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TACOMA POWER
TACOMA PUBLIC UTILITIES

Tacoma Power Conservation Potential Assessment 2024-2043

Prepared for: Tacoma Power

By: Applied Energy Group, Inc.

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EXECUTIVE SUMMARY

Applied Energy Group (AEG) has successfully partnered with Tacoma Power to perform prior Conservation Potential Assessments (CPAs) in 2014, 2016, 2019, and 2021 following the methodology of the Northwest Power and Conservation Council's (Council's) 6th, 7th, and most recently 2021 Power Plans, according to which was in effect at the time of each study (currently the 2021 Power Plan).[1,2,3] The new CPA builds on the background material established in those earlier studies, but includes updates to the latest available customer data from Tacoma Power, best and most recent market data from the Northwest Energy Efficiency Alliance's (NEEA's) regional market assessments (RBSA, CBSA, and IFSA), and updated technical data from the Regional Technical Forum, NEEA, and the US Department of Energy.

To produce a reliable and transparent estimate of conservation resource potential, AEG performed the following tasks to meet Tacoma's key objectives:

- Used information and data from Tacoma Power, as well as secondary data sources, to describe how customers currently use energy by sector, segment, end use, and technology.
- Developed a baseline projection of how customers are likely to use electricity in absence of future conservation programs; this defines the metric against which future program savings are measured. This projection used up-to-date technology data, modeling assumptions, and energy baselines that reflect both current and anticipated federal, state, and local energy efficiency legislation that will impact energy conservation potential. The baseline does not include additional electrification of fossil fuel equipment beyond any code requirements that might apply.
- Estimated Technical, Achievable Technical, and Achievable Economic Potential consistent with Council methodology, the 2021 Power Plan and Washington's Energy Independence Act.[4] AEG estimated energy efficiency potential at the measure level within the Tacoma service territory over the 2024 to 2043 planning horizon, including energy savings on an hourly basis for each year in the study.

In summary, the potential study provides a solid foundation for the development of Tacoma Power's 2024-2025 biennial conservation targets. The results were also prepared for Tacoma's Integrated Resource Planning (IRP) team, who use the estimated program costs and the hourly measure-level savings estimates as inputs to their long-term planning model.

Table ES-1 summarizes the high-level results of this study. AEG analyzed potential for the residential, commercial, industrial, street lighting, and Joint Base Lewis-McChord (JBLM) market sectors. The CPA results also integrate analysis of residential behavioral program savings (home energy reports, or HERs) and distribution system efficiency conducted separately by Tacoma Power and provided to AEG for inclusion in the overall results. The ten-year potential in 2033, is 228,949 MWh, or 26.1 aMW. Key opportunities for savings include residential heat pump water heaters, the continuation of LED lighting programs with controls in the commercial and industrial sectors, implementation of strategic energy management initiatives in the large commercial sectors, efficient HVAC technologies, industrial motor VFDs, compressed air system upgrades, and motor and process optimization in the Industrial sector.

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[1] "Sixth Northwest Conservation and Electric Power Plan". Northwest Power & Conservation Council, February 1, 2010. https://www.nwcouncil.org/energy/previous-energy-plans/6/sixth-northwest-conservation-and-electric-power-plan-0

[2] "Seventh Northwest Conservation and Electric Power Plan." Northwest Power & Conservation Council, February 10, 2016. http://www.nwcouncil.org/energy/powerplan/7/plan/

[3] Council 2021 Power Plan: https://www.nwcouncil.org/2021-northwest-power-plan

[4] Energy Independence Act (I-937). http://www.commerce.wa.gov/growing-the-economy/energy/energy-independence-act/

Table ES-1-1 Achievable Economic Potential in 2033 (10-year cumulative savings)

Market Sector	2033 Achievable Economic Potential (MWh)	% of Total Potential	Average MW (aMW)
Residential	95,033	41.5%	10.8
JBLM Residential	1,615	0.7%	0.2
Commercial	56,951	24.9%	6.5
JBLM Commercial	10,431	4.6%	1.2
Industrial	55,651	24.3%	6.4
Street Lighting	1,931	0.8%	0.2
Distribution Efficiency	7,337	3.2%	0.8
Total	**228,949**	**100.0%**	**26.1**

Comparison with Prior Study

Compared to the prior CPA, which informed the 2022-2023 biennial conservation targets, several key assumptions and methodologies used in the region have been updated. These include:

- Latest customer database and electric use per customer information from Tacoma Power
- Granular Commercial Building Stock Assessment (CBSA 2019) lighting data that was not yet available in the previous CPA process
- Latest RTF workbooks and underlying assumptions (except for residential weatherization where older workbooks still best reflect the conditions of extant housing where Tacoma's programs intervene)
- Incorporated Tacoma Power's Weatherization non-participation study data for remaining market of these measures
- Updated avoided costs from latest Tacoma Power projections and analysis
- Code requirements and other assumptions relating to the 2021 Washington State Energy Code
- Newest NEEA data on heat pump water heaters

Compared to the previous study, Achievable Economic Potential has increased by about 1.2%, however this small overall net change is the result of opposing large changes in residential and commercial potential. Key contributors to changes relative to the previous CPA include:

- The continuing impacts of the Energy Independence and Security Act of 2007 (EISA) lighting standard that took effect in 2020, and resulting related market transformation, have dramatically reduced the opportunity for lighting replacements, particularly in the residential sector. The most recent data from the US Department of Energy and used by the Regional Technical Forum project that the market baseline for general service lighting replacement will reach 100% LED within a few years, though slightly slower than assumed in the prior CPA.
- Additionally impacting lighting, NEEA's detailed lighting stock information from the 2019 Commercial Building Stock Assessment was not yet available at the time of the previous CPA. Updating the commercial sector's lighting stock to reflect these new data significantly impacted the estimate of remaining potential in that end use.
- Updated building stock efficiency in the Residential sector. This study accounts for the impacts of the 2021 Washington State Energy Code which was scheduled to take effect July 2023.[5] This new, more efficient code

[5] The order postponing the application of WSEC 2021 until October was not issued until the CPA analysis was nearly complete. Assumptions throughout this report reflect the original language and schedule of the code rollout. This is discussed thoroughly in later chapters.

further lowers consumption in new construction homes, which reduces the opportunity for claimable savings above code.

Table ES-2 compares 10-year sector-level potential between the two studies.

Table ES-1-2 Comparing Achievable Economic Potential in 10th Study Year

Market Sector	Current Study: 2024-2033 Potential (MWh)	*Prior Study: 2022-2031Potential (MWh)*	Change from Prior Study (MWh)	% Change from Prior Study (MWh)
Residential	95,033	*55,756*	39,277	70.4%
JBLM Residential	1,615	*1,210*	405	33.4%
Commercial	56,951	*94,171*	-37,220	-39.5%
JBLM Commercial	10,431	*9,474*	957	10.1%
Industrial	55,651	*57,062*	-1,411	-2.5%
Street Lighting	1,931	*1,931*	0	0.0%
Distribution	7,337	*6,570*	767	11.7%
Total	**228,949**	***226,174***	**2,775**	**1.2%**

Special Consideration: Large Customer Closure

After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the industrial and total achievable economic conservation potential. The report tables and figures throughout this document include this large customer.

To account for the closure, apply a deduct of 21,106 MWh to the achievable economic potentials shown in table ES-1 and Table ES-2. For additional details on the industrial plant closure and impacts to the conservation potential assessment see Appendix E

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1

INTRODUCTION

This report documents the results of the Tacoma Power 2024-2043 Conservation Potential Assessment (CPA) and the steps AEG followed in its completion. Throughout this study, AEG worked with Tacoma Power staff to understand the baseline characteristics of their service territory, including a detailed understanding of energy consumption, the assumptions and methodologies used in Tacoma's official load forecast, and recent programmatic accomplishments. Using methodologies consistent with the Northwest Power and Conservation Council's (Council's) 2021 Power Plan,[6] AEG then developed an independent estimate of available conservation potential within Tacoma Power's service territory between 2024 and 2043.

Photo: Getty Images

Goals of the 2024-2043 CPA

The primary objective of the current CPA was to assist in developing Tacoma Power's 2024-2025 biennial conservation target under the State of Washington's Energy Independence Act,[7] also known as I-937. To satisfy this requirement, AEG followed the methodologies set forth in the Washington Administrative Code (WAC) 194-37-070, as described in Appendix A.

Additionally, this study was developed to provide conservation inputs into Tacoma Power's Integrated Resource Planning process. To this end, AEG developed hourly Achievable Economic Potential inputs by program for input into Tacoma Power's Integrated Resource Plan (IRP) model. AEG also identified impacts not captured in Tacoma Power's official econometric forecast, including the effects of known future federal equipment efficiency standards and variation in customer growth rates by housing type. These impacts were provided in hourly format for use in the IRP and account for the differences between AEG's end-use projection and Tacoma Power's official forecast.

[6] Council 2021 Power Plan: https://www.nwcouncil.org/2021-northwest-power-plan

[7] Energy Independence Act (I-937). http://www.commerce.wa.gov/growing-the-economy/energy/energy-independence-act/

Finally, the CPA is intended to support the review and design of programs to be implemented by Tacoma Power during the following biennium. Using regional sources, supplemented by well-vetted nationwide data when appropriate, AEG developed a comprehensive summary of measures. This summary documents input assumptions and sources on a per-unit basis, assumed applicability and achievability, and potential results (units, incremental potential, and cumulative potential). This summary was developed in collaboration with Tacoma Power and refined throughout the project.

Project Background

Applied Energy Group (AEG) has successfully partnered with Tacoma Power to perform prior Conservation Potential Assessments (CPAs) in 2014, 2016, 2019, and 2021 following the methodology of the Northwest Power and Conservation Council's (Council's) 6th, 7th, and most recently 2021 Power Plans, according to which was in effect at the time of each study (currently the 2021 Power Plan).[8,9,10] The new CPA builds on the background material established in those earlier studies, but includes updates to the latest available customer data from Tacoma Power, best and most recent market data from the Northwest Energy Efficiency Alliance's (NEEA's) regional market assessments (RBSA, CBSA, and IFSA), and updated technical data from the Regional Technical Forum, NEEA, and the US Department of Energy.

This CPA was conducted under the then-current assumption that the provisions of WSEC 2021 would take effect as scheduled in July 2023. Analysis and modeling were complete by the time the order delaying the implementation of the code to October 2023 was published. With that caveat, at the time this report was developed, the code is still expected to be in effect by 2024, the first year of potential savings shown in this report, however potential modifications relative to the version initially planned to be enacted in July 2023 are yet unknown and are not reflected in the results shown in this report.

Report Contents

The remainder of this report is divided into six chapters and four appendices, summarizing the approach, assumptions, and results of Tacoma Power's 2024-2043 CPA. We describe each section below:

- **Analysis Approach and Data Development**. Detailed description of AEG's approach to conducting Tacoma Power's 2024-2043 CPA and documentation of primary and secondary sources used.
- **Market Characterization and Market Profiles**. Characterization of Tacoma Power's service territory in the base year of the study, 2021. This characterization includes total consumption, number of customers and market units, and energy intensity. This also includes a breakdown of the energy consumption for the residential, commercial, industrial, and JBLM residential and commercial sectors by end use and technology.
- **Baseline Projection**. Projection of baseline energy consumption under a frozen-efficiency case, described at the end-use level. The LoadMAP models were first aligned with Tacoma Power's official econometric forecast and then varied to include the impacts of future federal standards and residential growth assumptions. Note that this reference baseline assumes business-as-usual regarding customer equipment preferences, not a driven electrification scenario.
- **Overall Conservation Potential**. Summary of conservation potential for Tacoma Power's entire service territory for selected years between 2024 and 2043, including territory-wide supply curves and potential estimates for each sector, including behavioral programs in residential and distribution efficiency analysis provided by Tacoma Power.

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[8] "Sixth Northwest Conservation and Electric Power Plan". Northwest Power & Conservation Council, February 1, 2010. https://www.nwcouncil.org/energy/previous-energy-plans/6/sixth-northwest-conservation-and-electric-power-plan-0

[9] "Seventh Northwest Conservation and Electric Power Plan." Northwest Power & Conservation Council, February 10, 2016. http://www.nwcouncil.org/energy/powerplan/7/plan/

[10] Council 2021 Power Plan: https://www.nwcouncil.org/2021-northwest-power-plan

- **Sector-Level Conservation Potential**. Summary of conservation potential for each market sector within Tacoma Power's service territory, including residential, JBLM residential, commercial, JBLM commercial, industrial, street lighting and distribution efficiency. This section includes a more detailed breakdown of potential by measure type, vintage, market segment, and end use. Potential is also analyzed for level of risk based on its RTF workbook status and cost-effectiveness ratio. Supply curves by market sector are also provided.
- **Comparison with Prior Study**. Detailed comparison of changes between the prior and current CPA.

Appendices:

- **Consistency with Power Plan Methodology**. Documentation of how AEG's approach in conducting the 2024-2043 CPA aligns with the 2021 Power Plan under WAC 194-37-070.
- **Market Profiles**. Detailed market profiles for each non-industrial market sector. Includes equipment saturation, unit energy consumption or energy usage index, energy intensity, and total consumption.
- **Customer Adoption Factors**. Documentation of the ramp rates used in this analysis, generally taken from the 2021 Power Plan conservation workbooks.
- **Measure List**. List of measures, along with example baseline definitions and efficiency options by market sector analyzed. Distribution efficiency was not included in this list since it is a single measure.

Abbreviations and Acronyms

Throughout the report we use a number of abbreviations, acronyms, and initialisms. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Definitions of Abbreviations, Acronyms, and Initialisms

Term	Definition
aMW	Average Megawatt, obtained by dividing Megawatt-hours by 8760
AEO	Annual Energy Outlook forecast developed by EIA
B/C Ratio	Benefit to Cost Ratio
BEST	AEG's Building Energy Simulation Tool
BPA	Bonneville Power Administration
C&I	Commercial and Industrial
Council	Northwest Power and Conservation Council
DSM	Demand-Side Management
EE	Energy Efficiency
ECM	Energy Conservation Measure
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
EUL	Effective Useful Life
EUI	Energy Use Intensity
GWh	Gigawatt Hour
HVAC	Heating Ventilation and Air Conditioning
IRP	Integrated Resource Plan
LED	Light Emitting Diode lamp
LoadMAP	AEG's Load Management Analysis and Planning™ tool
MW	Megawatt
NPV	Net Present Value
NEEA	Northwest Energy Efficiency Alliance
O&M	Operations and Maintenance
RTF	Regional Technical Forum
TRC	Total Resource Cost test
UCT	Utility Cost Test
UEC	Unit Energy Consumption
UES	Unit Energy Savings
WAC	Washington Administrative Code

2

ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the study's analysis approach and the data sources used to develop the potential estimates.

Overview of Analysis Approach

To perform the potential analysis, AEG used a bottom-up approach following the major steps listed below. We describe these analysis steps in more detail throughout the remainder of this chapter.

1. Performed a market characterization to describe sector-level electricity use for the residential, commercial, industrial, street lighting, and JBLM sectors for the base period. This included using Tacoma data and other secondary data sources such as NEEA's 2016 RBSA and recently updated 2019 CBSA and publications from the U.S. Energy Information Administration (EIA).
2. Developed a baseline projection of energy consumption by sector, segment, end use, and technology for 2022 through 2043.
3. Defined and characterized several hundred energy conservation measures (ECMs) to be applied to all sectors, segments, and end uses.
4. Estimated Technical, Achievable Technical, and Achievable Economic Potential at the measure level for 2024-2043.

LoadMAP Model

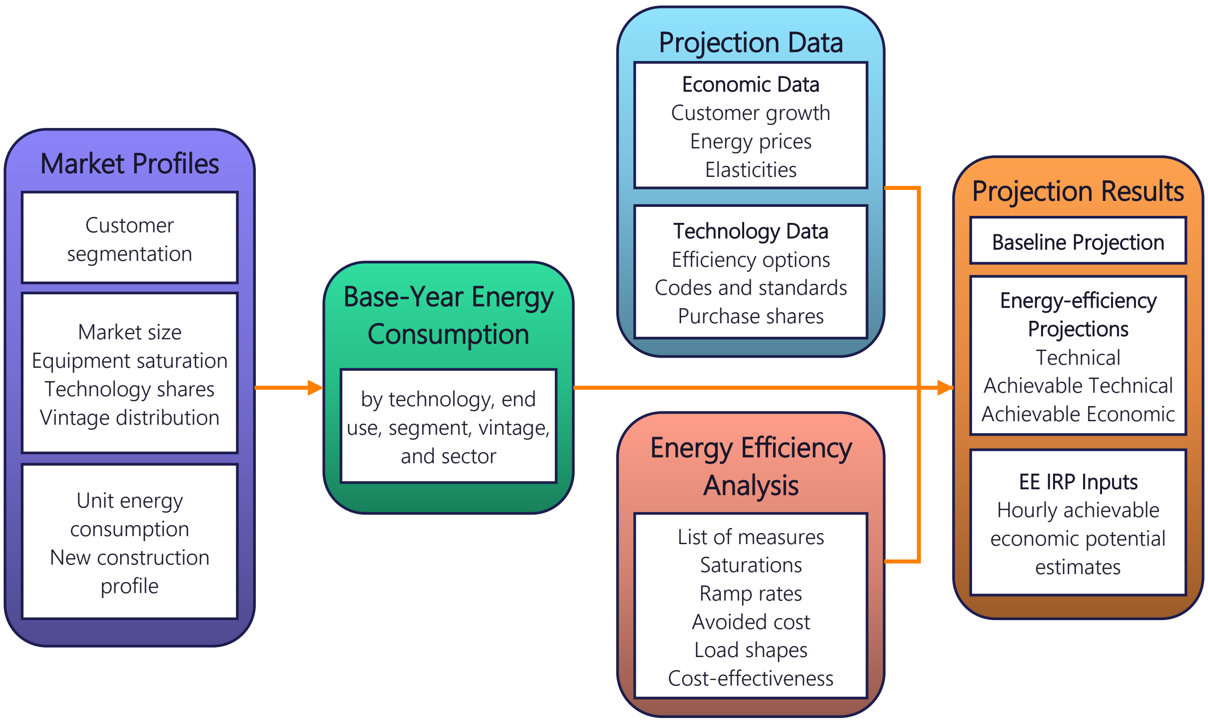
For this analysis, AEG used its Load Management Analysis and Planning tool (LoadMAP™) to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for the Electric Power Research Institute (EPRI) National Potential Study and numerous utility-specific forecasting and potential studies since. Built in Excel, the LoadMAP framework (see Figure 2-1) is accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.

- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).
- Natively outputs model results in a detailed line-by-line summary file, allowing for review of input assumptions, cost-effectiveness results, and potential estimates at a granular level.

Consistent with the segmentation scheme and the market profiles we describe below, the LoadMAP model provides projections of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides forecasts of total energy use and energy-efficiency savings associated with the various types of potential

Figure 2-1 LoadMAP Analysis Framework



Types of Potential Included in the Study

For this study, AEG analyzed three types of potential: Technical, Achievable Technical and Achievable Economic. Utilities can customize this analysis to best suit their needs and align with regulatory requirements in reporting energy efficiency potential. Chapter 5 provides more detail on each type of potential and what data informed potential scenarios for this study.

Table 2-1 Levels of Potential

Potential Type	Definition
Technical	Everyone chooses the most efficient option regardless of cost at time of equipment replacement or measure adoption, limited only by the presence of applicable equipment or space.
Achievable Technical	A modified technical potential that accounts for likely measure adoption within the market over the study timeline
Achievable Economic	A subset of achievable technical potential that includes only cost-effective measures

Market Characterization

To estimate the savings potential from energy-efficient measures, it is necessary to first understand how much energy is used today and what equipment is currently in service. This market characterization begins with a segmentation of Tacoma Power's electricity footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies in operation. For this we rely primarily on information from Tacoma Power, augmenting with secondary sources as necessary.

Segmentation for Modeling Purposes

This assessment first defined the market segments (building types, end uses, and other dimensions) that are relevant in the Tacoma Power service territory. The segmentation scheme for this project is presented in Table 2-2.

Table 2-2 Overview of Analysis Segmentation Scheme

Segmentation Variable	Description
Sector	Residential, commercial, industrial, JBLM residential, JBLM commercial, street lighting
Segment	Residential: single family, single family 2-4 units, low-rise multifamily, high-rise multifamily, and mobile homes, further differentiated by income Commercial: office, retail, college, school, grocery, hospital, other health, lodging, restaurant, assembly, warehouse, data center, multifamily common area, street lighting, classified miscellaneous, and unclassified miscellaneous Industrial: key industrial segments and other/misc. Street Lighting: rate class
Vintage	Existing and new construction
End uses	Cooling, lighting, water heating, motors, etc. (as appropriate by sector)
Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

With the segmentation scheme defined, we then performed a high-level market characterization of electricity sales in the base year. We used detailed Tacoma Power billing and customer data with minimal augmentation from secondary sources to allocate energy use and customers to the various sectors and segments such that the total customer count and energy consumption matched Tacoma Power's system totals for 2021. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base year.

Market Profiles

The market profile is a snapshot of an entire sector in the base year, summarizing energy use for each segment in the study and apportioning the annual energy consumption into the various end uses and technologies. The market profile serves as the foundation for the baseline projection by defining the count of stock units that are available, and what the consumption of those units looks like in each segment. Chapter 3 provides detail on the key market profile elements.

Baseline Projection

The next step was to develop the baseline projection of annual electricity use for 2022 through 2043 by customer segment and end use without new utility conservation programs. The baseline projection is the foundation for the analysis of savings in future conservation cases and scenarios as well as the metric that potential is measured against. AEG developed the reference baseline in alignment with Tacoma Power's long-term demand forecast, but some modifications to account for known future conditions were also made.

Inputs to the baseline projection include:

- Customer growth projections
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards, including requirements for electric heat pump space and water heating in new construction from the 2021 Washington State Energy Code, as well as other relevant provisions of the code

It should also be noted that this reference baseline does **not** include the following:

- Future DSM program impacts
- Legislation-driven electrification of existing equipment – as legislation that would drive this change is not yet established in Washington. If such legislation passes in the future, it may constitute a significant difference in projected baseline sales
- Climate change projections – to remain consistent with Tacoma Power's official load forecast, these projections assume normal weather conditions

We present the baseline projection results for the system as a whole and for each sector in Chapter 4.

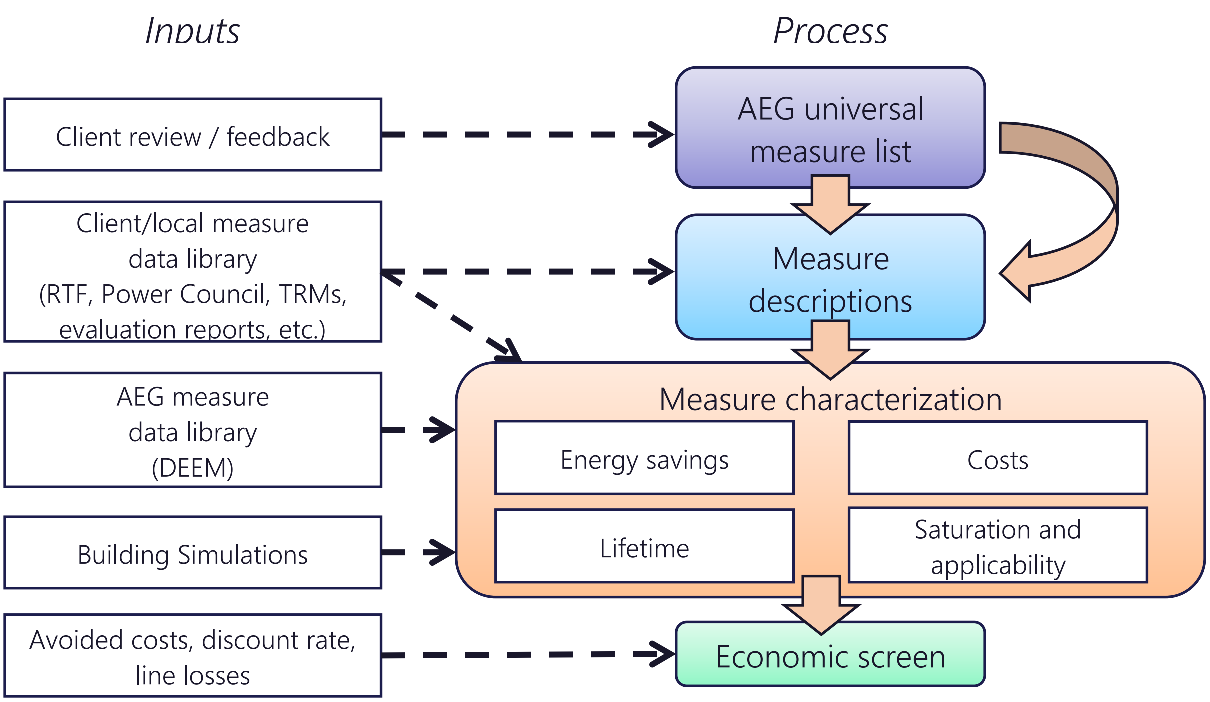
Energy Conservation Measure Development

This section describes the framework used to assess the savings, costs, and other attributes of energy conservation measures (ECMs). These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings.

Figure 2-2 outlines the framework for the ECM analysis. The framework for assessing savings, costs, and other attributes of ECMs involves identifying the list of ECMs to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Tacoma Power provided feedback during each step of the process to ensure measure assumptions and results aligned with programmatic experience.

AEG compiled a robust list of ECMs for each customer sector, primarily from Regional Technical Forum (RTF) measure workbooks, but also drawing upon Tacoma program experience, AEG's own measure databases and building simulation models, and secondary sources. This universal list of measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. While this list may ultimately not be exhaustive of every possible intervention, it presents a wide array of reasonable and possible options with sufficient data for modeling and applying in Tacoma Power's territory. If considered today, some of these measures would not pass the economic screens, but may pass in future years as a result of lower projected equipment costs or higher avoided cost benefits.

Figure 2-2 Approach for ECM Assessment



The selected measures are categorized into two types according to the LoadMAP modeling taxonomy: equipment measures and non-equipment measures.

- **Equipment measures** represent efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. For example, an ENERGY STAR refrigerator replacing a standard refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of residential central air conditioners, this list begins with the 2021 Washington state energy code minimum efficiency level unit and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit. These measures are applied on a stock-turnover basis, and in general, are referred to as lost opportunity measures by the Council since once a purchase decision is made, there will not be another opportunity to improve the efficiency of that equipment item until the lifetime expires again.
- **Non-equipment measures** save energy by reducing the need for delivered energy, but do not involve the replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). Since measure installation is not tied to a piece of equipment reaching the end of its useful life, these are generally categorized as "retrofit" measures. An example would be a wi-fi-enabled thermostat that is pre-set to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, the addition of wall insulation will affect the energy use of

both space heating and cooling equipment. Non-equipment measures typically fall into one of the following categories:

- Building shell (windows, insulation, roofing material)
- Equipment controls (thermostat, integrated lighting fixture controls)
- Whole-building design (zero-net energy, passive solar lighting)
- Displacement measures (ceiling fan to reduce use of central air conditioners)
- Retro-commissioning
- Residential behavioral programs
- Energy Management programs

AEG developed a preliminary list of efficient measures, which was distributed to the Tacoma project team for review. The measure list was finalized after incorporating comments and is presented in the Appendix D. Once the list of measures to assess was finalized, the project team fully characterized each measure in terms of energy savings, incremental cost, effective useful life, and other performance factors.

Calculation of Energy Conservation Potential

The approach used to calculate conservation potential adheres to the approaches and conventions outlined in the most recent Washington Administrative Code (WAC) 194-37-070(5), the Northwest Power & Conservation Council's 2021 Power Plan, and the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies.[11] Additional information on WAC 194-37 compliance is provided in Appendix A. As described in the Executive Summary, three types of potential were developed as part of this effort: Technical potential, Achievable Technical potential, and Achievable Economic Potential. The calculation of Technical potential is a straightforward algorithm which, as described in Table 2-1 above, assumes that all customers adopt all feasible measures regardless of their cost.

Estimating Customer Adoption

Once the Technical potential is established, estimates for the market adoption rates for each measure are applied, specifying the percentage of customers assumed to install the measure or select the chosen efficient option. This phases potential in over a realistic time frame that considers barriers such as imperfect information, supplier constraints, technology availability, and individual customer preferences. The intent of market adoption rates is to establish a path to full market maturity for each measure or technology group and ensure that resource planning does not overstep acquisition capabilities. Market adoption rates for each measure are based on 2021 Power Plan ramp rates for comparable measures. Applying these ramp rates to the Technical potential leads directly to the Achievable Technical potential.

Screening Measures for Cost-Effectiveness

With Achievable Technical potential established, the final step is to apply an economic screen to arrive at the subset of measures that are both achievable and cost-effective and ultimately included in Achievable Economic Potential. LoadMAP performs an economic screen for each individual measure in each year of the planning horizon. This study uses the Total Resource Cost (TRC) test as the cost-effectiveness metric, which compares the lifetime hourly energy benefits and monetized non-energy impacts of each applicable measure with its cost. The lifetime benefits are calculated by multiplying the annual energy savings for each measure by Tacoma Power's hourly weighted wholesale market avoided cost,[12] discounting the dollar savings to the present value equivalent. Final avoided costs for each measure also include some non-energy values and a 10% conservation

[11] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025: Developing a Framework for Change*. www.epa.gov/eeactionplan.

[12] Avoided costs are calculated for each measure by multiplying its normalized 8760 load shape and the provided hourly energy costs from Tacoma Power. In this way, the seasonality of a measure is reflected in its avoided energy cost.

adder, as described in Table 2-3. Lifetime costs represent incremental measure cost and annual O&M costs, also discounted to present value. The analysis uses each measure's values for savings, costs, and lifetimes developed as part of the measure characterization process described above.

Table 2-3 Overview of Non-Energy Impacts in the CPA

Modeling Component	Included Non-Energy Impacts/Adders
Avoided Costs	Wind Avoided REC Carbon Dioxide Adder Energy-related Capacity Value Energy-related T&D Deferral 10% Conservation Adder
Measure Characterization	As applicable: Water Savings Detergent Savings Deferred O&M benefits Any other impacts consistent with RTF workbooks and Council methodology

The LoadMAP model performs this screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast.

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus, if a measure is deemed to be irrelevant to a building type and vintage, it is excluded from the respective economic screen.
- Savings and cost effectiveness are considered in relation to the average customer case, characterized across the population.

This constitutes the Achievable Economic Potential and includes every program-ready opportunity for conservation savings. Potential results are presented in Chapters 4 and 5. Measure-level detail is available in Appendix D of this report.

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied. In general, data were adapted to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Data Sources

The data sources are organized into the following categories:

- Tacoma Power data
- Northwest regional data
- AEG's databases and analysis tools
- Other secondary data and reports

Tacoma Data

The highest priority data sources for this study were those specific to Tacoma Power's service territory.

- **Tacoma customer account database.** Tacoma Power provided billing data for development of customer counts and energy use for each sector. This included a detailed database of customer building classifications which was instrumental in the development of segmentation. In addition, the account database included the following information which was instrumental to informing the CPA.
    - Presence of electric heat study
    - County Assessor data
    - Conservation accomplishment data
    - Equipment saturation surveys
- **Load and customer forecasts.** Tacoma Power provided forecasts of energy consumption, customer counts by sector, and exogenous forecasting variables such as weather data.
- **Economic information.** Tacoma provided a discount rate as well as avoided cost forecasts and line loss factors on an 8,760-hour basis.
- **Avoided Costs.** The avoided costs provided by Tacoma Power for the CPA are also used in other aspects of planning and the IRP. For the CPA, the provided hourly costs of energy projected through the entire CPA cycle are weighted by each end use load shape to produce an average annual avoided cost of energy that varies for different measures and technologies based on how their impacts coincide with periods of higher and lower value to Tacoma Power.
- **Tacoma Power program data.** Tacoma Power provided information about past and current programs, including program descriptions, goals, and measure achievements to date.
- **On-site survey of JBLM military base.** The U.S. Military's Joint Base Lewis-McChord is one of the larger electricity consumers in Tacoma Power's service territory, and hosts both army and air force operations, personnel, and their families. Results of the onsite surveys conducted by AEG for Tacoma Power at JBLM as part of the 2014 study were used to generate JBLM-specific assumptions.
- **Hourly load shape data.** Select industrial customers and load profiles.

Northwest Regional Data

The study utilized a variety of local data and research, including research performed by the Northwest Energy Efficiency Alliance (NEEA) and analyses conducted by the Council. Most important among these are:

- **Regional Technical Forum (RTF) workbooks.** The Regional Technical Forum maintains regularly updated technical workbooks on measure data for use within the region, including Washington state. These workbooks were used as a primary data source when Tacoma Power-specific program data were not available.
- **Northwest Power and Conservation Council 2021 Power Plan** To develop its Power Plan, the Council maintains workbooks with detailed information about measures, frequently based on the RTF workbooks, but also including data for some measures not covered by the RTF, such as detailed industrial motors analysis. Where the 2021 Power Plan data was the most current and relevant, this information was used.
- **Northwest Energy Efficiency Alliance, 2016-2017 Residential Building Stock Assessment II,** https://neea.org/data/residential-building-stock-assessment

- **Northwest Energy Efficiency Alliance, 2011 Residential Building Stock Assessment**, https://neea.org/resources/washington-state-report
- **Northwest Energy Efficiency Alliance, 2019 Commercial Building Stock Assessment,** https://neea.org/resources/cbsa-4-2019-final-report
- **Northwest Energy Efficiency Alliance, 2014 Commercial Building Stock Assessment**, https://neea.org/resources/2014-cbsa-final-report
- **Northwest Energy Efficiency Alliance, 2014 Industrial Facilities Site Assessment,** https://neea.org/resources/2014-ifsa-final-report

The NEEA surveys were used extensively to develop base saturation and applicability assumptions for many of the non-equipment measures within the study. Legacy surveys (RBSA 2011 and CBSA 2014) are included because they often provide different granularity of data and/or valuable trend insight when combined with the more recent surveys.

AEG Data

AEG maintains several databases and modeling tools that we use for forecasting and potential studies. Relevant data from these tools has been incorporated into the analysis and deliverables for this study.

- **AEG Energy Market Profiles.** For more than 10 years, AEG staff has maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- **Building Energy Simulation Tool (BEST)**. AEG's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- **AEG's Database of Energy Efficiency Measures (DEEM).** AEG maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data**.**
- **Recent studies**. AEG has conducted numerous studies of energy efficiency potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include PacifiCorp, Avista, Idaho Power, and numerous studies from across the U.S.

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- **Annual Energy Outlook**. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2021 AEO.
- **Local Weather Data**. Weather from NOAA's National Climatic Data Center for Tacoma, WA (specifically from the McChord Air Force Base) was used where applicable.
- **EPRI End-Use Models (REEPS and COMMEND)**. These models provide the energy-use elasticities we apply to electricity prices, household income, home size and heating and cooling.

- **Other relevant resources:** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Application of Data to the Analysis

We now discuss how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity consumption and market size units (households for residential, floor space for commercial, employees for industrial, and fixtures for street lighting), we primarily used Tacoma Power billing data as well as secondary data from AEG's Energy Market Profiles database.

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-4. To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity. Tacoma's customer account database, which includes estimates on square footage as well as consumption, was used as the primary data point for the calculation of intensities. These calculations were then compared with other regional sources and prior AEG studies in the region for reasonableness. Adjustments to customer segmentation and intensity were then made as necessary.
2. Used Tacoma's 2018 Energy Use and Conservation Survey, the 2016 RBSA, 2014 and 2019 CBSA, 2014 IFSA, DOE's RECS 2015 and CBECS 2012, and AEG's Energy Market Profiles database to develop existing appliance saturations, appliance and equipment characteristics, and building characteristics.
3. Ensured calibration to control totals for annual electricity sales in each sector and segment.
4. Compared and cross-checked with other recent AEG studies.
5. Worked with Tacoma staff to vet the data against their knowledge and experience.

Table 2-4 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, and industrial employment	Tacoma Power account database Tacoma Power load forecasting
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee	Tacoma Power account database 2016 RBSA, 2014/2019 CBSA, and 2014 IFSA AEG's Energy Market Profiles Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Tacoma Power 2018 Energy Use and Conservation Survey 2016 RBSA, 2014/2019 CBSA, and 2014 IFSA RECS 2020 - Washington
UEC/EUI for each end-use technology	UEC: Annual electricity use in homes and buildings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for Tacoma Engineering analysis AEO 2021 RECS 2020 Recent AEG studies
Appliance/equipment age distribution	Age distribution for each technology	Recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	2021 Power Plan workbooks, RTF AEG DEEM AEO 2021 DEER Recent AEG studies
Load Shapes	Share of technology energy use that occurs during each hour of the year	Council generalized load shapes, as updated for the 2021 Power Plan Tacoma Power metered industrial and solar PV shapes

Data Application for Baseline Projection

Table 2-5 summarizes the LoadMAP model inputs required for the baseline projection. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-5 Data Applied for the Baseline Projection in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Tacoma Power load forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipment data from AEO and ENERGY STAR AEO 2021 regional forecast assumptions[13] Appliance/efficiency standards analysis Tacoma Power program results and evaluation reports RTF UES workbooks for measures with a market baseline
Electricity prices	Forecast of monthly average real retail price	Tacoma Power load forecast
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	Tacoma Power econometric coefficients EPRI's REEPS and COMMEND models

In addition, assumptions were incorporated for known future equipment standards as of March 2023, as shown in Table 2-6 and Table 2-7.

Table 2-6 Residential Electric Equipment Standards[14]

<table>
<tr><th>End Use</th><th>Technology</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th><th>2026</th></tr>
<tr><td rowspan="2">Cooling</td><td>Central AC</td><td colspan="2">SEER 13.0</td><td colspan="4">SEER 14.0</td></tr>
<tr><td>Room AC</td><td colspan="6">CEER 10.9</td></tr>
<tr><td>Cooling/ Heating</td><td>Air-Source Heat Pump</td><td colspan="3">SEER 14.0 / HSPF 8.2</td><td colspan="3">SEER 15.0 / HSPF 8.8 ENERGY STAR (5.0)</td></tr>
<tr><td rowspan="2">Water Heating</td><td>Water Heater (<=55 gallons)</td><td colspan="6">Federal Standard UEF 0.92</td></tr>
<tr><td>Water Heater (>55 gallons)</td><td colspan="6">CCE 2.0 - Federal Standard (NEEA Tier 1)</td></tr>
<tr><td rowspan="2">Lighting</td><td>General Service</td><td colspan="3">EISA Compliant (18.6 lm/W)</td><td colspan="3">EISA Compliant (45.0 lm/W)</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="6">T8 - F32 (80.0 lm/W lm/W system)</td></tr>
<tr><td rowspan="4">Appliances</td><td>Refrigerator</td><td colspan="6" rowspan="2">Standard 2014</td></tr>
<tr><td>Freezer</td></tr>
<tr><td>Clothes Washer</td><td colspan="6">2018 Standard Front Load (IMEF 1.84 / IWF 4.7)</td></tr>
<tr><td>Clothes Dryer</td><td colspan="6">UCEF 2.29 - RTF Conventional Baseline</td></tr>
<tr><td>Miscellaneous</td><td>Furnace Fans</td><td colspan="6">Pre-Existing Motor</td></tr>
</table>

[13] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2021), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match distributions/allocations of efficiency levels to manufacturer shipment data for recent years and then held values constant for the study period.

[14] The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

Table 2-7 Nonresidential (C&I) Electric Equipment Standards[15]

End Use	Technology	2021	2022	2023	2024	2025	2026
Cooling	Chillers	COP 5.78 (0.61 kW/ton)					
	RTUs	IEER 12.9 - Federal Standard 2018		IEER 14.8 - Federal Standard 2023			
	PTAC	EER 10.4 - Federal Standard					
Cooling/ Heating	Heat Pump	EER 10.4 / COP 3.1 - Federal Standard					
		IEER 12.2 / COP 3.3 - Federal Standard 2018		IEER 14.1 / COP 3.4 - Federal Standard 2023			
	PTHP	EER 10.4 / COP 3.1 - Federal Standard					
Ventilation	All	Constant Air Volume					
Lighting	General Service	EISA Compliant (18.6 lm/W)				EISA Compliant (45.0 lm/W)	
	Linear Lighting	T8 - F32 (80.0 lm/W system)					
	High Bay	High-Intensity Discharge (56.0 lm/W)					
Refrigeration	Walk-In	Standard 2020					
	Reach-In	Current Standard					
	Glass Door	Current Standard					
	Open Display	Current Standard					
	Icemaker	Current Standard					
Food Service	Pre-Rinse	Standard					
Motors	All	Standard (NEMA Premium)					

[15] The assumptions tables here extend through 2026, after which all standards are assumed to hold steady.

Conservation Measure Data Application

Table 2-8 details the energy-efficiency data inputs to the LoadMAP model. It describes each input and identifies the key sources used in the Tacoma analysis.

Table 2-8 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	2021 Power Plan workbooks, RTF BEST AEG DEEM AEO 2021 CA DEER Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak. Note that peak data are based on normal weather, not climate change or extreme scenarios.	8,760 Hourly load shapes developed from Council's GLS database
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-household, per-square-foot, or per employee basis for the residential, commercial, and industrial sectors, respectively. Non-Equipment Measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	2021 Power Plan workbooks, RTF Tacoma Power program data for some measure costs and all administrative costs AEG DEEM AEO 2021 CA DEER RS Means Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	2021 Power Plan workbooks, RTF AEG DEEM AEO 2021 CA DEER Other secondary sources
Applicability	Estimate of the percentage of dwellings in the residential sector, square feet in the commercial sector, or employees in the industrial sector where the measure is applicable and where it is technically feasible to implement.	2021 Power Plan workbooks, RTF AEG DEEM CA DEER Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	AEG appliance standards and building codes analysis

Data Application for Cost-Effectiveness Screening

To perform the cost-effectiveness screening, a number of economic assumptions were needed. All cost and benefit values were analyzed in real 2021 dollars using a real discount rate of 3% as provided by Tacoma Power. All impacts in this report are presented at the customer meter, but electric energy delivery losses were provided by Tacoma Power to estimate impacts at the generator for economic analysis. Tacoma provided hourly avoided cost values, which AEG converted into end-use specific annual avoided costs using the Council's end-use load shapes.

Estimates of Customer Adoption

To estimate the timing and rate of customer adoption in the potential forecasts, two sets of parameters are needed:

- **Technical diffusion curves for non-equipment measures**. Equipment measures are installed when existing units fail. Non-equipment measures do not have this natural periodicity, so rather than installing all available non-equipment measures in the first year of the projection (instantaneous potential), they are phased in according to adoption schedules that generally align with the diffusion of similar equipment measures. For this analysis, we used the Council's retrofit ramp rates, applied before the achievability adjustment.
- **Customer adoption rates**, also referred to as take rates or ramp rates, are applied to measures on a year-by-year basis. These rates represent customer adoption of measures when delivered through a best-practice portfolio of well-operated efficiency programs under a reasonable policy or regulatory framework. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. The primary barrier to adoption reflected in this case is customer preferences. Again, these are based on the ramp rates from the Council's 2021 Power Plan.

The customer adoption rates used in this study are provided in Appendix C.

3

MARKET CHARACTERIZATION AND MARKET PROFILE

In this section, we describe how customers in the Tacoma Power service territory use electricity in the base year of the study, 2021. It begins with a high-level summary of energy use across all sectors and then delves into each sector in more detail.

Each market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, the unit we use is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees. Street lighting is accounted for as number of lighting fixtures.
- **Saturations** define the fraction of homes and square feet with the various technologies (e.g., percent of homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in the base year by a specific technology in buildings that have the technology. UECs are expressed in kWh/household for the residential sector, and EUIs are expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors, respectively.
- **Annual energy intensity** for the residential sector represents the average energy use for the technology across all homes in 2021. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space or all employees in the base year.
- **Annual usage** is the annual energy used by each end-use technology in the segment. It is the product of the market size and intensity and is quantified in GWh.

Overall Energy Use Summary

Total electricity consumption for all sectors the base year was 4,394 GWh. As shown in Figure 3-1 and Table 3-1, the combined civilian residential and JBLM residential sectors account for more than one-third (45%) of annual energy use. The combined civilian commercial and JBLM commercial sectors account for 30% of annual energy use. The industrial sector accounts for 25% while street lighting accounts for the remaining 0.3% of usage.

Figure 3-1 Sector-Level Electricity Use in Base Year (Percent)

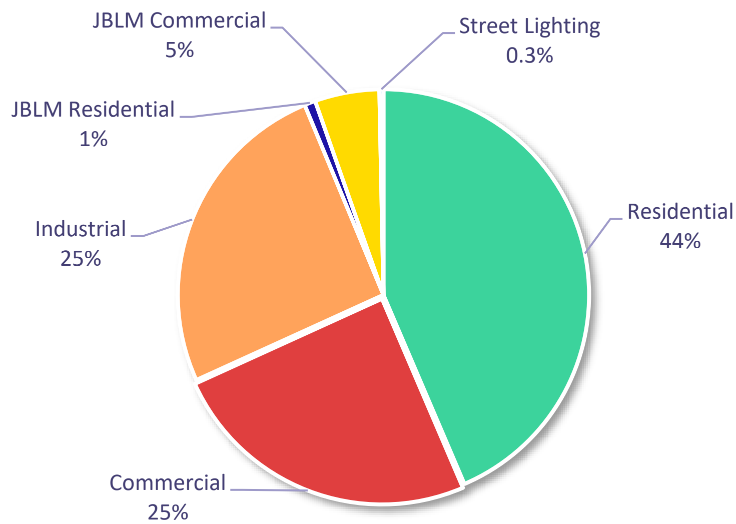


Table 3-1 Tacoma Sector Control Totals (2021)

Sector	Number of Premises/Fixtures	Electric Use (GWh)	% of Total Usage
Residential	165,613	1,914	44%
Commercial	15,034	1,083	25%
Industrial	976	1,122	26%
JBLM Residential	3,722	38	1%
JBLM Commercial	5,525	223	5%
Street Lighting	28,719	14	0.3%
Total	***219,589***	***4,394***	***100%***

Residential Sector

The total number of households and electricity sales for the service territory were obtained from Tacoma Power's customer database. In 2021, there were over 165 thousand households in Tacoma Power's service territory, using a total of 1,914 GWh of electricity. Average use per customer (or household) at 11,554 kWh is slightly higher than other regions of the country, reflecting relatively high penetrations of electric heat in the Pacific Northwest. These averages include energy use of both electric and non-electric heat dwellings. Individual household consumption may vary based on house size, age, and presence of natural gas or secondary heat. We allocated these totals into ten residential segments and the values are shown in Table 3-2. The average use per customer has decreased in every CPA since _____when AEG first started doing CPAs for Tacoma Power. This is due in part because of extensive conservation and codes and standards and in part because of an increasing number of apartments which typically consume less energy per household.

Table 3-2 Residential Sector Control Totals (2021)

Segment	Electric Use (GWh)	Households	kWh/HH	% of Annual Use
Single Family	1,176	91,485	12,857	61%
Single Family 2-4 units	58	5,476	10,601	3%
Low-Rise Multifamily	210	26,564	7,921	11%
Mid-Rise Multifamily	4	493	7,779	0%
Manufactured Home	90	5,386	16,666	5%
Single Family - Low Income	186	14,237	13,047	10%
Single Family 2-4 units - Low Income	26	2,364	10,845	1%
Low-Rise Multifamily - Low Income	147	18,427	8,001	8%
Mid-Rise Multifamily - Low Income	3	311	8,064	0%
Manufactured Home - Low Income	14	870	16,089	1%
Total	**1,914**	**165,613**	**11,554**	**100%**

As described in the previous chapter, the market profiles provide the foundation for development of the baseline projection and the potential estimates. The average market profile for the residential sector is presented in Table 3-3. Segment-specific market profiles are presented in Appendix B.

Figure 3-2 shows the average distribution of annual electricity use by end use across the residential sector. Three main electric end uses — space heating, water heating, and appliances — account for 67% of total use. Appliances include refrigerators, freezers, stoves/ovens, clothes washers, clothes dryers, dishwashers, microwaves, dehumidifiers, and air purifiers. The remainder of the energy falls into the electronics, lighting, cooling, and miscellaneous category – which is composed of furnace fans, pool pumps, and other "plug" loads (all other usage not covered by those listed in Table 3-3 such as hair dryers, power tools, coffee makers, etc.).

This reflects average consumption and is used to describe residential consumption for the entire service territory. These graphics would look significantly different between gas and electrically heated homes. Approximately 56.9% of homes within Tacoma Power's service territory are primarily heated by electricity; approximately 55% of single family homes are electrically heated whereas approximately 59% of multifamily homes are electrically heated.

Figure 3-3 presents the electricity intensities by end use and housing type.

Photo: Getty Images

Figure 3-2 Residential Electricity Use by End Use (2021)

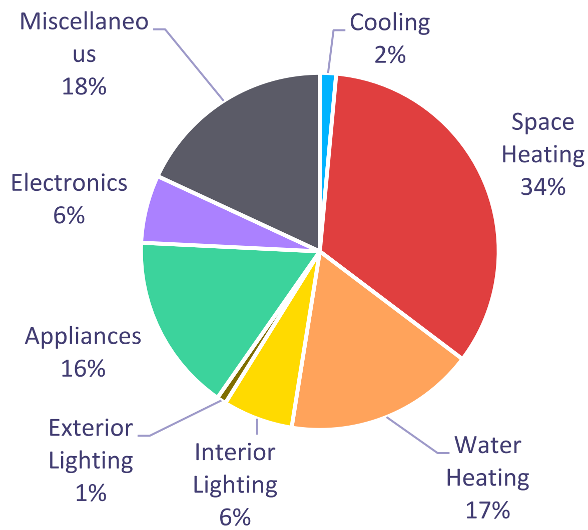


Figure 3-3 Residential Energy Intensity by End Use and Segment (Annual kWh/HH, 2021)

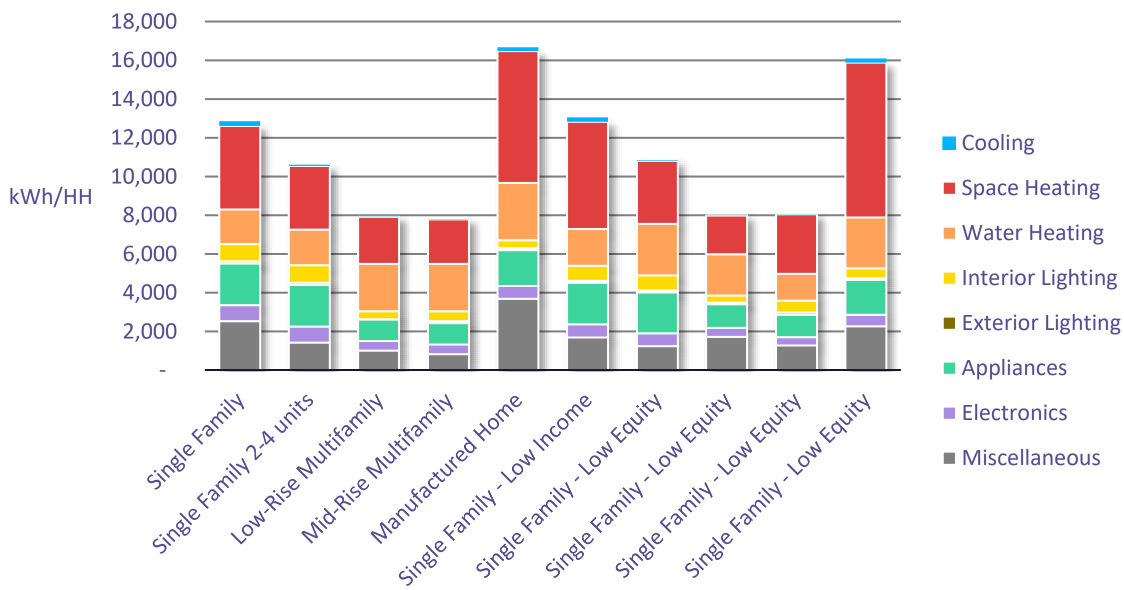


Table 3-3 Average Market Profile for the Residential Sector, 2021

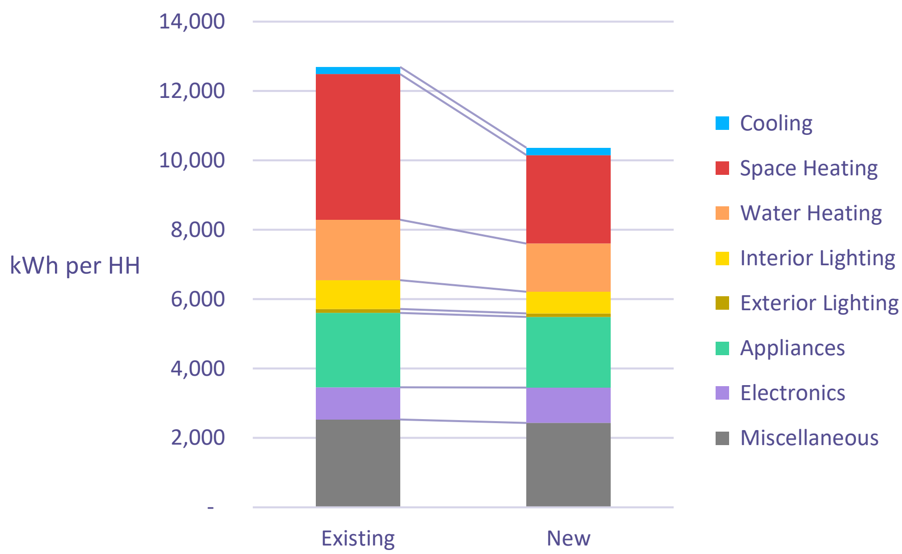
End Use	Technology	Saturation	UEC (kWh/year)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	5.1%	563	29	4.8
	Room AC	19.3%	421	81	13.4
	Air-Source Heat Pump	6.4%	619	39	6.5
	Ductless Mini Split Heat Pump	4.3%	441	19	3.1
Space Heating	Electric Room Heat	24.0%	7,651	1,840	304.7
	Electric Furnace	11.3%	9,893	1,120	185.4
	Air-Source Heat Pump	6.4%	6,255	398	65.9
	Ductless Mini Split Heat Pump	4.3%	5,516	236	39.1
	Secondary Heating	15.9%	1,937	308	51.0
Water Heating	Water Heater (<= 55 Gal)	47.6%	3,658	1,743	288.7
	Water Heater (> 55 Gal)	3.8%	6,403	246	40.7
Interior Lighting	General Service Lighting	78.1%	792	619	102.5
	Linear Lighting	78.1%	139	109	18.0
	Exempted Lighting	78.1%	5	4	0.7
Exterior Lighting	General Service Lighting	78.1%	125	98	16.2
Appliances	Clothes Washer	67.5%	54	37	6.0
	Clothes Dryer	60.6%	924	560	92.7
	Dishwasher	62.7%	100	63	10.4
	Refrigerator	77.7%	665	516	85.5
	Freezer	24.7%	552	136	22.6
	Second Refrigerator	23.0%	950	219	36.2
	Stove/Oven	54.7%	204	111	18.4
	Microwave	83.0%	141	117	19.4
	Dehumidifier	3.4%	1,859	62	10.3
	Air Purifier	8.9%	403	36	6.0
Electronics	Personal Computers	52.5%	137	72	11.9
	Monitor	105.0%	59	62	10.3
	Laptops	43.1%	38	17	2.7
	TVs	150.6%	156	236	39.0
	Printer/Fax/Copier	77.1%	44	34	5.6
	Set-top Boxes/DVRs	180.2%	108	194	32.2
	Devices and Gadgets	78.1%	124	97	16.0
Miscellaneous	Electric Vehicle Supply Equipment	2.8%	2,538	71	11.7
	Pool Pump	0.3%	1,825	6	0.9
	Hot Tub / Spa	0.4%	1,704	7	1.1
	Furnace Fan	42.8%	1,478	632	104.7
	Bathroom Exhaust Fan	24.6%	56	14	2.3
	Well pump	1.3%	647	8	1.4
	Miscellaneous	78.1%	1,729	1,351	223.8
Total				**11,554**	**1,913.5**

New Construction vs Existing – Code Impacts

The CPA reference case baseline assumes the provisions of the 2021 Washington State Energy Code take effect by the end of 2023. These include stricter R-value requirements on building shells than past codes and most notably require (or strongly push through the credit system) electric heat pump space and water heating. These differences are reflected in the use per home for new construction, which is tracked separately in modeling.

Figure 3-4 illustrates the difference between the existing average single family home compared to assumptions for new construction. See chapter 4 for the net effect on the reference baseline projection.

Figure 3-4 New Construction vs Existing Intensity (Single Family Homes)



JBLM Residential Sector

Tacoma Power has previously curated discussions, data exchange, and on-site survey assessments of energy consumption and conservation opportunities at the U.S. Military's Joint Base Lewis-McChord (JBLM) to facilitate customized treatment of these facilities in this analysis. This detailed data were deemed still current for the purposes of this CPA. JBLM has a substantial housing sector for residential customers as well as several large commercial and industrial facilities, which AEG combined into a single "JBLM commercial" sector for purposes of this analysis. JBLM has its own unique energy practices and characteristics, in general being more efficient with energy codes, construction practices, and technology procurement; but dealing with longer lead times and higher administrative costs related to new projects and adoption of new market practices.

The total number of residential households for JBLM were obtained from billing data provided by Equity Residential, the previous property management company responsible for housing at JBLM, during the 2014 CPA. Energy consumption was updated from prior study values by looking at the difference in JBLM annual consumption across the past several study cycles. In 2021, there were 3,722 households at JBLM with a total consumption of 38 GWh. The average use per customer (or household) at 10,317 kWh is lower than the civilian residential sector. We allocated the control totals into two residential segments for single family and multifamily households and the values are shown in Table 3-4.

Table 3-4 JBLM Residential Sector Control Totals (2021)

Segment	Electric Use (GWh)	Households	kWh/HH	% of Annual Use
Single Family	34	2,972	11,583	90%
Multifamily	4	750	5,295	10%
Total	**38**	**3,722**	**10,317**	**100%**

Figure 3-5 shows the distribution of annual electricity use by end use for all customers. Like the civilian residential sector, three main end uses — space heating, appliances, and water heating— account for the majority of use (72%). Appliances include refrigerators, freezers, stoves/ovens, clothes washers, clothes dryers, dishwashers, microwaves, dehumidifiers, and air purifiers. The remainder of the energy falls into the cooling, electronics, lighting, and miscellaneous category – which is comprised of furnace fans, bathroom exhaust fans, and other "plug" loads (all other usage not covered by those listed in Table 3-5 such as hair dryers, power tools, coffee makers, etc.).

Figure 3-6 presents the electricity intensities by end use andf housing type. Single-family homes have the highest use per customer at 11,583 kWh/year, which reflects a higher saturation of electric heating and a larger home size.

Figure 3-5 JBLM Residential Electricity Use by End Use (2021)

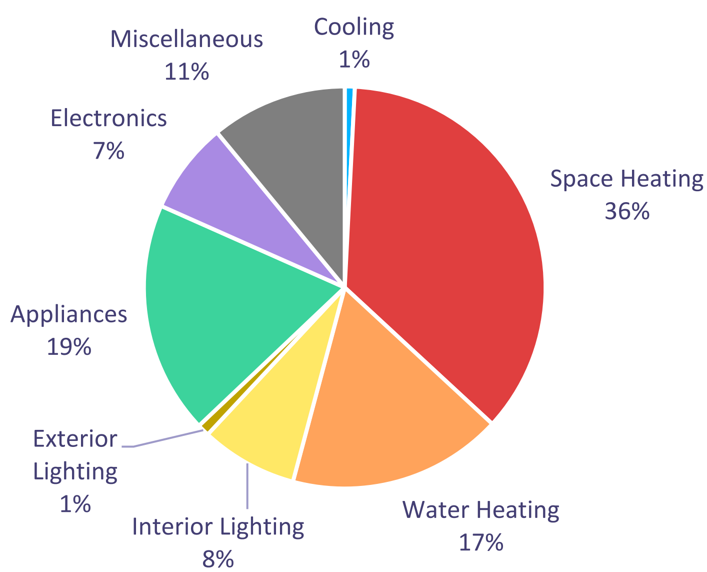


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Figure 3-6 JBLM Residential Energy Intensity by End Use and Segment (Annual kWh/HH, 2021)

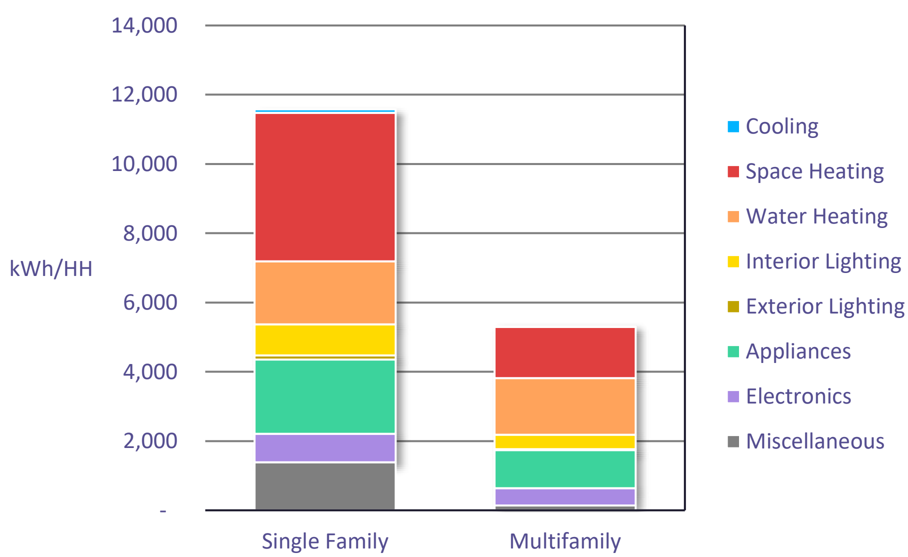


Table 3-5 shows the average market profile for electricity of the JBLM residential sector as a whole, representing a composite of both single family and multifamily homes. Market profiles for each segment are presented in the appendix to this volume.

Table 3-5 Average Market Profile for the JBLM Residential Sector, 2021

End Use	Technology	Saturation	UEC (kWh/year)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	0.0%	563	0	0.0
	Room AC	4.1%	356	15	0.1
	Air-Source Heat Pump	8.1%	543	44	0.2
	Ductless Mini Split Heat Pump	5.3%	469	25	0.1
Space Heating	Electric Room Heat	27.9%	5,775	1,612	6.0
	Electric Furnace	13.8%	8,236	1,139	4.2
	Air-Source Heat Pump	8.6%	4,888	422	1.6
	Ductless Mini Split Heat Pump	5.3%	4,639	246	0.9
	Secondary Heating	20.5%	1,465	301	1.1
Water Heating	Water Heater (<= 55 Gal)	30.6%	2,904	887	3.3
	Water Heater (> 55 Gal)	39.7%	2,258	896	3.3
Interior Lighting	General Service Lighting	100.0%	678	678	2.5
	Linear Lighting	100.0%	122	122	0.5
	Exempted Lighting	100.0%	4	4	0.0
Exterior Lighting	General Service Lighting	100.0%	101	101	0.4
Appliances	Clothes Washer	86.9%	45	40	0.1
	Clothes Dryer	77.7%	757	588	2.2
	Dishwasher	80.6%	84	67	0.3
	Refrigerator	99.6%	534	532	2.0
	Freezer	31.8%	484	154	0.6
	Second Refrigerator	30.4%	821	250	0.9
	Stove/Oven	68.8%	152	105	0.4
	Microwave	106.6%	116	123	0.5
	Dehumidifier	4.4%	782	34	0.1
	Air Purifier	11.7%	327	38	0.1
Electronics	Personal Computers	68.0%	124	84	0.3
	Monitor	136.8%	53	73	0.3
	Laptops	56.4%	33	19	0.1
	TVs	194.2%	126	244	0.9
	Printer/Fax/Copier	98.6%	37	37	0.1
	Set-top Boxes/DVRs	236.5%	88	208	0.8
	Devices and Gadgets	100.0%	97	97	0.4
Miscellaneous	Electric Vehicle Supply Equipment	0.0%	2,538	0	0.0
	Pool Pump	0.0%	1,825	0	0.0
	Hot Tub / Spa	0.5%	1,455	8	0.0
	Furnace Fan	56.9%	1,344	765	2.8
	Bathroom Exhaust Fan	31.2%	46	14	0.1
	Well pump	1.6%	561	9	0.0
	Miscellaneous	100.0%	337	337	1.3
Total				**10,317**	**38.4**

Commercial Sector

The total electric energy consumed by Tacoma Power's commercial customers in 2021 was 1,083 GWh. Tacoma billing data, forecast results and secondary data were used to allocate this energy usage among fifteen commercial segments and to develop estimates of energy intensity (annual kWh/square foot). AEG utilized Tacoma Power's detailed customer account database to classify each account into a market segment. Buildings with multiple accounts were classified based on the largest electric customer account in the building. Accounts that have yet to be classified were grouped into a "Miscellaneous - Unclassified" segment at Tacoma Power's request. The Miscellaneous – Classified group includes accounts classified by Tacoma Power, such as flower shops, fire stations, and the Tacoma Dome, which do not fit into the standard building types. When available in the account database, AEG extracted floor space information, which is the unit of analysis in LoadMAP for the commercial sector. When floor space data was unavailable, AEG utilized electricity consumption and intensity estimates to infer floor space. The values are shown in Table 3-6

Table 3-6 Commercial Sector Control Totals (2021)

Segment	Electric Use (GWh)	Floor Space (Million sqft)	kWh/Sqft	% of Annual Use
Office	197.2	13.3	14.8	18%
Retail	147.5	13.3	11.1	14%
Restaurant	65.2	2.4	26.6	6%
Grocery	72.5	2.3	31.8	7%
Hospital	109.8	3.4	32.3	10%
Other Health	28.6	3.0	9.5	3%
College	42.6	2.1	20.4	4%
School	91.2	10.1	9.1	8%
Lodging	33.1	1.7	19.0	3%
Assembly	23.1	1.6	14.8	2%
Warehouse	99.3	14.7	6.7	9%
Data Center	18.9	0.1	133.0	2%
Multifamily Common Area	67.9	6.3	10.9	6%
Misc - Classified	68.6	4.4	15.7	6%
Misc - Unclassified	17.2	1.0	17.3	2%
Grand Total	**1,083**	**79.8**	**13.6**	**100%**

Figure 3-7 shows the distribution of annual electricity consumption by end use across all commercial buildings. Most consumption is associated with lighting and HVAC, which comprise 57% of annual electricity usage.

Figure 3-8 presents the electricity intensities by end use and segment. Data centers have the highest use per square foot at 133 kWh/SqFt and are thus presented on a larger axis. Table 3-7 shows the average market profile for the commercial sector as a whole, representing a composite of all segments and buildings. Market profiles for each segment are presented in Appendix B.

Figure 3-7 Commercial Electricity Consumption by End Use (2021)

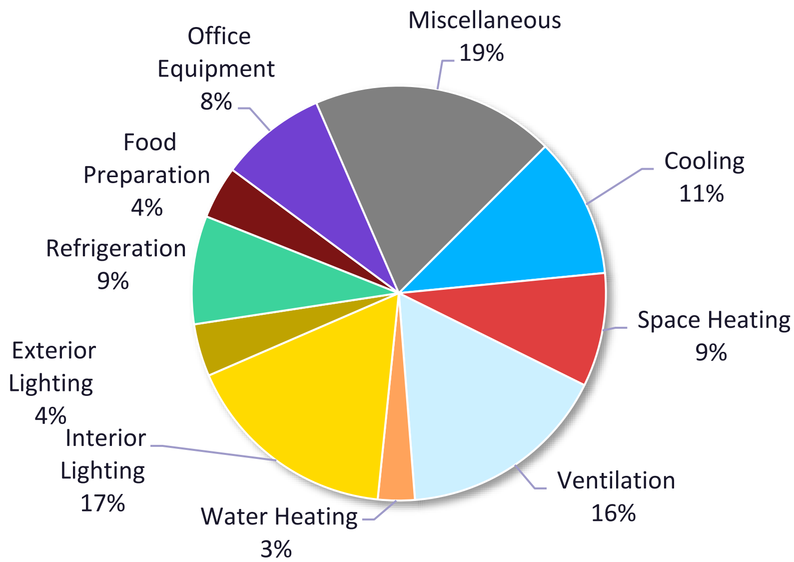


Figure 3-8 Commercial Energy Intensity by End Use and Segment (Annual kWh/SqFt, 2021)

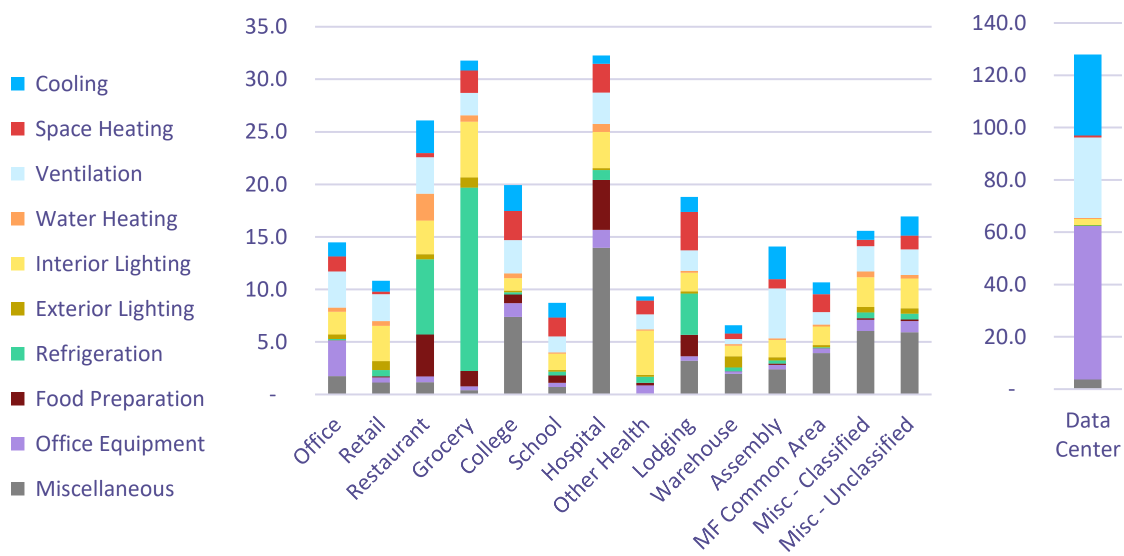


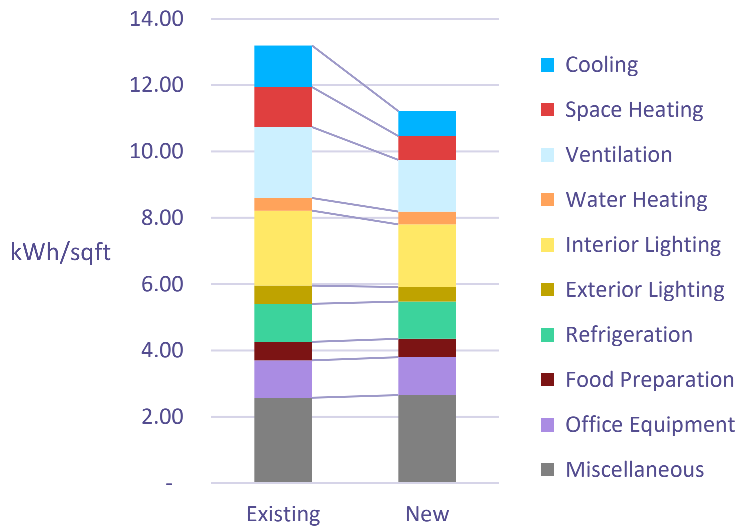
Table 3-7 Average Electric Market Profile for the Commercial Sector, 2021

End Use	Technology	Saturation	EUI (kWh/SqFt)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.3%	3.57	0.26	20.9
	Water-Cooled Chiller	3.2%	3.57	0.11	9.2
	RTU	51.3%	1.52	0.78	62.3
	PTAC	9.1%	1.34	0.12	9.7
	PTHP	3.5%	1.25	0.04	3.5
	Air-Source Heat Pump	7.7%	1.52	0.12	9.3
	Geothermal Heat Pump	3.5%	1.34	0.05	3.7
Space Heating	Electric Furnace	1.3%	6.63	0.09	7.0
	Electric Room Heat	10.1%	5.36	0.54	43.3
	PTHP	3.5%	3.40	0.12	9.4
	Air-Source Heat Pump	7.7%	4.00	0.31	24.4
	Geothermal Heat Pump	3.5%	4.27	0.15	11.9
Ventilation	Ventilation	100.0%	2.23	2.23	177.9
Water Heating	Water Heater	35.3%	1.10	0.39	31.1
Interior Lighting	General Service Lighting	100.0%	0.55	0.55	43.8
	Exempted Lighting	100.0%	0.00	0.00	0.2
	High-Bay Lighting	100.0%	0.28	0.28	22.6
	Linear Lighting	100.0%	1.45	1.45	116.0
Exterior Lighting	General Service Lighting	100.0%	0.23	0.23	18.6
	Area Lighting	100.0%	0.05	0.05	3.8
	Linear Lighting	100.0%	0.28	0.28	22.0
Refrigeration	Walk-in Refrigerator/Freezer	10.1%	0.74	0.07	5.9
	Reach-in Refrigerator/Freezer	13.1%	0.08	0.01	0.8
	Glass Door Display	11.3%	0.23	0.03	2.1
	Open Display Case	11.3%	4.65	0.52	41.8
	Icemaker	42.0%	1.05	0.44	35.0
	Vending Machine	42.0%	0.17	0.07	5.7
Food Preparation	Oven	28.3%	0.24	0.07	5.5
	Fryer	32.0%	0.58	0.19	14.9
	Dishwasher	28.3%	0.20	0.06	4.4
	Hot Food Container	30.5%	0.04	0.01	1.0
	Steamer	25.4%	0.55	0.14	11.1
	Griddle	25.0%	0.38	0.09	7.5
Office Equipment	Desktop Computer	100.0%	0.09	0.09	7.4
	Laptop	99.0%	0.03	0.03	2.0
	Server	90.1%	0.96	0.87	69.2
	Monitor	100.0%	0.04	0.04	3.4
	Printer/Copier/Fax	100.0%	0.09	0.09	7.0
	POS Terminal	67.9%	0.02	0.02	1.3
Miscellaneous	Non-HVAC Motors	53.2%	0.65	0.35	27.7
	Pool Pump	5.3%	0.02	0.00	0.1
	Pool Heater	1.6%	0.17	0.00	0.2
	Electric Vehicle Supply Equipment	13.5%	0.20	0.03	2.1
	Clothes Washer	11.0%	0.00	0.00	0.0
	Clothes Dryer	8.2%	0.05	0.00	0.4
	Other Miscellaneous	100.0%	2.20	2.20	175.4
Total				**13.57**	**1,082.7**

New Construction vs Existing – Code Impacts

The CPA reference case baseline assumes the provisions of the 2021 Washington State Energy Code take effect by the end of 2023. These include stricter R-value requirements on building shells than past codes and most notably require electric heat pump space and water heating with limited exceptions. Figure 3-9 illustrates the difference between the existing average building electric intensity compared to assumptions for new construction. See chapter 4 for the net effect on the reference baseline projection.

Figure 3-9 New Construction vs Existing Intensity



JBLM Commercial Sector

The total non-residential square footage and electricity sales for JBLM were obtained from Tacoma Power and adjusted from values used in the prior study. We relied on the onsite surveys conducted by AEG during the 2014 study to tailor assumptions unique to JBLM and capture differences with the civilian commercial sector. In 2021, the analysis shows about 14.9 million square feet of floor space on JBLM and a total consumption of 223 GWh.

Base-year consumption, floor space, and energy intensity, by segment, are shown in Table 3-8. Using information collected during onsite surveys of JBLM and facility information collected from JBLM staff, we kept the new "Mixed Use" market segment added during the 2014 CPA, which represents newer facilities where office, recreation, storage, and assembly spaces are combined into one facility. JBLM staff indicated that buildings undergo substantial reconfigurations throughout the years to fit the military's needs, which may result in variations between segments in later years.

Table 3-8 JBLM Commercial Sector Control Totals (2021)

Segment	Electric Use (GWh)	Floor Space (Million sqft)	kWh/Sqft	% of Annual Use
Office	39.2	2.7	14.8	18%
Retail	3.1	0.3	11.1	1%
Restaurant	9.5	0.4	26.6	4%
Grocery	2.6	0.1	31.8	1%
Health	45	1.4	32.3	20%
School	7.2	0.8	9.1	3%
Lodging	41.0	2.2	19.0	18%
Hangar	9.5	1.4	6.7	4%
Warehouse	23.5	3.5	6.7	11%
Data Center	9.9	0.1	133.0	4%
Mixed Use	16.5	1.1	15.7	7%
Other	13.5	0.8	17.3	6%
Industrial	2.2	0.3	6.7	1%
Grand Total	**223**	**14.9**	**15.0**	**100%**

Figure 3-10 shows the distribution of annual electricity consumption by end use across all JBLM commercial buildings. The distribution by end use is similar to the civilian commercial sector in that lighting and HVAC comprise the majority (53%) of consumption, but JBLM also includes more industrial-style facilities with mechanical, motor, and process usage that is classified in the larger Miscellaneous end use.

Figure 3-10 JBLM Commercial Electricity Consumption by End Use (2021)

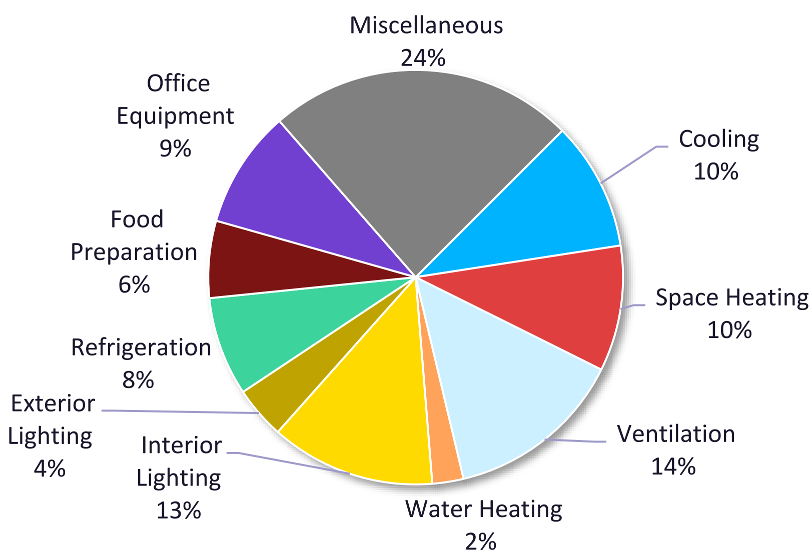


Figure 3-11 presents the electricity intensities by end use and segment. Data centers have the highest use per square foot at 133 kWh/SqFt.

Figure 3-11 JBLM Commercial Energy Intensity by End Use and Segment (Annual kWh/SqFt, 2021)

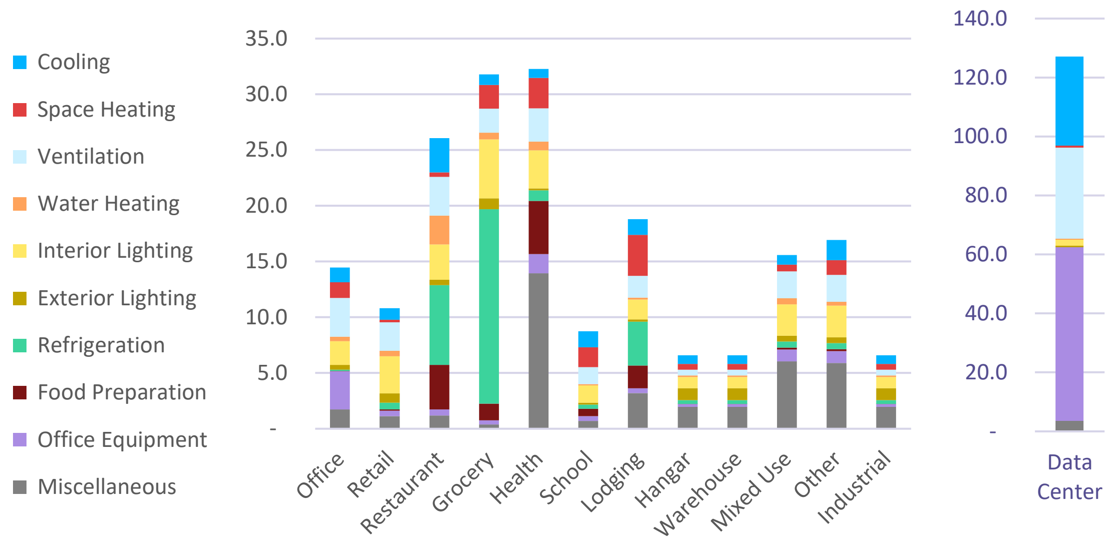


Table 3-9 shows the average market profile for electricity of the JBLM commercial sector as a whole, representing a composite of all segments and buildings. Market profiles for each segment are presented in Appendix B of this volume.

Table 3-9 Average Electric Market Profile for the JBLM Commercial Sector, 2021

End Use	Technology	Saturation	EUI (kWh/SqFt)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	5.46%	3.34	0.18	2.7
	Water-Cooled Chiller	3.77%	4.34	0.16	2.4
	RTU	44.27%	1.66	0.73	10.9
	PTAC	11.67%	1.55	0.18	2.7
	PTHP	4.06%	1.45	0.06	0.9
	Air-Source Heat Pump	7.56%	1.75	0.13	2.0
	Geothermal Heat Pump	3.36%	1.66	0.06	0.8
Space Heating	Electric Furnace	1.23%	6.46	0.08	1.2
	Electric Room Heat	10.56%	6.60	0.70	10.4
	PTHP	4.06%	4.97	0.20	3.0
	Air-Source Heat Pump	7.56%	4.30	0.32	4.8
	Geothermal Heat Pump	3.36%	4.96	0.17	2.5
Ventilation	Ventilation	100.00%	2.09	2.09	31.1
Water Heating	Water Heater	36.81%	0.99	0.36	5.4
Interior Lighting	General Service Lighting	100.00%	0.51	0.51	7.6
	Exempted Lighting	100.00%	0.00	0.00	0.0
	High-Bay Lighting	100.00%	0.23	0.23	3.5
	Linear Lighting	100.00%	1.18	1.18	17.5
Exterior Lighting	General Service Lighting	100.00%	0.22	0.22	3.3
	Area Lighting	100.00%	0.04	0.04	0.6
	Linear Lighting	100.00%	0.35	0.35	5.2
Refrigeration	Walk-in Refrigerator/Freezer	14.36%	0.65	0.09	1.4
	Reach-in Refrigerator/Freezer	15.25%	0.09	0.01	0.2
	Glass Door Display	9.98%	0.09	0.01	0.1
	Open Display Case	9.98%	1.82	0.18	2.7
	Icemaker	41.28%	1.80	0.74	11.0
	Vending Machine	41.28%	0.28	0.12	1.7
Food Preparation	Oven	24.95%	0.49	0.12	1.8
	Fryer	36.04%	0.85	0.31	4.6
	Dishwasher	27.34%	0.34	0.09	1.4
	Hot Food Container	32.78%	0.07	0.02	0.4
	Steamer	20.97%	0.97	0.20	3.0
	Griddle	21.53%	0.70	0.15	2.2
Office Equipment	Desktop Computer	100.00%	0.12	0.12	1.9
	Laptop	99.80%	0.02	0.02	0.3
	Server	90.39%	1.22	1.10	16.4
	Monitor	100.00%	0.03	0.03	0.5
	Printer/Copier/Fax	100.00%	0.08	0.08	1.2
	POS Terminal	62.48%	0.02	0.01	0.2
Miscellaneous	Non-HVAC Motors	60.75%	0.71	0.43	6.4
	Pool Pump	11.98%	0.03	0.00	0.0
	Pool Heater	4.05%	0.18	0.01	0.1
	Electric Vehicle Supply Equipment	14.61%	0.22	0.03	0.5
	Clothes Washer	18.43%	0.01	0.00	0.0
	Clothes Dryer	11.11%	0.14	0.02	0.2
	Other Miscellaneous	100.00%	3.10	3.10	46.0
Total				**15.00**	**222.89**

Industrial Sector

The total electricity used in 2021 by Tacoma Power's industrial customers was 1,122 GWh. Tacoma billing data, load forecast and secondary sources were used to allocate usage among end uses. Figure 3-12 shows the distribution of annual electricity consumption by end use for all industrial customers. Motors are the largest end use in the industrial sector, accounting for 68% of energy use. Note that this end use includes a wide range of industrial equipment, such as air and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 18% of annual energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by cooling, miscellaneous, ventilation, and space heating.

Photo: Getty Images

Figure 3-12 Industrial Electricity Use by End Use (2021), All Industries

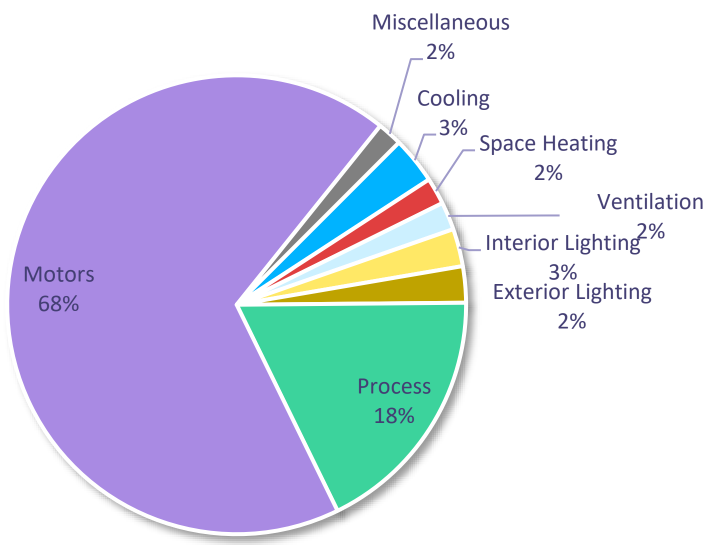


Table 3-10 shows the composite market profile for the industrial sector. Segment-level detail was included in the analysis of the industrial sector, but is excluded from the report to prevent disclosure of data that may be sensitive for some of Tacoma Power's larger customers.

Table 3-10 Average Electric Market Profile for the Industrial Sector, 2021

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/ Employee)	Usage (GWh)
Cooling	Air-Cooled Chiller	1.3%	3,144	39	1.0
	Water-Cooled Chiller	1.3%	4,225	53	1.3
	RTU	49.1%	2,552	1,254	31.3
	Air-Source Heat Pump	5.6%	2,522	142	3.5
	Geothermal Heat Pump	0.0%	1	0	0.0
Space Heating	Electric Furnace	1.1%	8,442	90	2.2
	Electric Room Heat	5.8%	8,040	464	11.6
	Air-Source Heat Pump	5.6%	5,205	293	7.3
	Geothermal Heat Pump	0.0%	1	0	0.0
Ventilation	Ventilation	100.0%	881	881	22.0
Interior Lighting	General Service Lighting	100.0%	117	117	2.9
	High-Bay Lighting	100.0%	456	456	11.4
	Linear Lighting	100.0%	618	618	15.4
Exterior Lighting	General Service Lighting	100.0%	365	365	9.1
	Area Lighting	100.0%	10	10	0.3
	Linear Lighting	100.0%	774	774	19.3
Motors	Pumps	91.5%	10,219	9,347	233.5
	Fans & Blowers	91.5%	3,561	3,257	81.4
	Compressed Air	91.5%	4,094	3,744	93.5
	Material Handling	100.0%	13,567	13,567	338.9
	Other Motors	86.8%	737	639	16.0
Process	Process Heating	100.0%	2,653	2,653	66.3
	Process Cooling	86.8%	2,039	1,769	44.2
	Process Refrigeration	86.8%	1,394	1,210	30.2
	Process Electrochemical	88.2%	1,815	1,601	40.0
	Process Other	88.2%	911	804	20.1
Miscellaneous	Miscellaneous	78.1%	997	778	19.4
Total				**44,923**	**1,122.3**

Street Lighting Sector

Tacoma Power has already converted a significant portion of street lighting and off-street lighting fixtures to LEDs. The City of Tacoma has some ornamental fixtures and irregular voltage fixtures remaining. Other jurisdictions are still mostly HID. Tacoma Power off-street lighting rentals are in process of conversion. The totals shown for this sector throughout the document are only for this remaining classification of fixtures not owned by Tacoma Power. The total electric energy consumed by these fixtures in the base period was 14,324 MWh. Inventory of fixtures, wattages, and usage was provided by Tacoma Power. In this study, we divided street lighting into three market segments based on rate class and jurisdiction. We define fixtures as our unit of analysis within LoadMAP, each represented by an average lamp wattage. The values are shown in Table 3-11 and Table 3-12.

Table 3-11 Street Lighting Sector Control Totals (2021)

Segment	Electricity Sales (MWh)	Usage per Fixture (Annual kWh/Fixt.)	Fixture Count
H1 Dusk to Dawn	4,896	874	5,605
H1 - Other Fixtures	1,406	92	15,231
H2 Service – All	8,021	1,018	7,883
Total	**14,324**	**499**	**28,719**

H1 lighting identified here is public street lighting service owned by a jurisdiction. The H1 – Dusk to Dawn fixtures consume an average of 874 kWh and H1 - Other Fixtures consume 92 kWh. The majority fixtures in both categories are already converted to LEDs, the first group includes ornamental light fixtures the Other Fixtures are mainly standard traffic signals and other public facing fixtures, mostly already converted to LED. H2 is a Tacoma Power owned, outdoor lighting service rental fixtures along private streets, parking lots or general area lighting of private property. Figure 3-13 shows the distribution of annual electricity consumption by fixture type across all streetlights.

Figure 3-13 Street Lighting Sector Electricity Consumption by Fixture Type (2021)

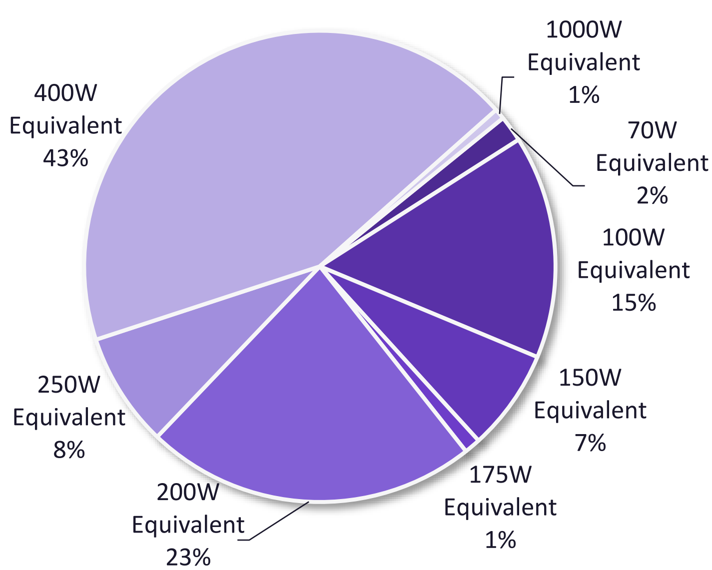


Table 3-12 shows the average market profile for the street lighting sector, representing a composite of all rate classes (H1 and H2 services). Market profiles for each rate class are presented in Appendix B.

Table 3-12 Average Electric Market Profile for the Street Lighting Sector, 2021

End Use	Technology	Saturation	EUI (kWh)	Fixtures	Usage (MWh)
Street Lighting	70W Equivalent	8.7%	103	2,496	258
	100W Equivalent	40.0%	191	11,482	2,195
	150W Equivalent	17.5%	198	5,036	997
	175W Equivalent	0.8%	678	235	159
	200W Equivalent	17.8%	639	5,100	3,261
	250W Equivalent	3.4%	1157	970	1,123
	400W Equivalent	11.7%	1,859	3,350	6,228
	1000W Equivalent	0.2%	2076	50	104
Total				**28,719**	**14,324**

4

BASELINE PROJECTION

Prior to developing estimates of energy-efficiency potential, AEG developed a baseline end-use projection to quantify expected consumption in the future in the absence of new conservation programs or efforts.

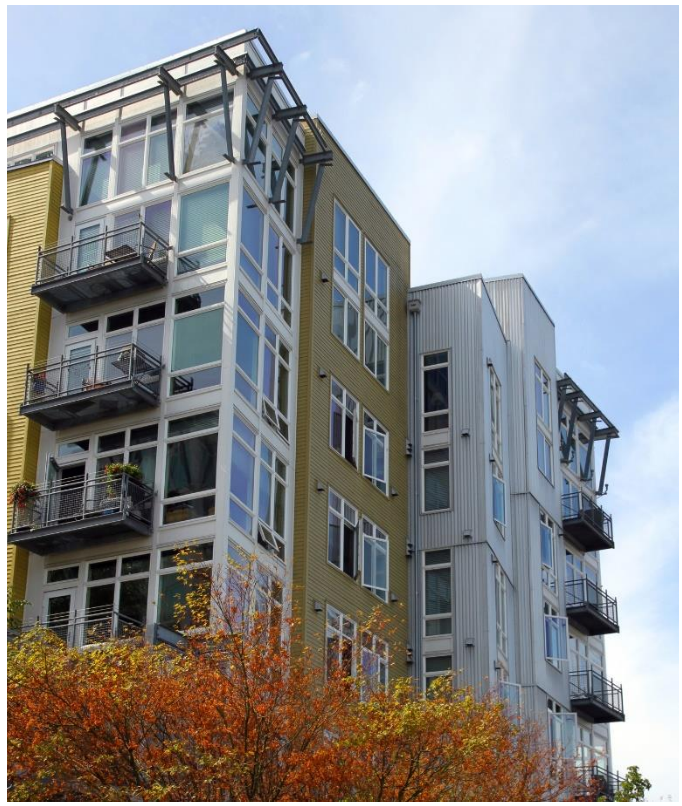


Photo: Getty Images

The first step was to align with Tacoma Power's official forecast. AEG worked with Tacoma Power's load forecasting group to incorporate assumptions and data utilized in the official utility forecast. These data points included customer growth and use-per-customer projections. These assumptions were incorporated into the LoadMAP model, ensuring alignment with the official load forecast.

The end-use projection includes the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of June 2022 are included in the baseline, including the impacts of the 2021 Washington State Energy Code (WSEC) which is expected to take effect by the end of 2023. The baseline projection does not include any naturally occurring conservation that might take place in the potential forecast period (2022 and beyond). This creates a frozen efficiency baseline consistent with Council methodology. As such, the baseline projection is the foundation for the analysis of savings from future efficiency cases and scenarios as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- An integrated database provided by Tacoma Power which includes energy consumption and account data, county assessor building characteristics, previous conservation accomplishment, and electric heat scoring
- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards
- Incorporation of the RTF's market baseline assumptions for measures such as general service lighting.

As noted in chapter 2, the reference baseline does *not* include electrification of existing fossil fuel equipment beyond the trend of new construction required by WSEC 2021.

Although it aligns closely, the baseline projection is not Tacoma Power's official load forecast. Rather it was developed as an integral component of AEG's modeling construct to serve as the metric against which conservation potentials are measured.

Special Consideration: Large Customer Closure

After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the baseline projections. As the study was already completed, the reporting throughout this document, including that shown above, include this large customer.

To account for the closure, apply a deduct of -32% to the industrial baseline projections to all years shown in the chart and table in the summary of baseline projections across sectors (e.g., 361 GWh in 2024). For additional details on the industrial plant closure and impacts to the conservation potential assessment see Appendix E.

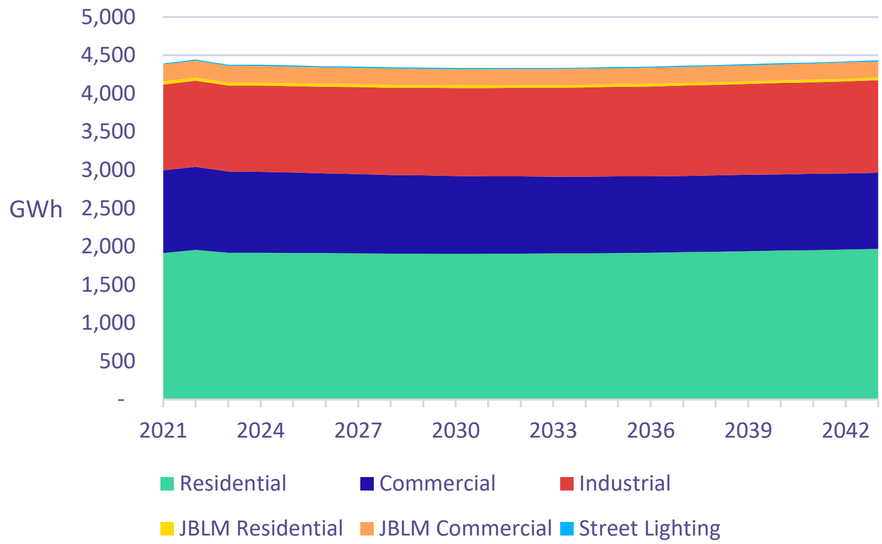
Summary of Baseline Projections Across Sectors

Table 4-1 and Figure 4-1 provide a summary of the baseline projection for annual use by sector for the entire Tacoma Power service territory. Overall, the forecast shows relatively modest growth in electricity use, driven primarily by customer growth forecasts and moderated by the effects of future codes and standards that have already been enacted.

Table 4-1 Baseline Projection Summary (GWh)

Sector	2024	2025	2028	2033	2038	2043	% Change ('24-'43)	Avg. Growth Rate
Residential	1,918	1,916	1,908	1,908	1,932	1,967	2.5%	0.1%
Commercial	1,058	1,050	1,028	1,006	997	998	-5.7%	-0.3%
Industrial	1,128	1,131	1,142	1,162	1,184	1,210	7.2%	0.4%
JBLM Residential	38	37	36	35	34	34	-11.0%	-0.6%
JBLM Commercial	219	218	214	211	210	211	-3.4%	-0.2%
Street Lighting	14	14	14	14	14	14	0.0%	0.0%
Total	**4,375**	**4,367**	**4,342**	**4,336**	**4,372**	**4,433**	**1.3%**	**0.0%**

Figure 4-1 Baseline Projection Summary (GWh)



Residential Sector Baseline Projection

Table 4-2 and Figure 4-2 present AEG's independent baseline projection for electricity at the end-use level for the residential sector as a whole. Overall, residential use increases from 1,918 GWh in 2024 to 1,967 GWh in 2043, an average increase of 0.13% per year. Table 4-2 presents the baseline projection of annual electricity use. Most noticeable is that lighting use decreases throughout the forecast period due to the impacts of the Washington state lighting standard.

Table 4-2 Residential Baseline Projection by End Use (GWh)

End Use	2024	2025	2028	2033	2038	2043	% Change	Avg. Growth Rate
Cooling	24	24	23	23	23	24	0.1%	0.0%
Space Heating	638	633	621	602	588	574	-10.1%	-0.6%
Water Heating	326	325	322	320	323	329	0.8%	0.0%
Interior Lighting	112	108	91	71	63	59	-47.6%	-3.4%
Exterior Lighting	15	15	13	10	8	7	-51.4%	-3.8%
Appliances	314	316	323	335	349	364	15.9%	0.8%
Electronics	136	141	155	172	189	206	50.9%	2.2%
Miscellaneous	352	354	362	374	388	405	14.8%	0.7%
Total	**1,918**	**1,916**	**1,908**	**1,908**	**1,932**	**1,967**	**2.5%**	**0.13%**

Figure 4-2 Residential Baseline Projection by End Use (GWh)

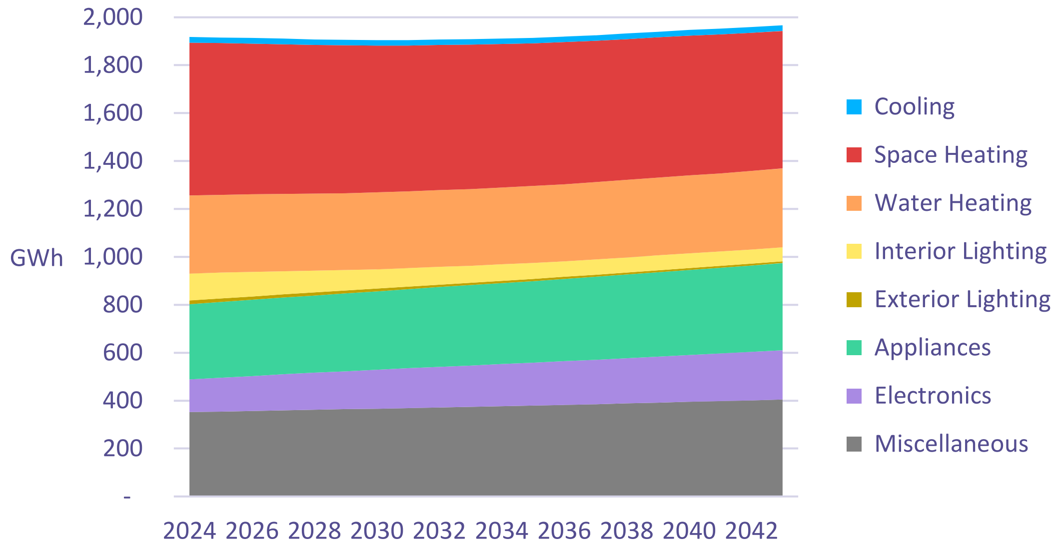
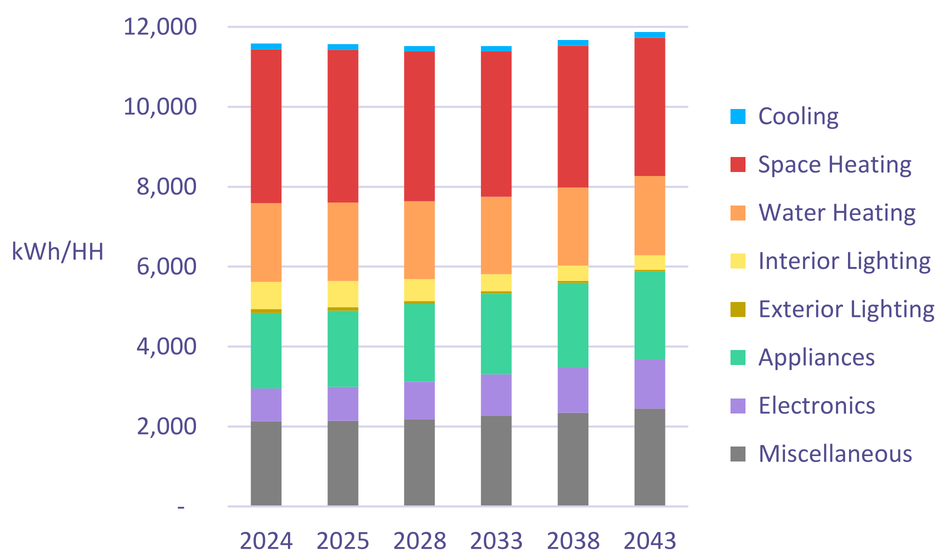


Figure 4-3 illustrates the baseline projection for electric use per household at the end use level. This perspective removes the effect of market size growth that pushes up the late-year forecast in Figure 4-2. It does however, include the state energy code impacts that promote higher saturation of electric heat pumps as the new construction market grows. This is highly mitigated by the majority of new construction in Tacoma being multifamily homes however, which have low use per household for HVAC needs. The growth of devices in electronics can also be seen to be a per-household increase in this chart.

Figure 4-3 Residential Baseline Projection by End Use – Annual Use per Household



Impact of Codes and Standards, and Naturally Occurring EE

Figure 4-4 contrasts three projections – the CPA reference baseline described above, compared to minimum standard codes from WSEC 2021 and federal standards, as well as a hypothetical projection without future codes, where use per customer remains at today's levels. This illustrates the impact of codes and standards over time, as well as the naturally occurring energy efficiency in the market baseline used by the CPA.

Note that the minimum codes projection includes the effect of extra heat pumps being brought onto the system due to the provisions of WSEC 2021, a load increase which offsets some of the reductions from standards. The naturally occurring (market based) energy efficiency comes primarily from LED lighting, with some from ENERGY STAR appliances and electronics.

Figure 4-4   Residential Reference Case Projection Comparison

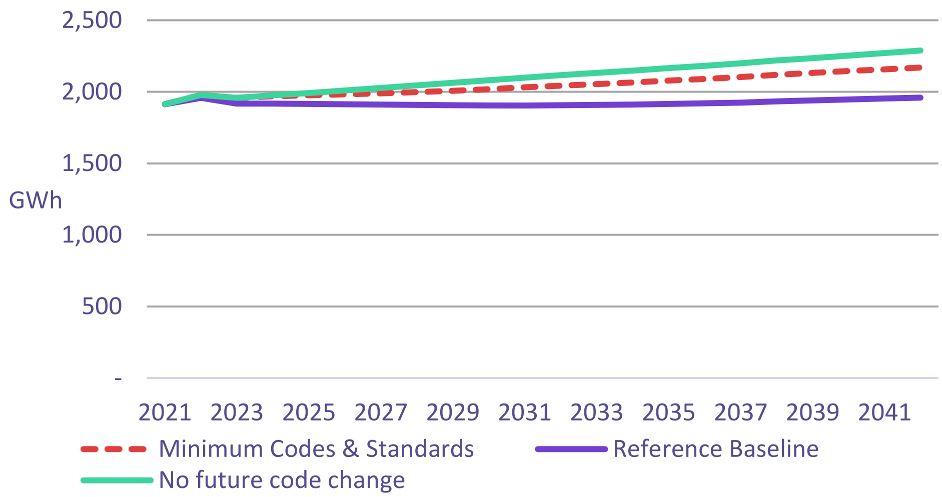


Table 4-3 shows the end-use forecast at the technology level for select years. This projection is in general alignment with Tacoma Power's residential load forecast. Specific observations include:

1. Lighting use declines as a result of the state lighting standard (which was originally based on phase two of the federal EISA lighting standards), and market baseline impacts savings for lighting measures.
2. Appliance energy use experiences significant efficiency gains from new standards, but this is offset by customer growth.
3. Growth in electronics is substantial and reflects an increase in the saturation of electronics, however ENERGY STAR shipment data shows many consumers choosing lower energy-use products, which offsets some growth particularly in computing technologies.

Table 4-3 Residential Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2024	2025	2028	2033	2038	2043	% Change ('24-'43)
Cooling	Central AC	4	4	5	5	6	6	46.1%
	Room AC	11	10	9	9	8	8	-29.5%
	Air-Source Heat Pump	6	6	5	5	5	5	-8.4%
	Geothermal Heat Pump	0	0	0	0	0	0	21.0%
	Ductless Mini Split Heat Pump	3	3	3	4	4	5	54.3%
Space Heating	Air-Source Heat Pump	67	67	68	70	72	74	9.9%
	Geothermal Heat Pump	2	2	2	2	3	3	86.4%
	Ductless Mini Split Heat Pump	43	44	47	53	59	64	50.8%
	Electric Furnace	178	176	168	155	144	134	-24.8%
	Electric Room Heat	299	296	289	278	270	259	-13.4%
	Secondary Heating	49	48	46	43	41	39	-20.2%
Water Heating	Water Heater (<= 55 Gal)	289	289	290	293	297	302	4.5%
	Water Heater (> 55 Gal)	37	36	32	27	26	27	-28.1%
Interior Lighting	General Service Lighting	93	89	72	52	43	39	-58.7%
	Linear Lighting	18	18	19	19	20	20	9.4%
	Exempted Lighting	1	1	0	0	0	0	-71.3%
Exterior Lighting	General Service Lighting	15	15	13	10	8	7	-51.4%
Appliances	Clothes Dryer	97	98	102	109	117	123	26.8%
	Stove/Oven	19	19	19	20	21	22	14.6%
	Refrigerator	87	87	89	91	94	97	11.2%
	Second Refrigerator	34	34	32	29	28	27	-21.7%
	Freezer	23	23	23	23	23	24	4.0%
	Microwave	20	21	22	24	26	28	36.6%
	Dishwasher	11	11	12	13	14	15	35.4%
	Clothes Washer	6	6	6	6	7	7	11.2%
	Dehumidifier	11	11	11	12	13	14	33.3%
	Air Purifier	6	6	7	7	8	9	38.5%
Electronics	Personal Computers	10	10	9	9	9	9	-10.0%
	Monitor	8	8	7	6	5	5	-38.8%
	Laptops	3	3	3	3	3	3	29.0%
	Printer/Fax/Copier	5	5	5	5	6	6	12.7%
	TVs	60	66	79	94	106	117	95.3%
	Set-top Boxes/DVRs	33	33	35	38	41	45	37.5%
	Devices and Gadgets	16	17	17	18	18	19	16.8%
Miscellaneous	Pool Heater	-	-	-	-	-	-	0.0%
	Miscellaneous	229	231	237	247	256	266	16.0%
	Pool Pump	1	1	0	0	0	0	-67.6%
	Furnace Fan	106	106	107	110	115	121	14.1%
	Bathroom Exhaust Fan	2	2	2	3	3	3	19.1%
	Well pump	1	1	1	1	1	1	2.4%
	Electric Vehicle Supply	12	12	12	12	12	12	2.4%
	Hot Tub / Spa	1	1	1	1	1	2	25.9%
Total		**1,918**	**1,916**	**1,908**	**1,908**	**1,932**	**1,967**	**2.5%**

JBLM Residential Sector Baseline Projection

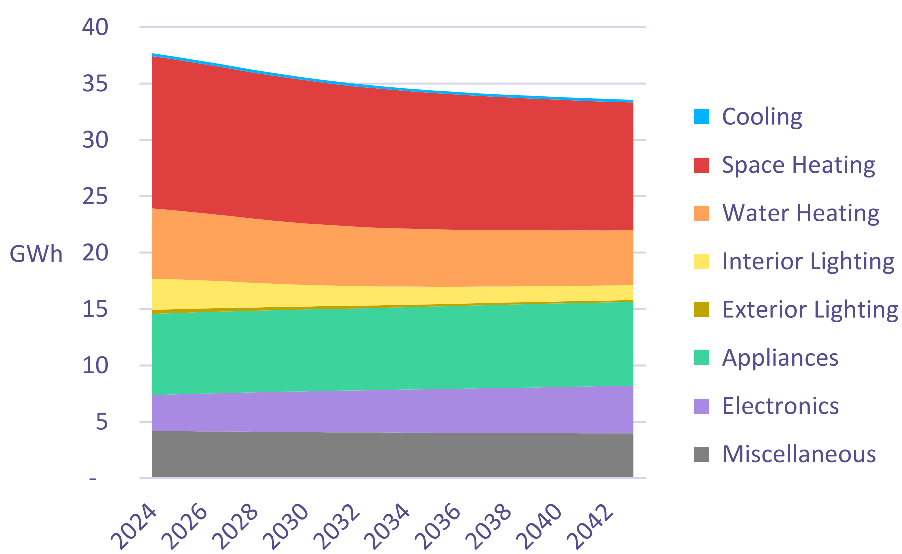
Annual electricity consumption in the JBLM residential sector declines during the overall forecast horizon, starting at 37,695 MWh in 2024 and declining to 33,555 MWh in 2043, a decrease of 11%. Unlike the civilian residential sector, the population of households is expected to be constant on the base. As a result, baseline energy projections do not increase over time, only decreasing with natural improvements in efficiency. Can we Table 4-4 presents the JBLM residential sector annual forecast by technology for select years. Like non-JBLM residential, lighting use decreases throughout the time period as the Washington State lighting standard affects the market baseline. Water heating and space heating consumption decreases as well.

Figure 4-5 and Figure 4-6 present the baseline projection at the end-use level for the sector as a whole. Table 4-5 shows the end-use forecast at the technology level for select years.

Table 4-4 JBLM Residential Baseline Projection by End Use (MWh) [16]

End Use	2024	2025	2028	2033	2038	2043	% Change
Cooling	263	261	254	245	241	240	-8.9%
Space Heating	13,514	13,369	12,954	12,327	11,785	11,323	-16.2%
Water Heating	6,251	6,108	5,694	5,205	4,983	4,891	-21.8%
Interior Lighting	2,747	2,629	2,186	1,669	1,435	1,305	-52.5%
Exterior Lighting	356	345	292	229	192	167	-53.1%
Appliances	7,207	7,213	7,235	7,290	7,376	7,427	3.1%
Electronics	3,183	3,275	3,498	3,774	4,003	4,225	32.7%
Miscellaneous	4,175	4,160	4,112	4,041	3,997	3,978	-4.7%
Total	**37,695**	**37,359**	**36,225**	**34,780**	**34,012**	**33,555**	**-11.0%**

Figure 4-5 JBLM Residential Baseline Projection by End Use (GWh)



[16] Values in this table have been converted to MWh as the JBLM Residential sector is comparatively smaller than others.

Figure 4-6 JBLM Residential Baseline Projection by End Use – Annual Use per Household

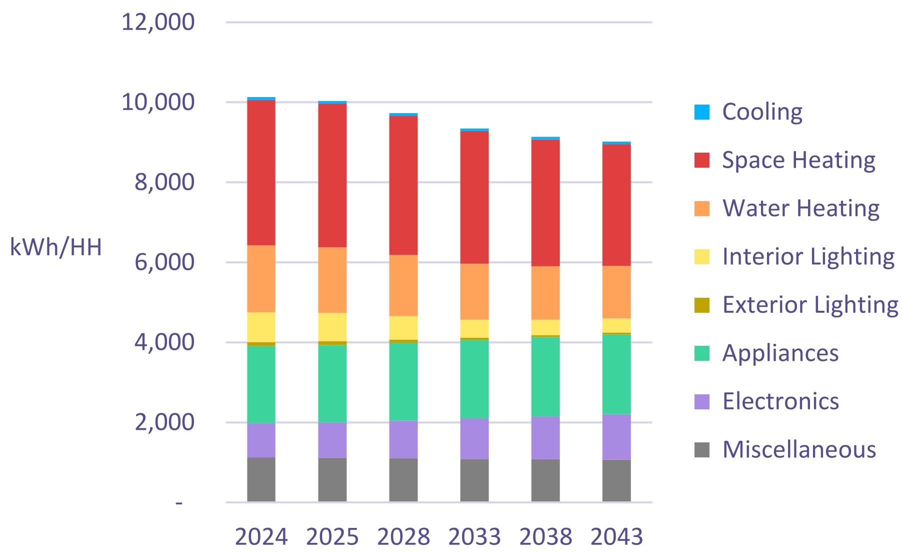


Table 4-5 JBLM Residential Baseline Projection by End Use and Technology (MWh) [17]

End Use	Technology	2024	2025	2028	2033	2038	2043	% Change ('24-'43)
Cooling	Central AC	-	-	-	-	-	-	0.0%
	Room AC	0.04	0.04	0.04	0.03	0.03	0.03	-30.4%
	Air-Source Heat Pump	0.14	0.14	0.13	0.12	0.12	0.11	-17.2%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
	Ductless Mini Split Heat Pump	0.08	0.08	0.09	0.09	0.09	0.10	16.0%
Space Heating	Electric Room Heat	1.56	1.55	1.52	1.49	1.46	1.44	-7.7%
	Electric Furnace	-	-	-	-	-	-	0.0%
	Air-Source Heat Pump	0.95	0.96	0.98	1.02	1.06	1.10	16.0%
	Geothermal Heat Pump	4.07	4.01	3.82	3.53	3.26	3.01	-26.0%
	Secondary Heating	5.86	5.80	5.63	5.38	5.17	4.99	-14.8%
	Ductless Mini Split Heat Pump	1.07	1.05	0.99	0.91	0.84	0.78	-27.2%
Water Heating	Water Heater (<= 55 Gal)	3.28	3.27	3.25	3.23	3.22	3.23	-1.7%
	Water Heater (> 55 Gal)	2.97	2.83	2.44	1.98	1.76	1.67	-43.9%
Interior Lighting	Exempted Lighting	2.28	2.16	1.72	1.21	0.98	0.85	-62.6%
	General Service Lighting	0.45	0.45	0.45	0.45	0.45	0.45	-0.9%
	Linear Lighting	0.01	0.01	0.01	0.01	0.00	0.00	-73.4%
Exterior Lighting	General Service Lighting	0.36	0.34	0.29	0.23	0.19	0.17	-53.1%
Appliances	Air Purifier	2.25	2.27	2.33	2.43	2.54	2.59	15.3%
	Clothes Dryer	0.39	0.38	0.38	0.37	0.37	0.36	-6.9%
	Clothes Washer	1.97	1.96	1.95	1.94	1.93	1.92	-2.3%
	Dehumidifier	0.88	0.86	0.80	0.73	0.68	0.65	-25.6%
	Dishwasher	0.57	0.57	0.57	0.57	0.57	0.57	-0.9%
	Freezer	0.47	0.48	0.49	0.51	0.54	0.57	19.9%
	Microwave	0.26	0.27	0.28	0.30	0.30	0.31	15.7%
	Refrigerator	0.15	0.15	0.15	0.15	0.15	0.15	0.3%
	Second Refrigerator	0.13	0.13	0.13	0.13	0.13	0.14	8.4%
	Stove/Oven	0.15	0.15	0.15	0.16	0.17	0.18	22.4%
Electronics	Devices and Gadgets	0.27	0.25	0.23	0.23	0.22	0.22	-17.3%
	Laptops	0.22	0.21	0.17	0.15	0.13	0.12	-43.9%
	Monitor	0.07	0.06	0.06	0.07	0.07	0.08	15.1%
	Personal Computers	0.13	0.13	0.12	0.12	0.12	0.13	-2.3%
	Printer/Fax/Copier	1.35	1.48	1.74	2.00	2.18	2.34	72.8%
	Set-top Boxes/DVRs	0.78	0.79	0.80	0.85	0.91	0.98	24.6%
	TVs	0.36	0.36	0.36	0.36	0.36	0.36	0.0%
Miscellaneous	Bathroom Exhaust Fan	-	-	-	-	-	-	0.0%
	Electric Vehicle Chargers	1.25	1.25	1.25	1.25	1.25	1.25	0.0%
	Furnace Fan	-	-	-	-	-	-	0.0%
	Hot Tub/Spa	2.80	2.78	2.73	2.66	2.61	2.59	-7.5%
	Miscellaneous	0.05	0.05	0.06	0.06	0.06	0.06	10.1%
	Pool Heater	0.03	0.03	0.03	0.03	0.03	0.03	0.0%
	Pool Pump	-	-	-	-	-	-	0.0%
	Well Pump	0.03	0.03	0.04	0.04	0.04	0.04	23.1%
Total		**37.70**	**37.36**	**36.22**	**34.78**	**34.01**	**33.56**	**-11.0%**

[17] Values in this table have been converted to MWh as the JBLM Residential sector is comparatively smaller than others.

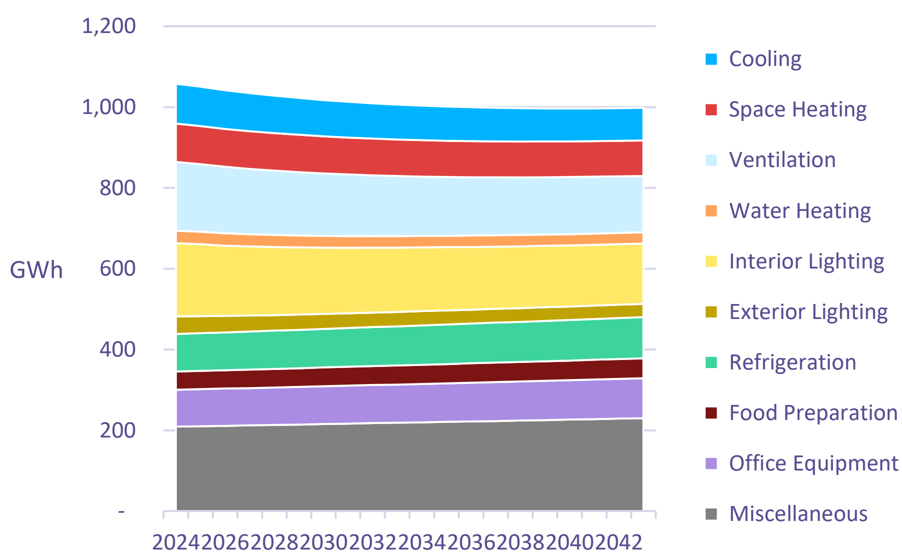
Commercial Sector Baseline Projection

Annual electricity usage in the commercial sector declines 6% during the overall forecast horizon, starting at 1,058 GWh in 2024, and decreasing to 998 GWh by 2043. Table 4-6 and Figure 4-7 present the baseline projection at the end-use level for the commercial sector as a whole. Usage in lighting is declining throughout the forecast, due largely to the phasing in of codes and standards such as the state lighting standards, as well as embedded market practices of stocking and purchasing high efficiency lamps. Usage in commercial ventilation decreases even though cooling and heating increase, due to market trends in fan efficiency and controls. Growth in miscellaneous use is substantial and has grown consistently in the past and incorporates future growth assumptions consistent with the Annual Energy Outlook.

Table 4-6 Commercial Baseline Projection by End Use (GWh)

End Use	2024	2025	2028	2033	2038	2043	% Change
Cooling	99	97	93	86	82	80	-18%
Space Heating	95	94	93	90	89	88	-8%
Ventilation	170	168	159	149	142	140	-18%
Water Heating	31	31	30	29	28	28	-10%
Interior Lighting	181	178	168	159	153	149	-18%
Exterior Lighting	44	42	39	36	34	33	-25%
Refrigeration	93	93	95	97	99	102	10%
Food Preparation	45	45	46	47	48	50	10%
Office Equipment	91	92	93	95	97	99	8%
Miscellaneous	209	210	213	219	224	230	10%
Total	**1,058**	**1,050**	**1,028**	**1,006**	**997**	**998**	**-6%**

Figure 4-7 Commercial Baseline Projection by End Use



Impact of Codes and Standards, and Naturally Occurring Energy Efficiency

Figure 4-8 contrasts three projections – the CPA reference baseline described above, compared to minimum standard codes from WSEC 2021 and federal standards, as well as a hypothetical projection without future codes, where use per customer remains at today's levels. This illustrates the impact of codes and standards over time, as well as the naturally occurring energy efficiency in the market baseline used by the CPA. Note that the minimum codes projection includes the effect of extra heat pumps being brought onto the system due to the provisions of WSEC 2021, a load increase which offsets some of the reductions from standards. The naturally occurring (market-based) energy efficiency comes mainly from LED lighting, with some from ENERGY STAR appliances and electronics.

Figure 4-8 Commercial Reference Case Projection Comparison

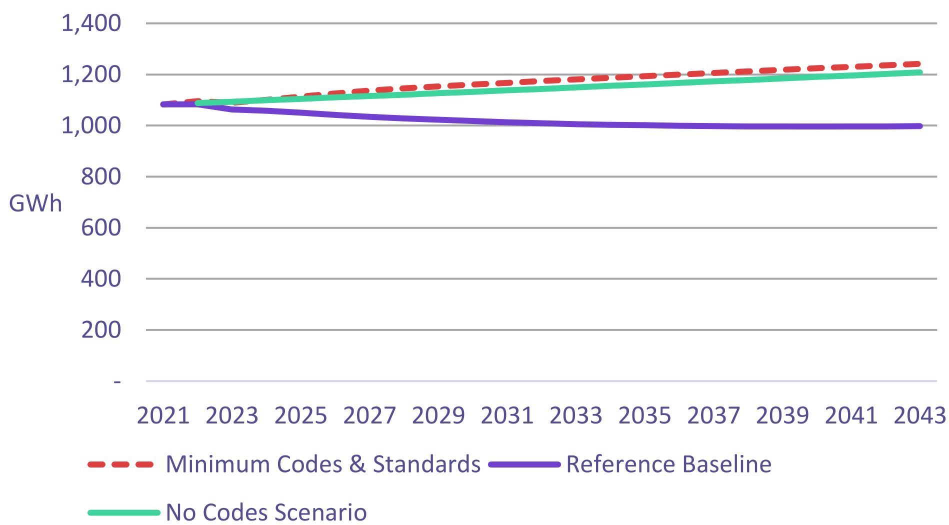


Table 4-7 presents the commercial sector annual forecast by technology for select years. General service and exempted lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2021 baseline.

Table 4-7 Commercial Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2024	2025	2028	2033	2038	2043	% Change ('24-43')
Cooling	Air-Source Heat Pump	8	8	8	8	8	8	-1.6%
	Geothermal Heat Pump	3	3	3	3	2	2	-20.7%
	Air-Cooled Chiller	17	17	16	14	13	13	-26.0%
	Water-Cooled Chiller	8	8	7	7	7	6	-17.5%
	RTU	51	50	47	43	40	39	-24.8%
	Packaged Terminal AC	8	8	8	8	8	8	-6.0%
	Packaged Terminal HP	3	3	4	4	4	5	48.3%
Space Heating	Air-Source Heat Pump	25	25	25	26	27	27	10.1%
	Geothermal Heat Pump	12	12	12	11	12	12	-1.0%
	Electric Furnace	7	7	6	6	5	5	-29.6%
	Electric Room Heat	41	41	38	35	32	29	-29.6%
	Packaged Terminal HP	10	11	11	12	14	15	42.5%
Interior Lighting	General Service Lighting	43	40	33	29	27	26	-40.3%
	Linear Lighting	116	115	113	109	106	103	-10.6%
	High-Bay Lighting	22	22	22	21	20	20	-9.6%
	Exempted Lighting	0	0	0	0	0	0	-49.6%
Exterior Lighting	General Service Lighting	18	17	13	11	10	10	-47.2%
	Linear Lighting	22	22	22	21	21	20	-8.3%
	Area Lighting	4	4	4	3	3	3	-18.8%
Ventilation	Ventilation	170	168	159	149	142	140	-17.7%
Miscellaneous	Miscellaneous	178	179	182	186	191	196	9.9%
	Non-HVAC Motors	28	28	29	29	30	31	9.9%
	Pool Pump	0	0	0	0	0	0	-5.8%
	Pool Heater	0	0	0	0	0	0	9.9%
	Electric Vehicle Chargers	2	2	2	2	2	2	9.9%
	Clothes Washer	0	0	0	0	0	0	9.9%
	Clothes Dryer	0	0	0	0	0	0	9.9%
Water Heating	Water Heater	31	31	30	29	28	28	-10.4%
Refrigeration	Walk-in Refrigerator/Freezer	6	6	6	6	6	7	9.9%
	Reach-in Refrigerator/Freezer	1	1	1	1	1	1	9.9%
	Glass Door Display	2	2	2	2	2	2	9.9%
	Open Display Case	42	43	43	44	46	47	9.9%
	Icemaker	36	36	36	37	38	39	9.9%
	Vending Machine	6	6	6	6	6	6	9.9%
Food Preparation	Oven	6	6	6	6	6	6	9.9%
	Fryer	15	15	15	16	16	17	9.9%
	Dishwasher	5	5	5	5	5	5	9.9%
	Hot Food Container	1	1	1	1	1	1	9.9%
	Steamer	11	11	11	12	12	12	9.9%
	Griddle	8	8	8	8	8	8	9.9%
Office Equipment	Desktop Computer	7	7	7	6	6	5	-23.1%
	Laptop	2	2	2	3	3	3	39.4%
	Server	70	71	72	73	75	77	9.9%
	Monitor	3	3	4	4	4	4	9.9%
	Printer/Copier/Fax	7	7	7	7	8	8	9.9%
	POS Terminal	1	1	1	1	1	1	9.9%
Total		**1,058**	**1,050**	**1,028**	**1,006**	**997**	**998**	**-5.7%**

JBLM Commercial Sector Baseline Projection

Annual electricity usage in the JBLM commercial sector declines during the forecast horizon, starting at 219 GWh in 2024, and decreasing to 211 GWh in 2043, a decline of 3%. Table 4-8 and Figure 4-9 present the baseline projection at the end-use level for the JBLM commercial sector as a whole.

Table 4-8 JBLM Commercial Baseline Projection by End Use (GWh)

End Use	2024	2025	2028	2033	2038	2043	% Change
Cooling	19	18	18	16	16	15	-18%
Space Heating	22	22	21	21	21	21	-5%
Ventilation	30	29	28	26	25	25	-17%
Water Heating	5	5	5	5	5	5	-12%
Interior Lighting	28	28	26	25	24	23	-18%
Exterior Lighting	9	9	8	7	7	7	-23%
Refrigeration	17	18	18	18	19	19	10%
Food Preparation	14	14	14	14	15	15	10%
Office Equipment	21	21	21	21	22	22	7%
Miscellaneous	54	54	55	57	58	59	10%
Total	**219**	**218**	**214**	**211**	**210**	**211**	**-3%**

Figure 4-9 JBLM Commercial Baseline Projection by End Use

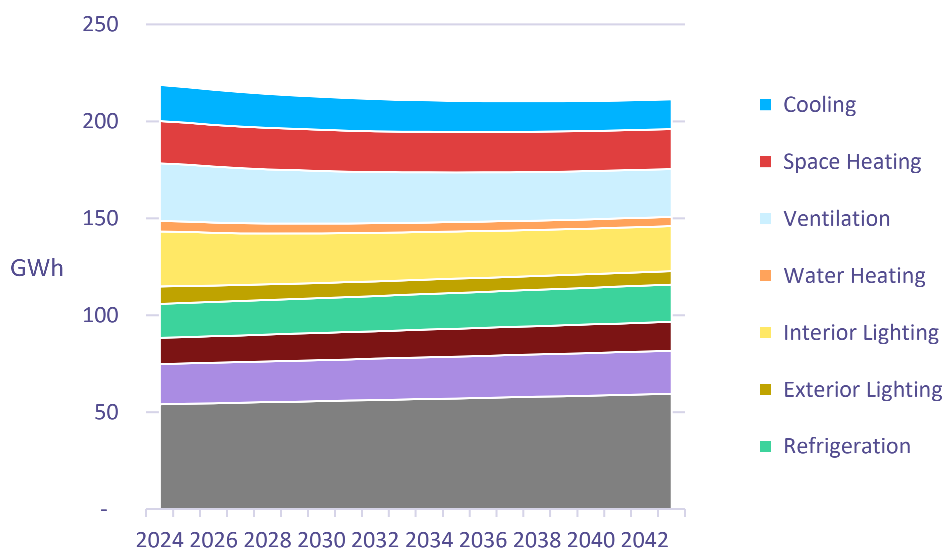


Table 4-9 presents the JBLM commercial sector annual forecast by technology for select years. Screw-in lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2021 baseline.

Table 4-9 JBLM Commercial Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2024	2025	2028	2033	2038	2043	% Change ('24-'43)
Cooling	Air-Source Heat Pump	2	2	2	2	2	2	0.5%
	Geothermal Heat Pump	1	1	1	1	1	1	-19.3%
	Air-Cooled Chiller	2	2	2	2	2	2	-26.9%
	Water-Cooled Chiller	2	2	2	2	2	1	-27.3%
	RTU	9	9	8	7	7	7	-26.1%
	Packaged Terminal AC	2	2	2	2	2	2	-6.8%
	Packaged Terminal HP	1	1	1	1	1	1	49.0%
Space Heating	Air-Source Heat Pump	5	5	5	5	5	5	11.0%
	Geothermal Heat Pump	2	2	2	2	2	2	0.9%
	Electric Furnace	1	1	1	1	1	1	-29.6%
	Electric Room Heat	10	10	9	9	8	7	-27.5%
	Packaged Terminal HP	3	3	4	4	4	5	42.5%
Ventilation	General Service Lighting	7	7	6	5	5	5	-39.3%
Water Heating	Linear Lighting	17	17	17	16	16	16	-10.9%
Interior Lighting	High-Bay Lighting	3	3	3	3	3	3	-9.9%
	Exempted Lighting	0	0	0	0	0	0	-49.7%
	General Service Lighting	3	3	2	2	2	2	-47.6%
	Linear Lighting	5	5	5	5	5	5	-8.4%
Exterior Lighting	Area Lighting	1	1	1	0	0	0	-19.6%
	Ventilation	30	29	28	26	25	25	-17.1%
	Miscellaneous	47	47	48	49	50	51	9.9%
Refrigeration	Non-HVAC Motors	6	7	7	7	7	7	9.9%
	Pool Pump	0	0	0	0	0	0	-6.0%
	Pool Heater	0	0	0	0	0	0	9.9%
	Electric Vehicle Chargers	0	0	0	1	1	1	9.9%
	Clothes Washer	0	0	0	0	0	0	9.9%
	Clothes Dryer	0	0	0	0	0	0	9.9%
Food Preparation	Water Heater	5	5	5	5	5	5	-11.8%
	Walk-in Refrigerator/Freezer	1	1	1	1	2	2	9.9%
	Reach-in Refrigerator/Freezer	0	0	0	0	0	0	9.9%
	Glass Door Display	0	0	0	0	0	0	9.9%
	Open Display Case	3	3	3	3	3	3	9.9%
	Icemaker	11	11	11	12	12	12	9.9%
Office Equipment	Vending Machine	2	2	2	2	2	2	9.9%
	Oven	2	2	2	2	2	2	9.9%
	Fryer	5	5	5	5	5	5	9.9%
	Dishwasher	1	1	1	1	2	2	9.9%
	Hot Food Container	0	0	0	0	0	0	9.9%
	Steamer	3	3	3	3	3	3	9.9%
Miscellaneous	Griddle	2	2	2	2	2	2	9.9%
	Desktop Computer	2	2	2	2	1	1	-23.6%
	Laptop	0	0	0	0	0	0	39.6%
	Server	17	17	17	17	18	18	9.9%
	Monitor	1	1	1	1	1	1	9.9%
	Printer/Copier/Fax	1	1	1	1	1	1	9.9%
	POS Terminal	0	0	0	0	0	0	9.9%
Total		**219**	**218**	**214**	**211**	**210**	**211**	**-3.4%**

Industrial Sector Baseline Projection

Annual industrial usage grows modestly throughout the forecast period. Table 4-10 and Figure 4-10 present the projection at the end-use level. Overall, industrial annual electricity use increases from 1,128 GWh in 2024 to 1,210 GWh in 2043 - an increase of 7.2% over the study period.

Special Consideration: Large Customer Closure

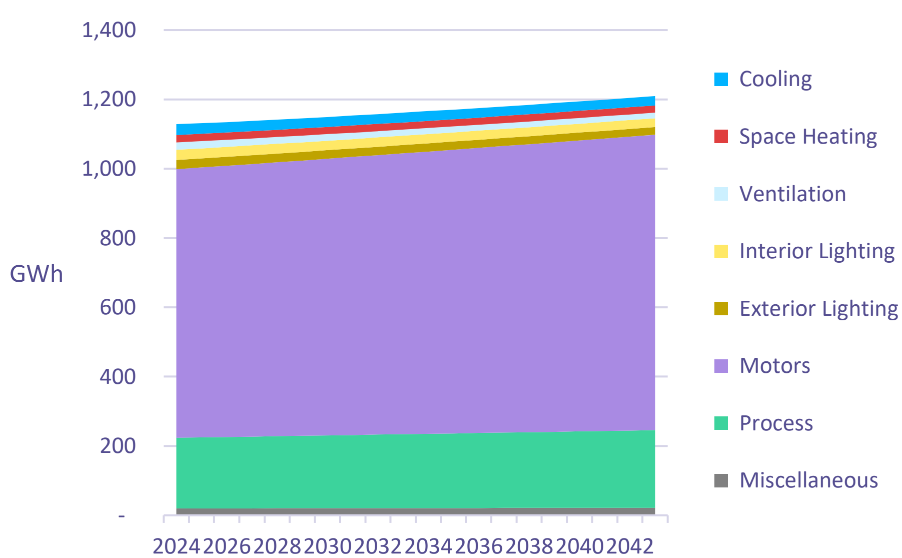
After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the baseline projections. As the study was already completed, the reporting throughout this document, including that shown above, include this large customer.

To account for the closure, apply a deduct of -32% to the baseline projections to all years shown in the chart and table in the summary of baseline projections across sectors (e.g., 361 GWh in 2024). For additional details on the industrial plant closure and impacts to the conservation potential assessment see Appendix E.

Table 4-10 Industrial Baseline Projection by End Use (GWh)

End Use	2024	2025	2028	2033	2038	2043	% Change
Cooling	31	31	30	28	27	27	-13%
Space Heating	21	21	21	21	21	21	-2%
Ventilation	21	21	19	18	17	16	-22%
Interior Lighting	29	29	28	27	26	25	-13%
Exterior Lighting	27	26	25	24	23	22	-17%
Motors	775	779	790	810	831	852	10%
Process	204	205	208	213	219	224	10%
Miscellaneous	20	20	20	21	21	22	10%
Total	**1,128**	**1,131**	**1,142**	**1,162**	**1,184**	**1,210**	**7.2%**

Figure 4-10 Industrial Baseline Projection by End Use (GWh)



Impact of Codes and Standards, and Naturally Occurring Energy Efficiency

Figure 4-11 contrasts three projections – the CPA reference baseline described above, compared to minimum standard codes from WSEC 2021 and federal standards, as well as a hypothetical projection without future codes, where use per customer remains at today's levels. This illustrates the impact of codes and standards over time, as well as the naturally occurring energy efficiency in the market baseline used by the CPA. As in the residential and commercial sectors, the minimum codes projection includes the effect of extra heat pumps being brought onto the system due to the provisions of WSEC 2021, a load increase which offsets some of the reductions from standards, however this end use is minimal in the industrial sector. The naturally occurring (market based) energy efficiency comes mainly from LED lighting and turnover of vintage motor systems to the current NEMA Premium standard.

Figure 4-11 Industrial Reference Case Projection Comparison

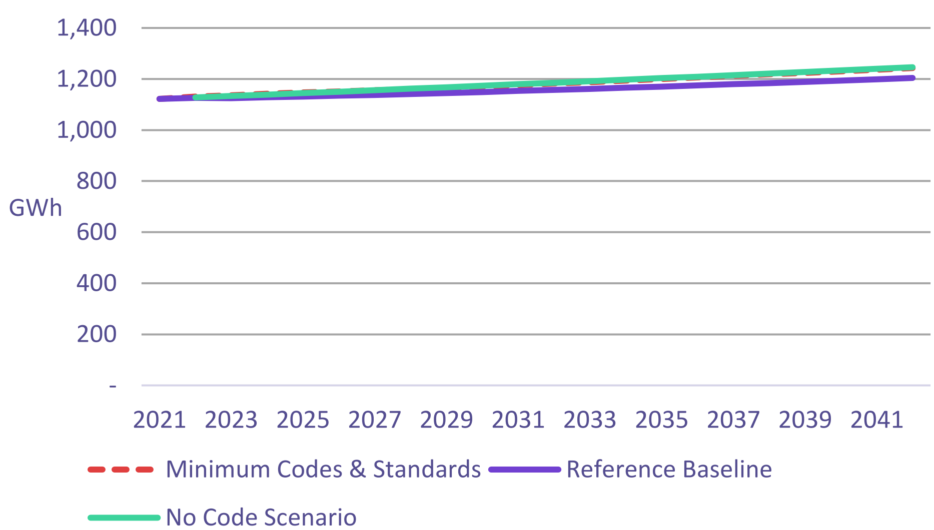


Table 4-11 presents the industrial sector annual forecast by technology for select years. General service lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2021 baseline.

Table 4-11 Industrial Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2024	2025	2028	2033	2038	2043	% Change ('24-'43)
Cooling	Air-Source Heat Pump	3	3	3	3	4	4	20.7%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
	Air-Cooled Chiller	1	1	1	1	1	1	5.0%
	Water-Cooled Chiller	1	1	1	1	1	1	-0.5%
	RTU	26	26	24	23	22	21	-18.6%
Space Heating	Air-Source Heat Pump	8	8	9	9	10	11	41.2%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
	Electric Furnace	2	2	2	2	2	2	-28.1%
	Electric Room Heat	11	11	10	9	9	8	-28.1%
Ventilation	General Service Lighting	3	2	2	2	2	1	-44.0%
Interior Lighting	Linear Lighting	15	15	15	15	14	14	-10.8%
	High-Bay Lighting	11	11	11	11	10	10	-9.8%
	General Service Lighting	7	7	6	5	5	5	-38.7%
Exterior Lighting	Linear Lighting	19	19	19	19	18	18	-8.4%
	Area Lighting	0	0	0	0	0	0	-19.8%
	Ventilation	21	21	19	18	17	16	-22.4%
Process	Pumps	237	238	242	248	254	261	9.9%
	Fans & Blowers	83	83	84	86	89	91	9.9%
	Compressed Air	95	95	97	99	102	104	9.9%
	Material Handling	344	346	351	360	369	378	9.9%
	Other Motors	16	16	17	17	17	18	9.9%
Motors	Process Heating	67	68	69	70	72	74	9.9%
	Process Cooling	45	45	46	47	48	49	9.9%
	Process Refrigeration	31	31	31	32	33	34	9.9%
	Process Electrochemical	41	41	41	42	44	45	9.9%
	Process Other	20	20	21	21	22	22	9.9%
Miscellaneous	Miscellaneous	20	20	20	21	21	22	9.9%
Total		**1,128**	**1,131**	**1,142**	**1,162**	**1,184**	**1,210**	**7.2%**

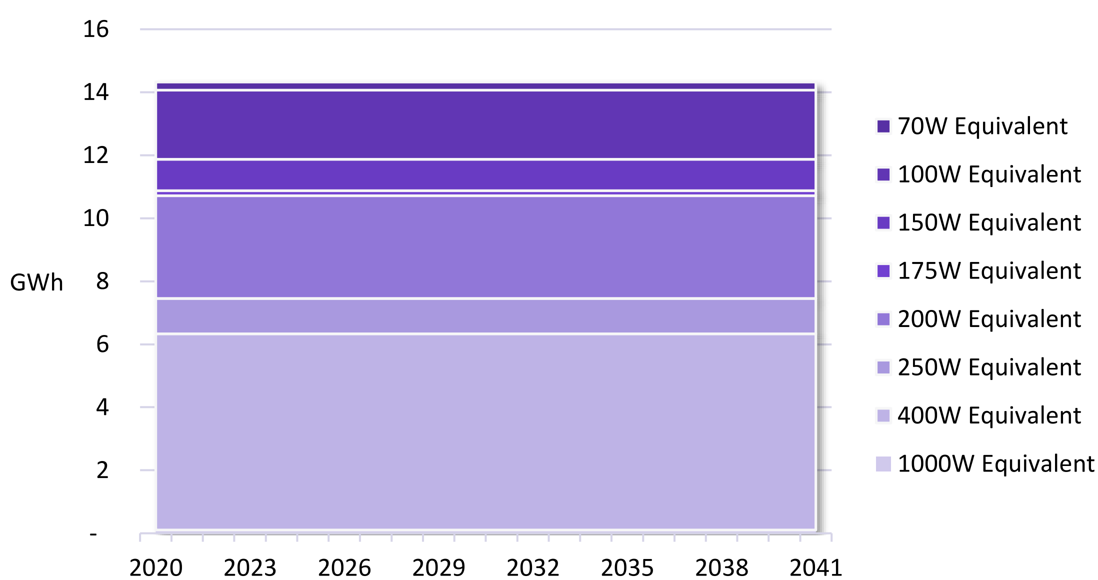
Street Lighting Sector Baseline Projection

Annual electricity use in the street lighting sector is assumed to remain flat throughout the forecast horizon at 14,324 MWh. Table 4-12 and Figure 4-12 present the baseline projection at the fixture level for the street lighting sector as a whole. As discussed in the previous chapter, street lighting fixtures are already mostly LEDs in the baseline. Because of this, there is no meaningful change in consumption as units are replaced due to age.

Table 4-12 Street Lighting Baseline Projection by End Use (MWh) [18]

End Use	2024	2025	2028	2033	2038	2043	% Change ('24-'43)
70W Equivalent	258	258	258	258	258	258	0.0%
100W Equivalent	2,195	2,195	2,195	2,195	2,195	2,195	0.0%
150W Equivalent	997	997	997	997	997	997	0.0%
175W Equivalent	159	159	159	159	159	159	0.0%
200W Equivalent	3,261	3,261	3,261	3,261	3,261	3,261	0.0%
250W Equivalent	1,123	1,123	1,123	1,123	1,123	1,123	0.0%
400W Equivalent	6,228	6,228	6,228	6,228	6,228	6,228	0.0%
1000W Equivalent	104	104	104	104	104	104	0.0%
Total	**14,324**	**14,324**	**14,324**	**14,324**	**14,324**	**14,324**	**0.0%**

Figure 4-12 Street Lighting Baseline Projection by End Use (GWh)



[18] Values in this table have been converted to MWh as Street Lighting is comparatively smaller than other sectors.

5

OVERALL CONSERVATION POTENTIAL

This chapter presents the measure-level energy conservation potential across all sectors. This includes every possible measure that is considered in the measure list, regardless of program implementation concerns. Year-by-year savings for annual energy usage are available in the LoadMAP model, which was provided to Tacoma Power at the conclusion of the study. Please note that all savings are provided at the customer meter. This section includes potential from the residential, JBLM residential, commercial, JBLM commercial, industrial, and street lighting sectors as well as a breakout of distribution efficiency improvements provided in a separate analysis provided by Tacoma Power.

Special Consideration: Large Customer Closure

After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the overall conservation potential. As the study was already completed, the reporting throughout this document, including the charts and figures in this section, include this customer.

To account for the closure, the following deducts should be applied to each of the years identified in Table 6-26 in the Summary of Conservation Potential. Technical Potential, Achievable Technical Potential, and Achievable Economic Potential all receive the same deduction, as the savings potential for this customer was estimated in a separate customized analysis identical to that performed in the prior CPA, and for which all reasonable and applicable savings measures were found to be cost effective.

Table 5-1 Large Customer Closure Deductions

Deductions (GWh)	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	361	362	365	372	379	387
Cumulative Savings (GWh)	2	3	10	21	26	30

For more details on the industrial plant closure and impacts to the conservation potential assessment see Appendix E.

Summary of Overall Conservation Potential

Table 5-1 and Figure 5-1 summarize the conservation potential in terms of annual impacts of all measures for three levels of potential relative to the baseline projection.

Figure 5-2 displays the conservation forecasts. Savings are represented in cumulative terms, reflecting the effects of persistent savings in prior years in addition to new savings. This allows for the reporting of annual savings impacts as they actually affect each year of the forecast.

- **Technical Potential** reflects the adoption of all conservation measures regardless of cost-effectiveness or market barriers. In this potential case, all equipment goes to the most efficient, technically feasible option (e.g. highest-tier heat pump water heaters) even when costs may be prohibitive. All retrofit measures are also installed, regardless of actual achievability. 2024 first-year savings are 78 GWh, or 1.8% of the baseline projection. Cumulative savings in 2033 are 768 GWh, or 17.8% of the baseline. By 2043, cumulative savings reach 1,111 GWh, or 25.1% of the baseline.
- **Achievable Technical Potential** refines technical potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of conservation measures. For the 2024-2043 CPA, unadjusted ramp rates from the Council's 2021 Power Plan were applied. For all Power Plan measures, the ramp rate assigned by the Council was applied directly. For additional measures, ramp rates were assigned based on similar technologies present in the Power Plan. Assumed ramp rates are provided in Appendix C. 2024 first-year achievable technical potential is 43 GWh, or 1.0% of the baseline projection. Cumulative savings in 2033 are 483 GWh, or 11.2% of the baseline. By 2043 cumulative savings reach 834 GWh, or 18.9% of the baseline.
- **Achievable Economic Potential** further refines Achievable Technical potential by applying a cost-effectiveness screen. In this analysis, the cost-effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the total customer and utility costs of delivering the measure through a utility program, including monetized non-energy impacts. Avoided costs of energy as well as avoided transmission and distribution and generation capacity costs were provided by Tacoma Power. A 10% conservation credit was applied to the avoided energy related avoided costs, consistent with Council methodology. Additional details on alignment with Council methodology can be found in Appendix A. 2024 first-year Achievable Economic potential are 25 GWh, or 0.6% of the baseline projection. Cumulative net savings in 2033 are 229 GWh, or 5.3% of the baseline. By 2043 cumulative savings reach 463 GWh, or 10.5% of the baseline.

Table 5-2 Summary of Conservation Potential (Annual Energy, GWh)

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	4,361	4,352	4,328	4,322	4,358	4,419
Cumulative Savings (GWh)						
Achievable Economic Potential	25	34	83	229	371	463
Achievable Technical Potential	43	72	194	483	707	834
Technical Potential	78	144	369	768	1,013	1,111
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.6%	0.8%	1.9%	5.3%	8.5%	10.5%
Achievable Technical Potential	1.0%	1.7%	4.5%	11.2%	16.2%	18.9%
Technical Potential	1.8%	3.3%	8.5%	17.8%	23.2%	25.1%

Figure 5-1 Summary of Conservation Potential as % of Baseline Projection (Annual Energy)

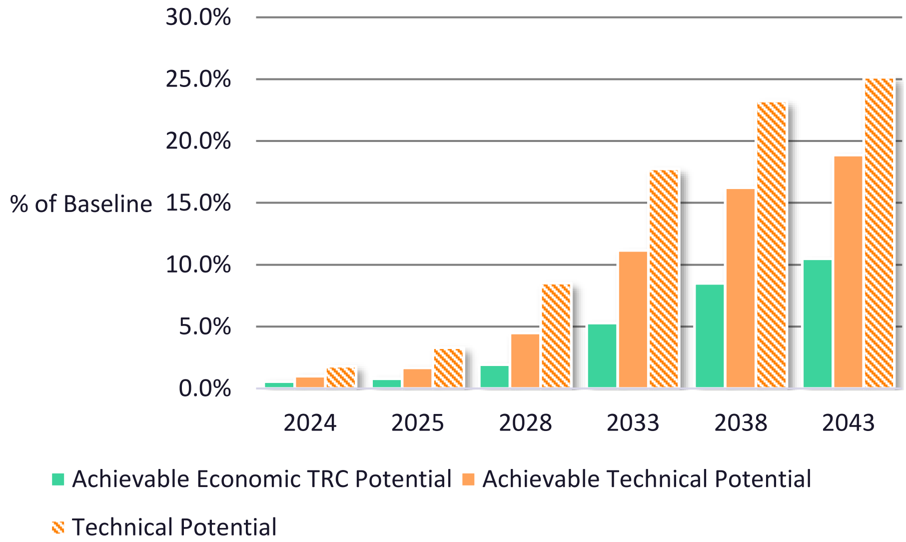


Figure 5-2 Baseline Projection and Conservation Forecast Summary (Annual Energy, GWh)

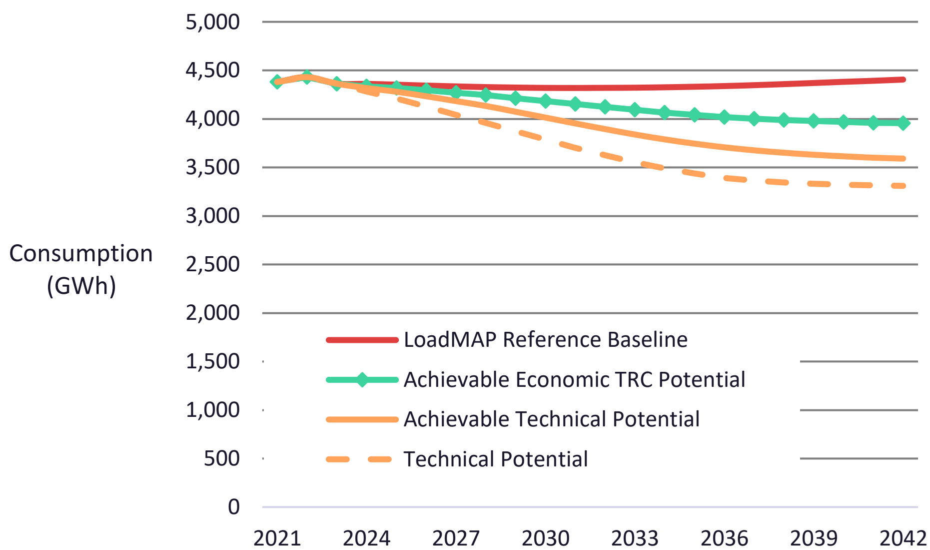


Figure 5-3 presents the supply curve of levelized cost of conserved energy ($/MWh) vs. the 20-year cumulative Achievable Technical potential for all sectors. The Achievable Technical supply curve represents the universe of measures evaluated for this study in the residential, commercial, industrial, JBLM residential, JBLM commercial, street lighting, and distribution efficiency sectors. These levelized costs per MWh represent the TRC cost, including incremental measure cost, programmatic costs, and non-electric benefits or costs associated with each measure. As the line grow to the right, savings increase, but as the line moves further to the top of the Y axis, those savings are more expensive.

Note that the first tranche of savings up to around 28 GWh have levelized costs that are zero or negative. This is because incremental costs for some measures, particularly LED replacements, are negative when considering the long lifetime and the multiple low-efficiency units that would have otherwise been installed in the baseline scenario.

Figure 5-3 Supply Curve, All Sectors in 2043 (Annual Energy, MWh)

Overview of Savings by Sector

Table 5-2 summarizes Achievable Economic Potential by market sector for selected years. In 2033, the residential sector represents the largest share of potential, followed by commercial, then industrial. JBLM makes up a small percentage of the total, driven by its relatively small share of baseline loads.

Table 5-3 Economic Achievable Potential by Sector, Selected Years (GWh)

Sector	2024	2025	2028	2033	2038	2043
Residential	14.1	13.5	23.3	95.0	180.8	239.5
Commercial	4.1	8.7	25.5	57.0	85.1	104.3
Industrial	4.2	8.1	25.1	56.6	72.8	81.5
JBLM Residential	0.0	0.1	0.4	1.6	3.0	3.7
JBLM Commercial	0.8	1.6	4.7	10.4	15.7	19.4
Street Lighting	0.1	0.2	0.6	1.9	3.6	5.2
Distribution Efficiency	1.3	2.0	4.0	7.3	10.7	10.7
Total	**24.7**	**34.2**	**83.7**	**229.9**	**371.6**	**464.4**

Achievable Economic vs. Achievable Technical Potential

Figure 5-4 illustrates the relationship between Achievable Economic Potential (EAP) and Achievable Technical Potential (ATP) by sector. Residential and Commercial savings are both substantially affected by the economic screen as there some very expensive but extremely efficient HVAC options on the market in both sectors.

Figure 5-4 Achievable Economic vs. Achievable Technical Cumulative Savings (GWh) by Sector

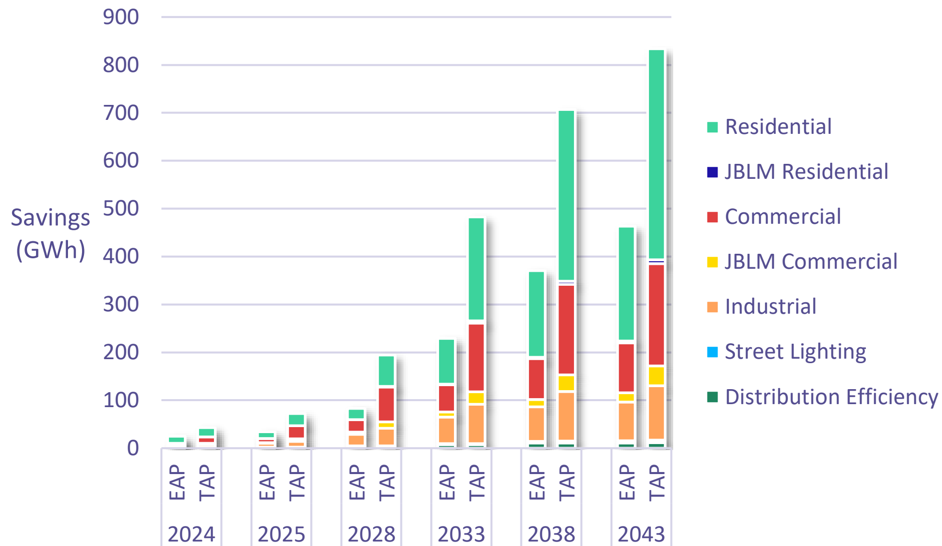
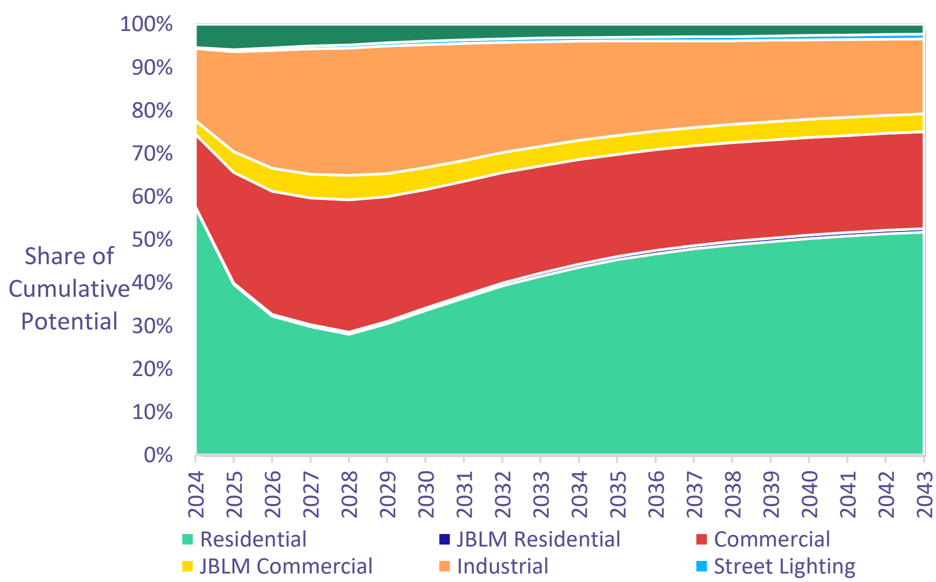


Figure 5-5 shows the cumulative Achievable Economic Potential by sector for the full timeframe of the analysis as a percent of total savings. While the distribution of savings among sectors shifts over the course of the study, in general, residential and commercial make up the majority of savings, with residential climbing to nearly half of all savings due to the late-year influence of heat pump water heater conversion.

While residential and commercial potential ramps up, industrial potential is mainly retrofit in nature, and is much flatter. This is because process equipment is highly custom and most potential comes from controls modifications or process adjustments rather than high-efficiency equipment upgrades. Additionally, we model retrocommissioning to phase in evenly over the next twenty years. This measure has a maintenance component, and not all existing facilities may be old enough to require the tune-up immediately but will be eligible at some point over the course of the study.

Figure 5-5 Cumulative Achievable Economic Potential by Sector (% of Total)



6

SECTOR-LEVEL CONSERVATION POTENTIAL

The previous section provided a summary of potential for Tacoma Power's service territory as a whole. In this section, we provide details for each sector.

For each sector, savings are shown in several tables and charts that summarize potential in different ways:

- Total potential by case (Technical, Achievable Technical, and Achievable Economic) and comparison to the reference baseline
- Top measures within the sector, ranked by Achievable Economic Potential over the first 10 years
- The supply curve for the sector, showing 10-year potential savings available at increasing levels of cost ($/MWh)
- Achievable Economic Potential broken down by vintage (existing vs. new construction), replacement type (lost opportunity vs. retrofit) and by end use

The final entry for each sector summarizes potential according to its level of risk. Risk was categorized in two ways. The first was by risk level, which rates measures by marginally cost-effective TRC ratios, an RTF workbook sunset within two years, or both. RTF category was also used; proven measures are assumed to be the least risky, followed by planning measures. Small savers come third, as the smaller potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped.

Residential Potential

Table 6-1 and Figure 6-1 present estimates for measure-level conservation potential for the residential sector. In 2033, Achievable Economic Potential includes nearly 44% of Achievable Technical potential.

Now that LED lighting impacts have moved into the baseline due to market transformation (consistent with RTF assumptions), there has been a continued search for the "next big thing" that could drive strong potential for programs. The latest data from NEEA and the US DOE are pointing in the direction of heat pump water heaters (HPWHs) possibly crossing the cost-effectiveness threshold and becoming a significant opportunity for utilities. While HPWH options have struggled with cost-effectiveness in prior CPAs, the latest cost updates from NEEA are showing reduced unit costs.

For building weatherization, data from Tacoma Power's Weatherization Non-Participation study was used to look at the remaining market and barriers to customers participating in Weatherization retrofits, however higher R-values for interventions required by the newest effective Washington State Energy Code push up savings per home where these can be acquired, the net effect produces a small increase to weatherization potential compared to the prior CPA.

Photo: Getty Images

Inclusion of Home Energy Reports. A separate analysis of Home Energy Reports (aka Behavioral Programs) conducted by Tacoma Power was provided to AEG for inclusion in the overall energy efficiency landscape. Annual participation and energy impacts were provided as data streams which account for customer attrition and variable savings year to year, providing more nuance than typical CPA measure characterization. Notably, behavioral savings are expected to decline sharply over the early years of the study for programmatic reasons, which leads to higher total savings in 2024 compared to 2025 as the program goes away.

Table 6-1 Residential Conservation Potential

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	1,918	1,916	1,908	1,908	1,932	1,967
Cumulative Savings (GWh)						
Achievable Economic Potential	14	13	23	95	181	240
Achievable Technical Potential	19	25	65	217	358	440
Technical Potential	42	71	183	419	578	634
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.7%	0.7%	1.2%	5.0%	9.4%	12.2%
Achievable Technical Potential	1.0%	1.3%	3.4%	11.4%	18.5%	22.4%
Technical Potential	2.2%	3.7%	9.6%	21.9%	29.9%	32.2%

Figure 6-1 Residential Savings as a % of the Baseline Projection

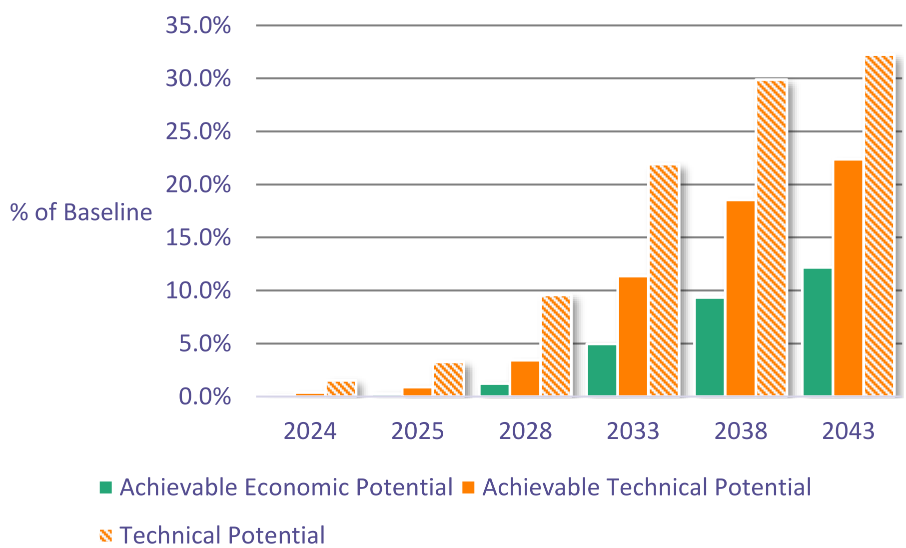


Figure 6-2 presents the supply curve of levelized cost per MWh vs. cumulative Achievable Technical potential for the residential sector in 2043. Heat pump water heaters make up nearly 40% of total cost-effective savings. Most like-for-like HVAC replacements were found not to be cost-effective under the TRC test due to a combination of lower savings and high equipment costs, however converting electric resistance space heat to a ductless heat pump system in whole or in part is cost-effective in some cases.

Figure 6-2 Supply Curve, Residential Sector Achievable Technical Potential in 2043

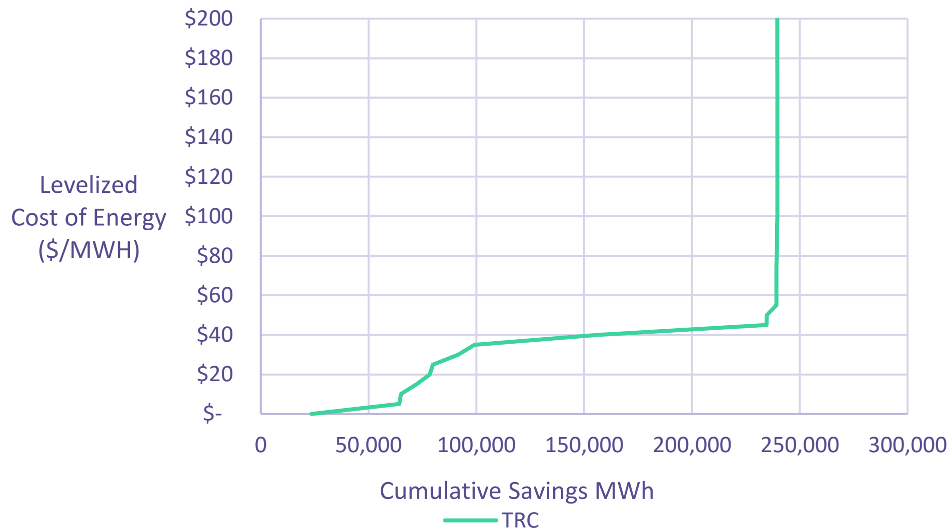
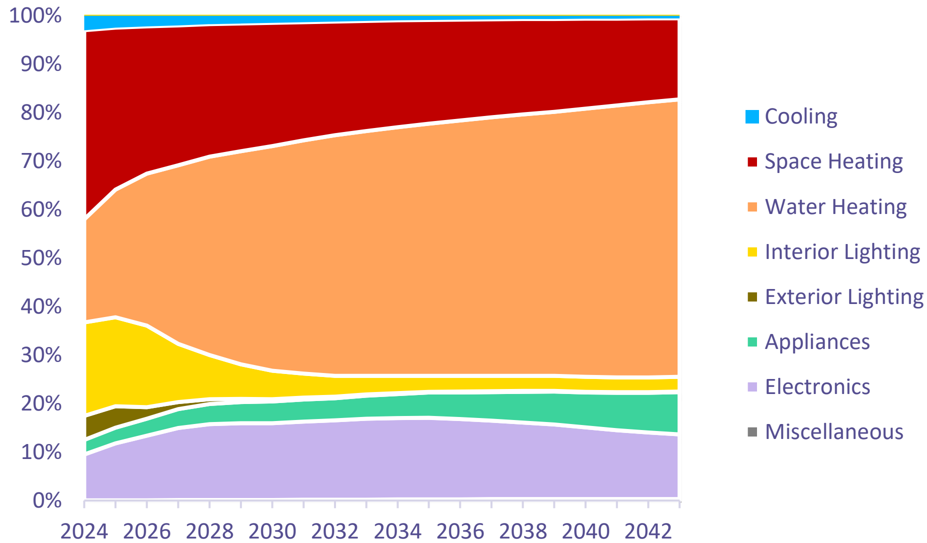


Table 6-2 Residential Top Measures in 2033

Rank	Measure / Technology	2033 Achievable Economic Potential (MWh)	% of Total
1	Water Heater (<= 55 Gal) - NEEA Tier 2 Heat Pump (CCE 2.3)	37,811	39.8%
2	Connected Thermostat - ENERGY STAR (1.0)	12,742	13.4%
3	TVs - ENERGY STAR (9.0)	9,813	10.3%
4	Set-top Boxes/DVRs - ENERGY STAR (5.1)	5,576	5.9%
5	Clothes Washer - ENERGY STAR (8.1) - Energy Star Washer	4,827	5.1%
6	Water Heater - Thermostatic Shower Restriction Valve - Installed	3,753	3.9%
7	Building Shell - Air Sealing (Infiltration Control) - 0.1 ACH Reduction	2,788	2.9%
8	Linear Lighting - LED 2020 (109 lm/W system)	2,391	2.5%
9	Insulation - Ceiling Installation - R-60	2,040	2.1%
10	Connected Thermostat - Line-Voltage - Programmed thermostat	2,028	2.1%
11	Water Heater - Drainwater Heat Recovery - Installed	1,764	1.9%
12	General Service Lighting - LED 2020 (105 lm/W)	1,486	1.6%
13	Water Heater (> 55 Gal) - NEEA Tier 5 Heat Pump (CCE 3.5)	1,301	1.4%
14	Refrigerator - CEE Tier 3 (30% above standard)	1,282	1.3%
15	Insulation - Wall Cavity Installation - R-21	1,112	1.2%
16	Circulation Pump - Controls - Installed	757	0.8%
17	Room AC - Recycling - Unit Removed	544	0.6%
18	Insulation - Wall Cavity Upgrade - R-21	480	0.5%
19	Insulation - Ceiling Upgrade - R-60	411	0.4%
20	Water Heater - Pipe Insulation - R-4 Insulation Installed	361	0.4%
	Total of Top 20 Measures	**93,267**	**98.1%**
	Total Cumulative Savings	**95,033**	**100.0%**

Figure 6-3 presents forecasts of cumulative Achievable Economic Potential by end use as a percent of total annual savings and in absolute terms. Space heating potential, representing the largest share of potential in the first year of the study, comes primarily from weatherization and control measures, such as smart thermostats, wall cavity insulation, duct repair and sealing, and whole-home aerosol sealing. Water heating savings, primarily from heat pump water heaters replacing electric resistance storage models are newly impactful, becomes the largest end use over time. The latest savings and cost assumptions from NEEA and the US DOE have made HPWH strongly cost effective, leading to HPWH becoming the dominant measure by the end of the study period. It is also worth noting that under the directives of I-937, the CPA includes measures that have little or no incremental cost such as ENERGY STAR electronics, which have a substantial footprint in the savings shown. However, these measures can be challenging to design programs to target – they may be better served by upstream initiatives or another method of addressing the market, rather than Tacoma Power program offerings.

Figure 6-3 Residential Achievable Economic Potential – Cumulative Savings by End Use (% of Total and Annual MWh)



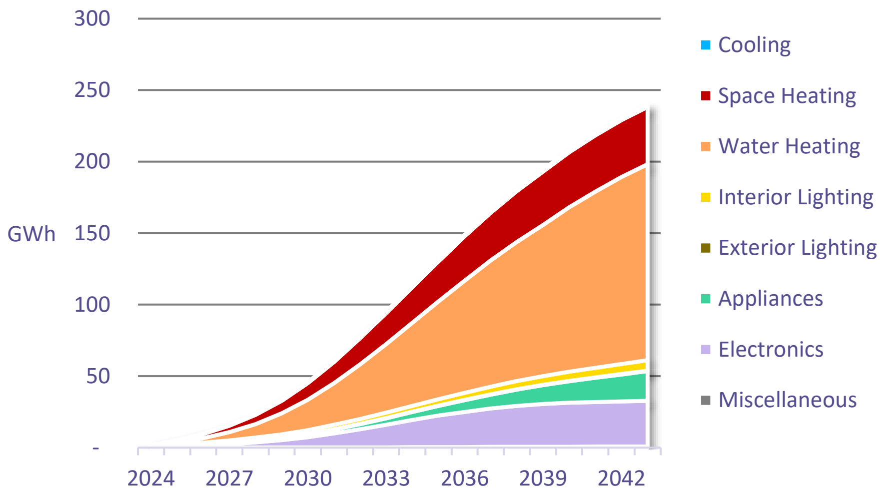


Table 6-3, Table 6-4, and Table 6-5 summarize residential sector cumulative Achievable Economic Potential by vintage, replacement type, and end use respectively.

Table 6-3 Residential Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Single Family	Existing	1,208	3,122	12,964	50,012	91,232	117,784
	New	25	67	261	1,032	2,525	4,146
Single Family 2-4 units	Existing	40	115	530	2,254	4,443	5,963
	New	4	10	41	177	425	684
Low-Rise Multifamily	Existing	157	486	2,900	14,289	28,661	38,209
	New	43	119	627	2,824	6,734	10,950
Manufactured Home	Existing	128	315	1,310	4,739	8,225	10,473
	New	2	5	22	99	257	415
Mid-Rise Multifamily	Existing	3	11	63	318	644	849
	New	1	2	11	50	118	191
Single Family - Low Income	Existing	207	531	2,288	8,877	16,269	20,693
	New	6	17	66	268	668	1,103
Single Family 2-4 units - Low Income	Existing	17	50	236	1,059	2,176	2,955
	New	1	2	6	22	53	87
Low-Rise Multifamily - Low Income	Existing	77	233	1,306	6,204	12,096	15,697
	New	25	69	370	1,788	4,377	7,000
Mid-Rise Multifamily - Low Income	Existing	1	4	22	101	198	259
	New	1	1	7	31	73	119
Manufactured Home - Low Income	Existing	23	57	235	874	1,543	1,906
	New	0	1	4	15	36	56
Total Residential	Existing	**1,863**	**4,923**	**21,853**	**88,728**	**165,486**	**214,788**
	New	**107**	**294**	**1,415**	**6,305**	**15,266**	**24,753**

Table 6-4 Residential Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Single Family	Lost Opportunity	616	1,794	8,121	34,106	68,373	95,102
	Retrofit	618	1,395	5,104	16,938	25,383	26,828
Single Family 2-4 units	Lost Opportunity	40	116	512	2,126	4,280	5,978
	Retrofit	4	9	59	305	587	669
Low-Rise Multifamily	Lost Opportunity	171	523	2,922	13,625	28,219	40,916
	Retrofit	29	82	604	3,488	7,176	8,243
Manufactured Home	Lost Opportunity	4	11	56	257	533	775
	Retrofit	1	2	18	110	229	265
Mid-Rise Multifamily	Lost Opportunity	33	102	564	2,616	5,358	7,574
	Retrofit	97	218	768	2,223	3,123	3,315
Single Family - Low Income	Lost Opportunity	87	257	1,221	5,255	10,655	14,939
	Retrofit	126	290	1,133	3,890	6,282	6,857
Single Family 2-4 units - Low Income	Lost Opportunity	15	45	203	879	1,792	2,516
	Retrofit	3	6	39	201	438	526
Low-Rise Multifamily - Low Income	Lost Opportunity	86	258	1,355	6,161	12,798	18,498
	Retrofit	16	44	320	1,831	3,674	4,199
Mid-Rise Multifamily - Low Income	Lost Opportunity	2	5	24	104	217	318
	Retrofit	0	1	5	28	54	60
Manufactured Home - Low Income	Lost Opportunity	6	17	80	345	688	951
	Retrofit	18	41	158	544	891	1,011
Total Residential	Lost Opportunity	**1,060**	**3,128**	**15,058**	**65,475**	**132,914**	**187,568**
	Retrofit	**910**	**2,089**	**8,209**	**29,558**	**47,838**	**51,973**

Table 6-5 Residential Achievable Economic Potential by End Use and Segment, 2033

End Use	Single Family	Single Family 2-4 units	Low-Rise Multifamily	Manufactured Home	Mid-Rise Multifamily
Cooling	796	2	6	49	0
Space Heating	12,711	199	1,863	2,031	79
Water Heating	23,042	1,309	11,933	2,115	224
Interior Lighting	2,323	162	474	71	11
Exterior Lighting	155	10	23	5	1
Appliances	2,652	179	636	134	12
Electronics	9,358	570	2,129	430	40
Miscellaneous	6	0	50	4	1
Total	**51,044**	**2,431**	**17,113**	**4,839**	**367**

End Use	Single Family - Low Income	Single Family 2-4 units - Low Income	Low-Rise Multifamily - Low Income	Mid-Rise Multifamily - Low Income	Manufactured Home - Low Income	Total Residential
Cooling	140	0.4	12	0.1	9	1,014
Space Heating	3,127	117	929	16	509	21,581
Water Heating	3,808	656	4,549	79	275	47,989
Interior Lighting	302	51	243	7	17	3,660
Exterior Lighting	20	6	15	0	1	236
Appliances	470	54	356	6	14	4,512
Electronics	1,278	196	1,750	24	65	15,840
Miscellaneous	1	0	139	1	0	202
Total	**9,145**	**1,081**	**7,992**	**132**	**889**	**95,033**

Table 6-6 summarizes the risk level of Achievable Economic potential in 2033 for the residential sector. Most of the savings from RTF measures is in measures with a sunset date before 2024. Importantly, the heat pump water heaters responsible for a large share of residential savings in this CPA are in the level 1 risk category (TRC cost effectiveness ratios between 1.0-1.2).

Table 6-6 Residential Achievable Economic Potential by Risk and RTF Category, 2033

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	1,301	5,671	-	31,508	**38,480**
1 - TRC B/C Ratio <1.2	37,811	159	-	17,797	**55,767**
2 - RTF Sunset before 2024	0	757	-	-	**758**
3 – Higher Risk (combined)	22	-	6	-	**28**
Total	**39,135**	**6,587**	**6**	**49,305**	**95,033**

JBLM Residential Potential

The Joint-Base Lewis-McChord (JBLM) is one of the largest users of energy in Tacoma Power's service territory, and hosts both army and air force operations, personnel, and their families. The residential facilities at JBLM consist mainly of single family and low-rise multifamily homes. The properties are managed by Lincoln Military Housing. For this study, AEG assumed that efficient homes will be built and maintained, similar to the previo us study. As a result, many existing buildings have undergone substantial energy efficiency retrofits, and the accelerated replacement of older, inefficient homes has increased the amount of newer, more efficient homes at JBLM. Accordingly, overall potential in the JBLM residential sector is lower than in other parts of the service territory.

Table 6-7 and Figure 6-4 present estimates for measure-level conservation potential for the JBLM residential sector.

Table 6-7 JBLM Residential Conservation Potential (Annual Energy, GWh)

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	38	37	36	35	34	34
Cumulative Savings (GWh)						
Achievable Economic Potential	0.04	0.10	0.42	1.61	2.95	3.75
Achievable Technical Potential	0.15	0.34	1.28	4.14	6.67	7.96
Technical Potential	0.53	1.14	3.31	7.62	10.54	11.50
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.1%	0.3%	1.2%	4.6%	8.7%	11.2%
Achievable Technical Potential	0.4%	0.9%	3.5%	11.9%	19.6%	23.7%
Technical Potential	1.4%	3.0%	9.2%	21.9%	31.0%	34.3%

Figure 6-4 JBLM Residential Savings as a % of the Baseline Projection (Annual Energy)

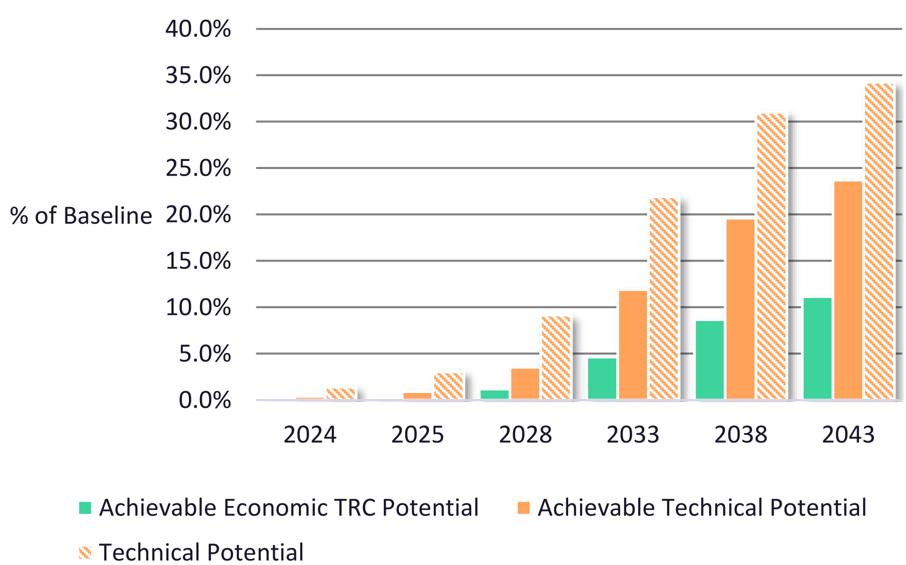


Figure 6-5 shows the supply curve of levelized cost per MWh saved vs. cumulative Achievable Technical potential for the JBLM residential sector in 2043. Similar to the civilian residential sector, weatherization measures comprise the majority of cost-effective savings. Compared to the civilian residential sector, Achievable Economic savings are a lower portion of both Achievable Technical potential and the baseline overall. This is due to the significant progress that JBLM and the property management companies have made in retrofitting existing homes and constructing efficient homes under their contract with JBLM. This reflects a higher efficiency baseline.

Figure 6-5   Supply Curve, JBLM Residential Sector Achievable Technical in 2033

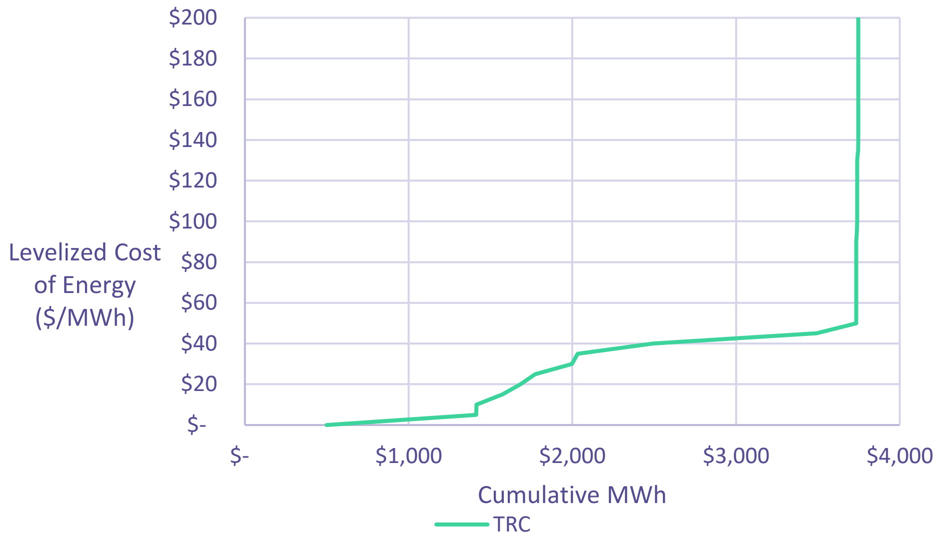


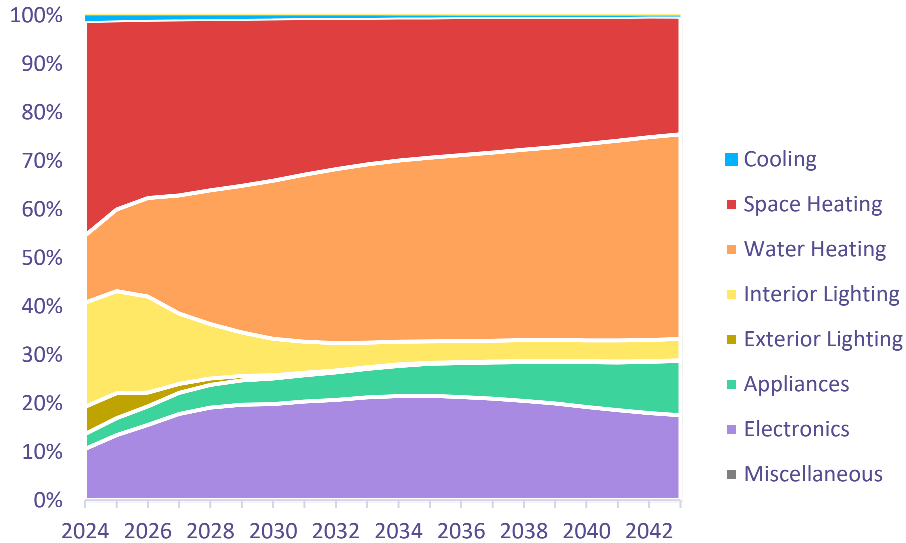
Table 6-8 identifies the top JBLM residential measures in 2033. The list of top measures is similar in most respects to the civilian sector, though some measures have lower savings due to differences in presence of equipment between the base and civilian homes.

Table 6-8 Top Measures in 2033

Rank	Measure / Technology	2033 Cumulative Achievable Economic Potential (MWh)	% of Total
1	Water Heater (<= 55 Gal) - NEEA Tier 1 Heat Pump (CCE 2.0)	323	20.0%
2	Connected Thermostat - ENERGY STAR (1.0) - Networked Thermostat Installed	282	17.4%
3	TVs - ENERGY STAR (9.0)	207	12.8%
4	Set-top Boxes/DVRs - ENERGY STAR (5.1)	124	7.7%
5	Clothes Washer - ENERGY STAR (8.1) - Energy Star Washer	98	6.0%
6	Water Heater (> 55 Gal) - NEEA Tier 5 Heat Pump (CCE 3.5)	86	5.3%
7	Water Heater - Thermostatic Shower Restriction Valve - Installed	76	4.7%
8	Insulation - Ceiling Installation - R-60	68	4.2%
9	Building Shell - Air Sealing (Infiltration Control) - 0.1 ACH Reduction	65	4.0%
10	Linear Lighting - LED 2020 (109 lm/W system)	53	3.3%
11	Water Heater - Drainwater Heat Recovery - Installed	48	3.0%
12	Connected Thermostat - Line-Voltage - Programmed thermostat	47	2.9%
13	General Service Lighting - LED 2020 (105 lm/W)	34	2.1%
14	Building Shell - Whole-Home Aerosol Sealing - Building Sealed	32	2.0%
15	Refrigerator - CEE Tier 3 (30% above standard)	26	1.6%
16	Circulation Pump - Controls - Installed	13	0.8%
17	Second Refrigerator - CEE Tier 3 (30% above standard)	8	0.5%
18	Laptops - ENERGY STAR (8.0)	6	0.4%
19	Water Heater - Pipe Insulation - R-4 Insulation Installed	6	0.4%
20	Dehumidifier Recycling - Unit Removed	4	0.3%
	Total of Top 20 Measures	**1,605**	**99.4%**
	Total Cumulative Savings	**1,615**	**100.0%**

Figure 6-6 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. The distribution of savings across end uses is similar to the civilian sector. Though in the past the more efficient lighting stock on the base caused its lighting savings to be lower as a portion of overall savings compared to the civilian sector, the civilian market has transformed to the point that the differences are now minimal.

Figure 6-6 JBLM Residential Achievable Economic Potential – Cumulative Savings by End Use (% of Total and Annual MWh)



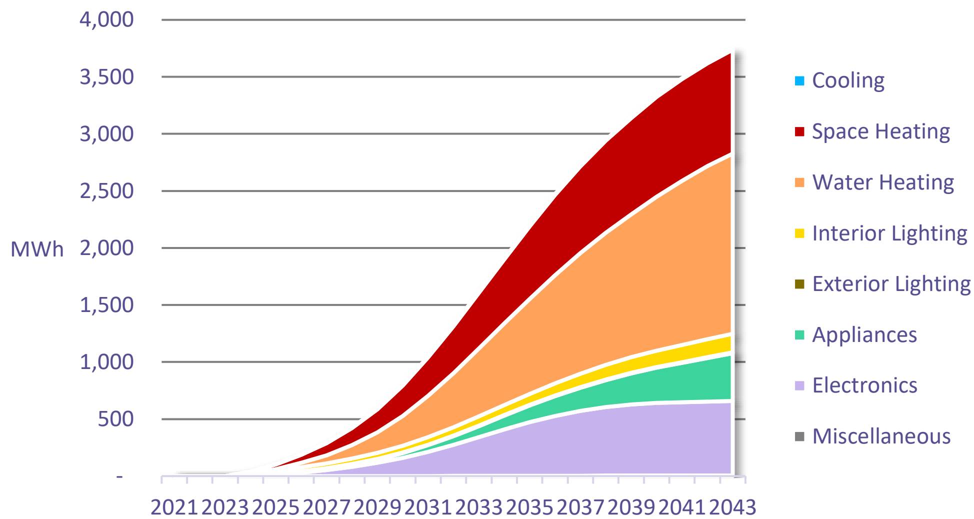


Table 6-9, Table 6-10, and Table 6-11 summarize JBLM Residential sector savings by vintage, replacement type, and end use respectively.

Table 6-9 JBLM Residential Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Single Family	Existing	37	94	378	1,412	2,531	3,189
	New	1	2	7	30	74	121
Multifamily	Existing	3	7	36	166	331	413
	New	0	0	2	7	15	24
Total Residential	**Existing**	**39**	**101**	**414**	**1,578**	**2,862**	**3,602**
	New	**1**	**2**	**8**	**37**	**89**	**145**

Tables 6-10 JBLM Residential Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Single Family	Lost Opportunity	18	51	216	885	1,729	2,363
	Retrofit	19	44	169	557	876	947
Multifamily	Lost Opportunity	2	6	23	86	164	218
	Retrofit	1	2	15	86	183	219
Total Residential	**Lost Opportunity**	**20**	**57**	**239**	**971**	**1,893**	**2,581**
	Retrofit	**20**	**46**	**184**	**643**	**1,059**	**1,166**

Table 6-11 JBLM Residential Achievable Economic Potential by End Use and Building Type, 2033

End Use	Single Family	Multifamily	**Total Residential**
Cooling	7.5	0.0	7.5
Space Heating	440.9	47.6	488.5
Water Heating	532.8	60.4	593.2
Interior Lighting	73.3	8.6	81.9
Exterior Lighting	4.9	0.5	5.4
Appliances	84.0	11.6	95.7
Electronics	298.6	42.3	340.9
Miscellaneous	0.1	1.5	1.5
Total	**1,442.2**	**172.5**	**1,614.6**

Table 6-12 shows the risk level of Achievable Economic potential in 2033 for the JBLM residential sector.

Table 6-12 JBLM Residential Achievable Economic Potential by Risk and RTF Category, 2033

Risk Level	Proven	Planning	Small Saver	None/Other	**Total**
0 - Lower Risk	86	123	-	657	**866**
1 - TRC B/C Ratio <1.2	323	-	-	413	**736**
2 - RTF Sunset before 2024	-	13	-	-	**13**
3 – Higher Risk (combined)	-	-	-	-	**-**
Total	**409**	**136**	**-**	**1,070**	**1,615**

Commercial Potential

Table 6-13 and Figure 6-7 present the annual energy savings estimates for the three levels of conservation potential for the commercial sector. Compared to the residential sector, commercial Achievable Economic potential is slightly lower as a percent of baseline, which is a contrast to past CPAs, which have been bolstered by lighting opportunities. Updates to the latest granular lighting lighting power density (LPD) and lamp mixture results from the 2019 CBSA study (detailed data released after the previous CPA was developed) have had a substantial impact on the remaining commercial lighting potential.

Photo: Getty Images

Table 6-13 Conservation Potential for the Commercial Sector

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	1,058	1,050	1,028	1,006	997	998
Cumulative Savings (GWh)						
Achievable Economic Potential	4	9	26	57	85	104
Achievable Technical Potential	13	27	73	144	189	213
Technical Potential	23	47	115	203	249	272
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.4%	0.8%	2.5%	5.7%	8.5%	10.5%
Achievable Technical Potential	1.3%	2.6%	7.1%	14.3%	18.9%	21.4%
Technical Potential	2.2%	4.5%	11.2%	20.1%	25.0%	27.3%

Figure 6-7 Commercial Savings as a % of the Baseline Projection (Annual Energy)

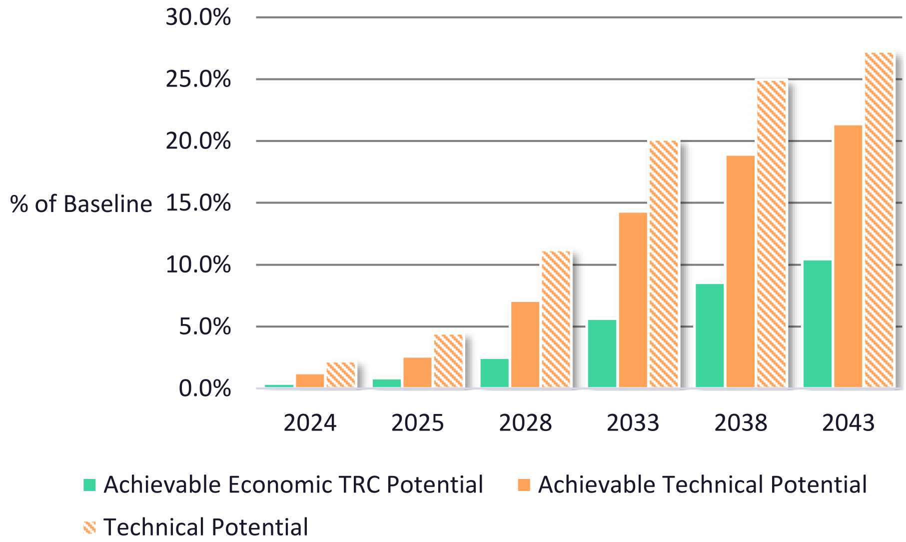


Figure 6-8 shows the supply curve of levelized cost per MWh vs. cumulative Achievable Technical potential for the commercial sector in 2043. Despite the update from CBSA lighting data mentioned previously, LED lighting still comprises over 50% of cost-effective savings, however the total of savings overall is reduced. Lighting is somewhat helped by built-in control systems bundled with the LED installation increase savings, offsetting the impacts of the market's transformation to LEDs. Strategic energy management in large, targeted buildings results in sizeable Achievable Economic Potential. Additionally, HVAC retrofit measures and water heating equipment were also found to be sources of cost-effective potential.

Figure 6-8 Supply Curve, Commercial Sector Achievable Technical Potential in 2043

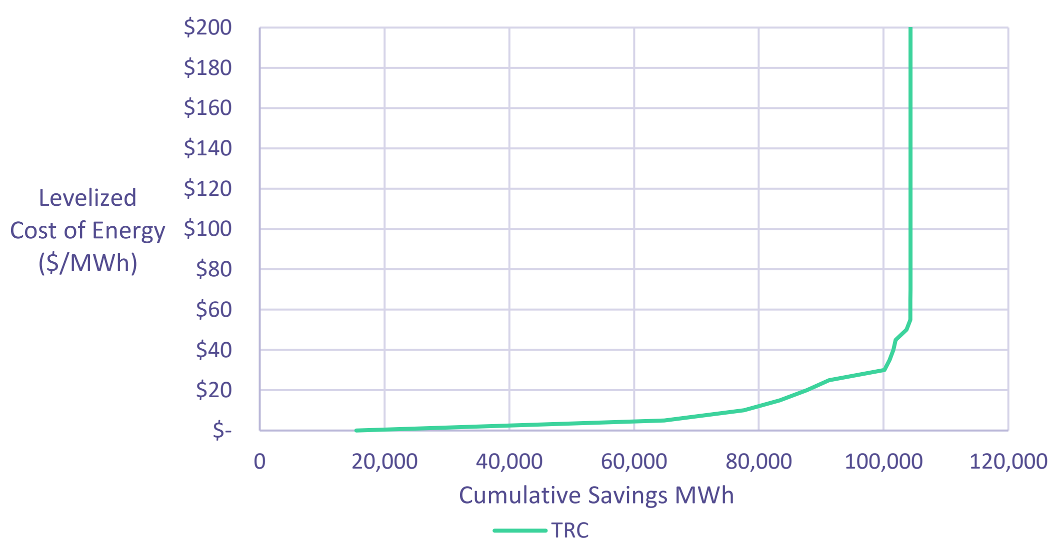


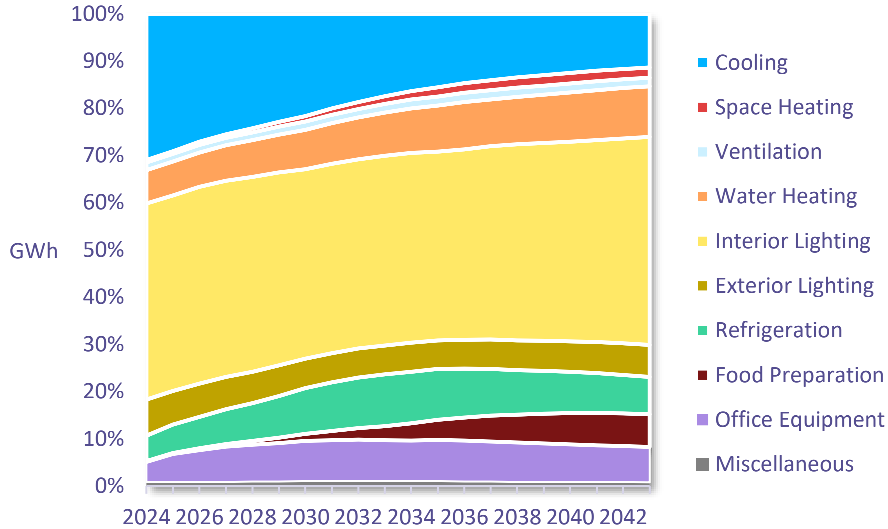
Table 6-14 identifies the top 20 commercial-sector measures in 2033 based on Achievable Economic potential. Only two of the top ten measures are lighting (contrasted with three out of the four top measures in the previous CPA). As in the residential sector, heat pump water heaters have large potential. Other measures showing significant potential include high-use servers, HVAC equipment, strategic energy management, and commercial refrigeration equipment.

Table 6-14 Commercial Sector Top Measures in 2033

Rank	Measure / Technology	2033 Cumulative Achievable Economic Potential (MWh)	% of Total
1	Linear Lighting – LED w/ Embedded Controls	21,051	42.7%
2	Chiller - Chilled Water Reset	5,860	5.8%
3	Server – ENERGY STAR 3.0	4,202	6.5%
4	High-Bay Lighting – LED w/ Embedded Controls	3,872	6.3%
5	Water Heater – COP 3.9 Heat Pump	3,718	9.7%
6	Refrigeration - Heat Recovery	2,502	3.2%
7	Refrigeration - High Efficiency Compressor	1,538	1.8%
8	Chiller - Variable Flow Chilled Water Pump	1,505	1.4%
9	Steamer – ENERGY STAR 1.2	1,394	5.7%
10	Retrocommissioning	1,035	1.0%
11	Refrigeration - High Efficiency Evaporator Fan Motors	944	1.1%
12	General Service Lighting – LED	783	1.0%
13	Icemaker – ENERGY STAR 3.0	663	1.1%
14	Water Heater - Pipe Insulation	642	0.4%
15	Windows - Secondary Glazing Systems	602	1.7%
16	Insulation – Ceiling – R-49/60 mix	531	1.3%
17	High Frequency Battery Chargers	513	0.6%
18	Water Heater - Pre-Rinse Spray Valve (<= 0.68 gpm)	460	0.3%
19	Water-Cooled Chiller - Condenser Water Temperature Reset	453	0.4%
20	Area Lighting – LED w/ Embedded Controls	400	0.6%
	Total of Top 20 Measures	**52,667**	**92.7%**
	Total Cumulative Savings	**56,951**	**100.0%**

Figure 6-9 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Savings generally reflect the end use mix of electricity in the sector, with relatively even distribution. End uses that formerly overperformed compared to their presence in the sector, such as lighting, have been captured through codes, standards, and market transformation, leaving lower potential for utility-sponsored conservation programs.

Figure 6-9   Commercial Achievable Economic Potential – Cumulative Savings by End Use (% of Total and Annual MWh)



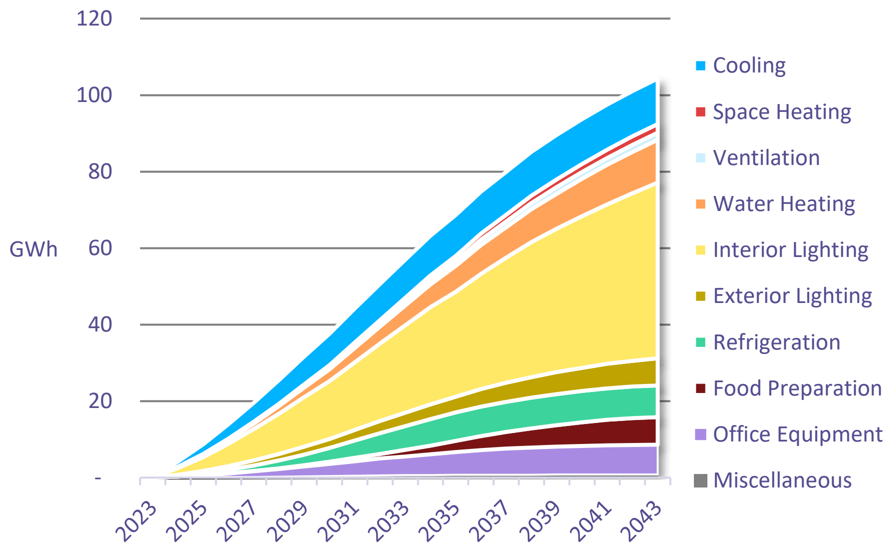


Table 6-15, Table 6-16, and Table 6-17 show commercial sector savings by vintage, replacement type, and end use respectively.

Table 6-15 Commercial Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Office	Existing	559	1,222	3,528	7,260	9,851	11,267
	New	151	327	1,067	2,710	4,779	6,734
Retail	Existing	612	1,281	3,619	7,473	10,742	12,584
	New	223	471	1,367	2,907	4,522	5,933
College	Existing	43	94	305	794	1,244	1,466
	New	14	30	96	286	589	873
School	Existing	337	689	1,832	3,545	5,022	5,892
	New	83	178	529	1,252	2,161	3,044
Grocery	Existing	211	454	1,378	3,111	4,353	5,084
	New	116	273	1,080	3,568	5,040	5,736
Hospital	Existing	173	371	1,134	2,821	4,342	5,235
	New	56	121	384	1,136	2,421	3,632
Other Health	Existing	104	211	589	1,212	1,736	2,060
	New	36	72	202	447	729	1,015
Lodging	Existing	62	124	340	676	976	1,119
	New	10	20	68	195	390	566
Restaurant	Existing	151	327	1,036	2,502	3,604	4,136
	New	33	73	272	887	1,787	2,689
Assembly	Existing	97	195	501	927	1,223	1,343
	New	16	34	106	250	412	540
Warehouse	Existing	**218**	**475**	**1,500**	**3,629**	**5,572**	**6,672**
	New	**110**	**232**	**667**	**1,492**	**2,382**	**3,161**
Data Center	Existing	215	432	1,078	1,866	2,209	2,358
	New	10	25	93	257	439	618
MF Common Area	Existing	153	302	798	1,560	2,212	2,476
	New	27	49	141	326	570	811
Misc - Classified	Existing	179	372	1,037	2,124	3,006	3,522
	New	64	134	402	950	1,635	2,322
Misc - Unclassified	Existing	51	105	286	575	806	932
	New	15	31	93	214	358	498
Total Commercial	Existing	**3,165**	**6,652**	**18,962**	**40,074**	**56,898**	**66,145**
	New	**963**	**2,071**	**6,568**	**16,876**	**28,213**	**38,172**

Table 6-16 Commercial Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Office	Lost Opportunity	406	950	3,188	7,916	12,482	15,936
	Discretionary	304	598	1,407	2,054	2,148	2,064
Retail	Lost Opportunity	552	1,191	3,643	8,335	13,079	16,350
	Discretionary	283	560	1,343	2,045	2,186	2,168
College	Lost Opportunity	32	72	244	695	1,291	1,754
	Discretionary	24	52	157	385	542	585
School	Lost Opportunity	179	393	1,229	3,080	5,367	7,181
	Discretionary	240	474	1,132	1,717	1,815	1,755
Grocery	Lost Opportunity	152	332	1,031	2,430	4,012	5,406
	Discretionary	175	395	1,428	4,249	5,380	5,413
Hospital	Lost Opportunity	132	293	997	2,964	5,511	7,577
	Discretionary	98	199	521	994	1,252	1,289
Other Health	Lost Opportunity	96	192	550	1,180	1,862	2,451
	Discretionary	44	91	241	478	603	623
Lodging	Lost Opportunity	28	57	198	544	1,012	1,336
	Discretionary	44	87	210	327	355	349
Restaurant	Lost Opportunity	84	190	705	2,107	3,967	5,457
	Discretionary	100	210	603	1,282	1,424	1,369
Assembly	Lost Opportunity	29	63	191	442	713	925
	Discretionary	83	166	415	735	922	959
Warehouse	Lost Opportunity	274	590	1,758	3,913	6,098	7,802
	Discretionary	54	117	408	1,208	1,856	2,030
Data Center	Lost Opportunity	14	36	146	443	810	1,141
	Discretionary	212	421	1,026	1,680	1,838	1,835
MF Common Area	Lost Opportunity	84	159	449	945	1,487	1,900
	Discretionary	96	192	490	941	1,295	1,387
Misc - Classified	Lost Opportunity	148	319	989	2,382	3,896	5,123
	Discretionary	94	187	450	692	745	721
Misc - Unclassified	Lost Opportunity	33	72	220	519	837	1,095
	Discretionary	32	64	159	270	327	334
Total Commercial	Lost Opportunity	**2,244**	**4,911**	**15,539**	**37,896**	**62,423**	**81,436**
	Discretionary	**1,885**	**3,813**	**9,990**	**19,055**	**22,688**	**22,881**

Table 6-17 Commercial Achievable Economic Potential by End Use, 2033

End Use	Office	Retail	College	School	Grocery	Hospital	Other Health	Lodging
Cooling	1,820	1,330	127	1,521	428	517	172	393
Space Heating	17	2	99	13	0	159	80	2
Interior Lighting	3,678	6,526	340	2,257	1,686	1,575	1,045	138
Exterior Lighting	549	642	31	146	147	55	50	21
Ventilation	-	110	112	6	-	176	73	-
Miscellaneous	-	59	22	-	6	1	0	14
Water Heating	1,037	1,004	174	247	231	431	23	47
Refrigeration	31	290	27	183	3,969	137	73	123
Food Preparation	16	63	85	325	106	717	46	86
Office Equipment	2,821	355	63	98	105	191	97	46
Total	**9,970**	**10,380**	**1,080**	**4,797**	**6,679**	**3,957**	**1,658**	**871**

End Use	Restaurant	Assembly	Warehouse	Data Center	MF Common Area	Misc - Classified	Misc - Unclassified	Total Commercial
Cooling	59	559	221	1,542	617	428	208	9,943
Space Heating	2	49	241	30	203	23	20	941
Interior Lighting	599	308	2,235	41	522	1,560	356	22,865
Exterior Lighting	80	42	1,471	5	79	152	35	3,505
Ventilation	-	108	82	251	31	72	28	1,050
Miscellaneous	-	-	508	-	-	2	0	612
Water Heating	1,073	44	103	11	209	495	64	5,193
Refrigeration	1,236	18	57	0	27	51	12	6,232
Food Preparation	194	9	0	0	3	32	7	1,689
Office Equipment	146	41	202	243	196	260	59	4,922
Total	**3,389**	**1,177**	**5,121**	**2,124**	**1,886**	**3,074**	**789**	**56,951**

Table 6-18 summarizes the risk level of Achievable Economic potential in 2033 for the commercial sector. Very few cost-effective measures have a TRC benefit-to-cost ratio of less than 1.2. The None/Other category includes a substantial number of 2021 Power Plan measures which have not been characterized by the RTF.

Table 6-18 Commercial Achievable Economic Potential by Risk and RTF Category, 2033

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	460	1,009	1,553	44,555	47,578
1 - TRC B/C Ratio <1.2	-	13	2,057	7,303	9,373
2 - RTF Sunset before 2024	-	-	-	-	-
3 – Higher Risk (combined)	-	-	-	-	-
Total	**460**	**1,022**	**3,610**	**51,858**	**56,951**

JBLM Commercial Potential

The JBLM non-residential facilities are similar to their civilian counterparts, so we began with the same assumptions for customer adoption rates and measure costs. The presence of high security and the additional administrative and logistical requirements of performing work on base, however, led us to apply an adjustment factor to decelerate the measure adoption rates and to increase the measure costs. An example of how this would play out is that the Army Corps of Engineers is required to review every project and contractors typically charge a premium to work on base due to the additional security, badging, etc. These factors reduce the overall Achievable Technical potential at JBLM. AEG reviewed this assumption with Tacoma Power for this CPA cycle and it was deemed to still be accurate.

Table 6-19 and Figure 6-10 present estimates for the three levels of conservation potential for the commercial sector.

Table 6-19 Conservation Potential for the JBLM Commercial Sector (Energy Savings)

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	219	218	214	211	210	211
Cumulative Savings (GWh)						
Achievable Economic TRC Potential	1	2	5	10	16	19
Achievable Technical Potential	2	5	13	26	35	42
Technical Potential	4	9	22	37	46	52
Energy Savings (% of Baseline)						
Achievable Economic TRC Potential	0.4%	0.8%	2.2%	4.9%	7.5%	9.2%
Achievable Technical Potential	1.1%	2.2%	6.1%	12.2%	16.7%	19.6%
Technical Potential	2.0%	4.1%	10.0%	17.7%	22.1%	24.7%

Figure 6-10 JBLM Commercial Energy Efficiency Savings

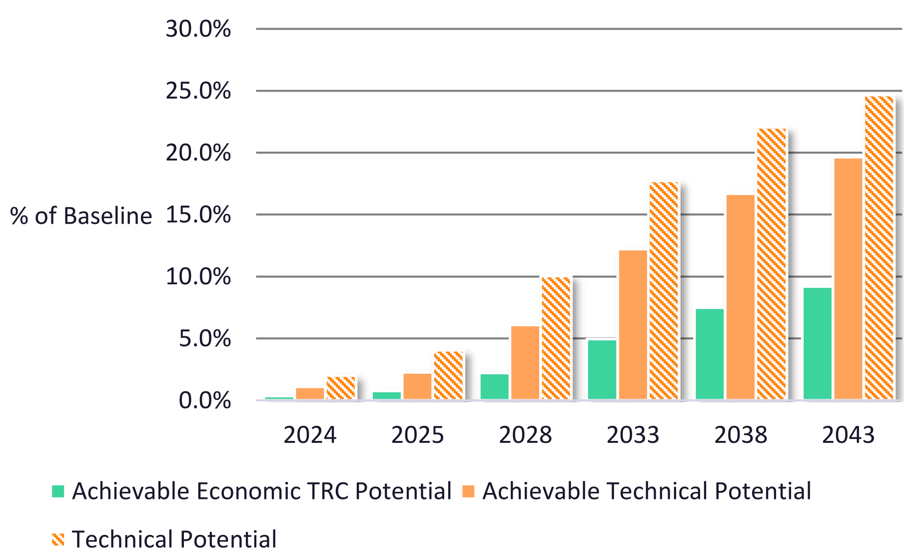


Figure 6-11 shows the supply curve of levelized cost per MWh saved vs. cumulative Achievable Technical potential for the JBLM commercial sector in 2043 Achievable Economic potential in the JBLM commercial sector. Overall Achievable Economic potential is lower than the civilian commercial sector relative to baseline. This is attributable to fewer measures passing the TRC screen due to the higher costs of doing business at JBLM.

Figure 6-11 Supply Curve, JBLM Commercial Sector Achievable Technical Potential in 2043

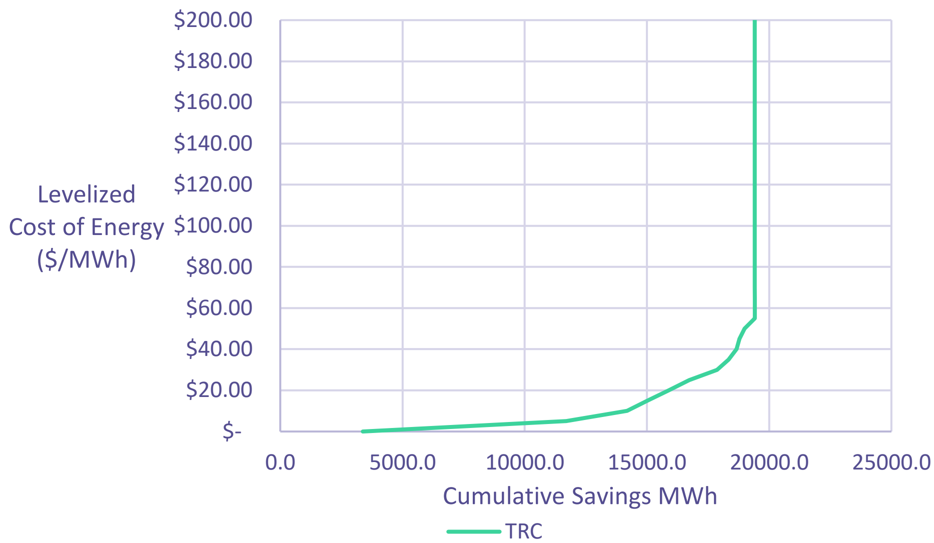


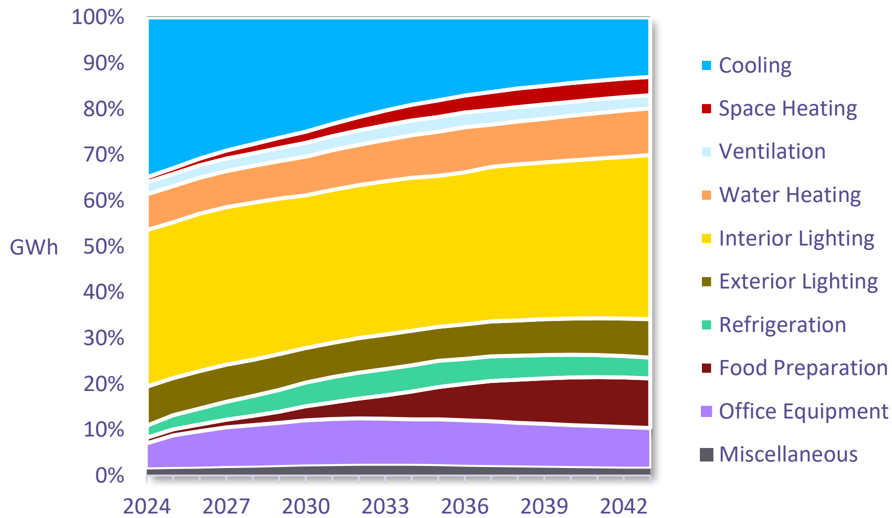
Table 6-20 identifies the top 20 measures in 2033 for the JBLM non-residential sector. Only one of the top 10 measures for JBLM is in lighting, which reflects the market transformed baseline and available market. Similar to the civilian sector, this reflects a combined installation of LED and control systems to gain additional efficiency beyond the simple lamp upgrade.

Table 6-20 JBLM Commercial Sector Top Measures in 2033

Rank	Measure / Technology	2033 Cumulative Achievable Economic Potential (MWh)	% of Total
1	Linear Lighting – LED w/ Embedded Controls	3,417	32.8%
2	Chiller - Chilled Water Reset	1,026	9.8%
3	Server – ENERGY STAR 3.0	837	8.0%
4	Water Heater – COP 3.9 Heat Pump	626	6.0%
5	High-Bay Lighting – LED w/ Embedded Controls	596	5.7%
6	Steamer – ENERGY STAR 1.2	381	3.7%
7	Chiller - Variable Flow Chilled Water Pump	344	3.3%
8	Retrocommissioning	243	2.3%
9	High Frequency Battery Chargers	220	2.1%
10	Icemaker – ENERGY STAR 3.0	208	2.0%
11	Packaged Terminal HP – EER 11.7 / COP 3.4	180	1.7%
12	Windows - Secondary Glazing Systems	170	1.6%
13	Water Heater - Pipe Insulation	150	1.4%
14	Strategic Energy Management	148	1.4%
15	General Service Lighting – LED	139	1.3%
16	Insulation – Ceiling – R49/60 Mixed	134	1.3%
17	Refrigeration - High Efficiency Compressor	123	1.2%
18	Ductless Mini Split Heat Pump (Zonal ER Heat Conversion)	119	1.1%
19	Water-Cooled Chiller - Condenser Water Temperature Reset	109	1.0%
20	Refrigeration - Heat Recovery	90	0.9%
	Total of Top 20 Measures	**9,262**	**88.8%**
	Total Cumulative Savings	**10,431**	**100.0%**

Figure 6-12 presents forecasts of energy savings by end use as a percent of cumulative Achievable Economic potential and in absolute terms. As in the civilian sector, savings are proportional to consumption in the end uses, with no particular end use overperforming relative to baseline.

Figure 6-12 JBLM Commercial Achievable Economic Potential – Cumulative Savings by End Use (% of Total and Annual GWh)



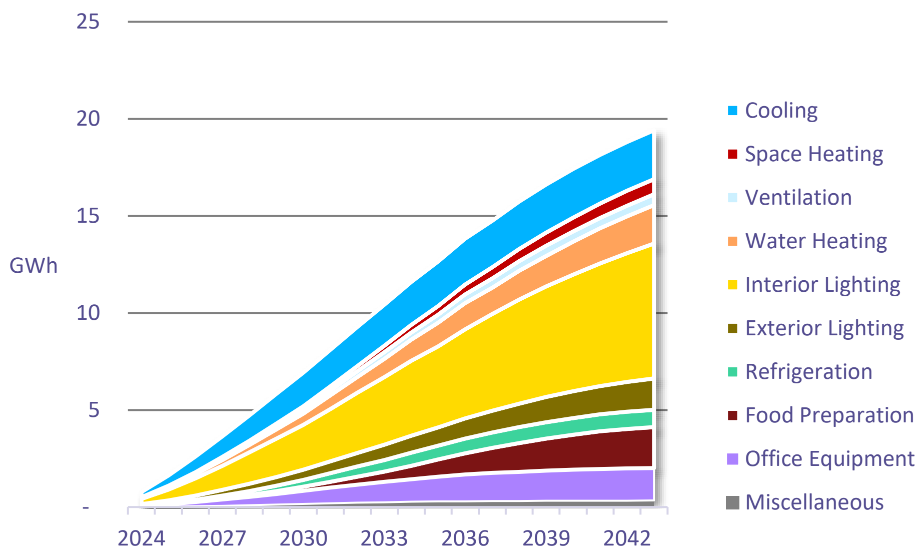


Table 6-21, Table 6-22, and Table 6-23 summarize JBLM commercial sector savings by vintage, replacement type, and end use respectively.

Table 6-21 JBLM Commercial Cumulative Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)
Office	Existing	111	243	702	1,445	1,960
	New	30	65	212	539	951
Retail	Existing	13	27	77	159	229
	New	5	10	29	62	96
School	Existing	27	54	144	279	396
	New	7	14	42	99	170
Grocery	Existing	8	16	49	112	156
	New	4	10	39	128	181
Health	Existing	78	166	499	1,209	1,834
	New	23	51	162	474	1,003
Lodging	Existing	76	153	421	836	1,208
	New	12	25	84	242	483
Restaurant	Existing	22	48	151	365	526
	New	5	11	40	129	261
Hangar	Existing	34	73	222	541	817
	New	11	24	69	156	242
Warehouse	Existing	52	112	355	859	1,318
	New	26	55	158	353	563
Data Center	Existing	108	214	514	849	964
	New	5	12	43	117	196
Mixed Use	Existing	42	87	242	485	682
	New	15	33	98	229	392
Other	Existing	42	85	229	442	601
	New	12	25	74	171	284
Industrial	Existing	8	17	49	114	171
	New	3	5	16	36	58
Total Commercial	Existing	**620**	**1,296**	**3,655**	**7,695**	**10,863**
	New	**158**	**339**	**1,065**	**2,736**	**4,880**

Table 6-22 JBLM Commercial Cumulative Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Office	Lost Opportunity	81	189	634	1,575	2,484	3,171
	Retrofit	61	119	280	409	427	411
Retail	Lost Opportunity	12	25	78	177	278	348
	Retrofit	6	12	29	44	47	46
School	Lost Opportunity	14	31	97	243	423	566
	Retrofit	19	37	89	135	143	138
Grocery	Lost Opportunity	5	12	37	87	144	194
	Retrofit	6	14	51	153	193	194
Lodging	Lost Opportunity	34	71	245	674	1,253	1,654
	Retrofit	54	107	260	404	439	432
Restaurant	Lost Opportunity	12	28	103	307	578	796
	Retrofit	15	31	88	187	208	200
Warehouse	Lost Opportunity	65	140	416	926	1,443	1,846
	Retrofit	13	28	97	286	439	480
Data Center	Lost Opportunity	4	10	40	129	243	339
	Retrofit	109	216	518	837	916	924
Health	Lost Opportunity	54	120	409	1,216	2,262	3,110
	Retrofit	48	97	251	467	575	588
Hangar	Lost Opportunity	27	57	169	376	586	751
	Retrofit	19	40	122	321	474	509
Mixed Use	Lost Opportunity	35	77	239	577	945	1,242
	Retrofit	22	43	101	138	129	111
Other	Lost Opportunity	26	57	174	409	660	863
	Retrofit	27	53	129	203	225	223
Industrial	Lost Opportunity	6	13	40	88	137	176
	Retrofit	4	9	25	63	91	99
Total Commercial	Lost Opportunity	**370**	**816**	**2,640**	**6,697**	**11,299**	**14,879**
	Retrofit	**397**	**796**	**2,015**	**3,583**	**4,215**	**4,256**

Table 6-23 JBLM Commercial Cumulative Achievable Economic Potential by End Use and Market Segment, 2033

End Use	Office	Retail	Restaurant	Grocery	Health	School	Lodging
Cooling	360	28	9	15	162	120	409
Space Heating	6	0	0	0	116	1	80
Ventilation	-	2	-	-	72	1	-
Water Heating	206	21	156	8	177	20	58
Interior Lighting	732	139	87	61	646	178	170
Exterior Lighting	109	14	12	5	23	12	27
Refrigeration	6	6	180	143	56	14	153
Food Preparation	3	1	28	4	348	26	107
Office Equipment	561	8	21	4	78	8	57
Miscellaneous	-	1	-	0	5	-	18
Total	**1,984**	**221**	**494**	**240**	**1,683**	**378**	**1,078**

End Use	Hangar	Warehouse	Data Center	Mixed Use	Other	Industrial	Total Commercial
Cooling	74	47	674	59	158	11	2,125
Space Heating	35	62	5	5	12	9	331
Ventilation	83	19	130	3	13	10	335
Water Heating	43	24	6	153	58	12	943
Interior Lighting	215	529	21	376	280	52	3,486
Exterior Lighting	140	348	3	36	27	33	788
Refrigeration	5	14	0	11	9	2	599
Food Preparation	0	0	0	9	7	0	534
Office Equipment	19	48	127	63	47	5	1,045
Miscellaneous	83	120	-	0	2	17	246
Total	**697**	**1,212**	**966**	**715**	**612**	**151**	**10,431**

Table 6-24 summarizes the risk level of Achievable Economic potential in 2033 for the JBLM commercial sector. Results are very similar to the civilian commercial sector.

Table 6-24 JBLM Commercial Cumulative Achievable Economic Potential by Risk and RTF Category, 2033

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	89	323	231	8,012	8,654
1 - TRC B/C Ratio <1.2	-	-	589	1,187	1,777
2 - RTF Sunset before 2024	-	-	-	-	-
3 – Higher Risk (combined)	-	-	-	-	-
Total	**89**	**323**	**820**	**9,199**	**10,431**

Industrial Potential

Table 6-25 and Figure 6-13 present potential estimates at the measure level for the industrial sector. As a percent of the baseline projection, industrial savings are the lowest as a result of stringent motor standards and the challenges of identifying additional opportunities to reduce process energy use. Many of these are control-type measures that affect large energy consuming motors and processes. Compressed air measures, which are on faster ramp rates than measures for other applications, make up a sizeable amount of the potential. Additionally, strategic energy management programs, which have recently been gaining significant traction in the region, are a large source of potential.

Photo: Getty Images

Special Consideration: Large Customer Closure

After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the overall conservation potential. As the study was already completed, the reporting throughout this document, including the charts and figures in this section, include this customer.

To account for the closure, the following deducts should be applied to each of the years identified in Table 6-26 in the Summary of Conservation Potential. Technical Potential, Achievable Technical Potential, and Achievable Economic Potential all receive the same deduction, as the savings potential for this customer was estimated in a separate customized analysis identical to that performed in the prior CPA, and for which all reasonable and applicable savings measures were found to be cost effective.

Table 6-25 Large Customer Closure Deductions

Deductions (GWh)	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	361	362	365	372	379	387
Cumulative Savings (GWh)	2	3	10	21	26	30

For more details on the industrial plant closure and impacts to the conservation potential assessment see Appendix E.

Table 6-26 Conservation Potential for the Industrial Sector (Annual Energy, GWh)

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	1,128	1,131	1,142	1,162	1,184	1,210
Cumulative Savings (GWh)						
Achievable Economic Potential	4	8	25	56	72	80
Achievable Technical Potential	6	12	37	82	103	114
Technical Potential	8	15	45	98	124	134
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.4%	0.7%	2.1%	4.8%	6.1%	6.6%

Achievable Technical Potential	0.5%	1.1%	3.2%	7.1%	8.7%	9.4%
Technical Potential	0.7%	1.4%	3.9%	8.4%	10.4%	11.1%

Figure 6-13 Industrial Potential as a % of the Baseline Projection

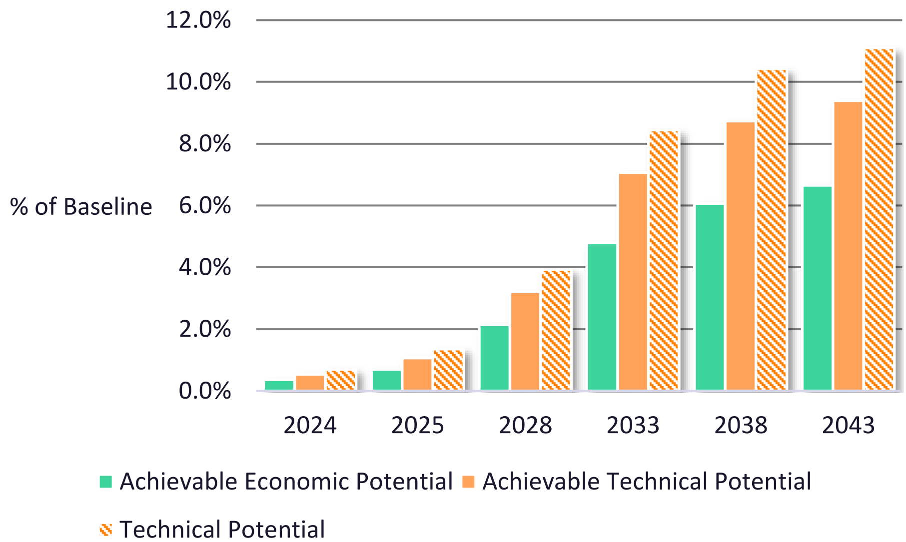


Figure 6-14 shows the supply curve of levelized cost per MWh saved vs. cumulative Achievable Technical potential for the industrial sector in 2043. Energy management measures, motor and process controls, and LED lighting make up a majority of the cost-effective savings potential. Although the linear LED cost reduction also applies to industrial spaces, high bay LED applications make up a majority of the fixtures and are highly cost-effective. Overall, Achievable Economic Potential in the industrial sector represents an even higher percentage of Achievable Technical potential when compared to both residential and commercial savings. This is mainly due to measures being either highly cost effective or ineffective. This is apparent by the amount of Achievable Technical savings with levelized costs of less than $30/MWh.

Figure 6-14 Supply Curve, Industrial Sector in 2043 (Annual Energy, MWh)

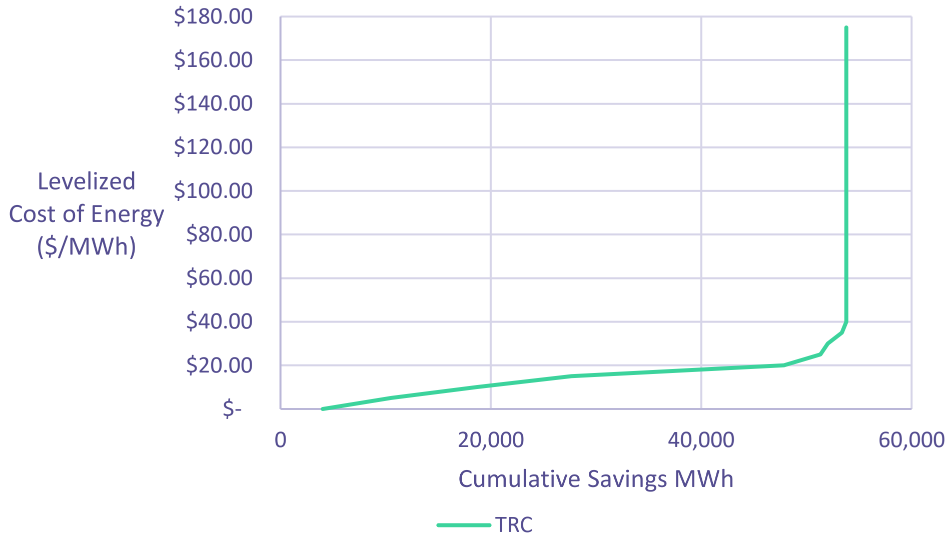


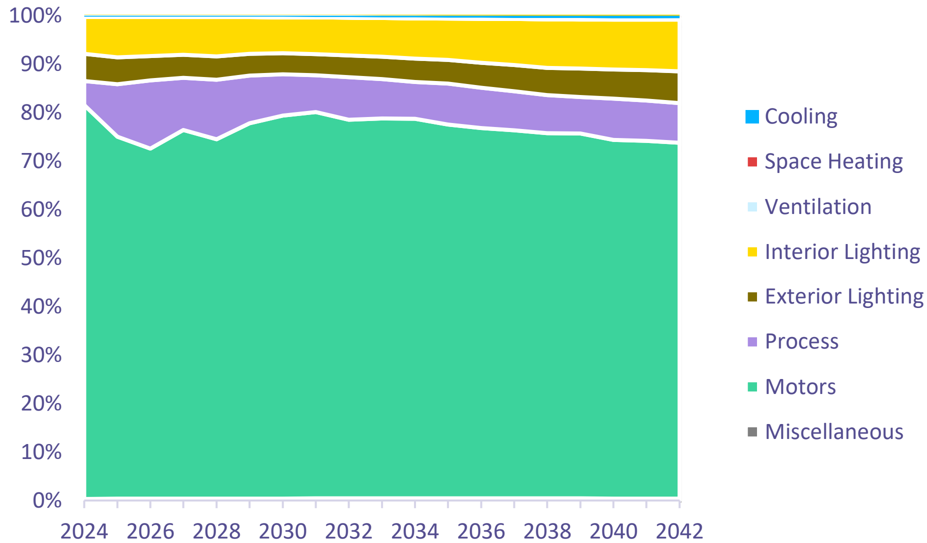
Table 6-26 identifies the top 20 industrial measures in 2033. The bulk of top measure opportunities in Industrial consist of variable speed motors in various applications, and system optimization to reduce waste in operations.

Table 6-27 Industrial Sector Top Measures in 2033

Rank	Measure / Technology	2033 Achievable Economic Potential (MWh)	% of Total
1	Material Handling - Variable Speed Drive	9,923	17.5%
2	Motor VFDs	9,152	16.2%
3	Controls & Optimization	5,999	10.6%
4	Linear Lighting	4,762	8.4%
5	Compressed Air - End Use Optimization	3,895	6.9%
6	Pumping System - System Optimization	3,676	6.5%
7	Process Equipment	2,946	5.2%
8	Impeller Trim	2,908	5.1%
9	Pumping System - Variable Speed Drive	2,806	5.0%
10	High-Bay Lighting	2,096	3.7%
11	Fan System - Variable Speed Drive	2,047	3.6%
12	Indoor Agriculture - LED Lighting	928	1.6%
13	Refrigeration - System Maintenance	631	1.1%
14	Advanced Industrial Motors	493	0.9%
15	Compressed Air - System Controls	461	0.8%
16	Fan System - Equipment Upgrade	409	0.7%
17	Compressed Air - Zero-Loss Condensate Drain	398	0.7%
18	Paper - Efficient Agitator	390	0.7%
19	Panel - Hydraulic Press	376	0.7%
20	Motors - Green Rewind (100 HP+)	313	0.6%
	Total of Top 20 Measures	**54,610**	**96.5%**
	Total Cumulative Savings	**56,577**	**100.0%**

Figure 6-15 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Motor-related measures account for most of the savings throughout the forecast horizon.

Figure 6-15 Industrial Achievable Economic Potential – Cumulative Savings by End Use (% of Total and Annual MWh)



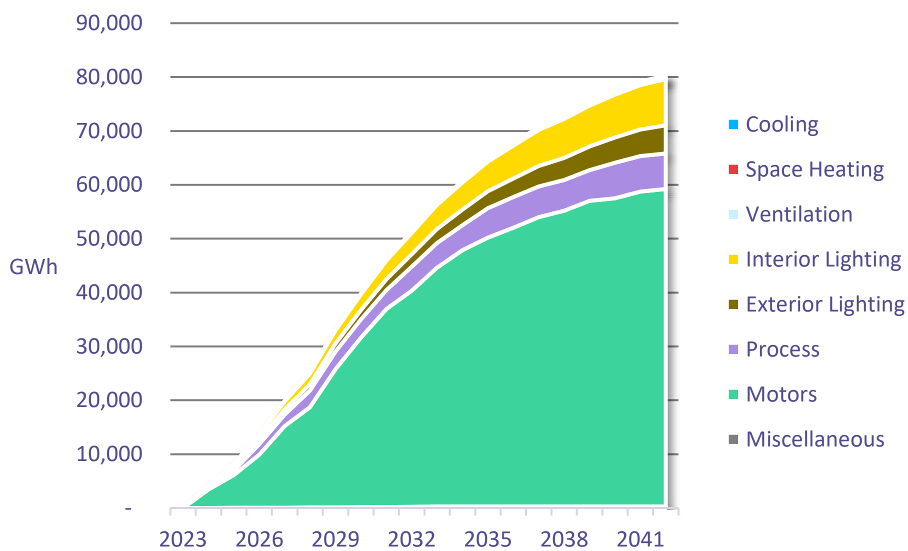


Table 6-27, Table 6-28, and Table 6-29 summarize Industrial sector savings by vintage, replacement type, and end use respectively.

Table 6-28 Industrial Cumulative Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
Paper Mfg	Existing	2,374	4,069	12,663	26,812	33,688	37,737
	New	54	130	483	1,497	2,214	2,551
Chemical Mfg	Existing	549	1,149	3,281	7,079	8,712	9,347
	New	55	130	487	1,481	2,164	2,594
Stone Clay Glass Products	Existing	104	231	751	1,862	2,287	2,381
	New	16	39	151	471	650	719
Petroleum Refining	Existing	230	483	1,386	3,099	3,900	4,313
	New	23	56	217	688	1,034	1,302
Lumber Wood Products	Existing	132	287	900	2,158	2,644	2,767
	New	18	43	165	522	736	829
Food Mfg	Existing	149	314	912	1,990	2,525	2,732
	New	24	56	195	530	780	932
Rubber and Plastics	Existing	96	206	630	1,468	1,928	2,146
	New	19	47	161	436	650	807
Other Industrial	Existing	326	703	2,139	4,962	6,601	7,419
	New	71	169	575	1,522	2,288	2,875
Total Industrial	Existing	**3,960**	**7,441**	**22,661**	**49,430**	**62,284**	**68,842**
	New	**279**	**670**	**2,434**	**7,146**	**10,515**	**12,611**

Table 6-29 Industrial Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential	2025 Achievable Economic Potential	2028 Achievable Economic Potential	2033 Achievable Economic Potential	2038 Achievable Economic Potential	2043 Achievable Economic Potential
Paper Mfg	Lost Opportunity	104	229	696	1,557	2,502	3,141
	Retrofit	2,325	3,970	12,449	26,752	33,400	37,147
Chemical Mfg	Lost Opportunity	66	146	443	991	1,592	1,999
	Retrofit	537	1,133	3,325	7,569	9,284	9,942
Stone Clay Glass Products	Lost Opportunity	21	48	150	337	538	692
	Retrofit	99	222	751	1,996	2,398	2,408
Petroleum Refining	Lost Opportunity	16	37	114	257	410	527
	Retrofit	237	502	1,488	3,530	4,525	5,088
Lumber Wood Products	Lost Opportunity	24	53	161	359	577	724
	Retrofit	125	276	905	2,321	2,802	2,872
Food Mfg	Lost Opportunity	41	90	274	614	986	1,238
	Retrofit	132	280	832	1,907	2,319	2,427
Rubber and Plastics	Lost Opportunity	39	89	275	618	987	1,269
	Retrofit	76	164	516	1,286	1,590	1,684
Other Industrial	Lost Opportunity	147	332	1,027	2,307	3,687	4,740
	Retrofit	250	540	1,687	4,177	5,201	5,554
Total Industrial	Lost Opportunity	**459**	**1,023**	**3,141**	**7,038**	**11,280**	**14,331**
	Retrofit	**3,780**	**7,088**	**21,954**	**49,539**	**61,519**	**67,122**

Table 6-30 Industrial Achievable Economic Potential by End Use, 2033

End Use	Paper Mfg	Chemical Mfg	Stone Clay Glass Products	Petroleum Refining	Lumber Wood Products	Food Mfg	Rubber and Plastics	Other Industrial	Total Industrial
Cooling	56	42	4	3	12	23	8	30	**179**
Space Heating	32	8	2	2	2	5	5	19	**75**
Interior Lighting	1,090	627	211	160	227	388	386	1,443	**4,533**
Exterior Lighting	575	364	126	96	132	225	231	864	**2,613**
Ventilation	2	1	0	0	0	1	1	3	**8**
Process	2,988	1,092	-	30	22	293	30	111	**4,566**
Motors	23,566	6,425	1,973	3,495	2,251	1,551	1,191	3,884	**44,336**
Miscellaneous	-	-	16	-	34	34	52	130	**266**
Total	**28,309**	**8,560**	**2,333**	**3,787**	**2,680**	**2,520**	**1,904**	**6,484**	**56,577**

Table 6-30 summarizes the risk level of Achievable Economic potential in 2033 for the industrial sector. Because the RTF characterizes very few industrial measures, most potential is in the None/Other category. This includes 2021 Power Plan measures, strategic energy management, and additional system optimization and controls measures identified by AEG.

Table 6-31 Industrial Achievable Economic Potential by Risk and RTF Category, 2033

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	-	10	313	52,809	53,133
1 - TRC B/C Ratio <1.2	-	-	-	3,444	3,444
2 - RTF Sunset before 2024	-	-	-	-	-
3 – Higher Risk (combined)	-	-	-	-	-
Total	**-**	**10**	**313**	**56,253**	**56,577**

Street Lighting Potential

Table 6-31 and Figure 6-16 present estimates for the three levels of conservation potential for the street lighting sector. Most Achievable Technical potential is cost-effective, however the remaining opportunity is small. As discussed in Chapter 3, lamps under Tacoma Power's direct control have been retrofit to LEDs already. The remaining potential comes from fixtures that Tacoma Power does not have direct access to and which are slower to respond to programs.

Table 6-32 Conservation Potential for the Street Lighting Sector

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	14.3	14.3	14.3	14.3	14.3	14.3
Cumulative Savings (GWh)						
Achievable Economic Potential	0.1	0.2	0.6	1.9	3.6	5.2
Achievable Technical Potential	0.1	0.3	1.0	2.3	4.0	5.6
Technical Potential	0.3	0.7	1.8	3.6	5.4	7.2
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.4%	1.0%	4.4%	13.5%	25.0%	36.5%
Achievable Technical Potential	0.7%	2.3%	6.8%	16.3%	27.9%	39.4%
Technical Potential	2.1%	5.0%	12.4%	24.8%	37.9%	50.2%

Figure 6-16 Street Lighting Energy Efficiency Potential

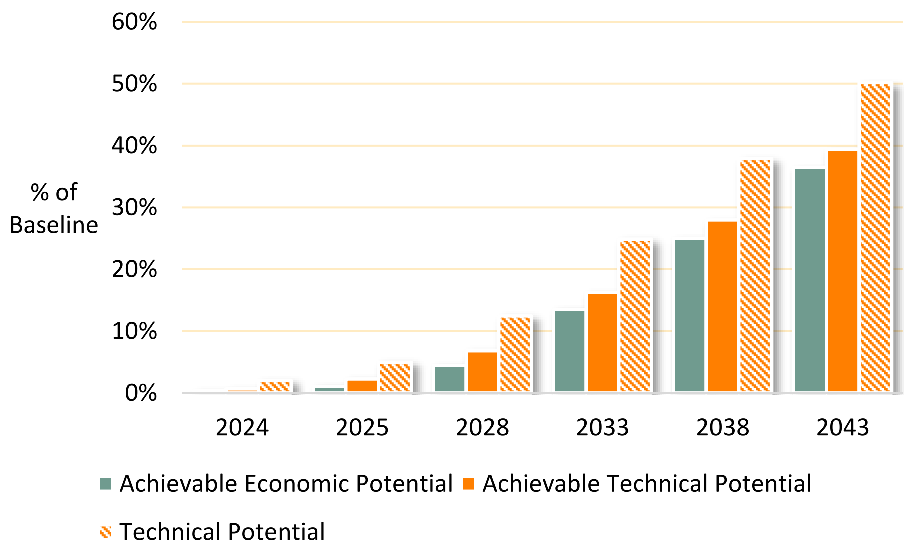


Figure 6-17 shows the supply curve of levelized cost per MWh saved vs. TRC and UCT for the street lighting sector in 2043. Cost-effective potential is mainly attributable to the installation of LED lighting fixtures. Using assumptions provided for labor and O&M of replacing existing high intensity lamps multiple times during the baseline fixture lifetime, LED fixtures become immediately cost-effective before even considering energy savings. These non-energy impacts allow most measures to easily pass and are reflected by the substantial savings that occur with near-zero levelized costs, as shown below.

Figure 6-17 Supply Curve, Street Lighting in 2043 (Annual Energy, MWh)

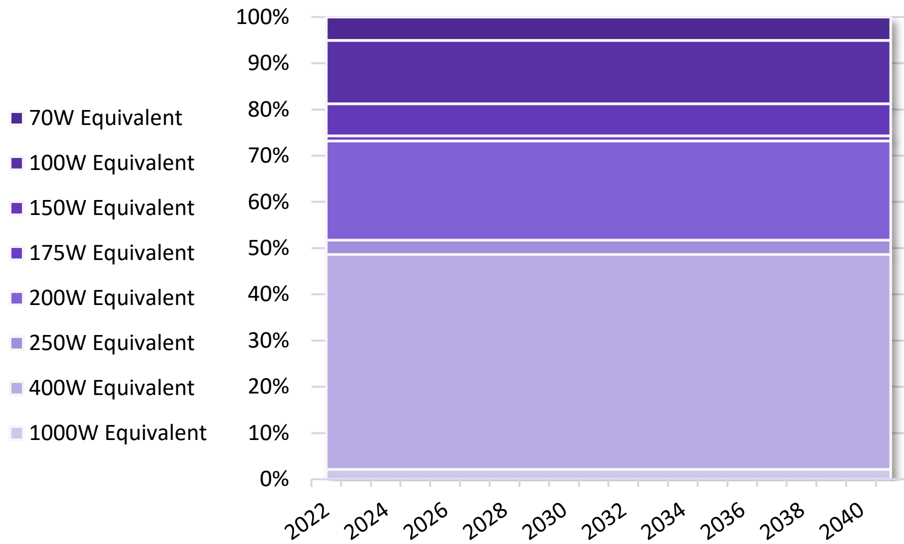
Table 6-32 identifies the top street lighting measures from the perspective of cumulative Achievable Economic potential in 2033. A high operations and maintenance cost savings leads to favorable benefit-to-cost ratios which allows all LED equipment replacement measures to pass the economic screen, along with high-use retrofits.

Table 6-33 Street Lighting Sector Top Measures in 2033

Rank	Measure / Technology	2033 Cumulative Achievable Economic Potential (MWh)	% of Total
1	400W Equivalent	944	48.9%
2	200W Equivalent	392	20.3%
3	100W Equivalent	231	12.0%
4	250W Equivalent	158	8.2%
5	150W Equivalent	130	6.7%
6	70W Equivalent	39	2.0%
7	175W Equivalent	21	1.1%
8	1000W Equivalent	15	0.8%
	Total	**1,931**	**100.0%**
	Total Savings in 2033	**1,931**	**100.0%**

Figure 6-18 presents forecasts of energy savings by street lighting fixture type as a percent of savings and cumulative potential and in absolute terms. The potential is mainly in the 100W, 250W, and 400W equivalent fixture sizes.

Figure 6-18 Street Lighting Achievable Economic Potential – Cumulative Savings by End Use



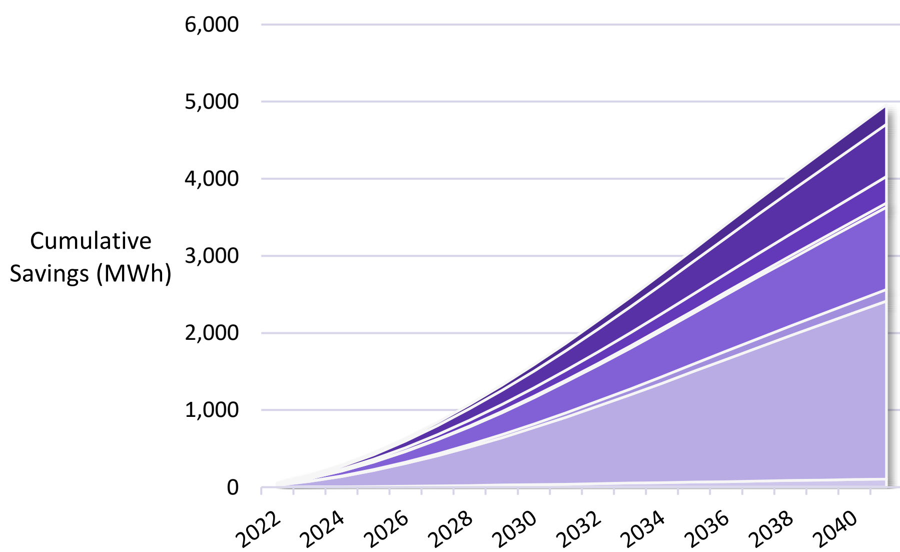


Table 6-33, Table 6-34, and Table 6-35 summarize street lighting sector savings by vintage, replacement type (though note that all cost effective savings are from bulb replacement and are therefore lost opportunity), and fixture wattage, respectively. Street lighting potential by end use is not reported as there is only one end use in this sector. Although the baseline projection is flat, it assumes that a small percentage of fixtures will turn over in any given year. Absent a utility program, the baseline assumes that these fixtures will be replaced with a high-intensity discharge fixture, such as a high-pressure sodium.

Table 6-34 Street Lighting Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
H1 Dusk to Dawn	Existing	16	46	198	614	1,153	1,667
	New	3	9	33	89	153	237
Other H1	Existing	1	4	17	53	99	143
	New	0	1	3	8	13	20
All H2	Existing	27	76	329	1,020	1,913	2,767
	New	5	14	55	148	255	393
Total Street Lighting	**Existing**	**44**	**126**	**544**	**1,687**	**3,165**	**4,577**
	New	**9**	**24**	**91**	**245**	**421**	**650**

Table 6-35 Street Lighting Achievable Economic Potential by Replacement Type, Select Years

Segment	Replacement Type	2024 Achievable Economic Potential (MWh)	2025 Achievable Economic Potential (MWh)	2028 Achievable Economic Potential (MWh)	2033 Achievable Economic Potential (MWh)	2038 Achievable Economic Potential (MWh)	2043 Achievable Economic Potential (MWh)
H1 Dusk to Dawn	Lost Opportunity	19	55	231	703	1,306	1,904
	Retrofit	0	0	0	0	0	0
Other H1	Lost Opportunity	2	5	20	60	112	163
	Retrofit	0	0	0	0	0	0
All H2	Lost Opportunity	32	91	384	1,168	2,168	3,160
	Retrofit	0	0	0	0	0	0
Total Street Lighting	**Lost Opportunity**	**53**	**150**	**635**	**1,931**	**3,586**	**5,227**
	Retrofit	**0**	**0**	**0**	**0**	**0**	**0**

Table 6-36 Street Lighting Achievable Economic Potential by Fixture Wattage, 2033

End Use	H1 Tacoma	H1 Other	H2 All	Total Street Lighting
70W Equivalent	39	0	-	**39**
100W Equivalent	79	20	133	**231**
150W Equivalent	128	2	-	**130**
175W Equivalent	19	1	-	**21**
200W Equivalent	78	9	305	**392**
250W Equivalent	154	4	-	**158**
400W Equivalent	191	24	729	**944**
1000W Equivalent	15	-	-	**15**
Total	**703**	**60**	**1,168**	**1,931**

Due to the large O&M benefits leading to strong cost-effectiveness, all LED street lighting potential is considered low risk.

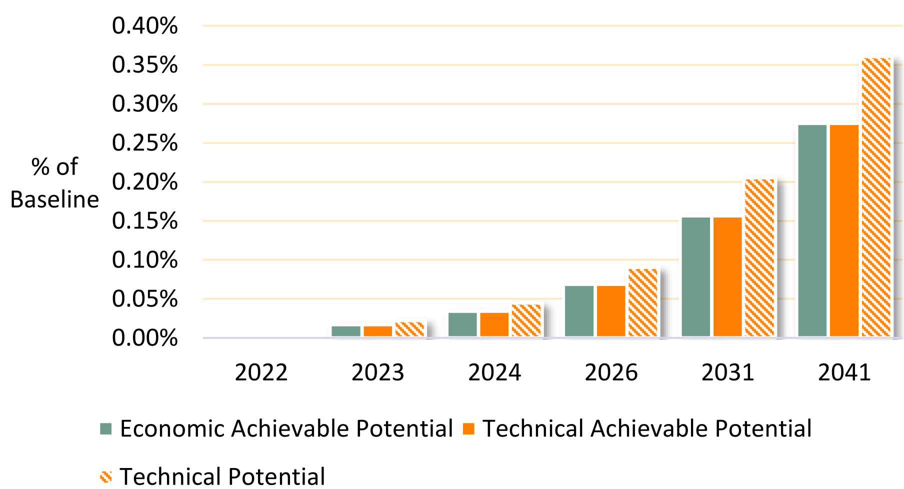
Distribution Efficiency Potential

Table 6-36 and Figure 6-19 present estimates for the three levels of conservation potential for the distribution efficiency analysis. Based on a three-substation study conducted by RW Beck for Tacoma Power, this measure set was found to be highly cost effective. For this reason, all Achievable Technical potential is deemed economic. The baseline displayed in this section refers to the entire territory since substations often impact more than one market sector at a time. Distribution efficiency assumptions were provided by Tacoma Power based on accomplishments in recent years. To date, Tacoma Power has upgraded 14 substations within the territory and expects to complete the remaining 14 at a rate of roughly one per year through 2038. After this point, cumulative potential remains flat.

Table 6-37 Conservation Potential for Distribution Efficiency

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	4,361	4,352	4,328	4,322	4,358	4,419
Cumulative Savings (GWh)						
Achievable Economic Potential	1.33	2.00	4.00	7.34	10.67	10.67
Achievable Technical Potential	1.33	2.00	4.00	7.34	10.67	11.34
Technical Potential	1.81	2.72	5.43	9.96	14.48	14.48
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.03%	0.05%	0.09%	0.17%	0.24%	0.24%
Achievable Technical Potential	0.03%	0.05%	0.09%	0.17%	0.24%	0.26%
Technical Potential	0.04%	0.06%	0.13%	0.23%	0.33%	0.33%

Figure 6-19 Distribution Efficiency Cumulative Energy Efficiency Potential



7

COMPARISON WITH PRIOR STUDY

Compared to the prior CPA, which estimated potential for the 2022-2023 biennium, several key assumptions used have been updated. These include:

- Latest customer database and electric use per customer information from Tacoma Power
- Granular NEEA Commercial Building Stock Assessment (CBSA 2019) lighting data not yet available in the previous CPA process
- Latest RTF workbooks and underlying assumptions (except for residential weatherization where older workbooks still best reflect the conditions of extant housing where Tacoma Power's programs intervene)
- Tacoma Power's Weatherization non-participation study data for remaining market of these measures
- Updated avoided costs from latest Tacoma Power projections and analysis
- Code requirements and other assumptions relating to the 2021 Washington State Energy Code
- Newest NEEA data on heat pump water heaters

The net effect of these changes is 10-year savings potential that is similar in magnitude to the previous CPA, but quite different in composition, both at the sector and end use level.

Table 7-1 Cumulative 10-Year Achievable Economic Potential

Market Sector	Current Study: 2024-2033 Potential (MWh)	*Prior Study: 2022-2031 Potential (MWh)*	Change from Prior Study (MWh)
Residential	95,033	55,756	39,277
JBLM Residential	1,615	1,210	405
Commercial	56,951	94,171	-37,220
JBLM Commercial	10,431	9,474	957
Industrial	55,651	57,062	-1,411
Street Lighting	1,931	1,931	0
Distribution	7,337	6,570	767
Total	**228,949**	**226,174**	**2,775**

Residential Sector Comparison

Table 7-2 compares 10-year potential between the current and prior studies for the residential market sector.

Table 7-2 Comparison of Residential Potential with Prior Study

End Use	Current Study: 2024-2033 Potential (MWh)	*Prior Study: 2022-2031 Potential (MWh)*	Change from Prior Study (MWh)
Cooling	1,014	834	-180
Space Heating	21,581	31,590	10,009
Water Heating	47,989	5,087	-42,902
Interior Lighting	3,660	5,063	1,403
Exterior Lighting	236	202	-34
Appliances	4,512	1,659	-2,853
Electronics	15,840	10,379	-5,461
Miscellaneous	202	943	741
Total	**95,033**	**55,756**	**-39,277**

Commercial Sector Comparison

Table 7-3 compares 10-year potential between the current and prior studies for the commercial market sector.

Table 7-3 Comparison of Commercial Potential with Prior Study

End Use	Current Study: 2024-2033 Potential (MWh)	*Prior Study: 2022-2031 Potential (MWh)*	Change from Prior Study (MWh)
Cooling	8,858	*12,507*	3,649
Space Heating	590	*1,791*	1,202
Ventilation	781	*4,403*	3,621
Water Heating	3,789	*274*	-3,515
Interior Lighting	17,691	*37,340*	19,648
Exterior Lighting	2,726	*18,405*	15,679
Refrigeration	4,548	*10,441*	5,893
Food Preparation	862	*378*	-485
Office Equipment	3,822	*6,493*	2,671
Miscellaneous	469	*2,139*	1,671
Total	**44,136**	***94,171***	**50,035**

A

COMPLIANCE WITH WASHINGTON I-937

This appendix presents information about how the Tacoma Power 2022-2041 conservation potential assessment complies with Washington State Initiative 937.

Background

A primary objective of the study was to inform the development of Tacoma's 2024-2025 biennial conservation target. The performance of this CPA was in accordance with the utility analysis option, using an analytical methodology consistent with Council procedures, and specified in Washington Administrative Code (WAC) 194-37-070, subsection (5).

Adherence to the Council's Analytical Methodology

The CPA completed by AEG for Tacoma Power established a ten-year potential from 2024-2033 using an analytical methodology consistent with the Council procedures outlined in WAC 194-37-070 (5) as filed by Washington Commerce on November 28, 2016.

The Market Assessment group at AEG was selected to complete this project because they are familiar with the Council's analytical methodology and with conservation measures and practices common to the Pacific Northwest.

The utility point of contact for the consulting firm was Rich Arneson, Senior Conservation Planner for Tacoma Power.

The development of the CPA and publication of the final report took place from October 2022 through August 2023. The base year of the study was 2021. The consultant was provided with the following information which was current as of September 2022:

- Utility customer account billing data – annual consumption for each customer by sector and market segment (residential, commercial, industrial, and street lighting), as well as SIC/NAICS (where available) and building type (where available). This database incorporates county assessor data, conservation accomplishment data, and heating fuel type.
- 2016 Residential Building Stock Assessment (RBSA) and 2018 Residential Appliance Saturation Survey (RASS) reports, residential saturation surveys were used again in this study as the 2020 RBSA data was not yet released at the time of development
- Load forecasts of energy and customer growth by rate class
- Facility information by building for the Joint-Base Lewis-McChord military base was retained from previous study
- Economic parameters: hourly avoided cost and price forecast, energy-related capacity costs, wind RECs, carbon dioxide emission costs, discount rate, and line loss factors (hourly for the residential market sector)
- Analysis of time-sensitive value for avoided costs, affecting the value of measures whose impacts on the peak hour are less substantive than at other times.
- Historical data from existing conservation and demand side management programs, including achievements, evaluation results, and program expenditures
- Additional data as necessary, referenced in the main body of this report.

In addition to the data provided by Tacoma Power, AEG also relied heavily on regional data, particularly measure data from the most recent Regional Technical Forum information when available, and the Council's 2021 Power Plan. When a measure was present in both RTF and 2021 Power Plan datasets, we prioritized RTF where it was the more recent source. The notable exception to this was the RTF's most recent Residential Weatherization workbooks, where Tacoma Power's program data is in much greater alignment with older versions of the RTF's input data. Other sources, such as NEEA, BPA, U.S. DOE, and AEG's internally developed tools and databases, were also utilized, as described in Section 2 of this report.

AEG's modeling approach for the 2024-2043 CPA analysis uses an end-use based, bottom-up analysis that considers individual equipment technologies to create a baseline energy forecast. The forecast is then modified interactively on a measure-by-measure basis to produce integrated forecasts of technical, achievable technical, and achievable economic potential.

The CPA was conducted with AEG's Microsoft Excel-based Load Management Analysis and Planning (LoadMAP) tool,[19] , the current version of which was specifically developed to handle data reporting requirements in the State of Washington and throughout the Northwest. In this version of the model, measure savings, cost-effectiveness, and levelized costs are calculated in straightforward and transparent spreadsheets then directly output into a comprehensive line-by-line measure summary spreadsheet formatted for use in both program and resource planning. At the same time, the rigorous stock-accounting is used to develop the baseline projection and to calculate turnover for lost-opportunity measures.

Quality Control Reviews

Before submitting inputs and information to AEG, Rich Arneson and Conservation Resource Management staff reviewed the data for reasonableness. Specifically, he reviewed the input data for each sector, proposed revisions, and collaborated with consultant staff on final solutions. Through regular project meetings and careful review of interim deliverables and multiple drafts of the results and final report, Tacoma Power gained an understanding and satisfactory level of comfort with the approach and modeling software utilized by the consultant.

The final results and values were approved by Rich Arneson.

Tacoma Power staff use the 10-year achievable economic potential results, along with input from the Tacoma Power Integrated Resource Planning process to develop a biennium target for the 2024-2025 period.

Adherence to Procedures in WAC 194-37-070 subsection (5):

Below we describe how AEG satisfied or addressed each methodology used by the Council in its most recently published regional power plan when creating the 2024-2025 conservation target. All four procedures in WAC 194-37-070 (5) (a-d) were followed.

(iv) Technical Potential

Determine the amount of conservation that is technically feasible, considering measures and the number of these measures that could physically be installed or implemented, without regard to achievability or cost.

The 2024-2043 CPA assessed technical potential prior to performing any cost-effectiveness screening. Achievability factors were not applied to potential at this point, allowing for 100% of all measures which could be physically installed or implemented to be counted. Results of this analysis may be found on the "Measure Summary" tab of the "LoadMAP Potential" files.

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[19] AEG originally developed LoadMAP in 2007 and has since used it for dozens of utility-specific forecasting and potential studies across the U.S. Built in Excel, the LoadMAP framework is both accessible and transparent. LoadMAP develops a bottom-up forecast based on energy use by end use of major energy-consuming equipment. It includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life defined by the user. More detail is provided in Section 2 of this report.

(b) Achievable Technical Potential

Determine the amount of the conservation technical potential that is available within the planning period, considering barriers to market penetration and the rate at which savings could be acquired.

The 2024-2043 CPA applied the 2021 Power Plan's Ramp Rates to the technical potential, assessing achievable conservation potential prior to the application of cost-effectiveness screening. Ramp rates assigned to each measure as well as results of this analysis may be found on the "Measure Summary" tab of the "LoadMAP Potential" files.

© Achievable Economic Potential

***Establish the Achievable Economic 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. A utility may use either of the following approaches to identify Achievable Economic Potential:*

(iv) AEG utilized approach (ii) as described below for the Tacoma Power 2024-2043 CP***i) Integrated portfolio approach.*** *A utility may analyze, as a part of its integrated resource plan, the cost-effective potential of conservation resources over a range of potential future outcomes for unknown variables, such as future demand, costs, and resource availability. Achievable Economic Potential will be based on resource plan that achieves a long-run least-cost and least-risk electric power system considering all power system costs and quantifiable nonenergy costs and benefits.*

Not applicable, AEG used approach (ii) below.

(ii) Benefit-cost ratio approach. *A utility may establish Achievable Economic Potential as those conservation measures or programs that pass a total resource cost test, in which the ratio of total benefits to total costs is one or greater. The benefit-cost calculation must use inputs that incorporate the cost of risks that would otherwise be reflected in an integrated portfolio approach.*

AEG utilized the "Benefit-cost ratio approach" in assessing Achievable Economic Potential in the 2024-2043 CPA. We worked with Tacoma staff to develop comprehensive, hourly avoided cost inputs, incorporating the total resource cost (TRC) test guidance in subsection (5) below.

(d) Total Resource Cost

***In determining Achievable Economic Potential** as provided ©(c) of this subsection, perform a life-cycle cost analysis of measures or programs to determine the net levelized cost, as described in this subsection:*

LoadMAP performs this life-cycle cost analysis. Calculations and formulas can be found on the "Economics" tab of the "LoadMAP Baseline" files and "Unstacked NEM Potential" tab of the "LoadMAP Potential" files.

***(ii) Include the incremental savings and incremental costs** of measures and replacement measures where resources or measures have different measure lifetimes;*

The LoadMAP model automatically accounts for savings throughout the lifetime of the selected efficient option. Additionally, LoadMAP monetizes the cost of additional replacements due to measures with varying lifetimes as a cost or benefit in the TRC calculation, depending on whether the baseline or efficient measure has a longer lifetime. This affects measures such as General Service Screw-In Lighting where a halogen or CFL would have to be replaced at some point throughout an LED lamp's lifetime.

***(iii) Calculate the value of the energy saved** based on when it is saved. In performing this calculation, use time differentiated avoided costs to conduct the analysis that determines the financial value of energy saved through conservation;*

AEG applied end use load shapes to the energy savings for each measure considered with the 2024-2043 CPA. These shapes were derived from the RTF's Generalized Load Shape (GLS) database and Tacoma Power billing data where appropriate. These load shapes were also applied to Tacoma's hourly price forecast, to account for the cost of energy, by end use, in each hour of the forecast horizon. Base-year load shapes were adjusted for each future year (2024 through 2043) to ensure like day-types between years (e.g. weekend and holidays are properly reflected within each year). The load shape used for each measure may be found on the "Measure Summary" tab of the "LoadMAP Potential" files.

(iv) Include the increase or decrease in annual or periodic operations and maintenance *costs due to conservation measures;*

Where these costs have been quantified by the RTF or included in the 2021 Plan Plan measure workbooks, they have been included in the analysis. Measure cost inputs are found on the "Measure Summary" tab of the "LoadMAP Potential" files.

(v) Include avoided energy costs equal to a forecast of regional market prices, *which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy efficiency measures to which it is compared;*

Tacoma provided AEG with avoided costs to use for the analysis.[20] These costs are based on the cost of the Block product under Tacoma Power's purchase power contract with the Bonneville Power Administration (BPA). Since Tacoma buys and sells energy on the market, costs were shaped at the hourly level to reflect additional market purchases and sales when prices are high and less value when prices are low. This was done by applying a fixed adder ($/MWh) to Tacoma Power's hourly market price forecast until the average hourly price equaled the cost of the BPA Block. This methodology was used as long as Tacoma Power's Net Requirement (NR) was below their High-Water Mark (HWM). In these cases, the raw Mic-C hourly price forecast was used as a basis of the conservation avoided cost. The data are in the "Avoided Costs" tab of each "LoadMAP" file. Newly in this study, the possible contract implications of conservation that does not impact the coincident peak load as strongly are incorporated in the value of a given measure – that is, if a conservation measure on an annual basis lowers the BPA contracted MWh amount but does *not* mitigate the peak load, it can potentially have a negative value for those hours.

(vi) Include deferred capacity expansion benefits *for transmission and distribution systems;*

Tacoma Power reviewed the basis of utility-specific T&D upgrades and determined that work was needed to address failing and old equipment rather than increasing capacity. Therefore, we determined that conservation would not result in a transmission or distribution system deferral. These costs are included in the avoided costs Tacoma Power provided for the analysis, available in the "Avoided Costs" tab of each "LoadMAP" file

(vii) Include deferred generation benefits *consistent with the contribution to system peak capacity of the conservation measure;*

Tacoma Power reviewed the basis of utility specific generation capacity benefits resulting from energy conservation and determined that the existing machine capacity of the utility's resource portfolio well exceeds peak retail demand. Therefore, as a placeholder for this study, Tacoma Power developed this cost based on analysis of a small, short-term capacity contract it has with a neighboring utility. These costs are included in the avoided costs Tacoma provided for the analysis, available in the "Avoided Costs" tab of each "LoadMAP" file. Tacoma Power plans to continue to investigate market values of generation capacity for use in future CPAs.

(viii) Include the social cost of carbon emissions *from avoided non-conservation resources;*

Tacoma Power provided results from applying the United States Government Inter-Agency Working Group on Social Cost of Carbon, cost assumptions at the 3% discount rate to the Tacoma Power resource portfolio as documented by the California Air Resource Board. These were used in the LoadMAP analysis and can be found on the "Avoided Cost" tab of the "LoadMAP Potential" files. These costs are externalized values.

[20] A detailed description of the process used by Tacoma Power to define hourly avoided energy costs may be found in Tacoma's "2016 Conservation Avoided Cost Write-Up" document.

***(ix) Include a risk mitigation credit** to reflect the additional value of conservation, not otherwise accounted for in other inputs, in reducing risk associated with costs of avoided non-conservation resources;*

The value of conservation includes the risk mitigation noted in v, vi, vii, viii and x. We found no other risk mitigation credits to account for at the time of the study.

***(x) Include all non-energy impacts** that a resource or measure may provide that can be quantified and monetized;*

Where these costs have been quantified by the RTF or 2021 Power Plan in measure workbooks, they have been included in the analysis. Measure cost inputs are found on the "Measure Summary" tab of the "LoadMAP Potential" files.

(xi) Include an estimate of program administrative costs;

Tacoma provided administrative costs estimates for each program offered. These were used in the LoadMAP analysis and can be found on the "Measure Summary" tab of the "LoadMAP Potential" files.

***(xii) Include the cost of financing measures** using the capital costs of the entity that is expected to pay for the measure;*

At the time of this study, the Tacoma Power financing cost of capital used throughout the organization is 3% real.

***(xiii) Discount future costs and benefits** at a discount rate equal to the discount rate used by the utility in evaluating non-conservation resources; and*

Tacoma uses a real discount rate when evaluating all resources which equals our capital financing costs. At this time that rate equals 3%. This value is incorporated in the LoadMAP analysis. This input is entered on the Variables tab of the LoadMAP files.

***(xiv) Include a ten percent bonus for the energy and capacity benefits** of conservation measures as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act.*

Tacoma Power applied the ten percent bonus to the value of energy related avoided costs (v, vi and vii above). The bonus was applied to avoided costs Tacoma provided to be used in the analysis. The specific values are available in the "Avoided Costs" tab of each "LoadMAP" file.

B

MARKET PROFILES

As described in Chapter 1 of this study, market profiles describe electricity use by sector, segment, end use and technology in the base year of the study (2021). The market profiles are given for average, existing buildings.

Chapter 2 includes market profiles for sectors as a whole, and this workbook contains segment-level detail within each sector. This appendix presents the following market profiles:

- Residential market profiles by segment (Table C-1 through C-5)
- JBLM Residential market profiles by segment (Table C-6 and C-7)
- Commercial market profiles by building type (Table C-8 through C-22)
- JBLM Commercial market profiles (Table C-23 through C-35)
- Street Lighting market profiles (Table C-36 through C-38)

Industrial market profiles by segment have not been included in this report. Segment-level detail was included in the analysis of the industrial sector but excluded from the report to prevent disclosure of data that may be sensitive for some of Tacoma Power's larger customers.

Tacoma Power 2022
Market Profiles.xlsx

C

CUSTOMER ADOPTION FACTORS

As described in Chapter 2, to estimate the rate at which measures are phased into the study given market barriers such as customer preference, imperfect information, and commercial availability of technologies; we apply a set of customer adoption factors. These are also referred to as ramp rates or take rates. The values are the factors applied to the technical potential for a given measure in a given year to arrive at the Achievable Technical potential. These factors may be found in Table C-1 below.

Measures are divided into two categories, each of which has its own timing and achievability considerations:

- **Lost Opportunity** potential occurs at the time of equipment burnout. When equipment is replaced, a unique opportunity exists to upgrade efficiency at incremental (above standard equipment), rather than full cost. If standard equipment is installed, the high-efficiency equipment would not be installed until the new equipment reaches the end of its normal life cycle, without early replacement (usually requiring a significantly higher incremental cost). The same applies for opportunities at the time of new construction. These "LO" ramp rate factors increase over time to 100% and apply only to the subset of units which turn over in any given year.
- **Retrofit** potential is not subject to such stringent timing constraints and can, theoretically, be acquired at any point in the planning period assuming customer willingness and necessary delivery infrastructure. Since these ramp rates apply to all units in the market, "Retro" ramp rates instead sum to 100% and are intended to phase in potential throughout the study period. The faster ramp rates (e.g. summing up to 100% sooner) will phase potential in over a shorter timeframe.

Table 7-4 Ramp Rates used in CPA Analysis (2021 Power Plan)

Ramp Rate	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	3036	3037	2038	2041	2042	2043
Retro12Med	10.9%	10.9%	10.9%	10.9%	10.9%	9.8%	7.9%	6.3%	5.0%	4.0%	3.2%	2.6%	2.1%	1.7%	1.3%	1.1%	0.0%	0.0%
Retro5Med	4.3%	5.3%	6.5%	7.5%	8.6%	10.0%	11.0%	11.2%	10.6%	9.1%	7.0%	4.7%	2.7%	1.3%	0.6%	0.2%	0.1%	0.0%
Retro1Slow	0.3%	0.5%	0.9%	1.5%	2.2%	3.2%	4.4%	5.7%	7.0%	8.3%	9.3%	9.9%	9.9%	9.4%	8.2%	6.8%	5.2%	3.6%
Retro50Fast	45.0%	21.0%	14.0%	9.0%	6.0%	3.0%	1.3%	0.5%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retro20Fast	22.1%	15.5%	10.7%	8.4%	7.3%	6.3%	5.4%	4.6%	3.9%	3.3%	2.7%	2.1%	1.7%	1.3%	1.0%	0.9%	0.7%	0.6%
RetroEven20	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Retro3Slow	0.6%	0.9%	1.7%	3.0%	4.7%	6.6%	8.4%	9.8%	10.6%	10.6%	9.9%	8.7%	7.1%	5.5%	4.1%	2.9%	1.9%	1.2%
LO12Med	10.9%	21.9%	32.8%	43.7%	54.7%	64.5%	72.4%	78.7%	83.7%	87.8%	91.0%	93.6%	95.6%	97.3%	98.6%	99.7%	99.7%	99.7%
LO5Med	4.3%	9.6%	16.0%	23.5%	32.1%	42.1%	53.1%	64.3%	74.8%	83.9%	90.9%	95.8%	98.7%	100.0%	100.0%	100.0%	100.0%	100.0%
LO1Slow	0.5%	0.8%	1.7%	3.2%	5.4%	8.6%	13.0%	18.7%	25.7%	34.0%	43.3%	53.1%	63.1%	72.4%	80.6%	87.3%	92.3%	96.0%
LO50Fast	45.0%	66.0%	80.0%	89.0%	95.0%	97.9%	99.3%	99.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
LO20Fast	22.1%	37.6%	48.4%	56.7%	64.0%	70.4%	75.8%	80.4%	84.3%	87.6%	90.3%	92.4%	94.1%	95.4%	96.4%	97.1%	97.7%	98.4%
LOEven20	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	35.0%	40.0%	45.0%	50.0%	55.0%	60.0%	65.0%	70.0%	75.0%	80.0%	85.0%	90.0%
LO3Slow	0.6%	1.4%	3.2%	6.2%	10.9%	17.6%	26.0%	35.8%	46.4%	57.0%	66.9%	75.6%	82.7%	88.3%	92.3%	95.2%	97.1%	98.3%
LO80Fast	76.0%	83.0%	88.0%	92.0%	95.0%	97.0%	98.0%	99.0%	99.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

D

MEASURE LIST

Here we summarize the list of measures evaluated in the 2024-2043 CPA. The data are presented in eight tables, separated by sector and modeling type (equipment or non-equipment).[21]

Tacoma Power 2023
Measure List - Clean

[21] See Chapter 2 for an explanation of equipment vs non-equipment measures in the LoadMAP framework

E

SPECIAL CONSIDERATION: LARGE CUSTOMER CLOSURE

After completing the CPA analysis and the report nearly finished, Tacoma Power received word that one of their largest industrial accounts would be closing and core sections of the plant dismantled. The closure materially impacts the overall conservation potential. As the study was already completed, the reporting throughout this document, including the charts and figures in this section, include this customer.

To account for the closure, the following deducts should be applied to each of the years identified in Table 6-26 in the Summary of Conservation Potential. Technical Potential, Achievable Technical Potential, and Achievable Economic Potential all receive the same deduction, as the savings potential for this customer was estimated in a separate customized analysis identical to that performed in the prior CPA, and for which all reasonable and applicable savings measures were found to be cost effective.

Below are select set of tables from the report which identify the impact of the plant closure on the baseline projections and the Conservation potential.

Deducts to Baseline and Savings Projections

The plant that closure was approximately 32% of 2024 industrial sector baseline projection. Industrial baseline projection in the report can reasonably be reduced by that same proportion.

Table E-1

Deductions (GWh)	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	361	362	365	372	379	387
Cumulative Savings (GWh)	2	3	10	21	26	30

Industrial Baseline and Potential with estimated impact of closure

(replaces Table 6-26)

Summary of Energy Savings (GWh), Selected Years	2024	2025	2028	2033	2038	2043
Baseline Forecast (GWh)	767	769	777	790	805	823
Cumulative Savings (GWh)						
Achievable Economic Potential	2	5	15	35	46	50
Achievable Technical Potential	4	9	27	61	77	84
Technical Potential	6	12	35	77	98	104
Energy Savings (% of Baseline)						
Achievable Economic Potential	0.25%	0.60%	1.88%	4.42%	5.67%	6.09%
Achievable Technical Potential	0.51%	1.12%	3.43%	7.71%	9.52%	10.22%
Technical Potential	0.77%	1.51%	4.46%	9.73%	12.13%	12.65%

Overall Potential with Estimated Impact of Closure

Replaces Table 5-3

Sector	2024	2025	2028	2033	2038	2043
Residential	14.1	13.5	23.3	95	180.8	239.5
Commercial	4.1	8.7	25.5	57	85.1	104.3
Industrial	2.1	4.7	14.7	35.5	46.5	51.6
JBLM Residential	0	0.1	0.4	1.6	3	3.7
JBLM Commercial	0.8	1.6	4.7	10.4	15.7	19.4
Street Lighting	0.1	0.2	0.6	1.9	3.6	5.2
Distribution Efficiency	1.3	2	4	7.3	10.7	10.7
Total	**24.7**	**34.2**	**83.7**	**229.9**	**371.6**	**464.4**

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