation Potential Assessment
Final Report

March 20, 2020

Prepared by:

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March 20, 2020

Ms. Sandi Edgemon
Richland Energy Services
625 Swift Boulevard, MS-23
Richland, Washington 99352

SUBJECT: 2019 Conservation Potential Assessment

Dear Ms. Edgemon:

Please find attached the final report summarizing the 2019 Richland Energy Services Conservation Potential Assessment (CPA). This report covers the time period from 2020 through 2039. The measures and information used to develop Richland's preliminary conservation potential incorporate the most current information available for Energy Independence Act (EIA) reporting.

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,

Steve Andersen
Manager of Project Evaluations

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Marietta, GA; Austin, TX; Auburn, AL; Manchester, NH; Madison, WI; Orlando, FL; Augusta, ME; Seattle, WA and Portland, OR

Contents

Executive Summary

This report describes the methodology and results of the 2019 Conservation Potential Assessment (CPA) for Richland Energy Services (Richland). This assessment provides estimates of energy savings by sector for the period 2020 to 2039. The assessment considers a wide range of conservation resources that are reliable, available and cost-effective within the 20-year planning period.

Background

Richland provides electricity service to over 24,500 customers in Benton County, Washington, excluding Benton PUD 1's service territory.

Washington's Energy Independence Act (EIA), effective January 1, 2010 and modified October 4, 2016, 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. Although Richland is currently below the customer requirement, the utility is expected to exceed the 25,000-customer threshold in 2020.

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 Richland's compliance with EIA requirements.

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

- New Avoided Costs
    - Recent forecast of power market prices
    - Updated values for avoided generation capacity
    - New transmission and distribution capacity costs based on new values from the Council
- Updated Customer Characteristics Data
    - New residential home counts
    - Updated commercial floor area
    - Updated industrial sector consumption
- Measure Updates
    - Measure savings, costs, and lifetimes were updated based on the latest updates available from the Regional Technical Forum (RTF)

- New measures not included in the Seventh Plan but subsequently reviewed by the RTF were added
- Accounting for Recent Achievements
  - Internal programs
  - NEEA programs

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

Results

Table ES-1 shows the high-level results of this assessment. The economically achievable potential by sector in 2, 6, 10, and 20-year increments is included. The total 20-year energy efficiency potential is 15.79 aMW. The most important numbers per the EIA are the 10-year potential of 9.75 aMW, and the two-year potential of 1.47 aMW.

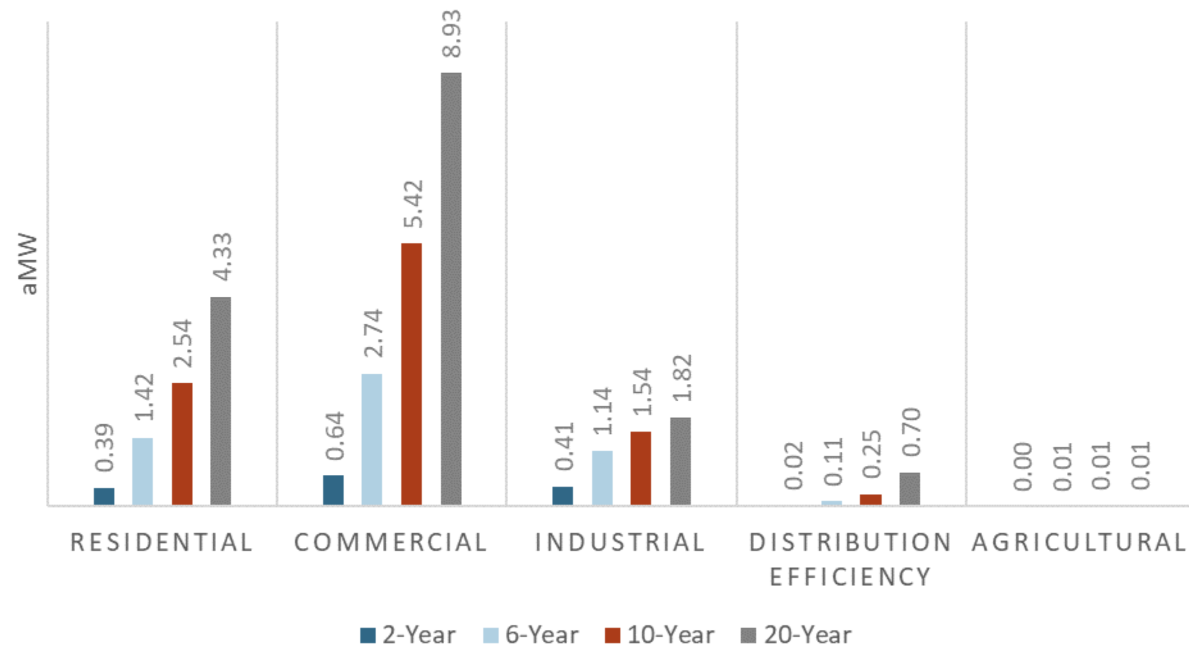
These estimates include energy efficiency that could be achieved through Richland's utility programs and also through Richland's share of the Northwest Energy Efficiency Alliance (NEEA) accomplishments. Some code and standard changes may also account for part of the potential, especially in the later years. In some cases, the savings from those changes will be quantified by NEEA or through BPA's Momentum Savings work. While not quantified at a utility-specific level, the Momentum Savings quantified by BPA could be further savings claimed against the Seventh Plan conservation targets.

Table ES-1
Cost Effective Potential (aMW)

	2-Year*	6-Year	10-Year	20-Year
Residential	0.39	1.42	2.54	4.33
Commercial	0.64	2.74	5.42	8.93
Industrial	0.41	1.14	1.54	1.82
Distribution Efficiency	0.02	0.11	0.25	0.70
Agricultural	0.00	0.01	0.01	0.01
Total	**1.47**	**5.41**	**9.75**	**15.79**

**2020 and 2021*
Note: Numbers in this table and others throughout the report may not add to total due to rounding.

Figure ES-1
Cost-Effective Potential



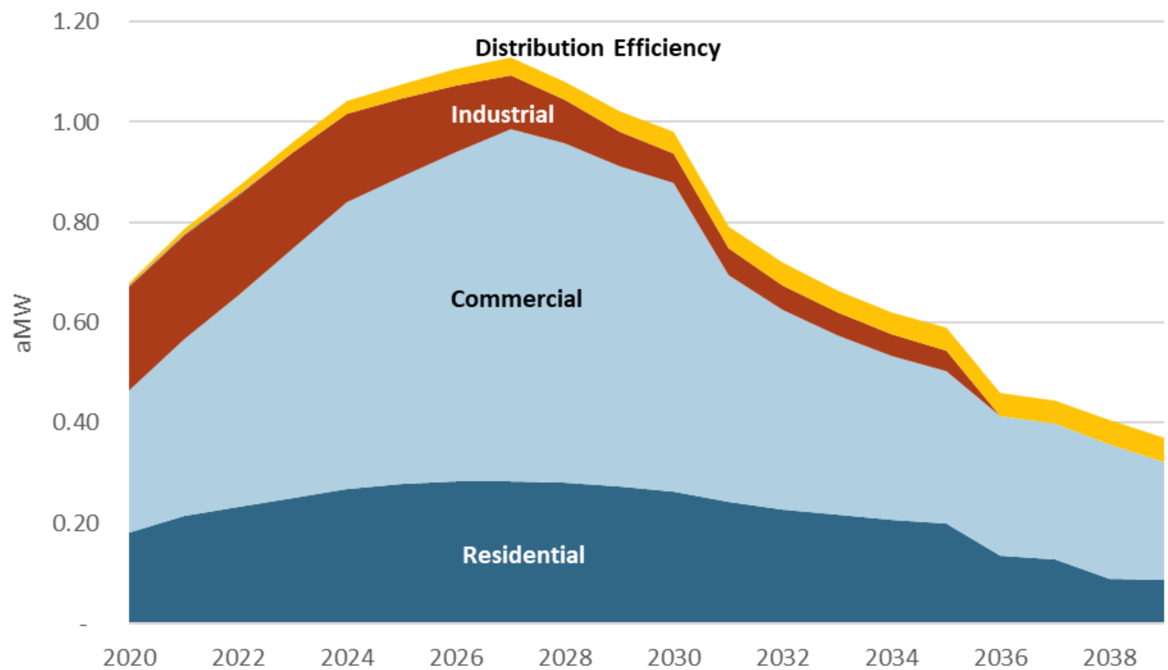
Energy efficiency also has the potential to reduce peak demands. Based upon hourly load profiles developed for the Seventh Power Plan and load data provided by Richland, the reductions in peak demand provided by energy efficiency are summarized in Table ES-2 below. Richland's annual peak occurs in the winter 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	1.24	4.15	7.04	11.62
Commercial	0.98	4.13	8.06	13.18
Industrial	0.48	1.30	1.76	2.08
Distribution Efficiency	0.02	0.13	0.31	0.87
Agricultural	0.00	0.01	0.01	0.01
Total	**2.72**	**9.73**	**17.17**	**27.76**

The 20-year energy efficiency potential is shown on an annual basis in Figure ES-2. This assessment shows annual potential starting at 0.68 aMW in 2020 and ramping up to 1.13 aMW in 2027. Ramp rates from the Northwest Power and Conservation Council's (Council) Seventh Power Plan technical documentation were used to develop the annual savings potential estimates over the 20-year study. In some instances, alternate ramp rates were assigned to measures to better fit Richland's recent potential.

Figure ES-2
Annual Cost-Effective Energy Efficiency Potential Estimates



Relative to the 2017 CPA cycle, the amount of cost-effective potential in the residential sector has decreased. Much of the change is due to federal lighting standards scheduled to take effect in 2020. These standards require efficiency levels only found in CFLs and LEDs; and with CFLs losing market share to LEDs, energy efficiency programs may not be necessary for residential lighting. While there is some uncertainty about whether the federal standard will be implemented, Washington state recently enacted identical standards, also scheduled to take effect in 2020. Accordingly, residential lighting measures have not been included in this CPA. The remaining conservation potential in the residential sector is among the HVAC and water heating end uses. Notable areas for achievement include:

- HVAC-related measures, including weatherization and duct sealing
- Water heating measures like heat pump water heaters and clothes washers

Significant conservation is also available in Richland's commercial sector. Notable areas for commercial sector savings potential include:

- Lighting – including exterior and lighting power density measures
- Commercial HVAC measures like rooftop unit controllers and ductless heat pumps

Comparison to Previous Assessment

Table ES-3 shows a comparison of 2, 10, and 20-year Base Case conservation potential by customer sector for this assessment and the results of Richland's 2010 and 2017 CPA.

Table ES-3 Comparison of 2010 and 2017 CPA to 2019 CPA Cost-Effective Potential								
	10-Year				20-Year			
	2010	2017	2019	% Change	2010	2017	2019	% Change
Residential	7.12	2.01	2.54	-44%	14.20	3.60	4.33	-51%
Commercial	7.38	1.01	5.42	29%	15.36	2.09	8.93	2%
Industrial	1.02	0.68	1.54	81%	2.18	0.89	1.82	19%
Distribution Efficiency	1.16	0.24	0.25	-64%	2.13	0.69	0.70	-50%
Agricultural	0.00	0.00	0.01	-	0.00	0.00	0.01	-
Total	**16.68**	**3.94**	**9.75**	**-5%**	**33.87**	**7.26**	**15.79**	**-23%**

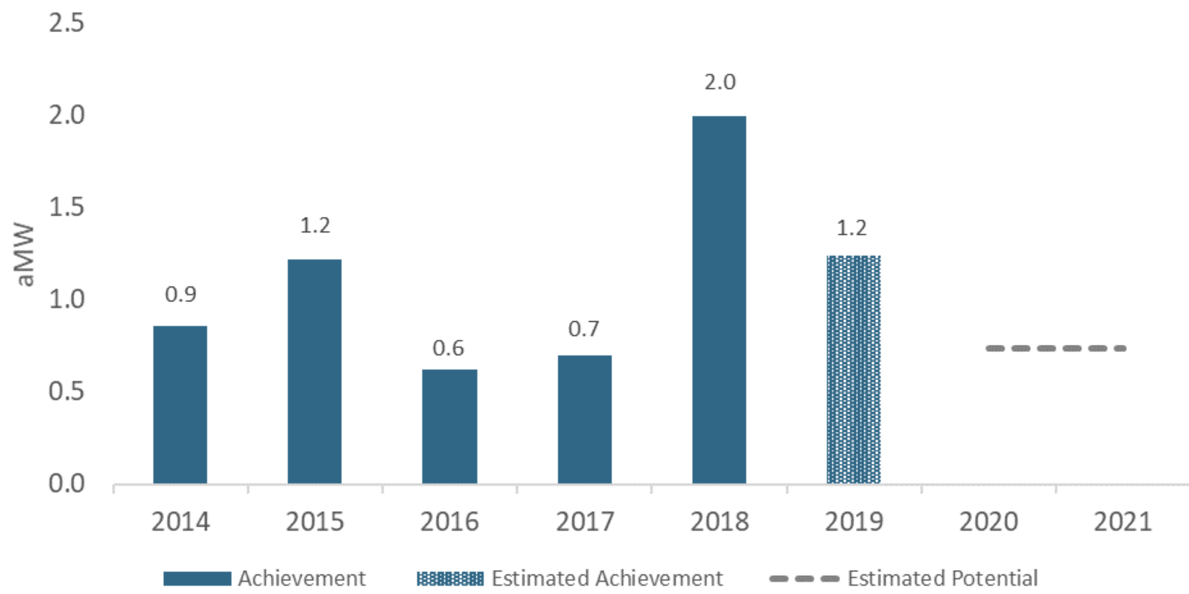
**Note that the 2010 columns refer to the CPA completed in 2009 for the time period of 2010 through 2029, the 2017 columns refer to the CPA completed in 2016 for the time period of 2017 through 2036. The % Change is calculated as the 2019 change from the average of 2010 and 2017 cost-effective potential.*

The results of this 2019 assessment are lower than the 2010 results and higher than 2017 for a variety of reasons. The CPA model has been updated in accordance to the Seventh Plan, avoided cost assumptions have changed, as well as the above-mentioned changes to lighting standards. On top of these changes Richland has experienced growth in population, load and other economic inputs to the CPA model which increases the pool from which cost-effective potential is estimated. Some of the change in potential between the commercial and industrial sectors is the result of more accurate industrial classification which has moved some load from the commercial to the industrial sector. Additionally, the Council updated its assumptions on the value of deferred transmission and distribution capital expenditures, with the new values being significantly lower. The extent to which each measure realizes these values depends on its contribution to reducing peak demands, so measures in the residential and commercial sectors, which tend to contribute more to reducing system peaks, were more impacted. Savings in the industrial sector tend to be more evenly distributed across time, so the changes in assumptions had less of an impact to the industrial sector.

Targets and Achievement

Figure ES-3 compares Richland's historic conservation achievement with its targets. The biennium potential for this assessment shows a decrease from historic achievement given the likely changes to residential lighting programs, however the potential remains realistic as these savings were not considered when aligning potential with recent program history. The figure shows that Richland has consistently met its projected energy efficiency target, and that the potential estimates presented in this report are achievable through Richland's utility conservation programs and the utility's share of NEEA savings.

Figure ES-3
Historic Achievement and Targets



Conclusion

This report summarizes the CPA conducted for Richland for the 2020 to 2039 timeframe. Based on the results of the Base Case scenario, the total 10-year cost effective potential is 9.75 aMW and the 2-year potential is 1.47 aMW. This assessment results in lower potential than the previous assessments, largely due to the exclusion of many residential lighting measures as well as the change in the valuation of transmission and distribution capacity costs. The avoided cost assumptions are discussed further in Appendix IV.

Introduction

Objectives

The objective of this report is to describe the results of the Richland Energy Services (Richland) 2019 Electric Conservation Potential Assessment (CPA). This assessment provides estimates of energy savings by sector for the period 2020 to 2039, with the primary focus on 2020 to 2029 (10 years). This analysis has been conducted in a manner consistent with requirements set forth in 19.285 RCW (EIA) and 194-37 WAC (EIA implementation) and is part of Richland's compliance documentation. The results and guidance presented in this report will also assist Richland in strategic planning for its conservation programs in the near future.

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

Electric Utility Resource Plan Requirements

According to Chapter 19.280 RCW, utilities with at least 25,000 customers are required to develop Integrated Resource Plans (IRPs) by September 2008 and biennially thereafter. Richland expects to exceed the 25,000-customer threshold in 2020 and, as such, is developing an IRP and CPA. The legislation mandates that these resource plans include assessments of commercially available conservation and efficiency measures. This CPA is designed to assist in meeting these requirements for conservation analyses. More background information is provided below.

Energy Independence Act

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

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

City of Richland I-937 Compliance Summary Steps: 2020 Qualification

Year	Conservation/ Renewable Target	January 1 - Compliance Actions	June 1 – Reporting Requirements
2021	NA		Report 25,000 customer status to State
2022	NA		
2023	NA	Complete/update 10-year CPA and expand EE programs. Augment staff.	
2024	10% of CPA	Acquire 1/10th of CPA within one year.	Report CPA and 2024 conservation savings (optional)
2025	Additional 10% of CPA (or 20% at end of 2 years)	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables. (optional)
2026	10% of CPA 3% Renewables		Report CPA and previous two years' conservation savings and renewables.
2027	Additional 10% of CPA (or 20% at end of 2 years) 3% of Renewables	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables.
2028	10% of CPA 3% Renewables		Report CPA and previous two years' conservation savings and renewables.
2029	Additional 10% of CPA (or 20% at end of 2 years) 3% of Renewables	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables.
2030	10% of CPA 9% Renewables		Report CPA and previous two years' conservation savings and renewables.
2031	Additional 10% of CPA (or 20% at end of 2 years) 9% of Renewables	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables.
2032	10% of CPA 9% Renewables		Report CPA and previous two years' conservation savings and renewables.
2033	Additional 10% of CPA (or 20% at end of 2 years) 9% of Renewables	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables.
2034	10% of CPA 15% Renewables		Report CPA and previous two years' conservation savings and renewables.
2035	Additional 10% of CPA (or 20% at end of 2 years) 15% of Renewables	Complete/update 10-year CPA. Acquire 2/10th of CPA within two years.	Report previous year's conservation savings and renewables.

Other Legislative Considerations

Washington State recently enacted several laws that impact conservation planning. Washington's Clean Energy Transformation Act (CETA), ESSB 5116, has several components that impact conservation planning. First it requires the use of a specific social cost of carbon in utility planning. It also sets several requirements for the retail sales of electricity to be from greenhouse gas free or renewable sources. This CPA has accounted for these changes to avoided cost assumptions associated with this legislation in the 2021 CPA.

Washington HB 1444 enacts efficiency standards for a variety of appliances, some of which are included as measures in this CPA. This law takes effect on July 28, 2019 and applies to products manufactured after January 1, 2021. As the law applies to the manufacturing date, products not meeting the efficiency levels set forth in the law could continue to be sold in 2021 and a reasonable time of six months or more may be necessary for product inventories to turn over. As such, the standards contained in this law will be addressed in the 2021 CPA.

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 Richland's service area is similar to that of the region, or that the regional survey data represents the population.
- Measure data – In particular, savings and cost estimates (when comparing to current market conditions), as prepared by the Council and RTF, will vary across the region. In some cases, measure applicability or other attributes have been estimated by the Council or the RTF based on professional judgment or limited market research.
- Market price forecasts – Market prices and forecasts are continually changing. The market price forecasts for electricity and natural gas utilized in this analysis represent a snapshot in time. Given a different snapshot in time, the results of the analysis would vary. However, 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 rate –This CPA uses a discount rate that is specific to Richland. The rate reflects the current borrowing market although changes in borrowing rates will likely vary over the study period.
- Forecasted load and customer growth – The CPA bases the 20-year potential estimates on forecasted loads and customer growth. Each of these forecasts includes a level of uncertainty.
- Load shape data – The Council provides conservation load shapes for evaluating the timing of energy savings. In practice, load shapes will vary by utility based on weather, customer types, and other factors. This assessment uses the hourly load shapes used in the Seventh Plan to estimate peak demand savings over the planning period, based on shaped energy savings. Since the load shapes are a mix of older Northwest and California data, peak demand savings presented in this report may vary from actual peak demand savings.
- Frozen Efficiency – Consistent with the Council's methodology, the measure baseline efficiency levels and end-using devices do not change over the planning period. In addition, it is assumed that once an energy efficiency measure is installed, it will remain in place over the remainder of the study period.

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

Report Organization

The main report is organized with the following main sections:

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

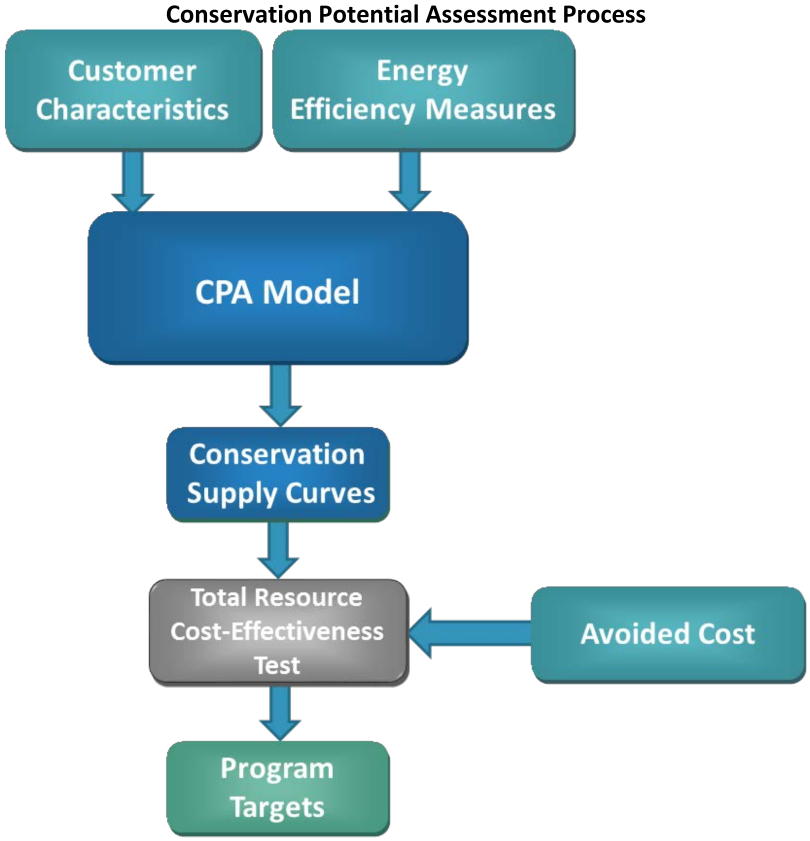
Methodology

This study is a comprehensive assessment of the energy efficiency potential in Richland'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 Richland's conservation potential target. Specific assumptions and details of methodology as it pertains to compliance with the EIA compliance are provided in Appendix III of this report.

Basic Modeling Methodology

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

Figure 1
Conservation Potential Assessment Process



Customer Characteristic Data

Assessment of customer characteristics includes estimating both the number of locations where a measure could feasibly be installed, as well as the share—or saturation—of measures that have already been installed. For this analysis, the characterization of Richland's service territory was determined using data from the Northwest Energy Efficiency Alliance (NEEA) commercial and residential building stock assessments. Details of data sources and assumptions are discussed for each sector later in the report.

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

Energy Efficiency Measure Data

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

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

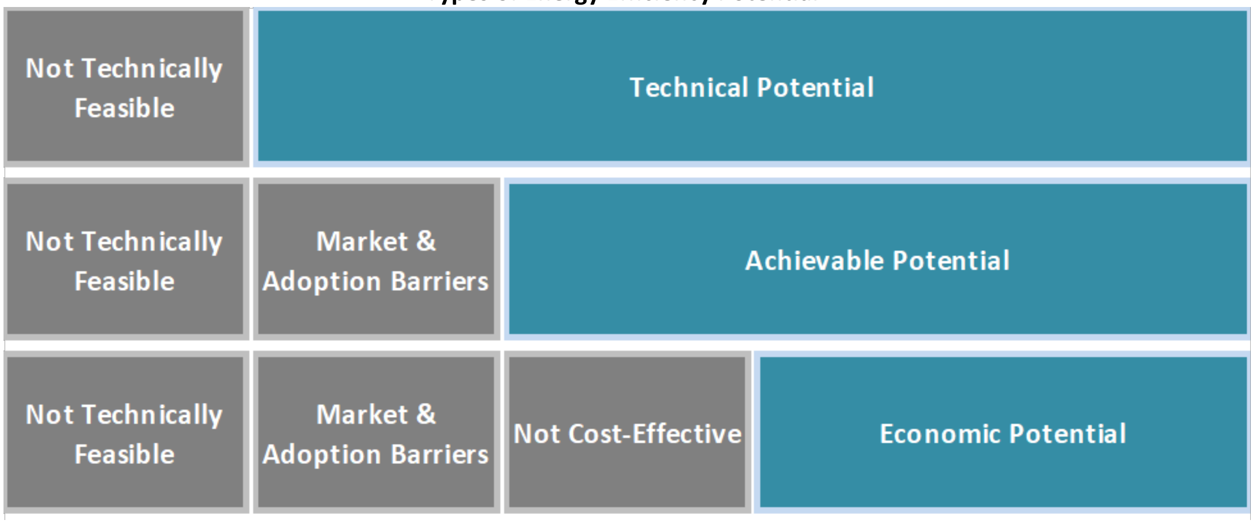
Other financial-related data needed for defining measure costs and benefits include: discount rate, avoided costs, line losses, and deferred capacity-expansion benefits.

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

Types of Potential

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

Figure 2
Types of Energy Efficiency Potential[1]



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

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

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

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

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

The total technical potential is often significantly more than the amount of achievable and economic potential. The difference between technical potential and achievable potential is a result of the number of measures assumed to be 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 Technical – Achievable technical potential, also referred to as achievable potential, is the amount of potential that can be achieved with a given set of market conditions. Achievable potential considers many of the realistic barriers to adopting energy efficiency measures. These barriers include market availability of technology, consumer acceptance, non-measure costs, and the practical limitations of ramping up a program over time. The level of achievable potential can increase or decrease depending on the given incentive level of the measure. The Council assumes a maximum achievability of 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.

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

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

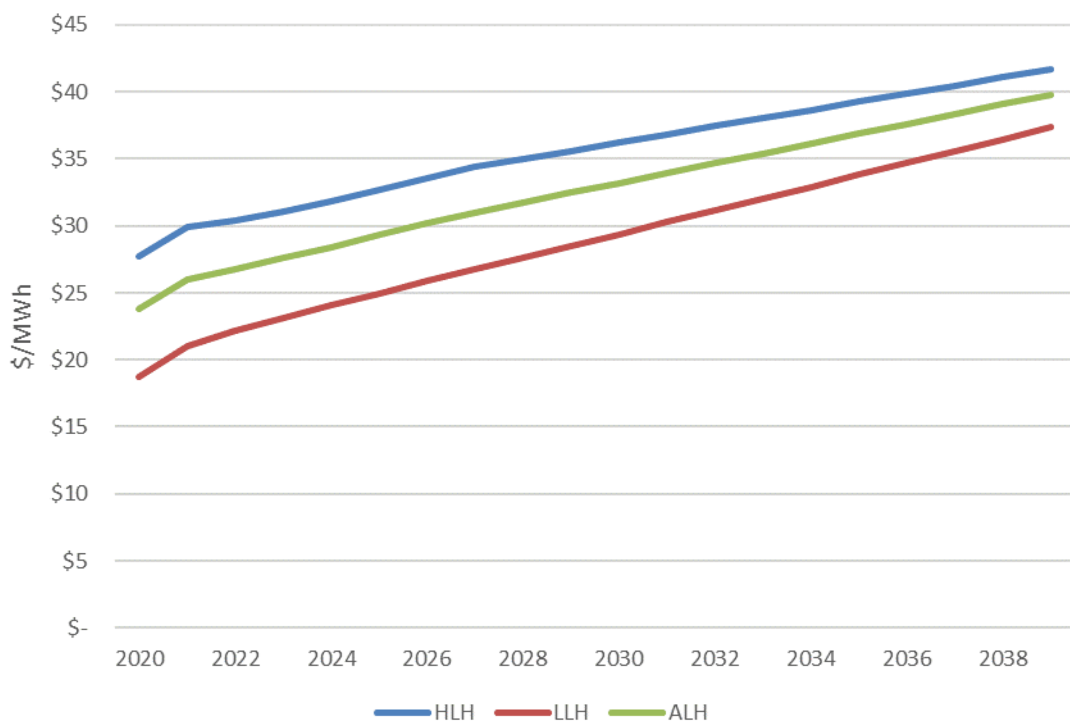
Avoided Cost

Energy

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

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

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



The EIA requires that utilities "…set avoided costs equal to a forecast of market prices." As discussed in Appendix IV, Richland currently meets the majority of its peak demands through purchases of Tier 1 power from BPA. Since Richland's loads exceed its rate period high water mark, as defined in the current BPA power contract, a relatively small amount of Richland's capacity needs are met through non-federal market purchases. As such, Richland's marginal purchases are currently market-based power purchase contracts. This matches up well with EIA rules that require the use of market prices in the calculation of avoided costs.

Social Cost of Carbon & Renewable Energy Credits

In addition to the avoided cost of energy, energy efficiency provides the benefit of reducing carbon emissions. The EIA rules require the inclusion of the social cost of carbon, and Washington's recently enacted Clean Energy Transformation Act seeks specifies which values should be used. These values were used in the development of the results discussed in this report. Additional scenarios considered other values. While rulemaking is still ongoing, state staff have proposed adopting the social cost of carbon developed by the federal Interagency Workgroup using the 2.5 percent discount rate, the same values that the CETA requires investor-owned utilities to use.

These carbon costs were included in all avoided cost scenarios.

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. In 2020, utilities are required to source 15% of all electricity sold to retail customers from renewable energy resources and in 2030 the requirement effectively goes to 100%, while allowing 20% of the requirement to be met through RECs or other means. Conservation can reduce the cost of this requirement by reducing Richland's load. Further details are discussed in Appendix IV.

Transmission and Distribution System Benefits

The EIA 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 transmission and distribution system expansion, Council staff developed a distribution system credit value of $6.33/kW-year and a transmission system credit of $2.85/kW-year applied to peak savings from conservation measures, at the time of the regional transmission and local distribution system peaks. These values were developed in preparation for the 2021 Power Plan.

Generation Capacity

Currently, Richland is a load-following customer of BPA and pays a demand charge to BPA, based on its peak demand every month. The demand charge is set in each rate case based on the marginal capacity resource. Currently, the demand charges are approximately $10/kw-month and are based on an LMS100 combustion turbine. These demand charges effectively serve as the marginal cost of generation capacity for Richland.

By assuming a monthly shape to conservation's demand savings, the charges were converted into a value of $81/kW-year. For the base case, it was assumed BPA's demand charges will increase in real terms by 3% annually. Over twenty years, the resulting cost of avoided capacity is $89/kW-year (2012$) in levelized terms. In the low scenario, no cost escalation was assumed, resulting in a 20-year levelized cost of $69/kW-yr.

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

Risk Analysis

In the past, CPAs have included risk mitigation credits in the scenario analysis to account for risks that were not quantified. Rather than including an explicit risk credit in each of the scenarios, this CPA addresses the uncertainty of the inputs by varying the avoided cost values. 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 $18/MWh and $26/kW-year were included in the avoided cost. For reference, in the past, the Council has calculated risk credits using stochastic portfolio modeling resulting in risk mitigation credits of up to $55/MWh ($2016) depending on the value of the avoided cost inputs.

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

Pacific Northwest Electric Power Planning and Conservation Act Credit

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

Discount and Finance Rate

The Council develops real discount rate assumptions for each of its Power Plans. The most recent real discount rate assumption developed by the Council is 4%, which was used in the Seventh Plan. For Richland, a discount rate of 3.75% was used to model conservation potential for this assessment. This discount rate is used by Richland in other financial modelling. 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.

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

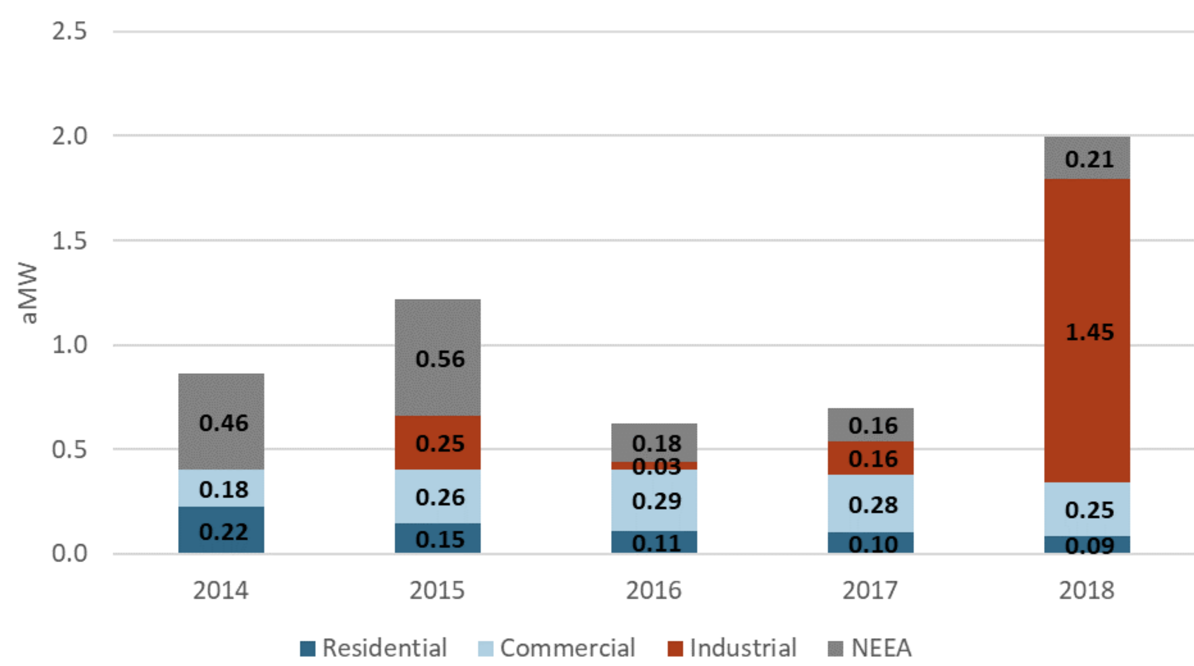
Recent Conservation Achievement

Richland has pursued conservation and energy efficiency resources. Currently, the utility offers several rebate programs for both residential and non-residential customers. These include residential heating and weatherization and programs for non-residential lighting and custom projects for non-residential customers.

Figure 4 details the distribution of conservation among the utility's customer sectors and through Northwest Energy Efficiency Alliance (NEEA) efforts over the past five years. Richland's conservation achievement has averaged 1.08 aMW per year since 2014. More detail for these savings is provided below for each sector.

Savings from NEEA declined significantly in 2016. The decline was caused by the adoption of the Seventh Power Plan, which resets the baseline against which NEEA's market transformation savings are claimed. As NEEA's work to transform markets continues and its initiatives continue to build market share of efficient products, the savings will continue to grow, as is apparent below. NEEA's work helps bring energy efficient emerging technologies, like ductless heat pumps and heat pump water heaters to the Northwest markets.

Figure 4
Richland's Recent Conservation History by Sector



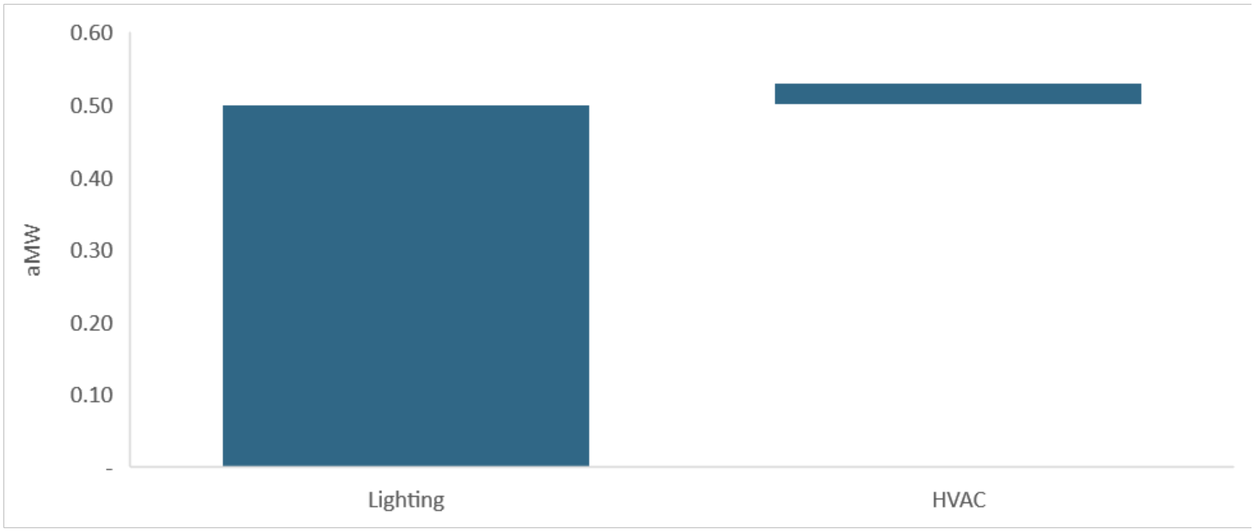
Residential

Richland achieved 0.19 aMW of residential conservation in 2017 and 2018. All of these savings occurred in the HVAC end-use.

Commercial

Historic achievement in the commercial sector is due to lighting and HVAC. Figure 5 shows the breakdown of 2017 and 2018 savings.

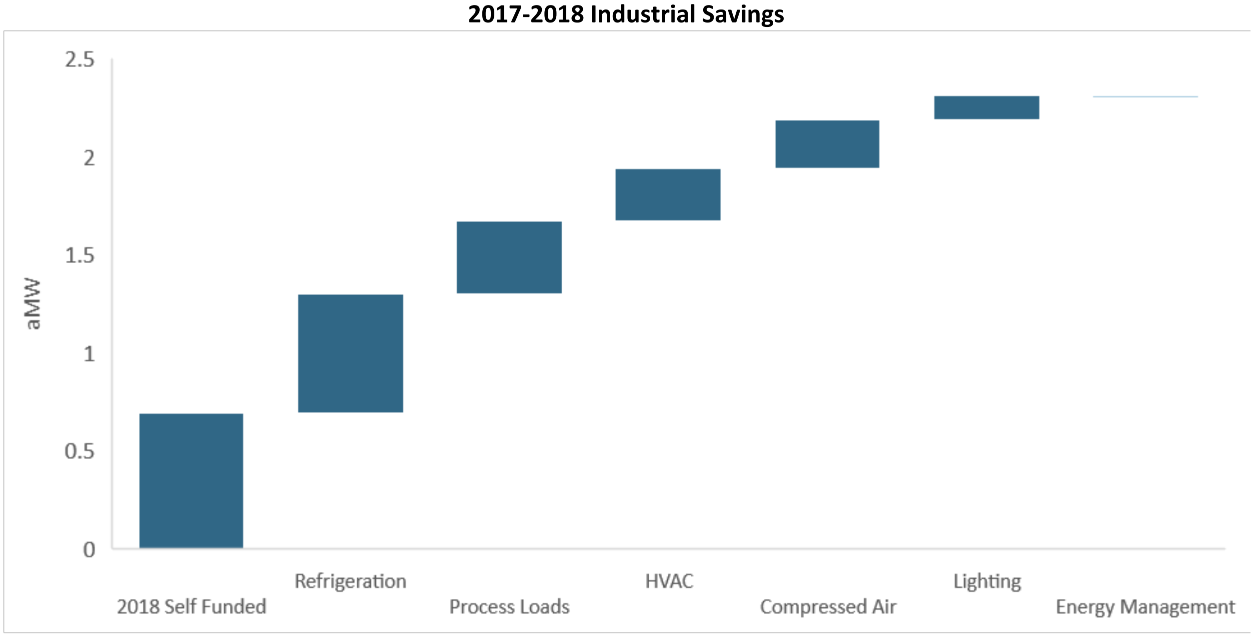
Figure 5
2017-2018 Commercial Savings



Industrial

Historic achievement in the industrial sector is primarily due to custom projects, refrigeration and process loads.

Figure 6
2017-2018 Industrial Savings



Current Conservation Programs

Richland offers a wide range of conservation programs to its customers. These programs include rebates and low-interest loans to qualified customers for energy efficient HVAC equipment and conservation measures including insulation, windows, and doors. Customers can select only a rebate or apply for a low-interest loan with a rebate. For commercial and industrial customers rebates are available for lighting and custom projects.

Summary

Richland plans to continue offering incentives for energy efficiency investments. The results of this study will help Richland program managers in strategic planning for energy efficiency program offerings, incentive levels, and program review.

Customer Characteristics Data

Richland serves more than 24,500 electric customers in Benton County, Washington, with a service area population of nearly 57,500. A key component of an energy efficiency assessment is to understand the characteristics of these customers – primarily the building and end-use characteristics. These characteristics are described below for each customer sector.

Residential

For the residential sector, the key characteristics include house type, heat fuel type, and water heating. Table 1 shows relevant residential data for single family, multi-family and manufactured homes in Richland's service territory. The data is based on the Northwest Energy Efficiency Alliance's (NEEA) 2016 Residential Building Stock Assessment (RBSA) as well as data from the US Census. The data shown in Table 1 provides estimates of the current residential characteristics in Richland's service territory and are utilized as the baseline in this study.

This assessment assumes an average annual residential growth rate of 1.0 percent.

Table 1
Residential Building Characteristics

Heating Zone	Cooling Zone	Solar Zone	Residential Households	Total Population
1	3	3	24,196	57,426
	Single Family	**Multifamily Low Rise**	**Multifamily High Rise**	**Manufactured**
Heating / Cooling System Saturations				
Electric Forced Air Furnace (FAF)	6%	16%	16%	56%
Heat Pump (HP)	61%	0%	0%	19%
Ductless HP (DHP)	3%	0%	0%	0%
Electric Zonal (Baseboard)	6%	67%	67%	0%
Central AC	20%	12%	12%	44%
Room AC	12%	63%	63%	13%
Appliance Saturations				
Electric WH	79%	77%	77%	94%
Refrigerator	136%	105%	105%	119%
Freezer	45%	16%	16%	50%
Clothes Washer	96%	53%	53%	100%
Clothes Dryer	91%	49%	49%	100%
Dishwasher	87%	67%	67%	88%
Electric Oven	96%	100%	100%	100%
Desktop	49%	40%	40%	56%
Laptop	53%	35%	35%	38%
Monitor	51%	44%	44%	56%

Commercial

Building 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). The 2020 commercial square footage was estimated with 2018 load data provided by Richland. Load data was converted to floor area by applying energy use intensity values from the Commercial Building Stock Assessment (CBSA).

Table 2 shows 2020 commercial square footage and growth rates in each of the 18 building categories. The growth rates presented in Table 2 do not include commercial building demolition assumptions for Richland's service territory. Demolition rates are based on Council assumptions and vary by year and building segment. The average growth rate for commercial buildings is 1.2%.

Table 2
Commercial Building Square Footage by Segment

Segment	Area (Square Feet)	Growth Rate
Large Office	6,625,296	
Medium Office	9,449,283	
Small Office	503,552	
Extra Large Retail	1,912,331	
Large Retail	690,311	
Medium Retail	478,259	
Small Retail	20,882	
School (K-12)	1,643,867	
University	413,762	
Warehouse	5,564,246	
Supermarket	17,243	
Mini Mart	49,832	
Restaurant	232,200	
Lodging	572,093	
Hospital	1,063,551	
Residential Care	341,531	
Assembly	506,939	
Other Commercial	1,395,817	
Total	**31,480,994**	**1.2%**

Industrial

The methodology for estimating industrial potential is different than approaches 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.

Richland provided 2018 energy use for its industrial customers. Individual industrial customer usage and projected growth is shown by industrial segment in Table 3.

Table 3
Industrial Sector Load by Segment

Segment	Annual Base Load (2018 MWh)	Annual Growth Rate
Foundries	25,355	1.0%
Frozen Food	57,487	1.7%
Other Food	9,328	1.0%
Metal Fabrication	37,715	0.5%
Cold Storage	3,311	4.1%
Chemical	189	1.0%
Miscellaneous Manufacturing	15,601	1.2%
Total	**148,986**	**1.2%**

Distribution Efficiency (DEI)

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

Richland provided a total system load for 2018. The forecast was then adjusted to account for transmission system losses only, since the savings happen at the distribution level. Distribution system potential is discussed in detail in the next section.

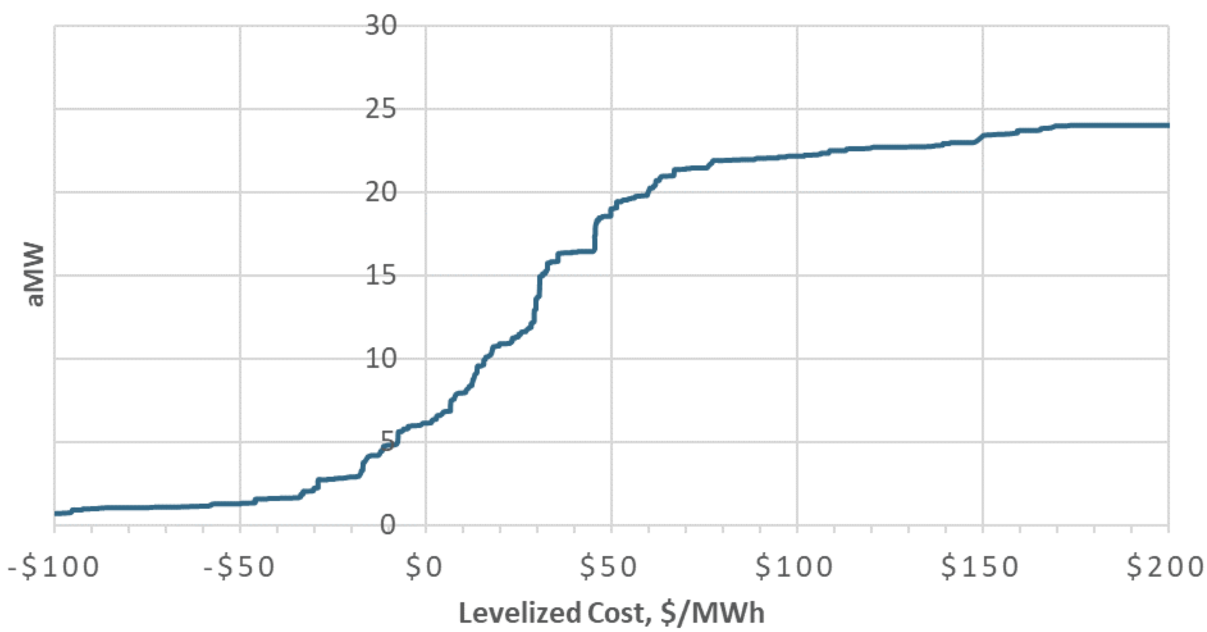
Results – Energy Savings and Costs

Achievable Conservation Potential

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

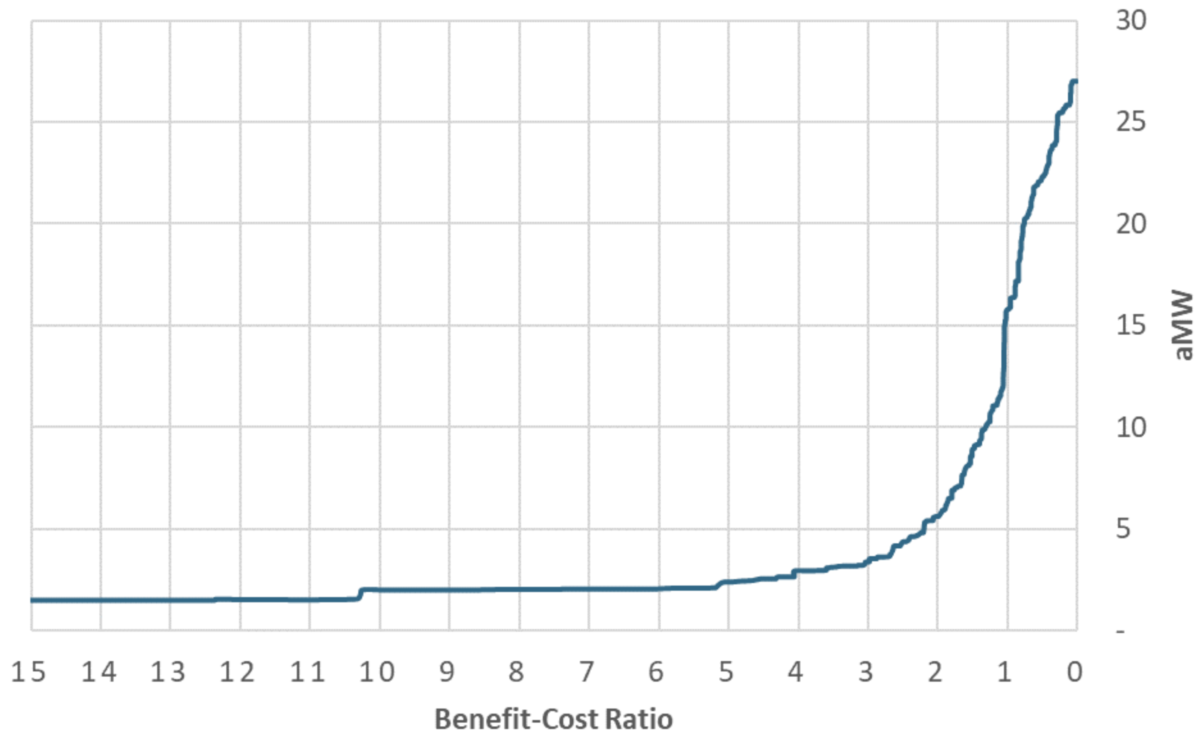
Figure 7, below, shows a supply curve of 20-year achievable potential. A supply curve is developed by plotting energy efficiency savings potential (aMW) against the levelized cost ($/MWh) of the conservation. The technical potential has not been screened for cost effectiveness. Costs are standardized (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 resource plans. Figure 7 shows that 13.2 aMW of saving potential are available for less than $30/MWh and over 22 aMW are available for under $80/aMW. Total achievable potential for Richland is approximately 27 aMW over the 20-year study period.

Figure 7
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 8 below. This figure repeats the overall finding that 15.79 aMW of potential is cost-effective with a benefit-cost ratio greater than or equal to 1.0. The line is steep near the point where the benefit-cost ratio is 1.0, suggesting significant changes in economic potential if avoided cost parameters are changed.

Figure 8
Benefit-Cost Ratio Supply Curve



Economic Achievable Conservation Potential

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

Table 4 shows aMW of economically achievable potential by sector in 2, 6, 10 and 20-year increments. Annual potential estimates by sector are included in Appendix VII. Compared with the achievable potential, it shows that 15.79 aMW of the total 27.03 aMW is cost-effective for Richland. The last section of this report discusses how these values could be used for setting targets.

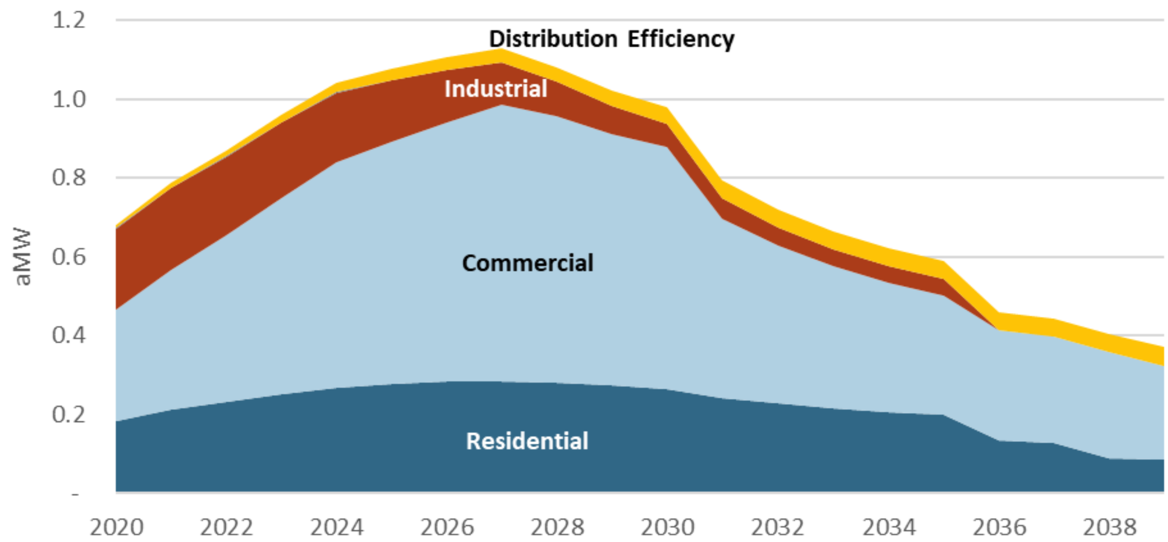
Table 4
Cost-Effective Achievable Potential - Base Case (aMW)

	2-Year	6-Year	10-Year	20-Year
Residential	0.39	1.42	2.54	4.33
Commercial	0.64	2.74	5.42	8.93
Industrial	0.41	1.14	1.54	1.82
Distribution Efficiency	0.02	0.11	0.25	0.70
Agricultural	0.00	0.01	0.01	0.01
Total	**1.47**	**5.41**	**9.75**	**15.79**

Sector Summary

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

Figure 9
Annual Achievable Potential by Sector



The largest share of the potential is in the commercial sector followed by substantial savings potential in the residential sector. Ramp rates are used to establish reasonable conservation achievement levels. Adjustments to these ramp rates were made to reflect the timeline of this CPA. Additionally, alternate ramp rates were assigned to reflect Richland's current rate of program achievement. These changes decelerated the acquisition of potential in all sectors except distribution efficiency and agricultural. Achievement levels are affected by factors including timing and availability of measure installation (lost opportunity), program (technological) maturity, non-programmatic savings, and current utility staffing and funding. Ramp rates are further discussed in Appendix V.

Table 7 below shows how recent program history compares to the near-term program potential. Residential savings exclude lighting savings, as these measures were excluded from the program potential. Savings from NEEA have been allocated to the appropriate sectors.

Table 7
Comparison of Program Achievement and Potential

	Program History				Potential		
	2017	**2018**	**2019**	**Average**	**2020**	**2021**	**2022**
Residential	0.229	0.249	0.220	0.233	0.181	0.213	0.232
Commercial	0.307	0.295	0.507	0.370	0.284	0.354	0.420
Industrial	0.165	1.453	0.514	0.711	0.206	0.207	0.201
Distribution Efficiency	-	-	-	-	0.001	0.001	0.001
Agricultural	-	-	-	-	0.007	0.011	0.015
Total	**0.701**	**1.997**	**1.241**	**1.313**	**0.680**	**0.786**	**0.870**

Residential

Residential savings potential has been impacted by the expected impact of federal lighting standards scheduled to take effect in 2020 as well as changes to the value of capacity savings in the avoided cost.

Figure 10 shows the distribution of annual residential potential across measure end uses for the first ten years of the planning period. As can be seen, the cost-effective potential is primarily comprised of measures in the HVAC and water heating end uses. Measures in other end uses, such as refrigeration, did not pass the economic screening.

The HVAC end use includes both heating equipment and weatherization measures such as attic insulation, ductless heat pumps, and Wi-Fi-enabled thermostats.

Water heating is a growing area of potential, with heat pump water heaters providing the majority of cost-effective savings. Showerheads are also a significant contributor. Other measures included in the water heating end use include aerators, behavior programs, clothes washers, and thermostatic shutoff valves.

Electronics contribute slightly to Richland's potential with both computer and monitor measures. Food preparation also contributes somewhat with electric oven and microwave measures.

Figure 10
Annual Residential Potential by End Use

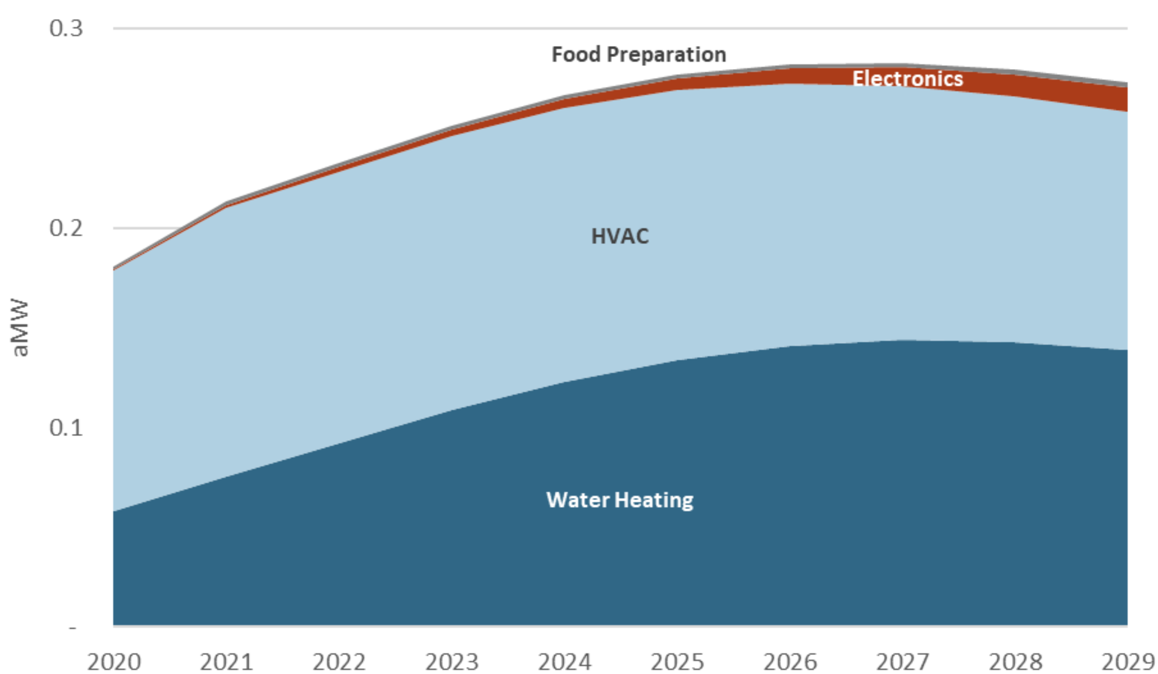
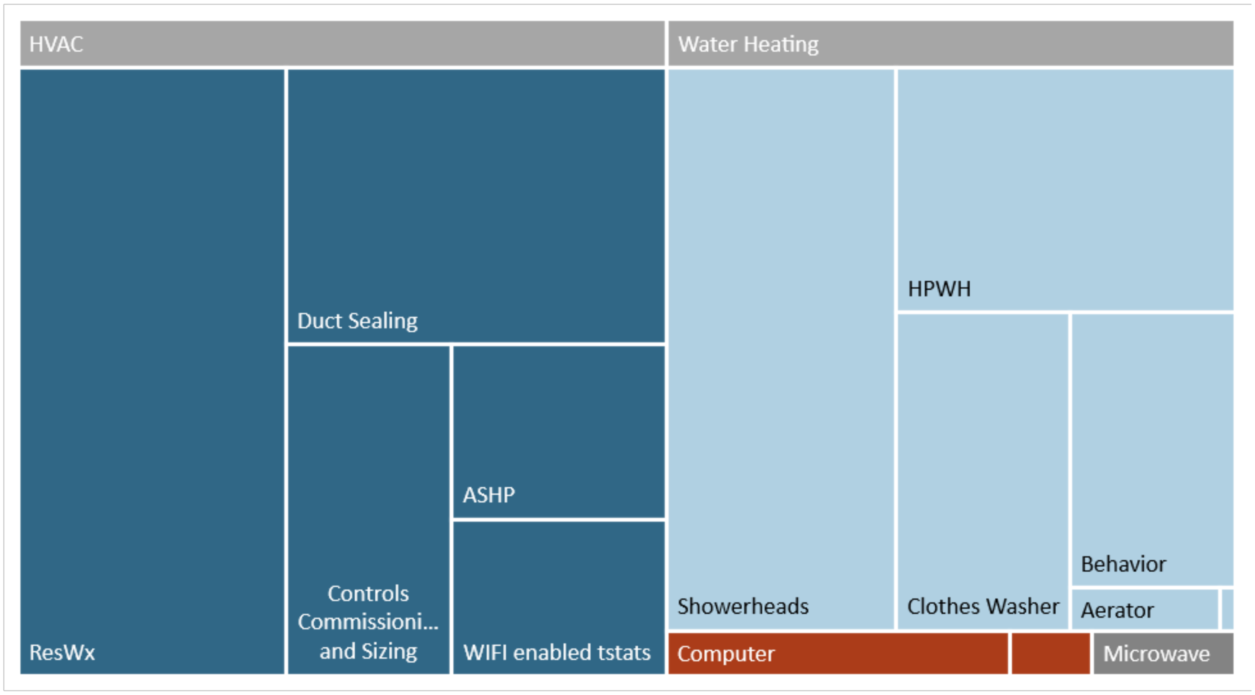


Figure 11 shows how the 10-year residential potential breaks down into end uses and key measure categories. The area of each block represents its share of the total 10-year residential potential.

Figure 11
Annual Residential Potential by End-Use



Commercial

Commercial lighting measures are the largest share of commercial conservation potential for the 2019 CPA planning period (Figure 12). Lighting savings are lower in this assessment after accounting for the federal EISA standard, which impacts several commercial measures.

HVAC control measures continue make up a substantial part of the balance of commercial conservation potential for this assessment period. Significant measures in this category include advanced rooftop controls, ductless heat pumps and variable refrigerant flow technology.

Commercial HVAC measures are often more complicated and disruptive to install compared to lighting measures and are, therefore, more slowly acquired.

Figure 12
Annual Commercial Potential by End Use

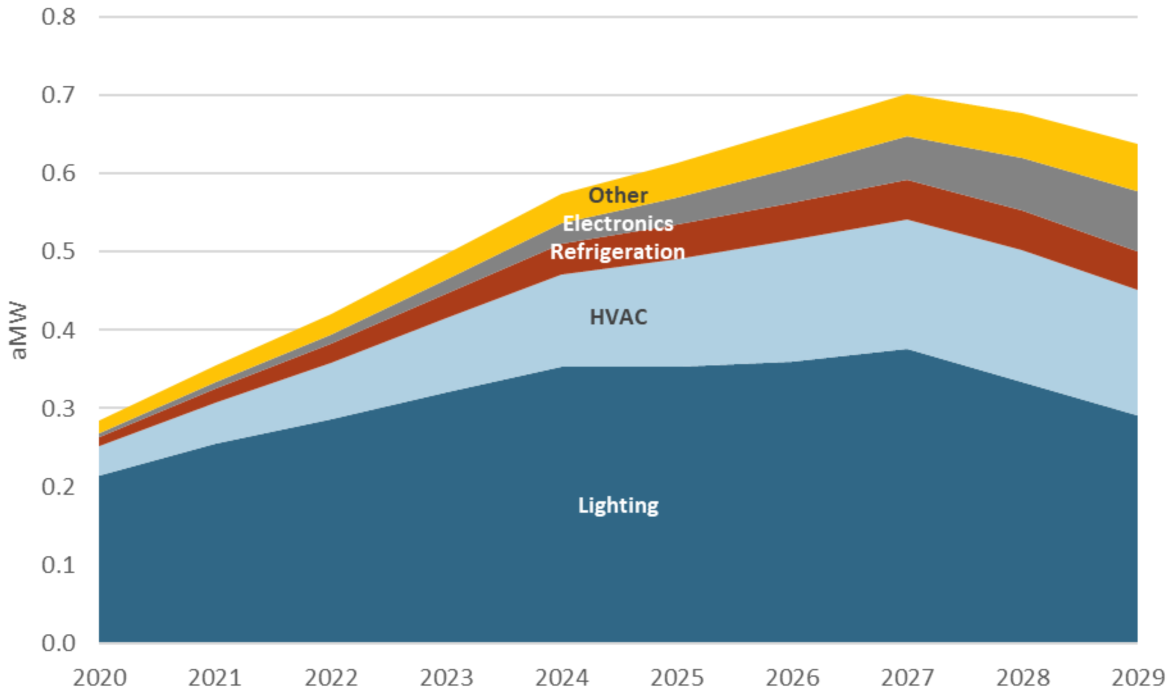
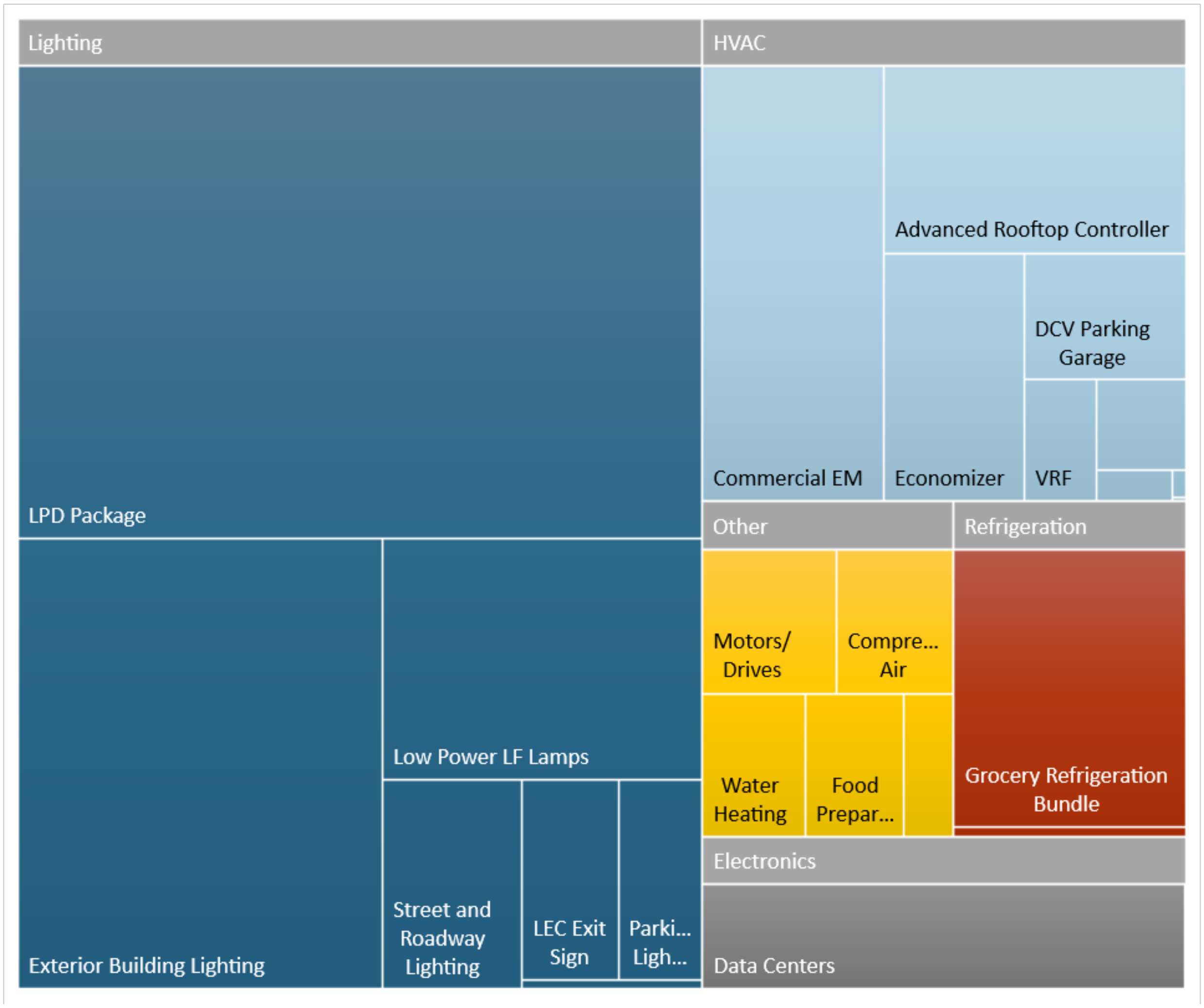


Figure 12 shows that, unlike residential potential, the commercial potential is characterized by a diverse set of measures and end uses due to the more varied nature of commercial buildings. The Other category is made up of measures in the compressed air, motors/drives, process loads, food preparation and water heating end uses. Detail of the savings by these end uses can be found in Appendix V.

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

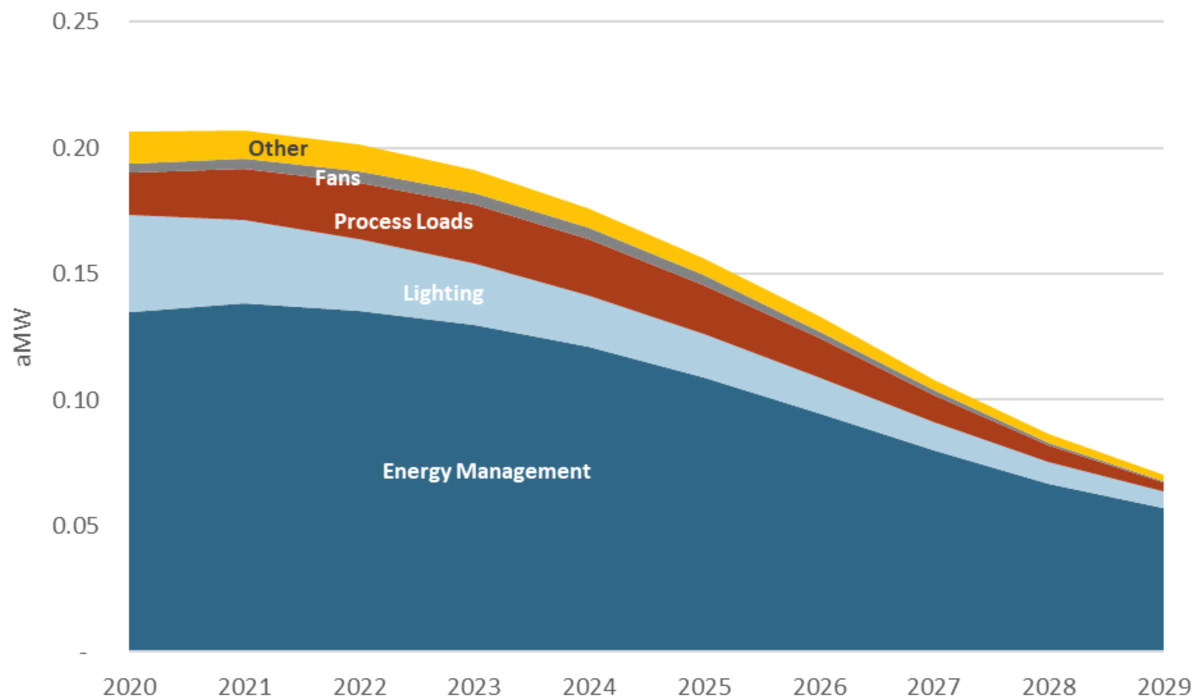
Figure 13
Commercial Potential by End Use and Measure Category



Industrial

Industrial sector potential by end-use category is shown in Figure 14. The majority of industrial potential is made up of energy management. Other measures also contribute savings to this sector, such as lighting and process load measures. The 2, 6, 10 and 20-year industrial sector potential estimates by measure end-use category are provided in Appendix VI.

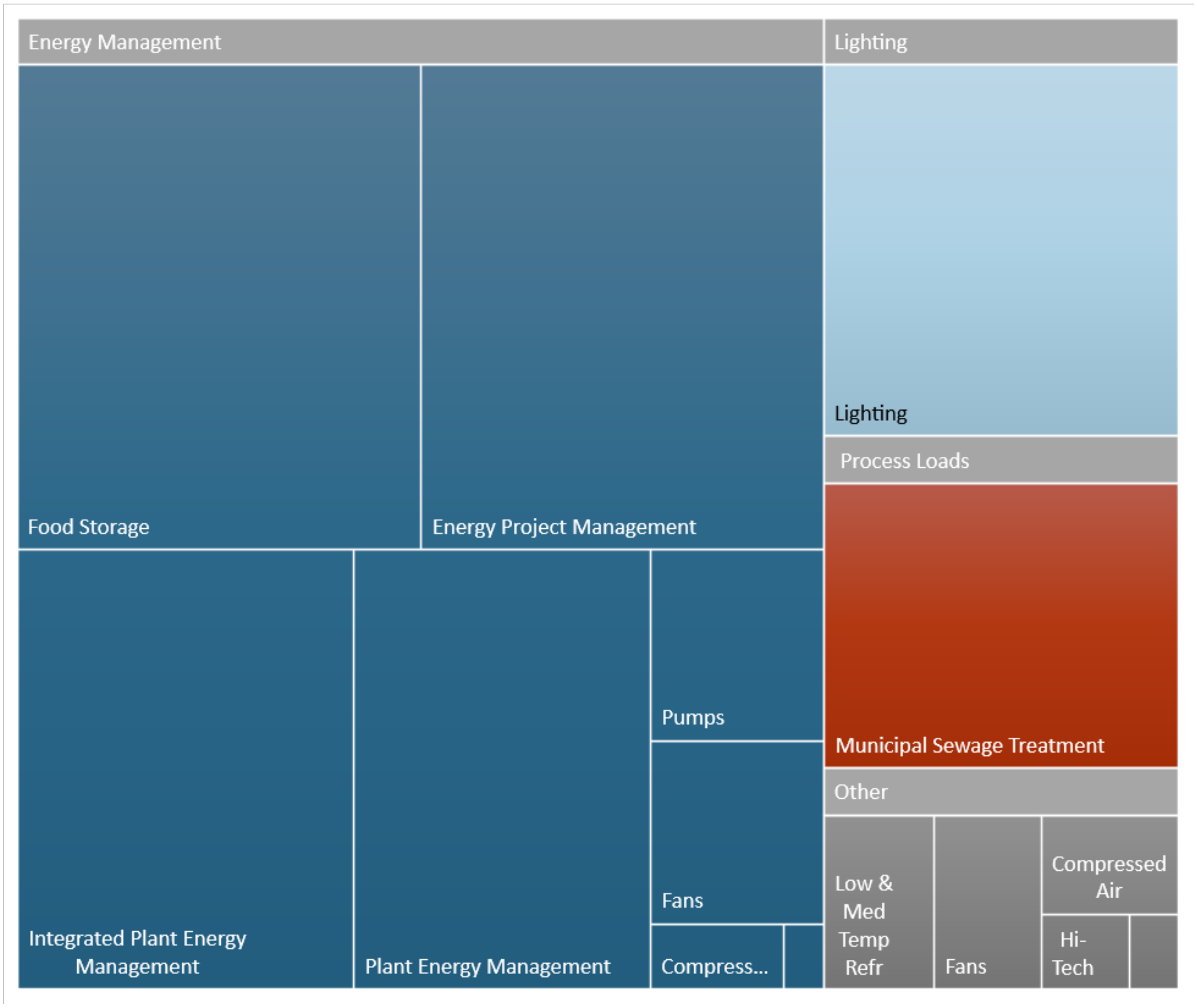
Figure 14
Annual Industrial Potential by End Use



In Figure 14, the Other category is comprised of measures in the high-tech, compressed air, low and medium temperature refrigeration, and metals end uses.

Figure 15 shows how the 10-year industrial potential breaks down by end use and measure categories. Energy management is a suite of behavioral measures targeted towards specific end uses or generally at industrial sites (such as energy project management, integrated plant energy management and plant energy management).

Figure 15
Industrial Potential by End Use and Measure Category

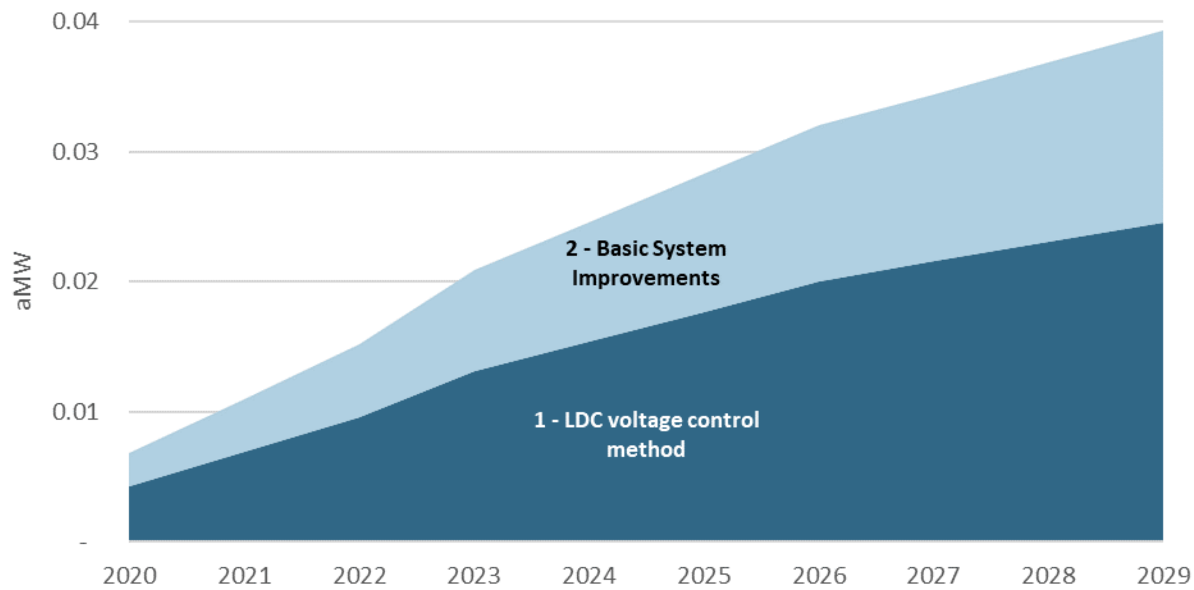


Distribution Efficiency

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

Distribution system conservation potential is shown in Figure 16. Although five measures were considered in the analysis, only two measures were identified as cost effective. The cost estimates for distribution system potential shown in Table 7 in the previous section are also based on the end-system sales method.

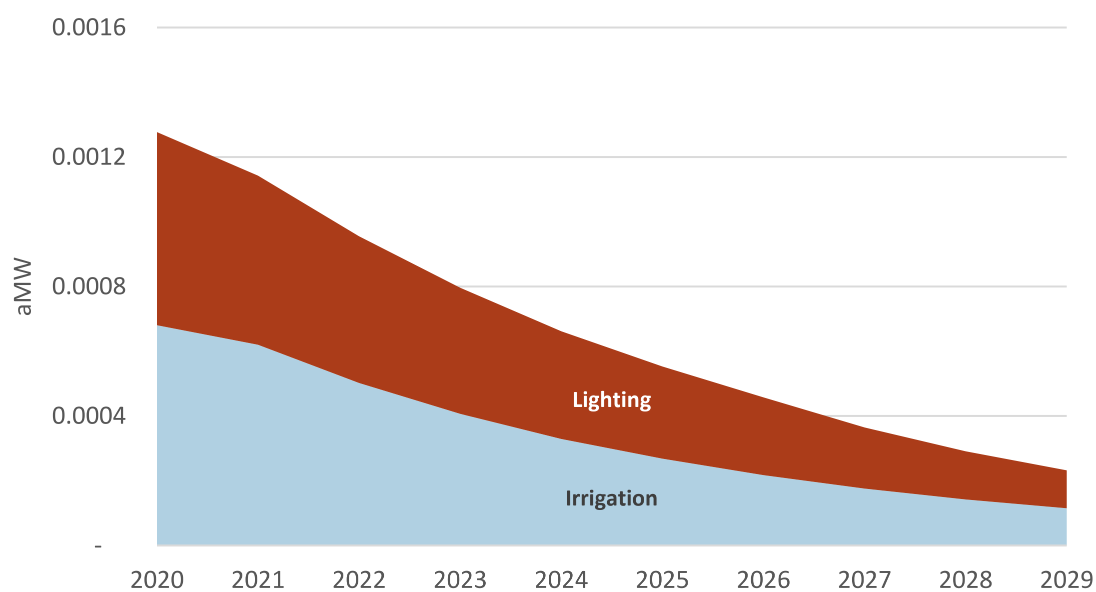
Figure 16
Annual Distribution System Potential by End Use



Agricultural

Figure 17 below show agricultural potential by end-use through 2029. Potential is made up of irrigation and lighting measures.

Figure 17
Annual Agricultural Potential by End Use



Cost

Budget costs can be estimated at a high level based on the incremental cost of the measures (Table 8). The assumptions in this estimate include: 20 percent of measure cost for administrative costs and 40 percent for incentive costs. These costs for administrative expenses and incentives are standard assumptions and are used in the Seventh Power Plan.

This table shows that Richland can expect to spend $3.5 million to realize estimated savings over the next two years including program administration costs. The bottom row of Table 8 shows the cost per MWh of first-year savings. Annual utility program costs can be found in Appendix VIII.

Table 8
Utility Program Costs (2019$)

	2-Year	6-Year	10-Year	20-Year
Residential	$1,587,000	$5,124,000	$8,426,000	$13,934,000
Commercial	$1,241,000	$5,415,000	$10,945,000	$20,245,000
Industrial	$517,000	$1,413,000	$1,908,000	$2,268,000
Distribution Efficiency	$6,000	$37,000	$85,000	$240,000
Agricultural	$4,000	$8,000	$11,000	$12,000
Total	**$3,355,000**	**$11,997,000**	**$21,375,000**	**$36,699,000**
$/First Year MWh	$261	$253	$250	$265

The cost estimates above are conservative estimates for costs going forward since they are based on historic values. Future conservation achievement may be more costly/difficult since the lowest cost, easiest programs are usually implemented first. In addition, as energy efficiency markets become more saturated, it may require more effort from Richland to acquire conservation through its programs. This additional effort may increase administrative costs.

Besides looking at the utility cost, Richland may also wish to consider the total resource cost (TRC) cost of energy efficiency. The total resource cost reflects the cost that the utility and ratepayer will together pay for conservation, similar to how the costs of other power resources are considered (such as in an IRP) and ultimately paid. The TRC costs are shown below (Table 9), levelized over the measure life of each measure. TRC costs by sector and end use are presented in Appendix VIII. Based on costs from the Seventh Power Plan, distribution efficiency measures are by far the lowest cost resource.

Table 9 TRC Levelized Cost (2019$/kWh)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	$0.063	$0.060	$0.058	$0.060
Commercial	$0.047	$0.048	$0.048	$0.052
Industrial	$0.036	$0.037	$0.037	$0.036
Distribution Efficiency	$0.007	$0.007	$0.007	$0.007
Agricultural	$0.042	$0.042	$0.042	$0.042
Total	**$0.049**	**$0.049**	**$0.049**	**$0.051**

Scenario Results

The costs and savings discussed in the results section describe the Base Case scenario. Under this scenario, annual potential for the planning period was estimated by applying assumptions that reflect Richland's expected most likely future loads and avoided costs. In addition, the Council's 20-year ramp rates were applied to each measure and then adjusted to more closely reflect Richland's recent historic conservation achievement.

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

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

Table 10 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 10 Avoided Cost Assumptions by Scenario, $2012			
	Base	**Low**	**High**
Energy	Market Forecast	-50%-85% Confidence Interval*	+50%-85% Confidence Interval*
Social Cost of Carbon	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
Value of REC Compliance	Existing RPS + CETA	Existing RPS + CETA	Existing RPS + CETA
Distribution System Credit, $/kW-year	$6.33	$6.33	$6.33
Transmission System Credit, $/kW-year	$2.85	$2.85	$2.85
Deferred Generation Capacity Credit, $/kW-year	$89	$69	$115
Implied Risk Adder: $/aMW $/kW-year	N/A	Up to -$18/aMW -$20/kW-year Average of -$11/aMW -$20/kW-year	Up to $18/aMW $26/kW-year Average of $11/aMW $26/kW-year

Table 11 summarizes results across each avoided input scenario, using Base Case load forecasts and measure acquisition rates.

Table 11 Cost-Effective Potential - Scenario Comparison (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Base Case	1.47	5.41	9.75	15.79
Low Scenario	1.05	3.85	6.77	10.29
High Scenario	1.82	6.46	11.58	19.07

In the table above, the change in cost-effective potential when going from the base to the low case is greater than the change in potential when going from the base to the high case. This suggests that there is less risk in pursuing energy efficiency that would end up costing more than the avoided costs, but more risk in undervaluing energy efficiency. This suggests that there is real risk of doing too little energy efficiency, as there could be additional energy efficiency that would be cost effective if some of the avoided costs assumed in the base case were too low.

This result is somewhat evident from the Benefit-Cost Ratio supply curve presented earlier in the report. The supply curve has a steep slope to the right of the threshold of cost-effectiveness, where the BCR equals 1.0, suggesting a high degree of sensitivity to upward changes in avoided cost parameters. The fact that the cost-effective potential increased more in the high avoided cost scenario than in the low scenario indicates the nature of the risk: there is more risk to undervaluing energy efficiency than overvaluing it. Richland should consider this outcome when selecting their goals.

In addition to analyzing the sensitivity of the 20-year cost-effective potential to variation in avoided costs, this analysis considered the sensitivity of results to the avoided cost scenarios described above in combination with different sector growth rates. These scenarios are described below.

Low Scenario

The Low Conservation scenario evaluates the cost-effective energy efficiency potential under a low market price forecast. The Base Case market price forecast and other avoided cost assumptions were adjusted downward as outlined in Table 10 above.

Under the Low scenario sector growth assumptions were not changed. Results of the Low scenario analysis are shown in Table 12.

Key parameters for the Low scenario include:

- Low avoided cost assumptions

Table 12
Cost-Effective Potential - Low Case (aMW)

	2-Year	6-Year	10-Year	20-Year
Residential	0.21	0.83	1.46	2.43
Commercial	0.51	2.07	3.91	5.86
Industrial	0.31	0.84	1.12	1.29
Distribution Efficiency	0.02	0.11	0.25	0.70
Agricultural	0.00	0.00	0.01	0.01
Total	**1.05**	**3.85**	**6.77**	**10.29**

High Scenario

Richland's High Conservation scenario makes use of the high avoided cost assumptions described above in Table 10.

Key parameters for the High scenario include:

- High avoided cost assumptions

Table 13 Cost Effective Achievable Potential - High Case (aMW)				
	2-Year	**6-Year**	**10-Year**	**20-Year**
Residential	0.44	1.68	3.16	5.93
Commercial	0.74	3.07	6.01	9.78
Industrial	0.61	1.56	2.05	2.36
Distribution Efficiency	0.03	0.15	0.35	0.99
Agricultural	0.00	0.01	0.01	0.01
Total	**1.82**	**6.46**	**11.58**	**19.07**

Summary

This report summarizes the results of the 2019 CPA conducted for Richland Energy Services. The assessment provides estimates of energy savings by sector for the period 2020 to 2039, with a focus on the first 10 years of the planning period, as 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.

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

Methodology and Compliance with State Mandates

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

Three types of energy-efficiency potential were calculated: technical, achievable, and economic. Most of the results shown in this report are the economic potential, or the potential that is cost effective in the Richland 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."[2] 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.[3]

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 Richland and approved by its City Council.

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.

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

[3] 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

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 House

MW –Megawatt

aMW –Megawatt-hour

NEEA – Northwest Energy Efficiency Alliance

NPV – Net Present Value

O&M – Operation and Maintenance

RPS – Renewable Portfolio Standard

RTF – Regional Technical Forum

SB 5116 – Washington Senate Bill 5116

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 considers 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.

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 – "Richland 2019 Conservation Potential Assessment." Final Report – March 20, 2020.
2) Model – "EES CPA Model-v3.3_base.xlsm" and supporting files
   a. MC_AND_LOADSHAPE-Richland-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 be 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 Richland 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.	Model – the use of these factors can be found on the sector measure tabs, such as 'Residential Measures'. Additionally, the complete set of ramp rates used can be found on the 'Ramp Rates' tab.
c) **Economic Achievable Potential**: Establish the economic achievable potential, which is the conservation potential that is cost-effective, reliable, and feasible, by comparing the total resource cost of conservation measures to the cost of other resources available to meet expected demand for electricity and capacity.	Benefits and costs were evaluated using multiple inputs; benefit was then divided by cost. Measures achieving a benefit-cost ratio greater than one were tallied. These measures are considered achievable and cost-effective (or "economic").	Model – BC Ratios are calculated at the individual level by ProCost and passed up to the model.

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

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
i) Include avoided energy costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy efficiency measures to which it is compared	A regional market price forecast for the planning period was created and provided by EES. A discussion of methodologies used to develop the avoided cost forecast is provided in Appendix IV.	Report –See Appendix IV. Model – See MC File ("TEA Base" worksheet).
j) Include deferred capacity expansion benefits for transmission and distribution systems	Deferred transmission capacity expansion benefits were given a benefit of $2.85/kW-year in the cost-effectiveness analysis. A distribution system credit of $6.33/kW-year was also used.	Model – this value can be found on the ProData page of each ProCost file.
k) Include deferred generation benefits consistent with the contribution to system peak capacity of the conservation measure	Deferred generation capacity expansion benefits were given a value of $ 72/kW-year in the base case cost effectiveness analysis. This is based upon Richland's marginal cost for generation capacity. Alternate values were used for the low and high scenarios.	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 the value has been combined with the distribution capacity benefit, since the timing of Richland's system peak and the regional peak are different.
l) Include the social cost of carbon emissions from avoided non-conservation resources	The avoided cost data include Federal 2.5% discount rate values.	Report – See avoided cost appendix
m) Include a risk mitigation credit to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources	In this analysis, risk was considered by varying avoided cost inputs and analyzing the variation in results. Rather than an individual and non-specific risk adder, our analysis included a range of possible values for each avoided cost input.	The scenarios section of the report documents the inputs used and the results associated.
n) Include all non-energy impacts that a resource or measure may provide that can be quantified and monetized	Quantifiable non-energy benefits were included where appropriate. Assumptions for non-energy benefits are the same as in the Council's Seventh Power Plan. Non-energy benefits include, for example, water savings from clothes washers.	Model – the ProCost files contain the same assumptions for non-power benefits as the Council and RTF. The calculations are handled in by ProCost.

WAC 194-37-070 Documenting Development of Conservation Targets; Utility Analysis Option		
NWPCC Methodology	**EES Consulting Procedure**	**Reference**
o) Include an estimate of program administrative costs	Total costs were tabulated and an estimated 20% of total was assigned as the administrative cost. This value is consistent with regional average and BPA programs. The 20% value was used in the Fifth, Sixth, and Seventh Power plans.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
p) Include the cost of financing measures using the capital costs of the entity that is expected to pay for the measure	Costs of financing measures were included utilizing the same assumptions from the Seventh Power Plan.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
q) Discount future costs and benefits at a discount rate equal to the discount rate used by the utility in evaluating non-conservation resources	Discount rates were applied to each measure based upon the Council's methodology. A real discount rate of 4% was used, based on the Council's most recent analyses in support of the Seventh Plan	Model – this value can be found on the ProData page of the ProCost Batch Runner file.
r) Include a ten percent bonus for the energy and capacity benefits of conservation measures as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act	A 10% bonus was added to all measures in the model parameters per the Conservation Act.	Model – this value can be found on the ProData page of the ProCost Batch Runner file.

Appendix IV – Avoided Cost and Risk Exposure

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

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

Avoided Energy Value

For the purposes of the 2019 CPA, EES has prepared a forecast of market prices for the Mid-Columbia (Mid-C) trading hub. This section summarizes the methodology used to develop the forecast, benchmarks it against other forecasts, and compares the forecast to the market forecast used in RES's 2015 CPA.

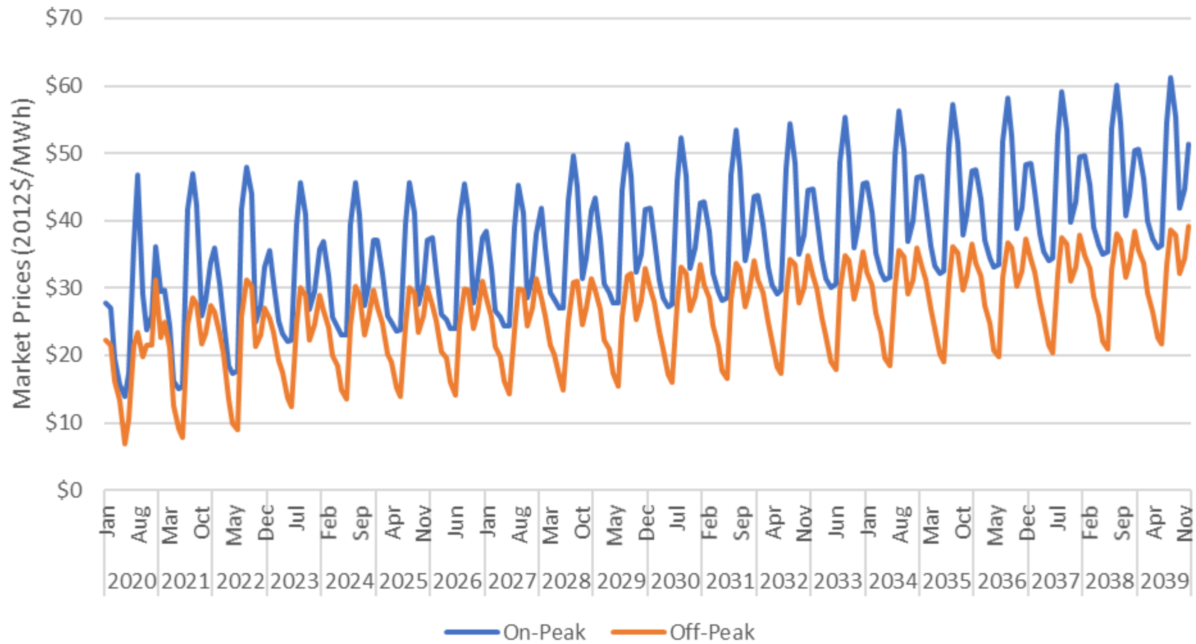
Methodology

For the period January 2020 to October 2029, projected monthly on- and off-peak market prices were provided through a subscription service. These market prices were sourced on November 1, 2019. EES extended the sourced market prices through the remainder of the CPA period by applying a simple linear model controlling for seasonal variation in prices. The resulting price forecast for the period January 2020 to December 2039 has an annual growth rate of 2.9%.

Results

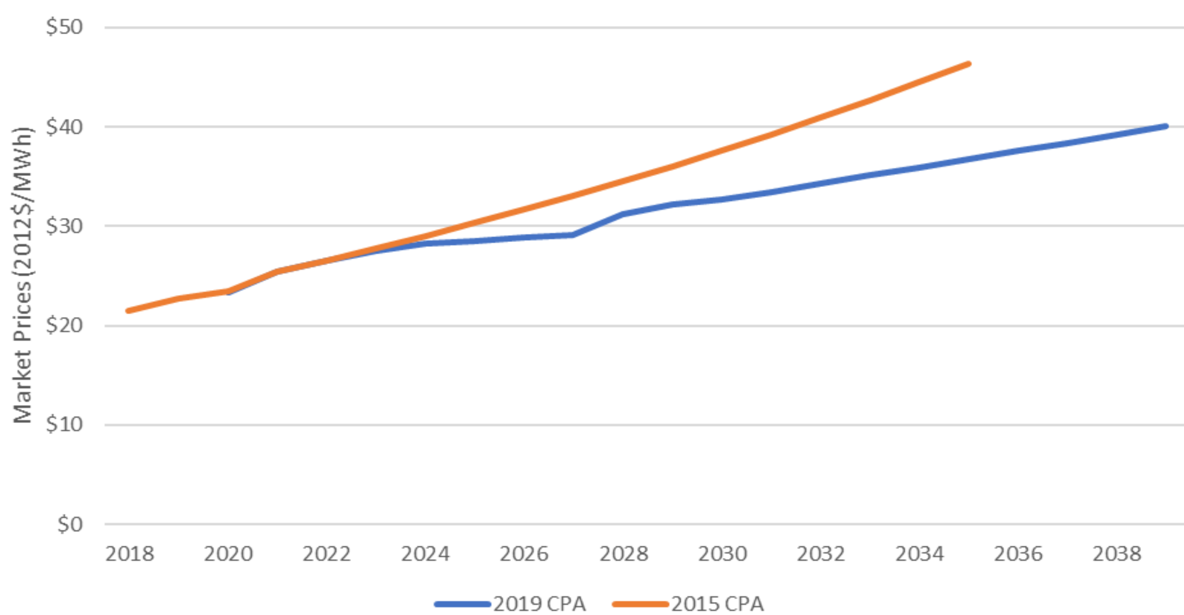
Figure IV-1 illustrates the resulting monthly, diurnal market price forecast. The levelized value of around-the-clock forecast market prices over the study period is $31.22/MWh in 2012 dollars, assuming a 3.75 percent real discount rate.

Figure IV-1
Forecast Mid-C Market Prices



This market price forecast is slightly lower than the market price forecast used in RES's previous CPA, conducted in 2015. Figure IV-2 compares the average annual price of the two forecasts. The 2019 CPA's 20-year market price forecast begins at approximately the same values as the 2015 CPA, however lower prices in 2024 through 2029 result in a divergence in the later forecast period of roughly nine dollars.

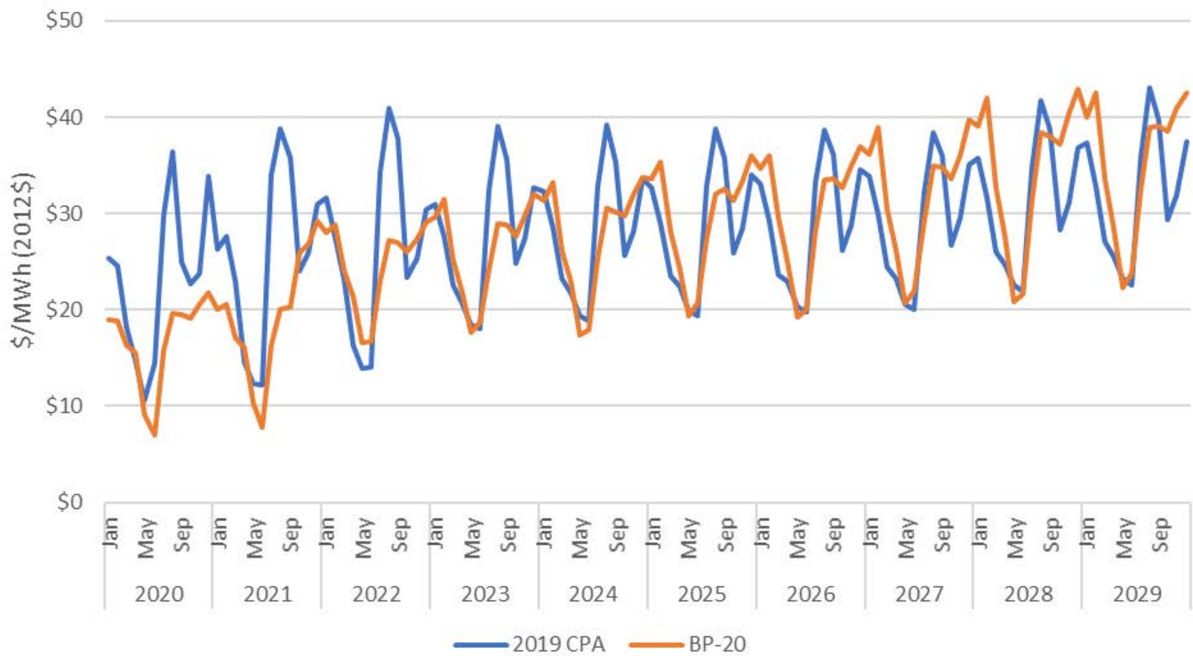
Figure IV-2
Forecast Mid-C Market Prices in 2019 CPA and 2015 CPA



Benchmarking

Figure IV-4 compares the EES market forecast with the 2020-29 market price forecast included in BPA's rate models used in the calculation of BPA's initial proposal for FY 2020-21 power rates. The monthly shapes differ in the short term as the BPA market price forecast is lower through the first few years, likely due to lower market power prices at the time it was prepared, in the second quarter of 2019. The forecasts are similar from summer 2021 forward, noting the CPA forecast peaks higher in summer months.

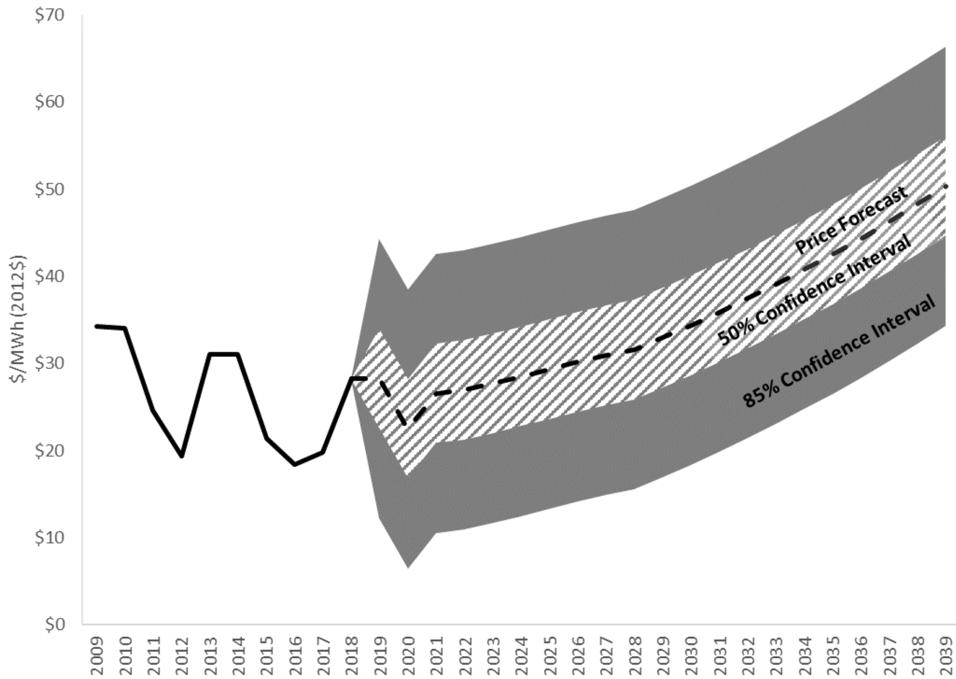
Figure IV-4
Forecast Mid-C Market Prices compared to BPA's Market Price Forecast



High and Low Scenarios

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

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



Figures IV-6 and IV-7 compare the resulting price forecasts, for on-peak and off-peak load hours, respectively.

Figure IV-6
On-Peak Mid-C Market Price Forecast

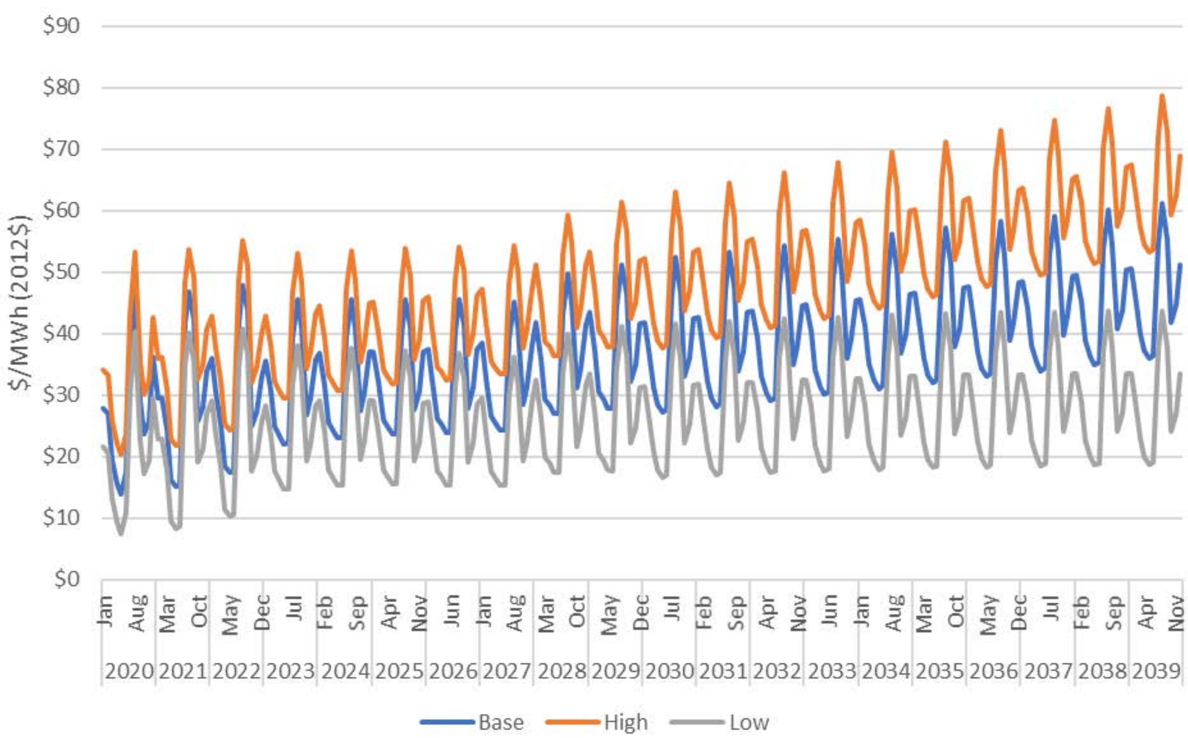
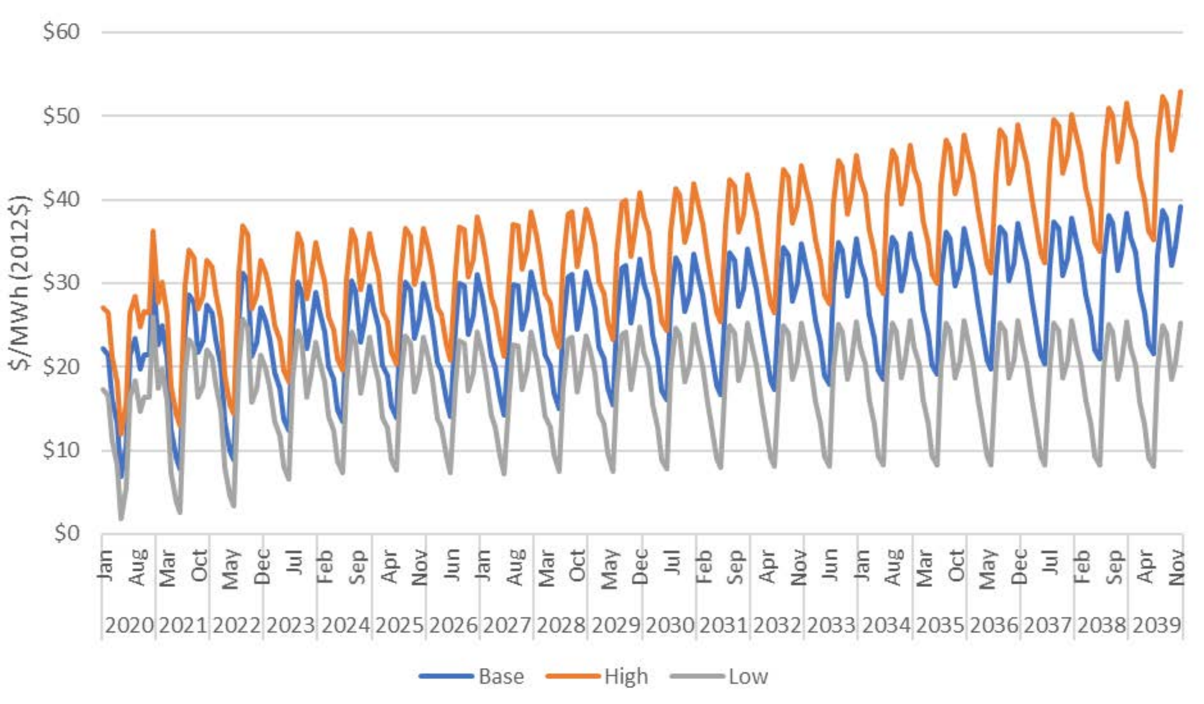


Figure IV-7
Off-Peak Mid-C Market Price Forecast



Avoided Cost Adders and Risk

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

Energy-Based Avoided Cost Adders:

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

Peak Demand-Based Adders:

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

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

Social Cost of Carbon

The social cost of carbon is a cost that society incurs when fossil fuels are burned to generate electricity. EIA rules require that CPAs include the social cost of carbon when evaluating cost effectiveness using the total resource cost test (TRC). Further, Washington state's Clean Energy Transformation Act (CETA) seeks to specify what values utilities use. While rulemaking is still ongoing, state staff have proposed adopting the social cost of carbon developed by the federal Interagency Workgroup using the 2.5 percent discount rate, the same values that the CETA requires investor-owned utilities to use.

These carbon costs were included in all avoided cost scenarios.

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

Beginning in 2030, CETA requires that all energy be greenhouse gas neutral, although there are provisions for alternate compliance paths until 2045. As such, the CPA assumes that all energy will be carbon-free from 2030 through the end of the study period.

Value of Renewable Portfolio Standard Compliance

Washington's Energy Independence Act established a Renewable Portfolio Standard (RPS) for utilities with 25,000 or more customers. RES will be required to source 3% of all electricity sold to retail customers from renewable energy resources beginning in 2026. In 2030, the requirement increases to 9%.

Washington's CETA requires that 100% of sales be greenhouse gas neutral in 2030, although 20% can be achieved through alternate compliance options such as the purchase of Renewable Energy Credits (RECs). Due to these requirements, energy efficiency's value in reducing RPS compliance costs changes over time.

From 2025 to 2029, energy efficiency can reduce the cost of compliance associated with the existing RPS requirements by reducing RES's overall load. Under a 3% RPS requirement, for every 100 units of energy efficiency acquired, RES's RPS spending requirement is reduced by 3 units. In effect, this adds 3 percent of the costs of RECs to the avoided costs of energy efficiency. EES has used a blend of several forecasts of REC prices and incorporated them into the avoided costs of energy efficiency accordingly.

Beginning in 2030, all energy sales must be greenhouse gas neutral, allowing for 20% of the compliance to be achieved through purchases of RECs or other means. Accordingly, the CPA assumes that the marginal cost of power in 2030 would be the market price of power plus the full cost of a REC.

Risk Adder

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

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

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

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

Deferred Transmission and Distribution System Investment

Energy efficiency measure savings reduce capacity requirements on both the transmission and distribution systems. The Council recently updated its estimates for these capacity savings, which were $31/kW-year and $26/kW-year for distribution and transmission systems, respectively (2012$). These values were used in the Seventh Plan. The new values, $2.85/kW-year and $6.33/kW-year (2012$) for transmission and distribution systems, respectively, will be used in the next Power Plan. These assumptions are used in all scenarios in the CPA.

Deferred Investment in Generation Capacity

Currently, RES is a load-following customer of BPA and pays a demand charge to BPA, based on its peak demand every month. The demand charge is set in each rate case based on the marginal capacity resource. Currently, the demand charges are approximately $10/kw-month and are based on an LMS100 combustion turbine. These demand charges effectively serve as the marginal cost of generation capacity for RES.

By assuming a monthly shape to conservation's demand savings, the charges were converted into a value of $81/kW-year. For the base case, it was assumed BPA's demand charges will increase in real terms by 3% annually. Over twenty years, the resulting cost of avoided capacity is $89/kW-year (2012$) in levelized terms. In the low scenario, no cost escalation was assumed, resulting in a 20-year levelized cost of $69/kW-yr.

In the Council's Seventh Power Plan[4], a generation capacity value of $115/kW-year was explicitly calculated ($2012). This value was used in the high scenario.

Summary of Scenario Assumptions

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

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

Table IV-1 Avoided Cost Assumptions by Scenario			
	Base	**Low**	**High**
Energy	Market Forecast	-50%-85% Confidence Interval*	+50%-85% Confidence Interval*
Social Cost of Carbon	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values	Federal 2.5% Discount Rate Values
Value of RPS Compliance	Existing RPS + CETA	Existing RPS + CETA	Existing RPS + CETA
Distribution System Credit, $/kW-year (2012$)	$6.33	$6.33	$6.33
Transmission System Credit, $/kW-year (2012$)	$2.85	$2.85	$2.85
Deferred Generation Capacity Credit, $/kW-year (2012$)	$89	$69	$115
Implied Risk Adder	N/A	Up to -$18/MWh -$20/kW-year Average of -$11/MWh -$20/kW-year	Up to $18/MWh $26/kW-year Average of $11/MWh $26/kW-year

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

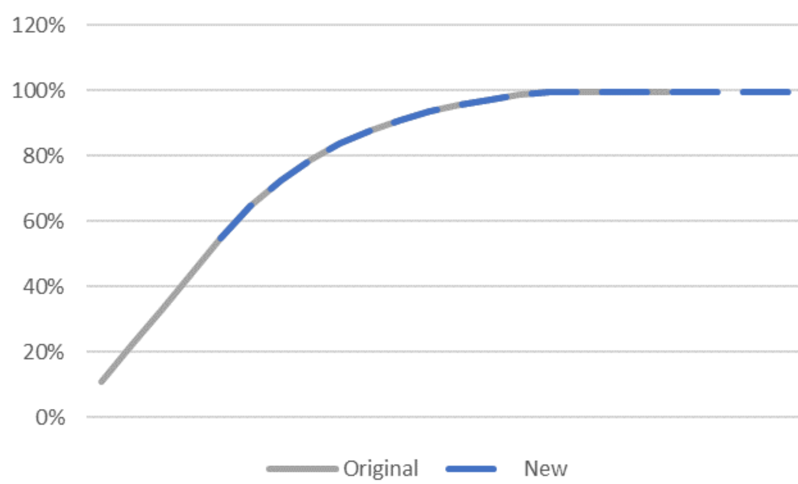
Appendix V – Ramp Rate Documentation

This section is intended to document how measure-level ramp rates were adjusted to align near term potential with recent achievements of Richland programs.

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

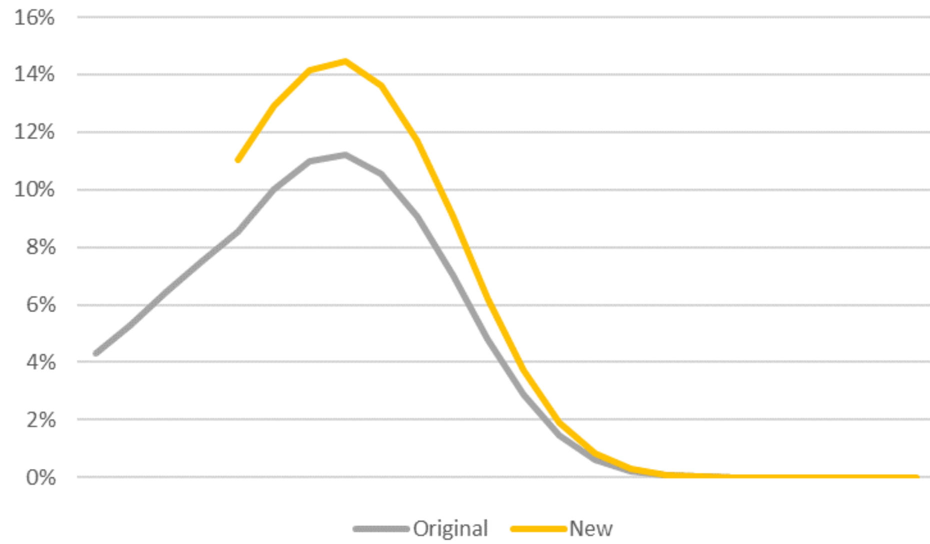
For lost opportunity measures, the ramp rates represent the share of equipment turning over in a given year that is achieved by efficiency programs. For these ramp rates, the only modification necessary was to extrapolate the final years to cover the time period relevant to the 2019 CPA. An example of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

Figure V-1
Example Lost Opportunity Ramp Rate Modification



For retrofit ramp rates, a different adjustment was necessary. The ramp rates applied to retrofit measures describe the portion of the entire stock that is acquired in a given year. For these ramp rates, new values were calculated based on the original ramp rate values. The new value was set as the original ramp rate value for a given year, divided by the sum of original ramp rate values over the 2020-2039 timeframe. This approach reflects the fact that a portion of the stock has already been acquired and continuing with the pace projected by the Seventh Plan would mean acquiring a larger percentage of a smaller remaining stock. An example of this is shown below in figure V-2.

Figure V-2
Example Retrofit Ramp Rate Modification



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

Table V-1 below shows the results of the comparison by sector *after* ramp rate adjustments were made. Note that these totals do not include savings from Richland's residential lighting program.

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

	Program History				Potential		
	2017	**2018**	**2019**	**Average**	**2020**	**2021**	**2022**
Residential	0.229	0.249	0.220	0.233	0.181	0.213	0.232
Commercial	0.307	0.295	0.507	0.370	0.284	0.354	0.497
Industrial	0.165	1.453	0.514	0.711	0.206	0.207	0.201
Agricultural	-	-	-	-	0.001	0.001	0.001
Distribution Efficiency	-	-	-	-	0.007	0.011	0.015
Total	**0.701**	**1.997**	**1.241**	**1.313**	**0.680**	**0.786**	**0.870**

Measure detail for each sector was acquired from BPA reporting, allowing for additional comparisons at the end use level, although savings from NEEA could not be allocated to individual measures or end uses.

Table V-2 below shows a comparison of historical accomplishments and future potential for the residential sector, by end use. Additional commentary is provided below.

Table V-2 Comparison of Residential Achievement and Potential (aMW)							
	Program History				Potential		
End Use	**2017**	**2018**	**2019**	**Average**	**2020**	**2021**	**2022**
Dryer	-	-	-	-	-	-	-
Electronics	-	-	-	-	0.001	0.002	0.002
Food Preparation	-	-	-	-	0.001	0.002	0.002
HVAC	0.102	0.086	-	0.094	0.121	0.135	0.136
Lighting	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-
Water Heating	-	-	-	-	0.058	0.075	0.092
Whole Bldg/Meter Level	-	-	-	-	-	-	-
NEEA	0.127	0.163	0.171	0.154	-	-	-
Total	**0.229**	**0.249**	**0.220**	**0.233**	**.181**	**0.213**	**0.232**

Electronics – Savings in this category were delayed and spread out as Richland has not achieved savings in this category in recent years. Savings from NEEA's consumer electronics initiative may apply here.

HVAC – This category was set to align approximately with the historical savings. Additional savings from NEEA's market transformation may apply here. Slower ramp rates were applied to some measures to align with program potential.

Water Heating – Savings in this category were delayed and spread out as Richland has not achieved savings in this category in recent years. Savings from NEEA's consumer electronics initiative may apply here.

The commercial sector achievements and estimated potential are shown in Table V-3, with additional commentary below.

Table V-3 Comparison of Commercial Achievement and Potential (aMW)							
	Program History				Potential		
End Use	**2017**	**2018**	**2019**	**Average**	**2020**	**2021**	**2022**
Compressed Air	-	-	-	-	0.004	0.005	0.007
Electronics	-	-	-	-	0.005	0.008	0.013
Food Preparation	-	-	-	-	0.004	0.005	0.006
HVAC	0.030	0.001	-	0.015	0.037	0.053	0.072
Lighting	0.245	0.254	-	0.250	0.214	0.254	0.285
Motors/Drives	-	-	-	-	0.003	0.004	0.006
Process Loads	-	-	-	-	0.001	0.002	0.002
Refrigeration	-	-	-	-	0.012	0.018	0.024
Water Heating	-	-	-	-	0.003	0.004	0.005
NEEA	0.032	0.041	0.043	0.038	-	-	-
Total	**0.307**	**0.295**	**0.51**	**0.370**	**0.284**	**0.354**	**0.420**

HVAC – Commercial HVAC ramp rates were decreased from Seventh Plan rates to more accurately reflect Richland's historical savings.

Lighting - Commercial lighting ramp rates were decreased from Seventh Plan rates to more accurately reflect Richland's historical savings.

Richland did not report savings in other end uses and ramp rates were decreased from Seventh Plan rates where cost-effective potential was identified.

The majority of savings in the Industrial sector are achieved by large custom projects and therefore are not directly mappable to individual end uses. Therefore, EES slowed down ramp rates in the Industrial sector to more closely align with recent levels of program achievement at the sector level and accounting for large custom projects completed in 2018 and 2019. The resulting conservation potential is shown above in Table V-1.

Appendix VI – Measure List

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

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

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

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

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

Table VI-3
Industrial End Uses and Measures

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

Table IV-4 Agriculture End Uses and Measures		
End Use	**Measures/Categories**	**Data Source**
Dairy Efficiency	Efficient Lighting	7th Plan
	Milk Pre-Cooler	7th Plan
	Vacuum Pump	7th Plan
Irrigation	Low Energy Sprinkler Application	7th Plan
	Irrigation Hardware	7th Plan, RTF
	Scientific Irrigation Scheduling	7th Plan, BPA
Lighting	Agricultural Lighting	7th Plan
Motors/Drives	Motor Rewinds	7th Plan

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

Appendix VII – Energy Efficiency Potential by End-Use

Residential	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Dryer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electronics	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food Preparation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HVAC	0.12	0.13	0.14	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.06	0.06	0.06	0.06
Lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating	0.06	0.08	0.09	0.11	0.12	0.13	0.14	0.14	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.09	0.07	0.06	0.03	0.02
Whole Bldg/Meter Le	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.18**	**0.21**	**0.23**	**0.25**	**0.27**	**0.28**	**0.28**	**0.28**	**0.28**	**0.27**	**0.26**	**0.24**	**0.23**	**0.22**	**0.21**	**0.20**	**0.13**	**0.13**	**0.09**	**0.09**

Residential - Detail	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Dryer																				
Clothes Dryer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electronics																				
Advanced Power Strips	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Computer	0.001	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.009	0.010	0.010	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Monitor	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Food Preparation																				
Electric Oven	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microwave	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HVAC																				
ASHP	0.003	0.004	0.006	0.009	0.011	0.014	0.016	0.018	0.020	0.021	0.022	0.023	0.023	0.024	0.024	0.024	0.024	0.024	0.024	0.024
Controls Commissioning and Sizing	0.004	0.006	0.009	0.013	0.017	0.020	0.024	0.027	0.029	0.031	0.033	0.034	0.034	0.035	0.035	0.035	0.035	0.035	0.035	0.035
DHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DHP Ducted	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duct Sealing	0.040	0.044	0.042	0.040	0.038	0.035	0.032	0.029	0.026	0.023	0.022	0.020	0.019	0.018	0.017	0.016	-	-	-	-
GSHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Recovery Ventilation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ResWx	0.062	0.068	0.066	0.064	0.060	0.055	0.049	0.043	0.038	0.034	0.031	0.028	0.026	0.025	0.023	0.022	-	-	-	-
WIFI enabled tstats	0.012	0.013	0.012	0.012	0.011	0.011	0.011	0.010	0.010	0.009	0.009	0.009	0.008	0.008	0.008	0.007	0.002	0.002	0.002	0.002
Lighting																				
LF Lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lighting PPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration																				
Freezer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigerator	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating																				
Aerator	0.001	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Behavior	0.016	0.019	0.021	0.021	0.020	0.018	0.014	0.010	0.007	0.005	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Clothes Washer	0.012	0.014	0.016	0.018	0.019	0.020	0.020	0.021	0.021	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.007	0.004	0.004	0.004
Dishwasher	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HPWH	0.006	0.010	0.014	0.020	0.025	0.031	0.036	0.041	0.045	0.048	0.050	0.052	0.053	0.054	0.054	0.054	0.054	0.049	0.012	0.009
Showerheads	0.016	0.022	0.029	0.036	0.044	0.051	0.056	0.060	0.060	0.057	0.051	0.043	0.034	0.026	0.019	0.014	0.009	0.009	0.009	0.009
Solar Water Heater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thermostatic Valve	0.005	0.007	0.009	0.011	0.012	0.012	0.011	0.009	0.008	0.006	0.004	0.003	0.002	0.001	0.001	0.000	-	-	-	-
WasteWater Heat Recovery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whole Bldg/Meter Level																				
EV Supply Equip	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.181**	**0.213**	**0.232**	**0.251**	**0.267**	**0.277**	**0.282**	**0.283**	**0.279**	**0.273**	**0.263**	**0.241**	**0.227**	**0.216**	**0.206**	**0.198**	**0.134**	**0.126**	**0.089**	**0.086**

Commercial **aMW**

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-	-	-
Electronics	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.08	0.09	0.02	-	-	-	-	-	-	-	-
Food Preparation	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-	-	-	-
HVAC	0.04	0.05	0.07	0.09	0.12	0.14	0.16	0.17	0.17	0.16	0.14	0.12	0.09	0.07	0.05	0.03	0.02	0.02	0.02	0.02
Lighting	0.21	0.25	0.29	0.32	0.35	0.35	0.36	0.38	0.33	0.29	0.28	0.22	0.22	0.23	0.23	0.23	0.23	0.22	0.22	0.19
Motors/Drives	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Process Loads	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Refrigeration	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.03	0.03	0.02	0.01	0.01	-	-	-	-
Water Heating	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	**0.28**	**0.35**	**0.42**	**0.50**	**0.57**	**0.61**	**0.66**	**0.70**	**0.68**	**0.64**	**0.62**	**0.45**	**0.40**	**0.36**	**0.33**	**0.30**	**0.28**	**0.27**	**0.27**	**0.24**

Commercial - Detail	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.004	0.005	0.007	0.008	0.009	0.011	0.012	0.012	0.012	0.012	0.011	0.009	0.008	0.006	0.005	0.004	0.000	-	-	-
Electronics																				
Data Centers	0.005	0.008	0.013	0.018	0.025	0.034	0.045	0.055	0.067	0.078	0.090	0.017	-	-	-	-	-	-	-	-
Desktop	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laptop	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Monitor	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smart Plug Power Strips	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Food Preparation																				
Cooking Equipment	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.009	0.010	0.010	0.011	0.011	0.011	0.004	-	-	-	-	-	-
Pre-Rinse Spray Valve	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
HVAC																				
Advanced Rooftop Controller	0.010	0.014	0.019	0.025	0.030	0.036	0.040	0.042	0.042	0.039	0.034	0.028	0.021	0.014	0.009	0.004	-	-	-	-
Commercial EM	0.013	0.019	0.026	0.034	0.042	0.050	0.055	0.059	0.059	0.055	0.049	0.039	0.029	0.020	0.012	0.006	-	-	-	-
DCV Parking Garage	0.004	0.005	0.007	0.009	0.011	0.013	0.014	0.015	0.015	0.014	0.012	0.010	0.008	0.005	0.003	0.001	-	-	-	-
DCV Restaurant Hood	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.003	0.002	0.002	0.001	-	-	-	-
Demand Control Ventilation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
DHP	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.008	0.009	0.008	0.008	0.006	0.005	0.004	0.003	0.002	0.001	0.001	0.001	0.001
Economizer	0.006	0.009	0.012	0.015	0.019	0.022	0.025	0.026	0.026	0.024	0.021	0.017	0.013	0.009	0.005	0.003	-	-	-	-
Premium Fume Hood	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005
Secondary Glazing Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VRF	0.001	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.011	0.011	0.012	0.012	0.012	0.012	0.012	0.012
WEPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Lighting																				
Bi-Level Stairwell Lighting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Exterior Building Lighting	0.040	0.050	0.057	0.071	0.085	0.099	0.111	0.121	0.100	0.084	0.070	0.013	0.013	0.013	0.013	0.014	0.014	0.014	0.014	0.014
LEC Exit Sign	0.007	0.008	0.009	0.009	0.010	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.012	0.012	0.004	0.003	0.003
Lighting Controls Interior	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
Low Power LF Lamps	0.032	0.037	0.041	0.045	0.048	0.050	0.051	0.053	0.028	-	-	-	-	-	-	-	-	-	-	-
LPD Package	0.102	0.123	0.138	0.152	0.165	0.175	0.182	0.187	0.190	0.192	0.193	0.195	0.194	0.195	0.196	0.196	0.197	0.197	0.197	0.164
Parking Lighting	0.008	0.011	0.014	0.017	0.020	0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Street and Roadway Lighting	0.024	0.025	0.025	0.026	0.026	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005
Motors/Drives																				
ECM-VAV	0.002	0.004	0.006	0.007	0.009	0.011	0.013	0.015	0.016	0.017	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
MotorsRewind	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Process Loads																				
Municipal Water Supply	0.001	0.002	0.002	0.003	0.004	0.005	0.005	0.006	0.006	0.006	0.005	0.004	0.003	0.002	0.001	0.001	-	-	-	-
Refrigeration																				
Grocery Refrigeration Bundle	0.012	0.017	0.022	0.029	0.036	0.042	0.048	0.051	0.051	0.048	0.042	0.034	0.026	0.017	0.011	0.005	-	-	-	-
Water Cooler Controls	0.001	0.001	0.002	0.003	0.004	0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Heating																				
Commercial Clothes Washer	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.000	-	-	-	-	-	-	-
Showerheads	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-	-	-	-
WHTanks	0.001	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.009	0.010	0.011	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Total	**0.284**	**0.354**	**0.420**	**0.497**	**0.574**	**0.613**	**0.657**	**0.702**	**0.677**	**0.638**	**0.615**	**0.454**	**0.400**	**0.359**	**0.327**	**0.304**	**0.278**	**0.271**	**0.269**	**0.236**

Industrial	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Energy Management	0.13	0.14	0.14	0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.04	-	-	-	-
Fans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Hi-Tech	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Lighting	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Low & Med Temp Ref	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Misc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Loads	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-
Pulp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.21**	**0.21**	**0.20**	**0.19**	**0.18**	**0.16**	**0.13**	**0.11**	**0.09**	**0.07**	**0.06**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**	**-**	**-**	**-**	**-**

Industrial - Detail	aMW																			
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Compressed Air	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Energy Management																				
Compressed Air	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Energy Project Management	0.032	0.034	0.032	0.030	0.029	0.027	0.026	0.024	0.023	0.021	0.020	0.019	0.018	0.017	0.016	0.015	-	-	-	-
Fans	0.005	0.006	0.007	0.007	0.006	0.005	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Food Storage	0.033	0.037	0.040	0.040	0.038	0.032	0.025	0.017	0.011	0.006	0.003	0.001	0.001	0.000	0.000	0.000	-	-	-	-
Hi-Tech	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Integrated Plant Energy Manageme	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	-	-	-	-
Plant Energy Management	0.036	0.031	0.026	0.022	0.019	0.016	0.013	0.010	0.008	0.006	0.005	0.004	0.003	0.002	0.002	0.001	-	-	-	-
Pumps	0.005	0.006	0.007	0.007	0.007	0.006	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Fans	0.004	0.004	0.005	0.005	0.004	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Hi-Tech	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
Lighting	0.038	0.033	0.028	0.024	0.020	0.017	0.014	0.011	0.009	0.007	0.005	0.004	0.003	0.002	0.002	0.002	-	-	-	-
Low & Med Temp Refr																				
Food Processing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Food Storage	0.006	0.005	0.005	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	-	-	-	-
Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	-	-	-
Misc																				
Belts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Food Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Loads																				
Municipal Sewage Treatment	0.017	0.020	0.022	0.023	0.022	0.019	0.015	0.011	0.006	0.003	0.001	0.001	0.000	0.000	0.000	0.000	-	-	-	-
Pulp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transformers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**0.206**	**0.207**	**0.201**	**0.191**	**0.176**	**0.156**	**0.133**	**0.108**	**0.087**	**0.070**	**0.059**	**0.052**	**0.048**	**0.045**	**0.043**	**0.041**	**-**	**-**	**-**	**-**

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

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

Appendix VIII – Cost Estimates by End-Use

	Utility Program Costs (2019$)																			
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Residential	$744,000	$843,000	$865,000	$887,000	$896,000	$889,000	$870,000	$841,000	$810,000	$781,000	$753,000	$712,000	$686,000	$666,000	$648,000	$632,000	$359,000	$353,000	$351,000	$349,000
Commercial	$548,000	$693,000	$828,000	$982,000	$1,136,000	$1,228,000	$1,325,000	$1,416,000	$1,411,000	$1,378,000	$1,337,000	$1,103,000	$1,020,000	$959,000	$910,000	$874,000	$833,000	$785,000	$779,000	$701,000
Industrial	$260,000	$257,000	$249,000	$236,000	$217,000	$193,000	$165,000	$134,000	$108,000	$88,000	$74,000	$65,000	$60,000	$56,000	$53,000	$51,000	$0	$0	$0	$0
Distribution Efficiency	$2,000	$4,000	$5,000	$7,000	$8,000	$10,000	$11,000	$12,000	$13,000	$13,000	$14,000	$15,000	$15,000	$15,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Agricultural	$2,000	$2,000	$2,000	$1,000	$1,000	$1,000	$1,000	$1,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	**$1,556,000**	**$1,799,000**	**$1,949,000**	**$2,113,000**	**$2,258,000**	**$2,321,000**	**$2,372,000**	**$2,404,000**	**$2,342,000**	**$2,260,000**	**$2,178,000**	**$1,895,000**	**$1,781,000**	**$1,696,000**	**$1,627,000**	**$1,573,000**	**$1,208,000**	**$1,154,000**	**$1,146,000**	**$1,066,000**
$/First Year MWh	$261	$261	$256	$251	$248	$246	$245	$243	$247	$253	$254	$273	$283	$291	$299	$305	$301	$297	$323	$329

TRC Levelized Cost (2019$/kWh)				
	2-Year	6-Year	10-Year	20-Year
Residential	**$ 0.063**	**0.059949**	**0.058323**	**0.059527**
Dryer				
Electronics	$ 0.070	$ 0.070	$ 0.070	$ 0.070
Food Preparation	$ 0.083	$ 0.083	$ 0.083	$ 0.083
HVAC	$ 0.072	$ 0.074	$ 0.076	$ 0.082
Lighting				
Refrigeration				
Water Heating	$ 0.042	$ 0.034	$ 0.029	$ 0.023
Whole Bldg/Meter Level				
Commercial	**$ 0.047**	**$ 0.048**	**$ 0.048**	**$ 0.052**
Compressed Air	$ 0.008	$ 0.008	$ 0.008	$ 0.008
Electronics	$ 0.041	$ 0.041	$ 0.041	$ 0.041
Food Preparation	$ 0.034	$ 0.022	$ 0.018	$ 0.016
HVAC	$ 0.048	$ 0.049	$ 0.049	$ 0.051
Lighting	$ 0.049	$ 0.050	$ 0.052	$ 0.056
Motors/Drives	$ 0.035	$ 0.035	$ 0.035	$ 0.035
Process Loads	$ 0.039	$ 0.039	$ 0.039	$ 0.039
Refrigeration	$ 0.038	$ 0.038	$ 0.038	$ 0.038
Water Heating	$ 0.052	$ 0.058	$ 0.062	$ 0.064
Industrial	**$ 0.036**	**$ 0.037**	**$ 0.037**	**$ 0.036**
Compressed Air	$ 0.015	$ 0.015	$ 0.015	$ 0.015
Energy Management	$ 0.022	$ 0.023	$ 0.024	$ 0.026
Fans	$ 0.017	$ 0.017	$ 0.017	$ 0.017
Hi-Tech	$ 0.015	$ 0.015	$ 0.015	$ 0.015
Lighting	$ 0.059	$ 0.059	$ 0.059	$ 0.059
Low & Med Temp Refr	$ 0.054	$ 0.054	$ 0.054	$ 0.054
Material Handling				
Metals	$ 0.017	$ 0.017	$ 0.017	$ 0.017
Misc				
Motors				
Paper				
Process Loads	$ 0.075	$ 0.075	$ 0.075	$ 0.075
Pulp				
Pumps				
Transformers				
Wood				
Distribution Efficiency	**$ 0.007**	**$ 0.007**	**$ 0.007**	**$ 0.007**
Agricultural	**$ 0.042**	**$ 0.042**	**$ 0.042**	**$ 0.042**
Dairy Efficiency				
Irrigation	$ 0.051	$ 0.051	$ 0.051	$ 0.051
Lighting	$ 0.040	$ 0.040	$ 0.040	$ 0.040
Motors/Drives				
Total	**$0.049**	**$0.049**	**$0.049**	**$0.051**