TACOMA POWER CONSERVATION POTENTIAL ASSESSMENT, 2018-2037

November 10, 2017

Report prepared for:
TACOMA POWER

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EXECUTIVE SUMMARY

In mid-2016, Tacoma Power (Tacoma) contracted with Applied Energy Group (AEG) to conduct this Conservation Potential Assessment (CPA) in support of its conservation and resource planning activities. This report documents this effort and provides estimates of the potential reductions in annual energy usage for electricity customers in the Tacoma Power service territory from energy conservation efforts in the time period of 2018 to 2037.

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

- Used information and data from Tacoma, 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.
- Estimated the technical, achievable technical, and achievable economic potential at the measure level for energy efficiency within the Tacoma service territory over the 2018 to 2037 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 2018-2019 Biennium savings 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 results of this study at a high level. AEG analyzed potential for the residential, commercial, industrial, street lighting, and JBLM market sectors as well as for substation distribution efficiency improvements. The ten-year potential, in 2027, is 277,564 MWh, or 31.7 aMW.

Table ES-1 Achievable Economic Potential in 2027

Market Sector	Achievable Economic Potential (MWh)	% of Total Potential	Average Megawatts, aMW
Residential	99,164	35.7%	11.3
JBLM Residential	1,477	0.5%	0.2
Commercial	87,880	31.7%	10.0
JBLM Commercial	7,068	2.5%	0.8
Industrial	57,569	20.7%	6.6
Street Lighting	8,582	3.1%	1.0
Distribution	15,822	5.7%	1.8
Total	**277,564**	**100.0%**	**31.7**

Key opportunities for savings include the continuation of LED lighting programs, implementation of strategic energy management initiatives in the large commercial sectors, efficient HVAC technologies, compressed air system upgrades, and LED street lighting retrofits.

Comparison with Prior Study

Compared to the prior CPA, which estimated potential for the 2016-2017 biennium, several key assumptions and methodologies used in the region have been updated. These include:

- Referencing the Council's Seventh Power Plan instead of the Sixth Power Plan, which includes new measures, major revisions to previous measures, and substantial modifications to ramp rates
- Updates to Regional Technical Forum (RTF) unit energy savings (UES) measures and standard protocols – two additional years of analysis
- Updates to Tacoma Power programs – most recent results from Tacoma's implementation database
- Updates to the avoided cost of energy – migration to a shaped BPA block pricing from Tacoma's forecasted wholesale price

Compared to the previous study, TRC achievable economic potential has decreased by about one-third. Differences in potential affect primarily the residential and commercial sectors and are mainly due to:

- Increased saturation of efficient technologies in the baseline. For example, the baseline saturation of linear LEDs in the Seventh Plan approaches nearly 20% by 2018, whereas these fixtures were not yet commercially viable during development of the Sixth Plan so none were considered in the baseline for the previous study.
- Updating ramp rates to the Seventh Plan reduced achievable potential in the early years.
- In the residential sector, additional CFLs and LEDs in the baseline, as well as the second phase of the EISA 2007 general service lighting standard in 2020 substantially lowers potential.

Table ES-2 compares 10-year potential between the two studies at a sector level. Although the residential and commercial sector results declined between the two studies as noted above, savings potential for the JBLM residential, industrial, and street lighting market sectors is very similar to that of the previous CPA.

Table ES-2 Achievable Economic Potential in 2027

Market Sector	Current Study: 2018-2027 Potential (MWh)	*Prior Study: 2016-2025 Potential (MWh)*	Change from Prior Study (MWh)
Residential	99,164	160,903	-61,738
JBLM Residential	1,477	1,495	-18
Commercial	87,880	144,579	-56,698
JBLM Commercial	7,068	14,164	-7,096
Industrial	57,569	60,183	-2,613
Street Lighting	8,582	6,792	1,790
Total	**261,742**	**388,116**	**-126,374**

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1

INTRODUCTION

This report documents the results of the Tacoma Power 2018-2037 Conservation Potential Assessment (CPA) as well as the steps followed in its completion. Throughout this study, AEG worked with Tacoma Power to understand the baseline characteristics of their service territory, including a detailed understanding of energy consumption in the territory, 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) Seventh Power Plan[1], AEG then developed an independent estimate of achievable, economic conservation potential within Tacoma Power's service territory between 2018 and 2037.

Goals of the 2018-2037 CPA

The primary objective of this CPA was to assist in developing Tacoma Power's 2018-2019 Biennium conservation target under the State of Washington's Energy Independence Act[2], 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 later in this document.

Additionally, this study was developed to provide conservation inputs into Tacoma Power's Integrated Resource Planning (IRP) process. To this end, AEG developed hourly achievable economic conservation inputs by program for input into Tacoma Power's PLEXOS-based model. AEG also identified impacts not captured in Tacoma Power's official econometric forecast, including the effects of known future federal standards and variation in customer growth rates by housing type. These impacts were also 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.

Finally, the CPA is intended to support the design of programs to be implemented by Tacoma Power during the following two years. Using regional sources, and well-vetted nationwide data when appropriate, AEG developed a comprehensive summary of measures. This summary documents input assumptions and sources on a per-unit value, program 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

Between 2014 and 2015, AEG successfully completed Tacoma Power's 2016-2035 Conservation Potential Assessment, following the methodology of the Council's then-current Sixth Power Plan. In the two years since, the Council has published their Seventh Power Plan, which includes updated measure assumptions, new measures, and a new suite of achievability Ramp Rates. Between studies, NEEA also finalized the 2014 Commercial Building Stock Assessment (CBSA), which AEG incorporated into the current CPA.

In addition to updates in Council methodology, AEG updated the base-year of the potential study from 2013 to 2015 and incorporated two additional years of conservation accomplishments into the baseline.

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

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

Tacoma Power also provided an updated load forecasts, new avoided costs, and updated measure data (such as weatherization assumptions and commercial SEM eligible accounts). AEG then developed modeling assumptions independent of the prior study to estimate potential between 2018 and 2037 using the most up-to-date data available.

Report Contents

This report is divided into six chapters and four appendices, summarizing the approach, assumptions, and results of Tacoma Power's 2018-2037 CPA. We describe each section below:

- Analysis Approach and Data Development. Detailed description of AEG's approach to conducting Tacoma Power's 2018-2037 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, 2015, including 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, street lighting, and JBLM 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.
- Overall Conservation Potential. Summary of conservation potential for Tacoma Power's entire service territory for selected years between 2018 and 2037. Includes territory-wide supply curves and potential estimates for each sector and distribution efficiency.
- 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, end use, and risk. Supply curves by market sector are also provided.
- Comparison with Prior Study. Detailed comparison of changes between prior CPA and current study.

Appendices:

- Consistency with Seventh Plan Methodology. Documentation of how AEG's approach in conducting the 2018-2037 CPA aligns with the Seventh 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. A majority were applied directly from the Seventh Plan conservation workbooks. In addition, AEG developed custom behavioral and street lighting ramp rates to reflect Tacoma Power's current implementation plans for these measures.
- 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 several abbreviations and acronyms. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
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 (NWPCC)
CFL	Compact Fluorescent Lamp
DHW	Domestic Hot Water
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Energy Information Administration
EUL	Estimated Useful Life
EUI	Energy Usage 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
WH	Water Heater

2

ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the analysis approach taken for the study 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 year, 2015. This included using Tacoma data and other secondary data sources such as the Energy Information Administration (EIA).
2. Developed a baseline projection of energy consumption by sector, segment, end use, and technology for 2016 through 2037.
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 energy savings at the measure level for 2018-2037.

LoadMAP Model

For this analysis, AEG used its Load Management Analysis and Planning tool (LoadMAP™) version 5.0 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 EPRI National Potential Study and numerous utility-specific forecasting and potential studies since. Built in Excel, the LoadMAP framework (see

Figure 2-1) is both accessible and transparent and has the following key features.

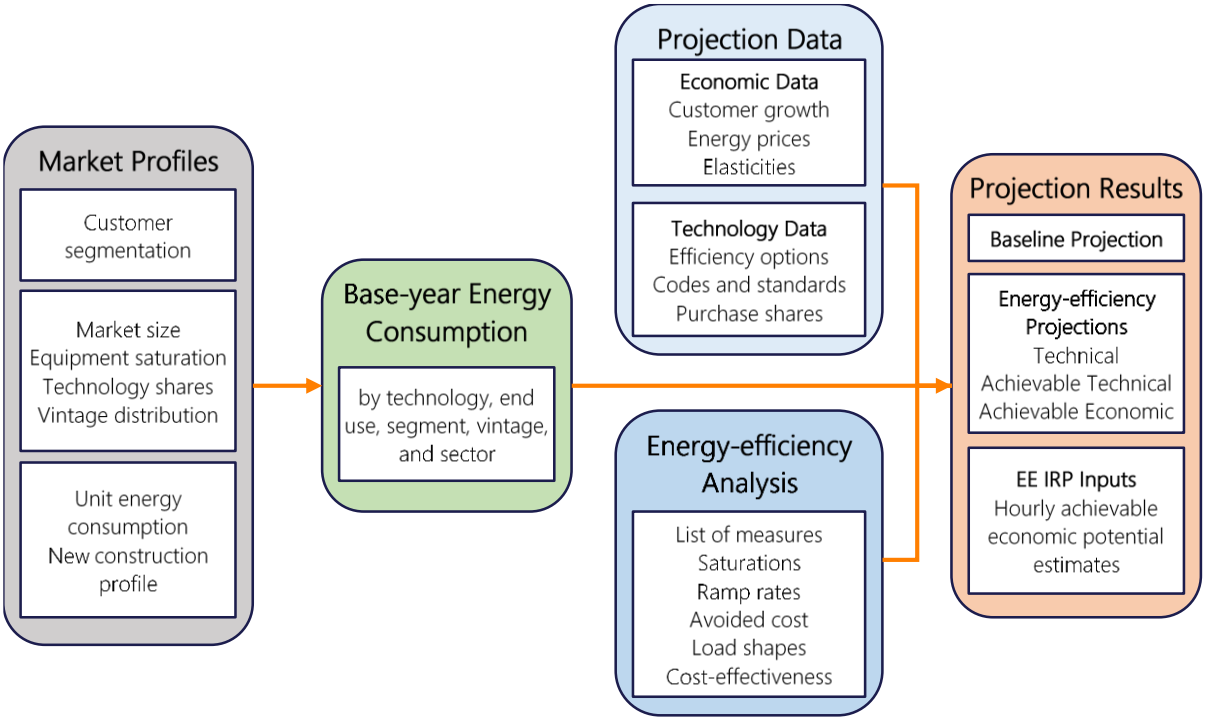
- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced 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.

- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- 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. [3]

Figure 2-1 LoadMAP Analysis Framework



Definitions of Potential

Before we delve into the details of the analysis approach, it is important to define what we mean when discussing conservation potential. In this study, the savings estimates are developed for three types of potential: technical potential, achievable technical potential, and achievable economic potential. These are developed at the measure level, and results are provided as hourly savings impacts over the 20-year forecasting horizon. The various levels are described below.

[3] The model computes energy and peak-demand forecasts for each type of potential for each end use as an intermediate calculation. Annual-energy and peak-demand savings are calculated as the difference between the value in the baseline projection and the value in the potential forecast (e.g., the technical potential forecast).

- Technical Potential is defined as the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option.

  Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning. These retrofit measures are phased in over a number of years to align with the stock turnover of related equipment units, rather than modeled as immediately available all at once.

- 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. The customer adoption rates used in this study were the ramp rates developed for the Northwest Power & Conservation Council's Seventh Plan.

- Achievable Economic Potential further refines achievable technical potential by applying an economic 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 costs of delivering the measure through a utility program, including monetized non-energy impacts. These costs are the incremental cost of the given efficiency measure relative to the relevant baseline course of action, plus any administrative costs that are incurred by the program to deliver and implement the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is included in the economic potential.

Market Characterization

Now that we have described the modeling tool and provided the definitions of the potential cases, the first step in the actual analysis approach is market characterization. In order to estimate the savings potential from energy-efficient measures, it is necessary to understand how much energy is used today and what equipment is currently in service. This characterization begins with a segmentation of Tacoma's electricity footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies used. For this we rely primarily on information from Tacoma, 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 2-1.

Table 2-1 Overview of Tacoma Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
1	Sector	Residential, commercial, industrial, JBLM residential, JBLM commercial, street lighting
2	Segment	Residential: single family, single family 2-4 units, low-rise multifamily, high-rise multifamily, and mobile homes 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
3	Vintage	Existing and new construction
4	End uses	Cooling, lighting, water heating, motors, etc. (as appropriate by sector)
5	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
6	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, 2015. We used detailed Tacoma 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 the Tacoma system totals from 2015 billing data. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A 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 2015. 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.

The market characterization results and the market profiles are presented in Chapter 3 and Appendix B.

Baseline Projection

The next step was to develop the baseline projection of annual electricity use for 2016 through 2037 by customer segment and end use without new utility conservation programs.

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, changes in retail rates, and unemployment projections. These assumptions, along with econometric coefficients, were incorporated into the LoadMAP model, ensuring alignment with the official load forecast. When aligning with the official forecast, AEG excluded the impacts of future federal standards as well as differing customer growth rates between market segments. AEG also backed future conservation impacts out of the official forecast using data provided by Tacoma Power.

We then updated the end-use projection for use in the CPA. With guidance from Tacoma Power, we included additional impacts that were not captured by the official econometric model. This includes the impacts of future federal standards, which drive energy consumption down through the study period. Of particular interest is the second phase of the EISA 2007 general service lighting standard which will be going into effect in 2020. Additionally, per discussions with Tacoma Power, we varied the customer growth rate in the residential market sector. Based on recent large construction projects in the territory, a large majority of new construction is estimated to occur in the multifamily market segments. To account for this, AEG varied growth rates by segment, allocating 90% of customer growth to the multifamily segments, 9% to the single-family segments, and 1% to manufactured homes. Since multifamily dwellings tend to consume less energy, this had the effect of lowering the baseline projection.

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 December 2016 are included in the baseline. This includes the impacts of 2015 Washington State Energy Code (WSEC). The baseline projection does not include any naturally occurring conservation that might take place in the potential forecast period (2018 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 which includes 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

We present the baseline-projection results for the system as a whole and for each sector in Chapter 3.

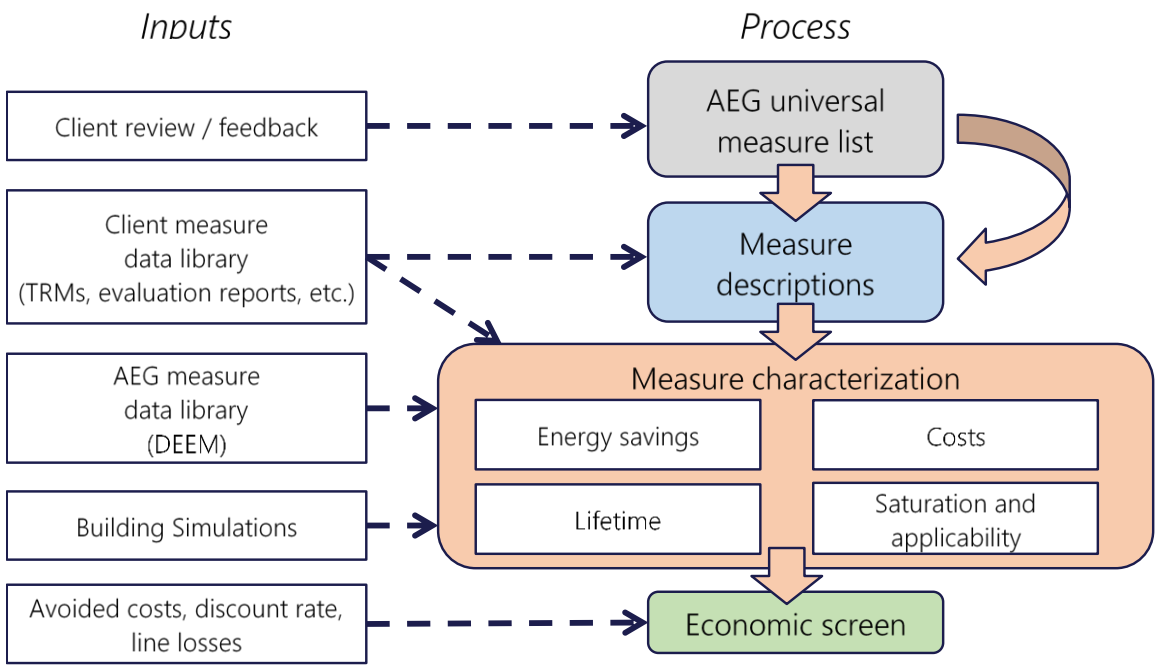
Energy Conservation Measure Development

This section describes the framework used to assess the savings, costs, and other attributes of energy conservation measures (ECM). These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, AEG assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information along with Tacoma's avoided cost data in the economic screen to determine economically feasible measures.

Figure 2-2 outlines the framework for 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 lined up with programmatic experience.

We compiled a robust list of ECMs for each customer sector, drawing upon Tacoma program experience, AEG's own measure databases and building simulation models, and secondary sources, primarily Regional Technical Forum (RTF) measure spreadsheets. This universal list of measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially, 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 are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency 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 central air conditioners, this list begins with the current federal standard SEER 13 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 (LO) 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 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 end of 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, 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 (building orientation, passive solar lighting)
  - Displacement measures (ceiling fan to reduce use of central air conditioners)
  - Retro-commissioning
  - Residential behavioral programs
  - Energy Management programs

We developed a preliminary list of efficient measures, which was distributed to the Tacoma project team for review. The list was finalized after incorporating comments and is presented in the final appendix to this volume with measure-level detail.

Once we assembled the list of measures, the project team assessed their energy-saving characteristics. For each measure, we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential.

Representative Measure Data Inputs

To provide an example of the energy-efficiency measure data, Table 2-2 and Table 2-3 present examples of the detailed data inputs behind both equipment and non-equipment measures, respectively, for the case of residential Central Air Conditioning (CAC) in single-family homes. Table 2-2 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market.

Table 2-2 Example Equipment Measures for Central AC – Single-Family Home

Efficiency Level	Useful Life	Equipment Cost	Energy Usage (kWh/yr)	On Market	Off Market
SEER 13	15	$2,031	543	2015	n/a
SEER 14 (Energy Star)	15	$2,426	498	2015	n/a
SEER 15 (CEE Tier 2)	15	$2,820	476	2015	n/a
SEER 16 (CEE Tier 3)	15	$3,215	457	2015	n/a
SEER 18	15	$4,008	428	2015	n/a
SEER 21	15	$4,682	396	2015	n/a

Table 2-3 lists some of the non-equipment measures applicable to zonal electric resistance heating in an existing single-family home. All measures are evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings, costs, and monetized non-energy impacts are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[4] of the measure, and the savings as a percentage of the relevant energy end uses.

Table 2-3 Example Non-Equipment Measures – Single Family Home, Existing

End Use	Measure	Saturation in 2016[5]	Applicability	Lifetime (yrs.)	Measure Installed Cost	Energy Savings (%)
Heating	Insulation - Ceiling Installation	16%	19%	45	$1,255	22%
Heating	Ductless Mini Split Heat Pump (Zonal)	5%	60.8%	15	$3,439	21%
Heating	Windows - High Efficiency (SP to CI30)	15%	21%	45	$2,531	18%
Heating	Windows - High Efficiency (SP to CI22)	2%	3%	45	$2,998	20%

[4] The applicability factors take into account whether the measure is applicable to a particular building type and whether it is feasible to install the measure. For instance, attic fans are not applicable to homes where there is insufficient space in the attic or there is no attic at all.

[5] Note that saturation levels reflected for the base year change over time as more measures are adopted.

Table 2-4 summarizes the number of measures evaluated for each segment within each sector.

Table 2-4 Number of Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ All Segments
Residential	95	190	950
Commercial	88	176	2,640
Industrial	89	178	1,424
JBLM Residential	95	190	380
JBLM Commercial	88	176	2,288
Street Lighting	41	82	246
Distribution	1	1	1
Total Measures Evaluated	**497**	**993**	**7,929**

Calculation of Energy Conservation Potential

The approach we used for this study to calculate the 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 Seventh Plan, and the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies. [6] These documents represent credible and comprehensive industry best practices for specifying conservation potential. Additional information on WAC 194-37 compliance may be found 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 above, assumes that 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 that specify the percentage of customers that will select the highest–efficiency economic option. This phases potential in over a more 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. We used the Northwest Power and Conservation Council's Seventh Plan ramp rates to develop these achievability factors for each measure. Applying these ramp rates as factors 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 and arrive at the subset of measures that are cost-effective and ultimately included in achievable economic potential.

[6] 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.

LoadMAP performs an economic screen for each individual measure in each year of the planning horizon. This study uses the 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, and discounting the dollar savings to the present value equivalent. 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 that were developed as part of the measure characterization process described above.

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.

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 the final appendix to 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 data
- Northwest regional data
- AEG's databases and analysis tools
- Other secondary data and reports

Tacoma Data

Our highest priority data sources for this study were those that were specific to Tacoma.

- Tacoma customer account database. Tacoma provided billing data for development of customer counts and energy use for each sector. This included a very 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
  - Tacoma also provided numerous equipment saturation surveys, including a regional oversample for the 2011 RBSA.
- Load forecasts. Tacoma provided forecasts by sector of energy consumption, customer counts, and exogenous forecasting variables such as economic activity.
- Economic information. Tacoma provided a discount rate as well as avoided cost forecasts and line loss factors on an 8,760-hour basis.
- Tacoma program data. Tacoma 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 prior study were used to generate JBLM-specific assumptions.
- Case Study of Residential New Construction Ductless Heat-Pump Performance and Cost Effectiveness. June 2015, WSU
- 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:

- Northwest Power and Conservation Council Seventh Plan and Regional Technical Forum workbooks. To develop its Power Plan, the Council maintains workbooks with detailed information about measures. This was used as the primary data source when Tacoma-specific program data was not available. The most recent data and workbooks available were used at the time of this study.
- Northwest Power and Conservation Council Generalized Least Squares (GLS) Load Shapes. September 29, 2016. https://rtf.nwcouncil.org/work-products/supporting-documents
- Bonneville Power Administration Implementation Manual. Select measures
- Northwest Energy Efficiency Alliance, 2011 Residential Building Stock Assessment Single-Family, Market Research Report, http://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=8
- Northwest Energy Efficiency Alliance, 2011 Residential Building Stock Assessment: Manufactured Home, Market Research Report, #E13-249, January, 2013. http://neea.org/docs/default-source/reports/residential-building-stock-assessment--manufactured-homes-characteristics-and-energy-use.pdf?sfvrsn=8
- Northwest Energy Efficiency Alliance, Long-Term Northwest Residential Lighting Tracking and Monitoring Study, Market Research Report, 11-228, August, 2011. http://neea.org/research/reports/E11-231 Combinedv2.pdf
- Northwest Energy Efficiency Alliance, 2011 Residential Building Stock Assessment:

Multifamily, Market Research Report, #13-263, September, 2013. http://neea.org/docs/default-source/reports/residential-building-stock-assessment--multi-family-characteristics-and-energy-use.pdf?sfvrsn=4

- Northwest Energy Efficiency Alliance, 2014 Commercial Building Stock Assessment, December 16, 2014, http://neea.org/docs/default-source/reports/2014-cbsa-final-report_05-dec-2014.pdf?sfvrsn=12.
- Northwest Energy Efficiency Alliance, 2014 Industrial Facilities Site Assessment, December 29, 2014, http://neea.org/resource-center/regional-data-resources/industrial-facilities-site-assessment

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 EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include Seattle City Light, PacifiCorp, Avista and numerous studies from across the U.S. In addition, we used the information about impacts of building codes and appliance standards from recent reports for the Edison Electric Institute[7].

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 2013 AEO.

[7] AEG staff has prepared three white papers on the topic of factors that affect U.S. electricity consumption, including appliance standards and building codes. Links to all three white papers are provided:
http://www.edisonfoundation.net/IEE/Documents/IEE_RohmundApplianceStandardsEfficiencyCodes1209.pdf
http://www.edisonfoundation.net/iee/Documents/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf.
http://www.edisonfoundation.net/iee/Documents/IEE_FactorsAffectingUSElecConsumption_Final.pdf

- American Community Survey. The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. Data for Tacoma were available for this study. http://www.census.gov/acs/www/
- Local Weather Data. Weather from NOAA's National Climatic Data Center for Tacoma, WA 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.
- Database for Energy Efficient Resources (DEER). The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California. We used the DEER database to cross check the measure savings we developed using BEST and DEEM.
- 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 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 2-5. 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 2011 Energy Use and Conservation Survey, the 2011 RBSA, 2014 CBSA, 2014 IFSA, DOE's RECS 2009, the American Housing Survey, 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 2-5 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, and industrial employment	Tacoma account database Tacoma Load Forecasting AEO 2015
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee	Tacoma account database 2011 RBSA, 2014 CBSA, and 2014 IFSA AEG's Energy Market Profiles AEO 2015 Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Tacoma's 2011 Energy Use and Conservation Survey 2011 RBSA, 2014 CBSA, and 2014 IFSA American Community Survey AEG's Energy Market Profiles Tacoma Load Forecasting
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 AEG DEEM 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	NWPCC workbooks, RTF AEG DEEM AEO 2016 DEER Recent AEG studies
Load Shapes	Share of technology energy use that occurs during each hour of the year	NWPCC's Generalized Least Square (GLS) load shapes, as updated for the Seventh Plan Tacoma Power metered industrial and solar PV shapes (for street lighting)

Data Application for Baseline Projection

Table 2-6 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 2-6 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 load forecast AEO 2016 economic growth 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	Shipments data from AEO and ENERGY STAR AEO 2016 regional forecast assumptions[8] Appliance/efficiency standards analysis Tacoma program results and evaluation reports
Electricity prices	Forecast of monthly average real retail price	Tacoma load forecast
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	Tacoma econometric coefficients EPRI's REEPS and COMMEND models

In addition, assumptions were incorporated for known future equipment standards as of September 2016, as shown in Table 2-7, Table 2-8 and Table 2-9. The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

[8] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2016), 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.

Table 2-7 Residential Electric Equipment Standards [9]

End Use	Technology	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13										
	Room AC	EER 11.0										
Cooling/Heating	Heat Pump	SEER 14.0/HSPF 8.0										
Water Heating	Water Heater (<=55 gallons)	EF 0.95										
	Water Heater (>55 gallons)	Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Advanced Incandescent (~20 lumens/watt)					Advanced Incandescent (45 lumens/watt)					
	Linear Fluorescent	T8 (89 lumens/watt)					T8 (92.5 lumens/watt)					
Appliances	Refrigerator	25% more efficient										
	Freezer	25% more efficient										
	Clothes Washer	1.29 IMEF top loader					1.57 IMEF top loader					
	Clothes Dryer	3.73 Combined EF										
Miscellaneous	Furnace Fans	Conventional					40% more efficient					

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

Table 2-8 Commercial Electric Equipment Standards [10]

End Use	Technology	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1										
	Roof Top Units	EER 11.0/11.2										
	PTAC	EER 11.7		EER 11.9								
Cooling/Heating	Heat Pump	EER 11.0/COP 3.3										
Ventilation	Ventilation	Constant Air Volume/Variable Air Volume										
Lighting	Screw-in/Pin Lamps	Advanced Incandescent (~20 lumens/watt)					Advanced Incandescent (45 lumens/watt)					
	Linear Fluorescent	T8 (89 lumens/watt)				T8 (92.5 lumens/watt)						
	High Intensity Discharge	EPACT 2005		Metal Halide Ballast Improvement								
Water Heating	Water Heater	EF 0.97										
Refrigeration	Walk-in Refrigerator/Freezer	EISA 2007		10-38% more efficient								
	Reach-in Refrigerator/Freezer	EPACT 2005		40% more efficient								
	Glass Door Display	EPACT 2005		12-28% more efficient								
	Open Display Case	EPACT 2005		10-20% more efficient								
	Ice maker	EPACT 2005				15% more efficient						
Food Service	Pre-rinse Spray Valve	1.6 GPM					1.0 GPM					
Miscellaneous	Motors	EISA '07	Expanded EISA 2007									

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

Table 2-9 Industrial Electric Equipment Standards [11]

End Use	Technology	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1										
	Roof Top Units	EER 11.0/11.2										
	PTAC	EER 11.7		EER 11.9								
Cooling/Heating	Heat Pump	EER 11.0/COP 3.3										
	PTHP	EER 11.9/COP 3.3										
Ventilation	Ventilation	Constant Air Volume/Variable Air Volume										
Lighting	Screw-in/Pin Lamps	Advanced Incandescent (~20 lumens/watt)					Advanced Incandescent - tier 2 (45 lumens/watt)					
	Linear Fluorescent	T8 (89 lumens/watt)					T8 (92.5 lumens/watt)					
	High Intensity Discharge	EPACT 2005 (Mercury Vapor Fixture Phase-out)		Metal Halide Ballast Improvement								
Motors	Pumps, Fans & Blowers, Compressors	EISA '07		Expanded EISA 2007								

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

Conservation Measure Data Application

Table 2-10 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 2-10 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.	NWPCC workbooks, RTF BEST AEG DEEM AEO 2015 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.	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.	NWPCC workbooks, RTF Tacoma Power program data for some measure costs and all administrative costs AEG DEEM AEO 2015 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.	NWPCC workbooks, RTF AEG DEEM AEO 2015 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.	NWPCC 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 as real 2018 dollars. We applied a discount rate of 3% in real dollars. All impacts in this report are presented at the customer meter, but electric energy delivery losses were provided by Tacoma to estimate impacts at the generator for economic analysis. Tacoma provided hourly values, which were converted into annual values 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, "Retro", applied before the 85% 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 Northwest Power and Conservation Council's Seventh Plan.

The customer adoption rates used in this study are available in the appendix.

3

MARKET CHARACTERIZATION AND MARKET PROFILES

In this section, we describe how customers in the Tacoma Power service territory use electricity in the base year of the study, 2015. It begins with a high-level summary of energy use across all sectors and then delves into each sector in more detail.

Figure 3-1 Tacoma Skyline (courtesy of Rob Green)

Overall Energy Use Summary

Total electricity consumption for all sectors for Tacoma in 2015 was 4,476 GWh. As shown in Figure 3-2 and Table 3-1, the combined civilian residential and JBLM residential sectors account for more than one-third (40.0%) of annual energy use. The combined civilian commercial and JBLM commercial sectors account for 35.8% of annual energy use. The industrial sector accounts for 23.5% while street lighting accounts for the remaining 0.7% of usage.

Within the Residential sector, civilian usage accounts for 38.9% of overall usage while JBLM residential accounts for 1.1%. Within the commercial sector, civilian usage accounts for 29.3% of overall usage while JBLM commercial accounts for 6.6%.

Figure 3-2 Sector-Level Electricity Use in Base Year 2015 (Annual GWh, Percent)

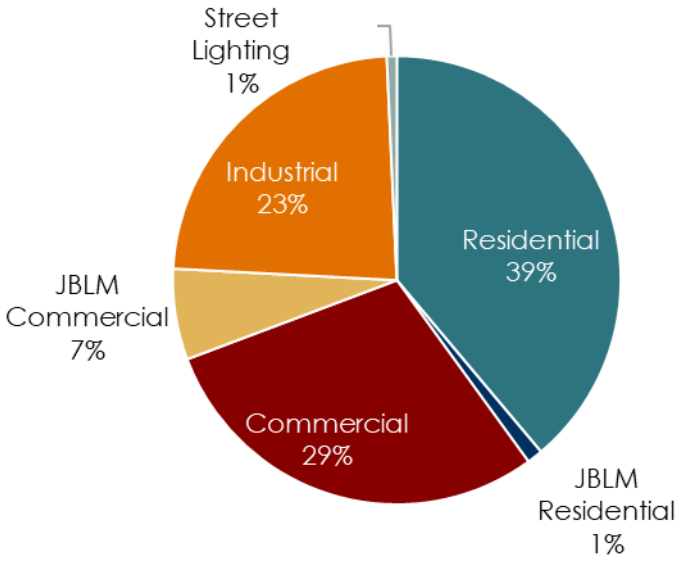


Table 3-1 Tacoma Sector Control Totals (2015)

Sector	Number of Customers/Buildings	Annual Electricity Use (GWh)	% of Annual Use
Residential	152,901	1,740	38.9%
JBLM Residential	4,647	51	1.1%
Commercial	22,912	1,310	29.3%
JBLM Commercial	5,525	293	6.6%
Industrial	767	1,050	23.5%
Street Lighting	41,368	32	0.7%
Total	**228,120**	**4,476**	**100.0%**

Residential Sector

The total number of households and electricity sales for the service territory were obtained from Tacoma's customer database. In 2015, there were nearly 153 thousand households in the Tacoma territory that used a total of 1,740 GWh. Average use per customer (or household) at 11,377 kWh is slightly higher than other regions of the country, reflecting relatively high penetrations of electric heat in the Pacific Northwest. These averages include both electric and non-electric heat. Individual household consumption may vary based on house size, age, and presence of natural gas or secondary heat. We allocated these totals into five residential segments and the values are shown in Table 3-2.

Table 3-2 Residential Sector Control Totals (2015)

Segment	Number of Customers	Electricity Use (GWh)	% of Annual Use	Annual Use/Customer (kWh/HH)
Single Family	105,900	1,273	73%	12,020
Single Family 2-4 units	4,485	46	3%	10,179
Low-Rise Multifamily	36,051	322	19%	8,945
High-Rise Multifamily	720	8	0%	11,188
Manufactured Home	5,745	91	5%	15,761
Total	**152,901**	**1,740**	**100%**	**11,377**

As we describe 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 3-3 shows the average distribution of annual electricity use by end use for all customers. Three main electricity end uses — space heating, water heating, and appliances — account for 74% of total use. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the electronics, lighting, cooling and the miscellaneous category – which is comprised 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 consumption residential consumption for the entire service territory. These graphics would look significantly different between gas and electrically heated homes. Approximately 58.6% of homes within Tacoma Power's service territory contain some form of electric space heating. Approximately 45% of single family homes are electrically heater whereas approximately 90% of multifamily homes are electrically heated.

Figure 3-4 presents the electricity intensities by end use and housing type. Manufactured homes have the highest use per customer at 15,761 kWh/year, reflecting less efficient construction and equipment options as well as a higher saturation of electric space heating.

Figure 3-3 Residential Electricity Use by End Use (2015)

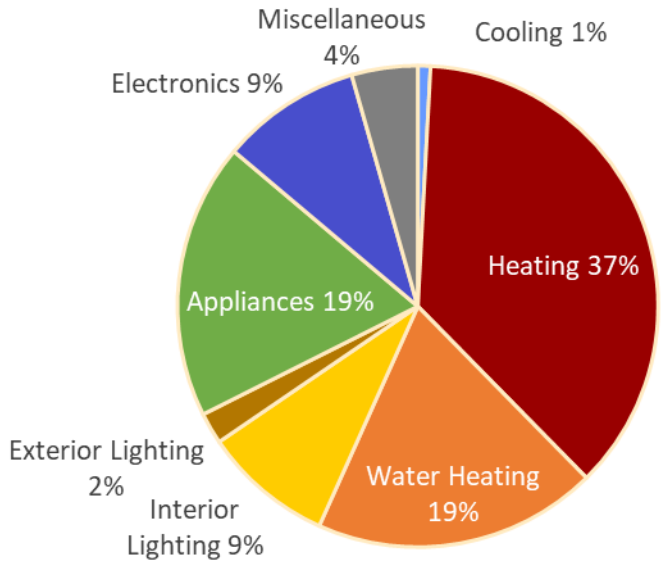


Figure 3-4 Residential Energy Intensity by End Use and Segment (Annual kWh/HH, 2015)

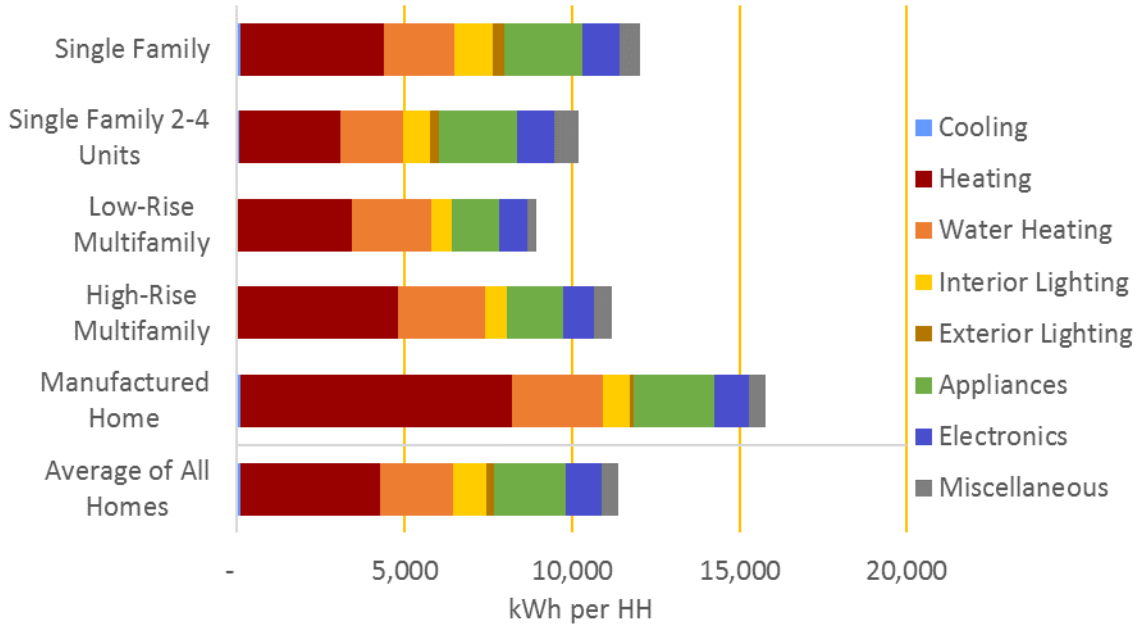


Table 3-3 Average Market Profile for the Residential Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	6.7%	546	36	5.6
	Room AC	11.6%	253	29	4.5
	Air-Source Heat Pump	5.1%	562	29	4.4
	Geothermal Heat Pump	0.3%	533	2	0.2
Heating	Air-Source Heat Pump	5.1%	5,606	287	43.9
	Geothermal Heat Pump	0.3%	2,675	8	1.2
	Electric Room Heat	40.5%	6,034	2,441	373.3
	Electric Furnace	12.7%	11,393	1,448	221.3
Water Heating	Water Heater (<= 55 Gal)	64.4%	2,923	1,883	287.9
	Water Heater (55 to 75 Gal)	8.8%	3,104	273	41.7
	Water Heater (> 75 Gal)	0.6%	3,339	19	2.9
Interior Lighting	General Service Lighting	100.0%	655	655	100.2
	Linear Lighting	100.0%	124	124	18.9
	Exempted Lighting	100.0%	218	218	33.3
Exterior Lighting	Screw-In/Hard-Wire	100.0%	240	240	36.7
Appliances	Clothes Washer	84.1%	52	44	6.7
	Clothes Dryer	82.8%	681	564	86.2
	Dishwasher	84.3%	229	193	29.5
	Refrigerator	100.0%	581	581	88.8
	Freezer	47.5%	578	275	42.0
	Second Refrigerator	15.1%	669	101	15.5
	Stove/Oven	78.6%	287	226	34.5
	Microwave	102.8%	123	127	19.3
Electronics	Personal Computers	70.3%	166	117	17.9
	Monitor	88.2%	70	62	9.5
	Laptops	133.9%	44	59	9.0
	TVs	214.6%	247	529	80.9
	Printer/Fax/Copier	99.1%	57	56	8.6
	Set-Top Boxes/DVRs	142.3%	104	148	22.7
	Devices and Gadgets	100.0%	100	100	15.3
Miscellaneous	Electric Vehicles	0.1%	4,324	5	0.8
	Pool Pump	2.2%	2,087	47	7.1
	Pool Heater	0.6%	3,341	19	2.9
	Furnace Fan	43.4%	192	83	12.7
	Well Pump	15.3%	533	82	12.5
	Miscellaneous	100.0%	270	270	41.2
Total				**11,377**	**1,739.6**

JBLM Residential Sector

Tacoma Power 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. JBLM has a substantial housing sector for residential customers as well as several large commercial and industrial facilities, which we have combined into a single "JBLM commercial" section 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. A brief summarizing this assessment and the associated findings is included in Appendix B.

The total number of residential households for JBLM were obtained from billing data provided by Equity Residential, the property management company responsible for housing at JBLM, during the prior study. Energy consumption was updated from prior study values by looking at the difference in JBLM annual JBLM consumption between 2013 and 2015. In 2015, there were nearly five thousand households at JBLM with a total consumption of 50,502 MWh. The average use per customer (or household) at 10,868 kWh is slightly 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 (2015)

Segment	Number of Customers	Electricity Use (MWh)	% of Annual Use	Annual Use/Customer (kWh/HH)
Single Family	3,865	45,281	90%	11,716
Multifamily	782	5,221	10%	6,676
Total	**4,647**	**50,502**	**100%**	**10,868**

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 total use (72%). Lighting is significantly lower than civilian homes due to JBLM policies that are already in place to procure exclusively high efficiency screw-in lamps. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the cooling, electronics, lighting, and the miscellaneous category – which is comprised of furnace fans, pool pumps, and other "plug" loads (all other usage not covered by those listed in Figure 2-4 such as hair dryers, power tools, coffee makers, etc.).

Figure 3-6 presents the electricity intensities by end use and housing type. Single-family homes have the highest use per customer at 11,716 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 (2015)

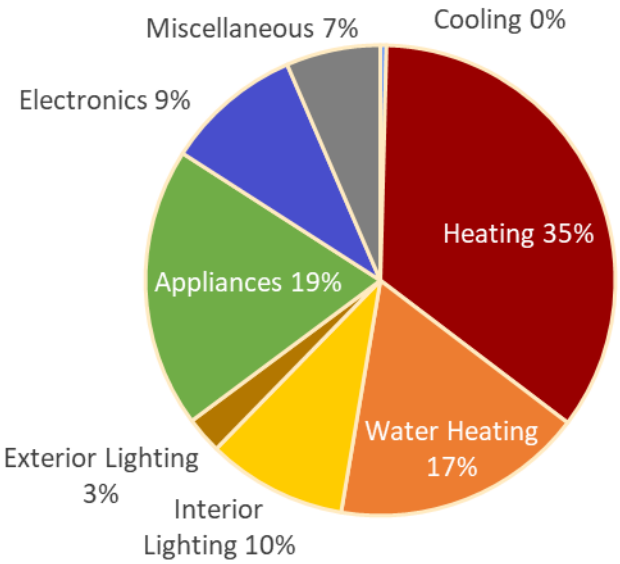


Figure 3-6 JBLM Residential Energy Intensity by End Use and Segment (Annual kWh/HH, 2015)

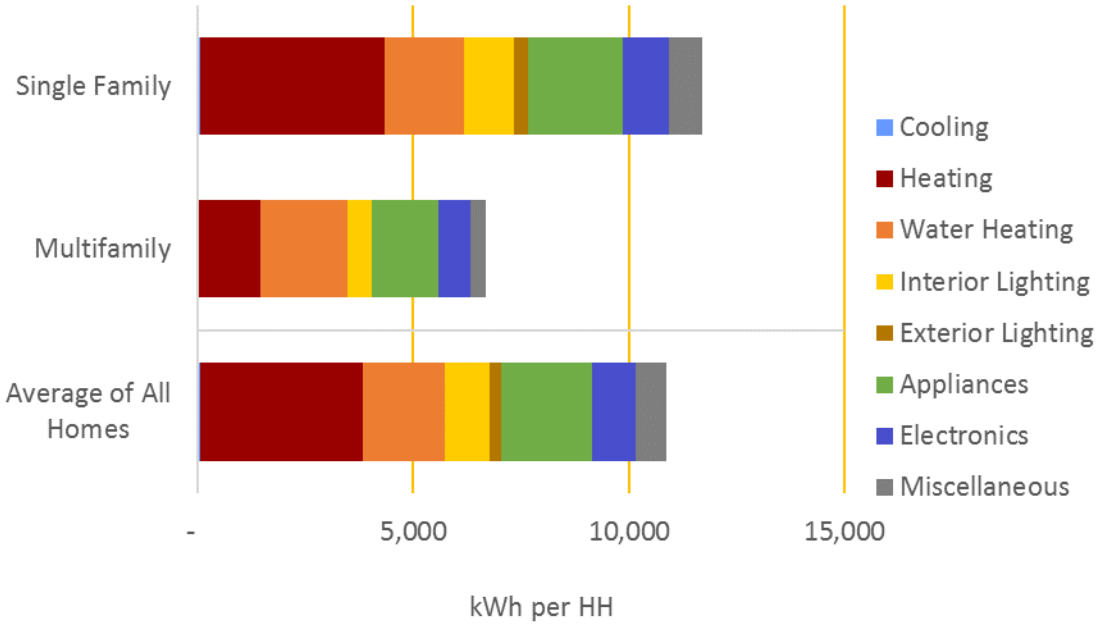


Table 3-5 shows the average market profile for electricity of the JBLM residential sector as a whole, representing a composite of both single and multi-family homes. Market profiles for each segment are presented in the appendix to this volume.

Table 3-5 Average Market Profile for the JBLM Residential Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (MWh)
Cooling	Central AC	0.0%	0	0	0
	Room AC	4.3%	337	14	67
	Air-Source Heat Pump	5.1%	613	31	144
	Geothermal Heat Pump	0.0%	0	0	0
Heating	Air-Source Heat Pump	5.1%	5,896	298	1,385
	Geothermal Heat Pump	0.0%	0	0	0
	Electric Room Heat	31.6%	6,751	2,135	9,919
	Electric Furnace	12.0%	11,391	1,363	6,332
Water Heating	Water Heater (<= 55 Gal)	30.1%	2,634	794	3,688
	Water Heater (55 to 75 Gal)	36.8%	2,757	1,016	4,720
	Water Heater (> 75 Gal)	2.5%	3,005	75	351
Interior Lighting	General Service Lighting	100.0%	669	669	3,109
	Linear Lighting	100.0%	136	136	633
	Exempted Lighting	100.0%	241	241	1,121
Exterior Lighting	Screw-In/Hard-Wire	100.0%	273	273	1,271
Appliances	Clothes Washer	97.2%	49	48	221
	Clothes Dryer	95.2%	625	595	2,764
	Dishwasher	92.8%	213	197	918
	Refrigerator	100.0%	538	538	2,502
	Freezer	52.9%	548	290	1,347
	Second Refrigerator	16.4%	633	104	481
	Stove/Oven	75.8%	268	203	943
	Microwave	103.2%	114	118	548
Electronics	Personal Computers	74.4%	155	116	538
	Monitor	93.7%	66	61	286
	Laptops	138.5%	41	57	263
	TVs	221.0%	228	503	2,339
	Printer/Fax/Copier	103.6%	53	55	254
	Set-Top Boxes/DVRs	143.3%	97	139	645
	Devices and Gadgets	100.0%	93	93	432
Miscellaneous	Electric Vehicles	0.0%	0	0	0
	Pool Pump	2.6%	1,977	51	236
	Pool Heater	0.6%	3,165	20	95
	Furnace Fan	46.4%	186	86	401
	Well Pump	17.6%	505	89	414
	Miscellaneous	100.0%	460	460	2,136
Total				**10,868**	**50,502**

Commercial Sector

The total electric energy consumed by commercial customers in Tacoma's service area in 2015 was 1,310 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 which do not fit into the standard building types, such as flower shops, fire stations, and the Tacoma Dome. 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 (2015)

Segment	Electricity Sales (GWh)	Intensity (Annual kWh/SqFt)	Floor Space (Million SqFt)
Office	153	15.9	9.6
Retail	167	12.2	13.7
Restaurant	57	39.8	1.4
Grocery	98	51.8	1.9
Hospital	111	27.4	4.1
Other Health	73	14.9	4.9
College	48	19.5	2.4
School	91	8.9	10.2
Lodging	48	14.3	3.3
Assembly	45	7.4	6.1
Warehouse	86	7.2	11.8
Data Center	40	175.0	0.2
MF Common Area	51	7.7	6.6
Misc. - Classified	76	8.2	9.2
Misc. - Unclassified	165	7.5	22.1
Total	**1,310**	**12.2**	**107.8**

Figure 3-7 shows the distribution of annual electricity consumption by end use across all commercial buildings. Most of consumption is associated with lighting and HVAC usage, which comprises 70% 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 175 kWh/SqFt. We present the higher intensity segments, restaurants, grocery stores, and data centers on a larger axis. Table 3-7 shows the average market profile for electricity of the

commercial sector as a whole, representing a composite of all segments and buildings. Market profiles for each segment are presented in the appendix to this volume.

Figure 3-7 Commercial Sector Electricity Consumption by End Use (2015)

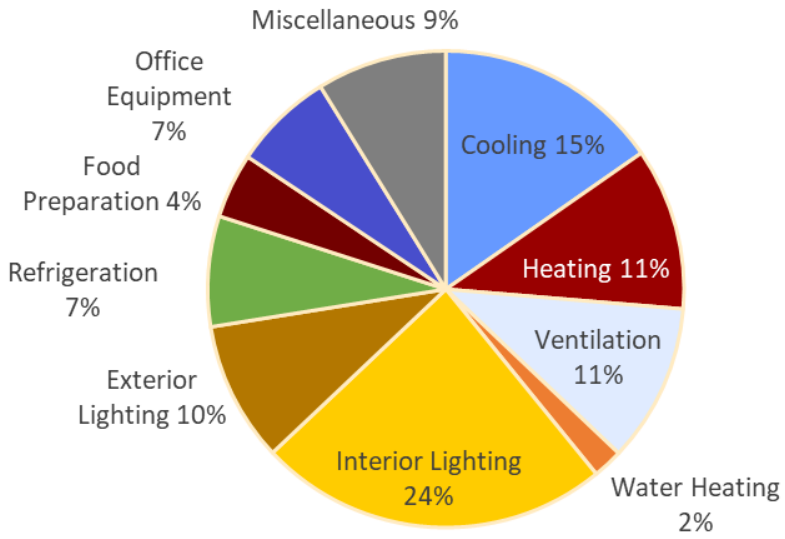


Figure 3-8 Commercial Energy Intensity by End Use and Segment (Annual kWh/SqFt, 2015)

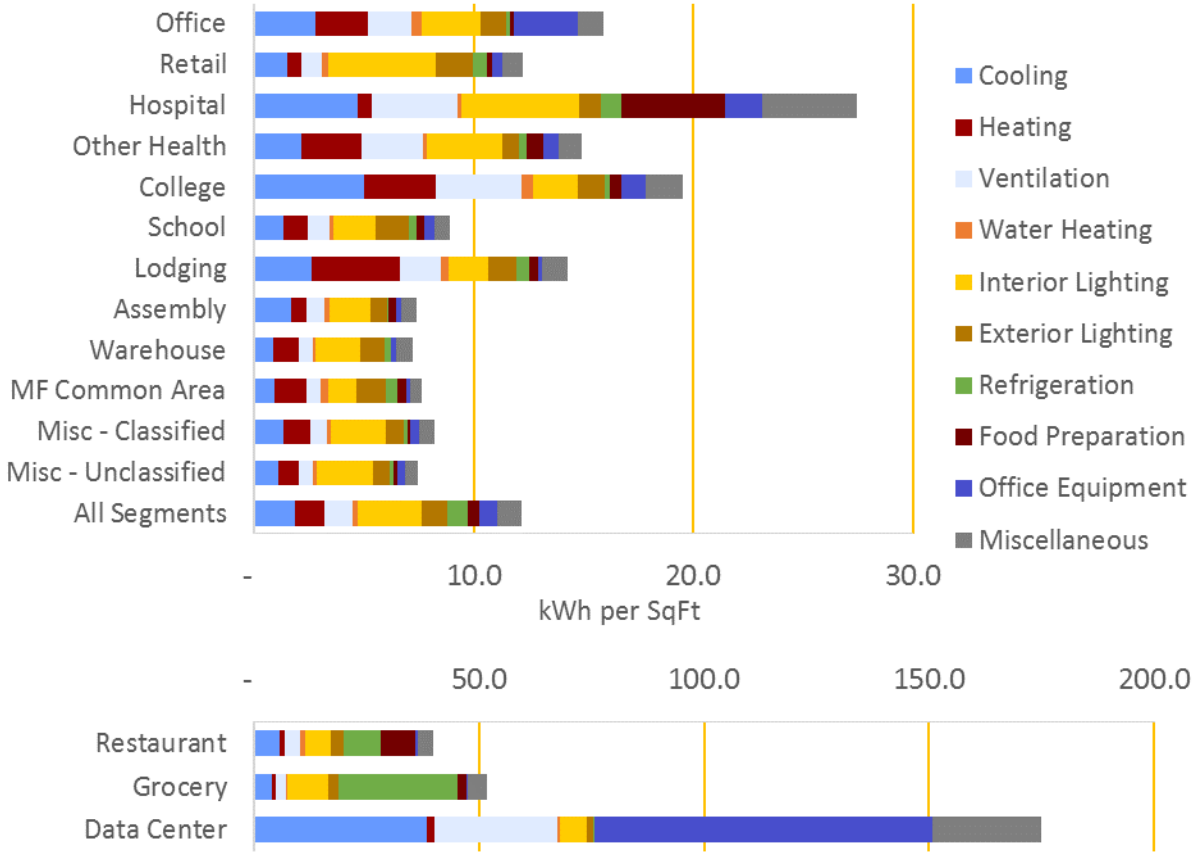


Table 3-7 Average Electric Market Profile for the Commercial Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.5%	3.17	0.24	25.8
	Water-Cooled Chiller	6.4%	4.59	0.29	31.5
	RTU	39.2%	2.45	0.96	103.4
	Room AC	8.6%	2.09	0.18	19.5
	Air-Source Heat Pump	6.0%	2.40	0.14	15.6
	Geothermal Heat Pump	3.1%	1.51	0.05	5.0
Heating	Air-Source Heat Pump	6.0%	4.53	0.27	29.4
	Geothermal Heat Pump	3.1%	3.99	0.12	13.2
	Electric Furnace	3.1%	5.21	0.16	17.5
	Electric Room Heat	16.5%	4.72	0.78	84.1
Ventilation	Ventilation	100.0%	1.31	1.31	140.9
Water Heating	Water Heater	21.9%	1.13	0.25	26.7
Interior Lighting	Screw-in/Hard-wire	100.0%	0.64	0.64	68.8
	Linear Lighting	100.0%	1.41	1.41	151.9
	High-Bay Fixtures	100.0%	0.85	0.85	91.8
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.28	0.28	30.5
	Linear Lighting	100.0%	0.30	0.30	32.1
	Area Lighting	100.0%	0.57	0.57	61.9
Refrigeration	Walk-in Refrigerator/Freezer	8.5%	1.43	0.12	13.2
	Reach-in Refrigerator/Freezer	10.8%	0.28	0.03	3.2
	Glass Door Display	16.6%	0.61	0.10	11.0
	Open Display Case	5.8%	8.10	0.47	51.0
	Icemaker	35.2%	0.36	0.13	13.6
	Vending Machine	23.2%	0.25	0.06	6.1
Food Preparation	Oven	29.3%	0.59	0.17	18.5
	Fryer	5.4%	1.94	0.10	11.2
	Dishwasher	14.2%	1.47	0.21	22.5
	Hot Food Container	10.3%	0.17	0.02	1.9
	Steamer	5.6%	0.61	0.03	3.7
Office Equipment	Desktop Computer	100.0%	0.50	0.50	53.6
	Laptop	99.4%	0.06	0.06	6.6
	Monitor	100.0%	0.09	0.09	9.5
	Server	81.9%	0.14	0.11	12.0
	Printer/Copier/Fax	100.0%	0.06	0.06	6.0
	POS Terminal	34.1%	0.04	0.01	1.6
Miscellaneous	Non-HVAC Motors	59.0%	0.19	0.11	12.1
	Pool Pump	14.1%	0.02	0.00	0.2
	Pool Heater	6.6%	0.02	0.00	0.1
	Other Miscellaneous	100.0%	0.96	0.96	103.2
Total				**12.15**	**1,310.3**

JBLM Commercial Sector

The total non-residential square footage and electricity sales for the JBLM were obtained from Tacoma and adjusted from values used in the prior study. We relied on the onsite surveys conducted by AEG during the prior study to tailor assumptions unique to JBLM and capture differences with the civilian commercial sector. In 2015, the analysis shows just under 21 million square feet of floor space on JBLM which used a total consumption of 293 GWh.

The values 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 market segment added during the prior CPA, "Mixed Use", 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 (2015)

Segment	Electricity Sales (GWh)	Intensity (Annual kWh/SqFt)	Floor Space (Million SqFt)
Office	52	15.9	3.2
Retail	4	12.2	0.3
School	9	8.9	1.1
Grocery	3	51.8	0.1
Lodging	54	14.3	3.8
Restaurant	13	39.8	0.3
Warehouse	31	7.2	4.3
Data Center	13	175.0	0.1
Health	59	27.4	2.2
Other	18	8.2	2.2
Hangar	13	9.8	1.3
Mixed Use	22	11.1	2.0
Industrial	3	38.4	0.1
Total	**293**	**14.1**	**20.8**

Figure 3-9 shows the distribution of annual electricity consumption by end use across all commercial buildings. The electric usage looks like the civilian commercial sector in that lighting and HVAC comprise the lion's share (66%), but JBLM also includes more industrial-style facilities with mechanical, motor, and process usage that is classified in the larger Miscellaneous end use of the commercial template used to model this sector.

Figure 3-10 presents the electricity intensities by end use and segment. Data centers have the highest use per square foot at 175 kWh/SqFt.

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 the appendix to this volume.

Figure 3-9 JBLM Commercial Sector Electricity Consumption by End Use (2015)

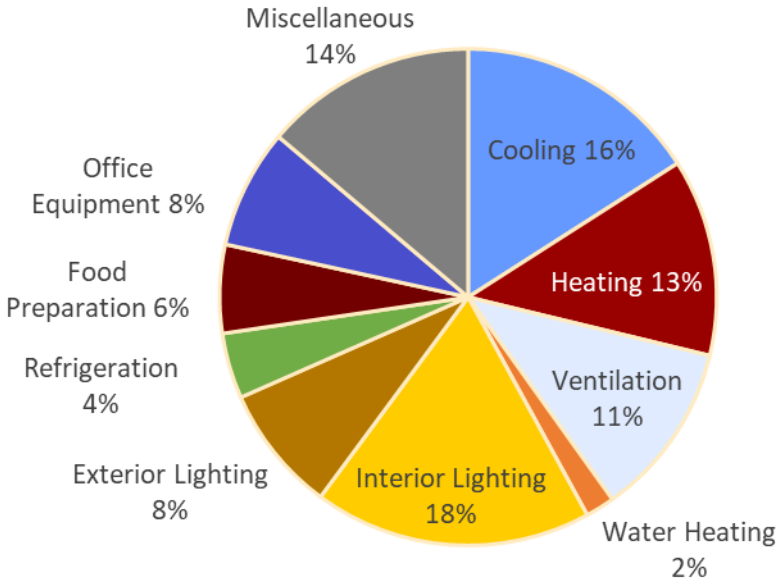


Figure 3-10 JBLM Commercial Energy Intensity by End Use and Segment (Annual kWh/SqFt., 2015)

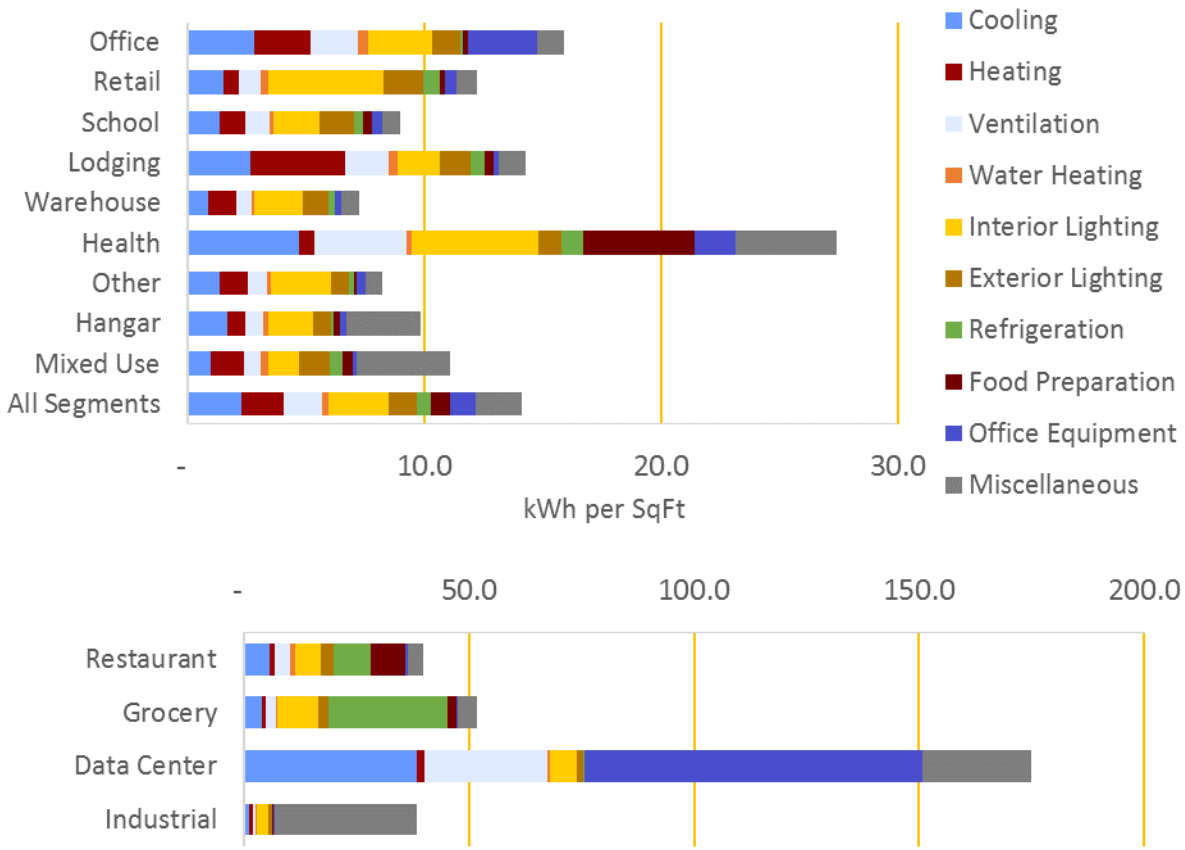


Table 3-9 Average Electric Market Profile for the JBLM Commercial Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.4%	3.34	0.25	5.1
	Water-Cooled Chiller	11.3%	5.01	0.56	11.7
	RTU	27.9%	2.99	0.84	17.4
	Room AC	14.5%	2.47	0.36	7.4
	Air-Source Heat Pump	6.1%	3.00	0.18	3.8
	Geothermal Heat Pump	3.1%	2.03	0.06	1.3
Heating	Air-Source Heat Pump	6.1%	5.02	0.31	6.4
	Geothermal Heat Pump	3.1%	4.00	0.12	2.6
	Electric Furnace	2.3%	6.58	0.15	3.1
	Electric Room Heat	25.8%	4.77	1.23	25.5
Ventilation	Ventilation	100.0%	1.60	1.60	33.3
Water Heating	Water Heater	22.9%	1.17	0.27	5.6
Interior Lighting	Screw-in/Hard-wire	100.0%	0.64	0.64	13.3
	Linear Lighting	100.0%	1.21	1.21	25.1
	High-Bay Fixtures	100.0%	0.70	0.70	14.6
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.23	0.23	4.8
	Linear Lighting	100.0%	0.22	0.22	4.5
	Area Lighting	100.0%	0.72	0.72	14.9
Refrigeration	Walk-in Refrigerator/Freezer	8.5%	1.60	0.14	2.8
	Reach-in Refrigerator/Freezer	15.1%	0.25	0.04	0.8
	Glass Door Display	17.9%	0.28	0.05	1.0
	Open Display Case	2.9%	4.42	0.13	2.6
	Icemaker	41.1%	0.44	0.18	3.7
	Vending Machine	27.0%	0.26	0.07	1.5
Food Preparation	Oven	26.0%	1.05	0.27	5.7
	Fryer	5.1%	2.81	0.14	3.0
	Dishwasher	20.1%	1.69	0.34	7.0
	Hot Food Container	8.7%	0.26	0.02	0.5
	Steamer	4.0%	0.94	0.04	0.8
Office Equipment	Desktop Computer	100.0%	0.68	0.68	14.2
	Laptop	99.9%	0.08	0.08	1.6
	Monitor	100.0%	0.12	0.12	2.5
	Server	87.7%	0.15	0.13	2.7
	Printer/Copier/Fax	100.0%	0.07	0.07	1.5
	POS Terminal	28.7%	0.04	0.01	0.2
Miscellaneous	Non-HVAC Motors	67.1%	0.33	0.22	4.6
	Pool Pump	21.8%	0.05	0.01	0.2
	Pool Heater	3.7%	0.03	0.00	0.0
	Other Miscellaneous	100.0%	1.72	1.72	35.6
Total				**14.11**	**293.2**

Industrial Sector

The total electricity used in 2015 by Tacoma's industrial customers was 1,050 GWh. Tacoma billing data, load forecast and secondary sources were used to allocate usage among end uses. Figure 3-11 shows the distribution of annual electricity consumption by end use for all industrial customers. Motors are the largest overall end use for the industrial sector, accounting for 62% 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 19% of annual energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by cooling, miscellaneous, space heating, and ventilation.

Figure 3-11 Industrial Electricity Use by End Use (2015), All Industries

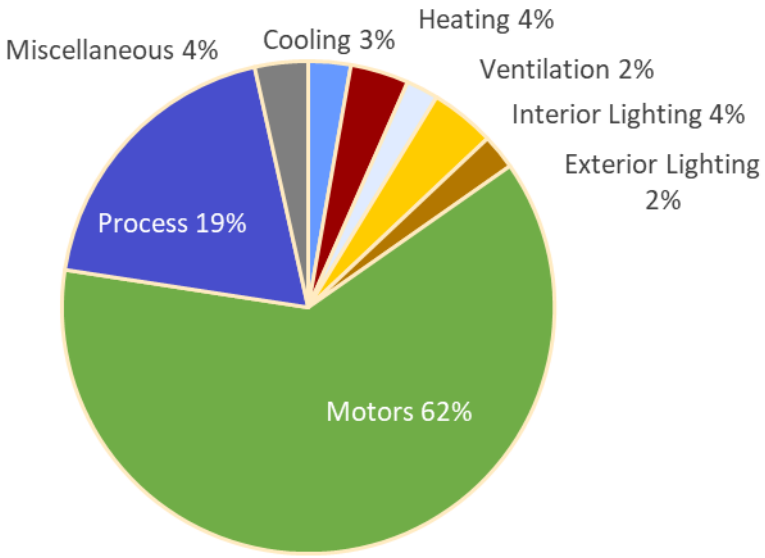


Table 3-10 shows the composite market profile for the industrial sector. Segment-level detail was included in the analysis of the industrial sector, but excluded from the report to prevent disclosure of data that may be sensitive for some of Tacoma's larger customers.

Table 3-10 Average Electric Market Profile for the Industrial Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Empl)	Usage (MWh)
Cooling	Air-Cooled Chiller	2.5%	8,400	210	4.4
	Water-Cooled Chiller	2.5%	9,964	249	5.2
	RTU	10.3%	7,231	747	15.7
	Air-Source Heat Pump	2.7%	6,623	180	3.8
	Geothermal Heat Pump	0.0%	4,418	0	0.0
Heating	Air-Source Heat Pump	2.7%	11,617	316	6.7
	Geothermal Heat Pump	0.0%	7,749	0	0.0
	Electric Furnace	1.9%	13,419	259	5.5
	Electric Room Heat	10.5%	12,780	1,336	28.1
Ventilation	Ventilation	100.0%	1,051	1,051	22.1
Interior Lighting	Screw-in/Hard-wire	100.0%	139	139	2.9
	Linear Lighting	100.0%	446	446	9.4
	High-Bay Fixtures	100.0%	1,533	1,533	32.3
Exterior Lighting	Screw-in/Hard-wire	100.0%	161	161	3.4
	Linear Lighting	100.0%	241	241	5.1
	Area Lighting	100.0%	745	745	15.7
Motors	Pumps	100.0%	8,429	8,429	177.6
	Fans & Blowers	100.0%	4,856	4,856	102.3
	Compressed Air	100.0%	4,145	4,145	87.3
	Material Handling	100.0%	12,876	12,876	271.2
	Other Motors	100.0%	689	689	14.5
Process	Process Heating	100.0%	4,475	4,475	94.3
	Process Cooling	100.0%	1,203	1,203	25.3
	Process Refrigeration	100.0%	1,203	1,203	25.3
	Process Electrochemical	100.0%	1,893	1,893	39.9
	Process Other	100.0%	727	727	15.3
Miscellaneous	Other Miscellaneous	100.0%	1,744	1,744	36.7
Total				**49,854**	**1,050.2**

Street Lighting Sector

The total electric energy consumed by street lighting in Tacoma's service area in 2015 was 32,024 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. Tacoma Power is planning to upgrade the city-owned H1 fixtures, so those are isolated to capture this potential. 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.

Table 3-11 Street Lighting Sector Control Totals (2015)

Segment	Electricity Sales (MWh)	Usage per Fixture (Annual kWh/Fixt.)	Fixture Count
H1 - Tacoma Street and Highway	20,518	937	21,903
H1 - Other Fixtures	4,586	331	13,849
H2 Service - All	6,919	1,232	5,616
Total	**32,024**	**774**	**41,368**

The H1 - Tacoma Street and Highway fixtures consume an average of 937 kWh and H1 - Other Fixtures consume 331 kWh. This is due to the Tacoma fixtures being mostly high-intensity discharge lamps whereas the Other Fixtures are mainly LEDs. H2 Service lamps are unmetered fixtures.

Figure 3-12 shows the distribution of annual electricity consumption by fixture type across all street lights.

Figure 3-12 Street Lighting Sector Electricity Consumption by Fixture Type (2015)

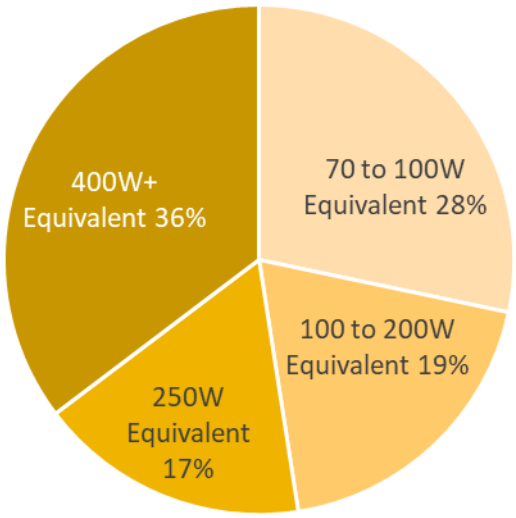


Table 3-12 shows the average market profile for electricity of the street lighting sector, representing a composite of all rate classes (H1 and H2 services). Market profiles for each rate class are presented in the appendix to this volume.

Table 3-12 Average Electric Market Profile for the Street Lighting Sector, 2015

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (MWh)
Street Lighting	70W Equivalent	4.4%	235	1,829	430
	100W Equivalent	50.5%	413	20,888	8,634
	150W Equivalent	3.3%	612	1,364	835
	175W Equivalent	7.8%	716	3,221	2,306
	200W Equivalent	7.5%	977	3,089	3,019
	250W Equivalent	12.3%	1,079	5,090	5,493
	400W Equivalent	14.0%	1,883	5,810	10,941
	1000W Equivalent	0.2%	4,810	76	366
Total				**41,368**	**32,024**

4

BASELINE PROJECTION

Prior to developing estimates of energy-efficiency potential, we developed a baseline end-use projection to quantify what the consumption is likely to be in the future in absence of any conservation or efficiency programs. The savings from past programs are embedded in the forecast, but the baseline projection assumes that those past programs cease to exist in the future. Thus, the potential analysis captures all possible savings from future programs.

Figure 4-1 Apartment Buildings at the Theas Landing Marina (courtesy of Rob Green)

The baseline projection incorporates assumptions about:

- 2015 account data classified by sector and building types and rate classes
- Customer population and economic growth
- Appliance/equipment standards and building codes already mandated (see Chapter 2)
- Appliance/equipment purchase decisions frozen at contemporary levels throughout (except where superseded by a code or standard)
- Forecasts of future electricity prices
- Tacoma Power load forecast by rate class, updated in November 2016
- Residential, commercial, and industrial building stock assessments
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous electricity growth

AEG removed the impacts of future DSM programs from Tacoma's official load forecast prior to aligning. This was done at the sector-level using load forecast documentation provided by Tacoma. Although it aligns closely, the baseline projection is not Tacoma's official load forecast. Rather it was developed as an integral component of our modeling construct to serve as the metric against which conservation

potentials are measured. This chapter presents the baseline projections we developed for this study.

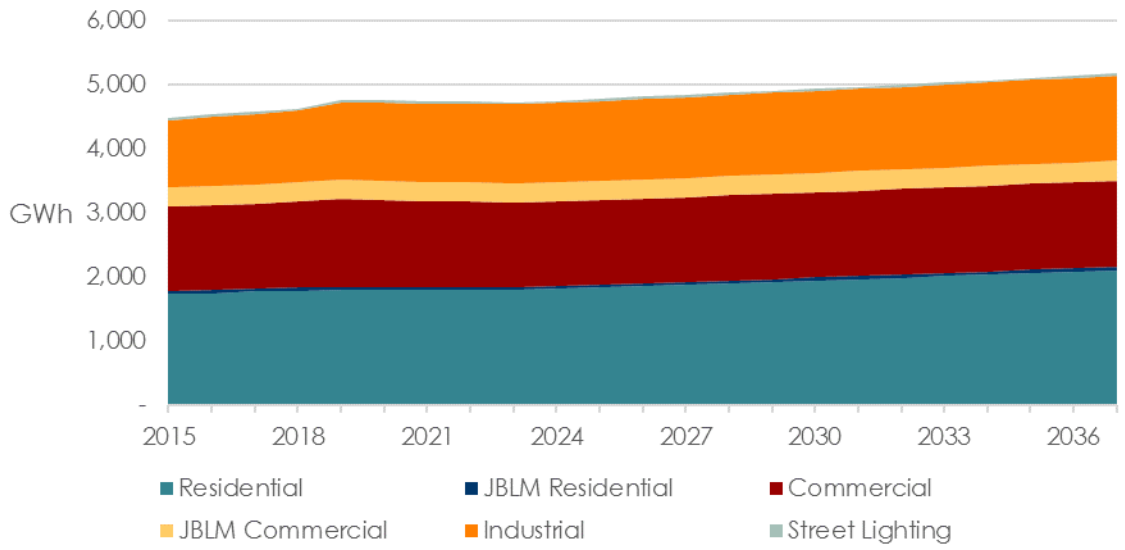
Below, we present the baseline projections for each sector, which include projections of annual use in GWh. We also present a summary across all sectors. Summary of Baseline Projections Across Sectors

Table 4-1 and Figure 4-2 provide a summary of the baseline projection for annual use by sector for the entire Tacoma 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 will be enacted per all current legislation.

Table 4-1 Baseline Projection Summary (GWh)

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)	Avg. Growth Rate
Residential	1,740	1,794	1,801	1,800	1,877	2,112	21.4%	0.9%
JBLM Residential	51	50	50	49	48	49	-2.4%	-0.1%
Commercial	1,310	1,340	1,373	1,327	1,327	1,348	2.9%	0.1%
JBLM Commercial	293	299	300	297	299	304	3.7%	0.2%
Industrial	1,050	1,112	1,205	1,226	1,257	1,324	26.1%	1.1%
Street Lighting	32	32	32	32	32	32	0.0%	0.0%
Total	**4,476**	**4,627**	**4,761**	**4,732**	**4,840**	**5,170**	**15.5%**	**0.7%**

Figure 4-2 Baseline Projection Summary (GWh)



Residential Sector Baseline Projection

Table 4-2 and Figure 4-4 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 1,740 GWh in 2015 to 2,112 GWh in 2037, an increase of 21.4%. Figure 4-5 presents the baseline projection of annual electricity use per household. Most noticeable is that lighting use decreases throughout the time period as the lighting standards from EISA come into effect.

Figure 4-3 Townhomes Under Construction (courtesy of Tacoma Power)

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

1. Lighting use declines as a result of phase two of the EISA lighting standards coming online in 2020.
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 and the trend toward higher-powered computers. Growth in other miscellaneous use is also substantial. This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.
4. Electric vehicle growth is very high due to projections in the recent AEO studies.

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

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	15	15	15	15	15	17	12.5%
Heating	640	668	673	688	725	800	25.0%
Water Heating	332	338	337	337	344	369	11.1%
Interior Lighting	152	150	147	115	96	98	-35.7%
Exterior Lighting	37	35	35	33	31	31	-14.9%
Appliances	323	330	331	335	347	377	16.8%
Electronics	164	173	175	181	199	245	49.7%
Miscellaneous	77	85	88	97	119	175	126.0%
Total	**1,740**	**1,794**	**1,801**	**1,800**	**1,877**	**2,112**	**21.4%**

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

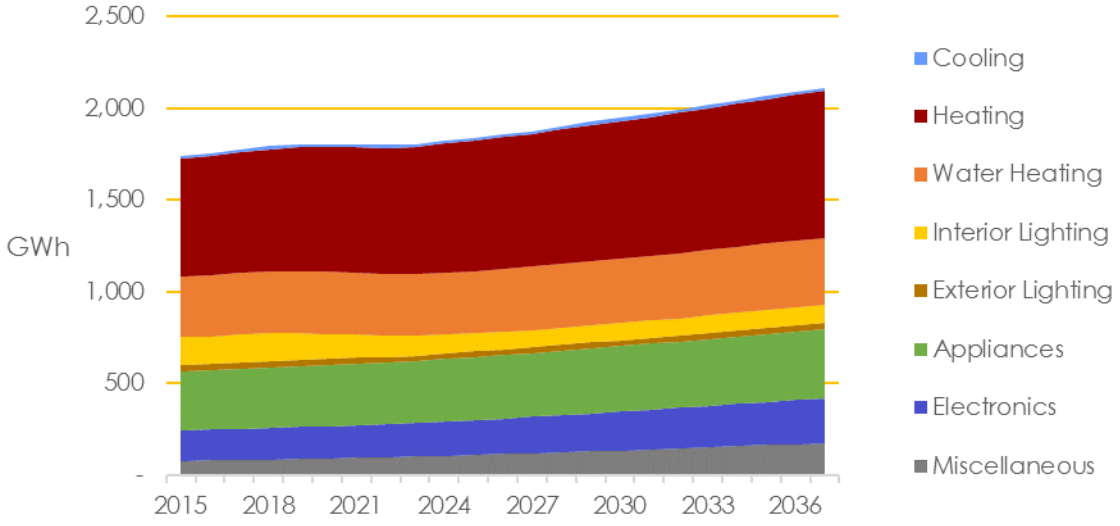


Figure 4-5 Residential Baseline Projection by End Use – Annual Use per Household

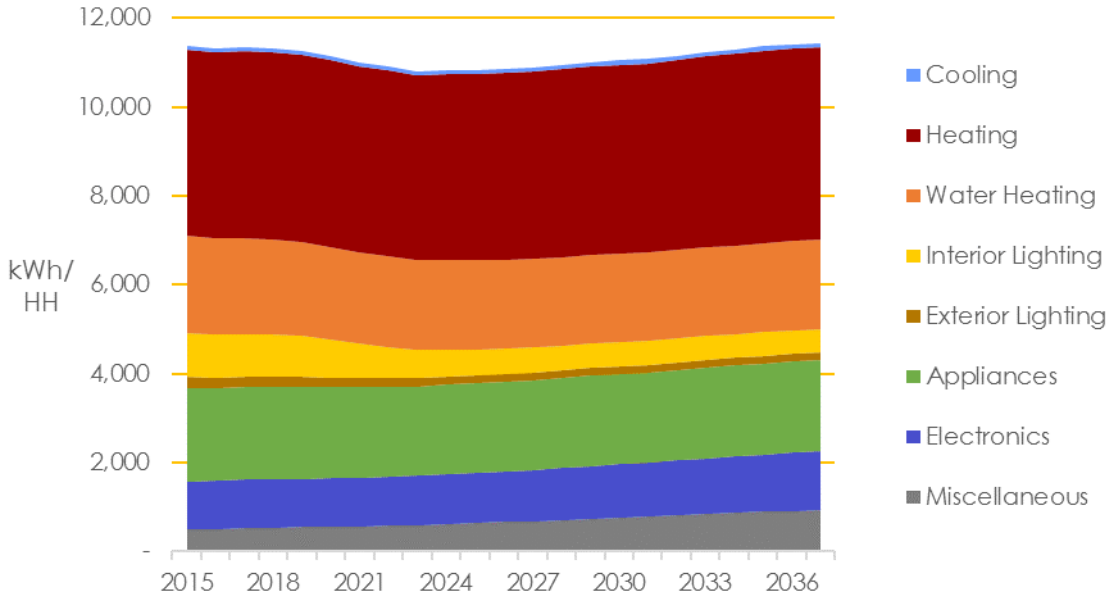


Table 4-3 Residential Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	Central AC	6	6	6	6	6	6	11.9%
	Room AC	5	5	5	5	5	5	15.8%
	Air-Source Heat Pump	4	4	4	4	4	5	10.6%
	Geothermal Heat Pump	0	0	0	0	0	0	0.8%
Heating	Air-Source Heat Pump	44	44	44	43	44	48	8.6%
	Geothermal Heat Pump	1	1	1	1	1	1	2.6%
	Electric Room Heat	373	399	405	422	457	522	39.9%
	Electric Furnace	221	224	223	222	224	229	3.3%
Water Heating	Water Heater (<= 55 Gal)	288	294	295	297	308	335	16.5%
	Water Heater (55 to 75 Gal)	42	41	40	37	34	32	-23.1%
	Water Heater (> 75 Gal)	3	3	3	3	2	2	-26.6%
Interior Lighting	General Service Lighting	100	100	99	70	52	53	-47.5%
	Linear Lighting	19	19	19	19	18	19	-0.1%
	Exempted Lighting	33	31	30	27	25	26	-20.5%
Ext. Lighting	Screw-In/Hard-Wire	37	35	35	33	31	31	-14.9%
Appliances	Clothes Washer	7	7	7	7	7	7	6.3%
	Clothes Dryer	86	89	90	91	96	105	22.1%
	Dishwasher	29	31	31	32	34	38	29.2%
	Refrigerator	89	91	91	92	95	103	16.4%
	Freezer	42	42	42	41	41	41	-3.1%
	Second Refrigerator	15	16	16	15	16	16	5.9%
	Stove/Oven	35	36	36	37	39	43	24.0%
	Microwave	19	19	19	20	21	23	18.5%
Electronics	Personal Computers	18	19	19	19	20	22	24.0%
	Monitor	9	10	10	10	11	12	24.4%
	Laptops	9	10	10	11	13	17	84.5%
	TVs	81	87	89	94	104	126	56.1%
	Printer/Fax/Copier	9	9	9	10	11	13	56.9%
	Set-Top Boxes/DVRs	23	21	19	16	13	13	-42.4%
	Devices and Gadgets	15	18	19	21	27	42	172.7%
Miscellaneous	Electric Vehicles	1	2	3	5	12	27	3057.4%
	Pool Pump	7	7	7	7	7	7	-1.4%
	Pool Heater	3	3	3	3	3	3	0.3%
	Furnace Fan	13	13	13	12	12	13	-1.2%
	Well pump	12	13	13	13	13	13	4.9%
	Miscellaneous	41	48	50	57	72	113	173.0%
Total		**1,740**	**1,794**	**1,801**	**1,800**	**1,877**	**2,112**	**21.4%**

JBLM Residential Sector Baseline Projection

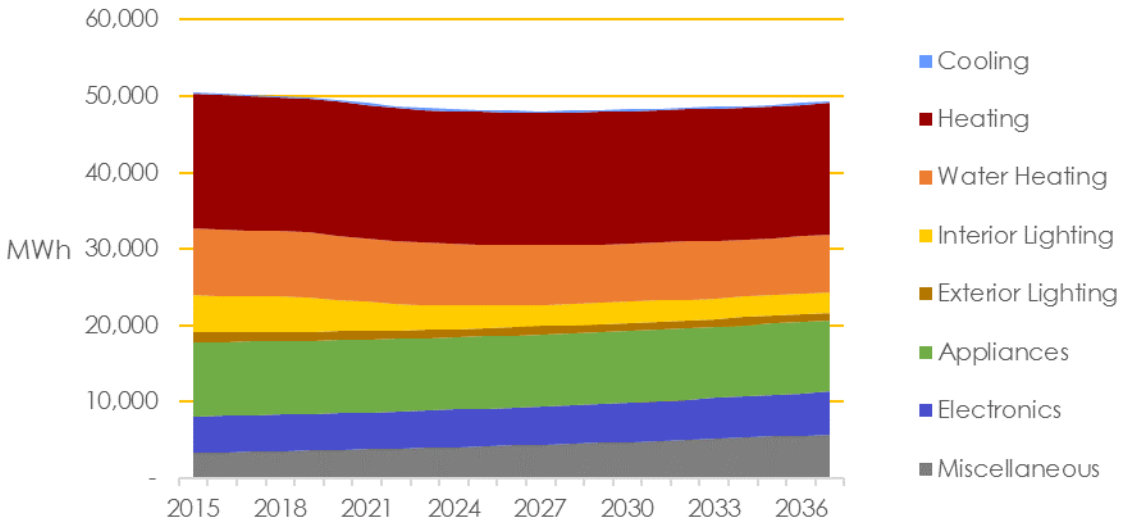
Annual electricity consumption in the JBLM residential sector declines during the overall forecast horizon, starting at 50,502 MWh in 2015 decreasing to 49,294 MWh in 2037, a decrease of 2.4%. Table 4-4 presents the JBLM residential sector annual forecast by technology for select years. Like non-JBLM residential, lighting use decreases throughout the time period as the lighting standards from EISA come into effect. Heating, water heating, and appliance consumption decreases as well.

Figure 4-6 and Figure 4-7 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) [12]

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	211	209	208	207	207	213	1.0%
Heating	17,636	17,557	17,533	17,465	17,373	17,254	-2.2%
Water Heating	8,759	8,555	8,463	8,197	7,792	7,483	-14.6%
Interior Lighting	4,863	4,621	4,508	3,514	2,834	2,669	-45.1%
Exterior Lighting	1,271	1,212	1,191	1,127	1,065	1,032	-19.0%
Appliances	9,725	9,598	9,567	9,487	9,406	9,321	-4.2%
Electronics	4,757	4,802	4,805	4,854	5,018	5,578	17.3%
Miscellaneous	3,281	3,508	3,590	3,855	4,373	5,745	75.1%
Total	**50,502**	**50,062**	**49,865**	**48,706**	**48,067**	**49,294**	**-2.4%**

Figure 4-6 JBLM Residential Baseline Projection by End Use (GWh)



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

Figure 4-7 JBLM Residential Baseline Projection by End Use – Annual Use per Household

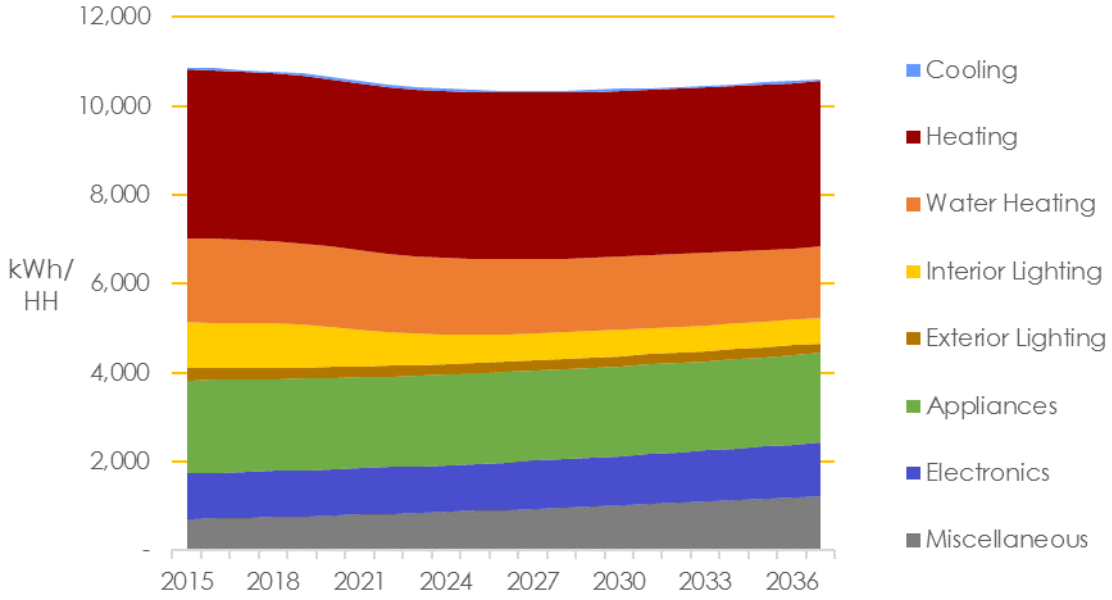


Table 4-5 JBLM Residential Baseline Projection by End Use and Technology (MWh) [13]

End Use	Technology	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	Central AC	-	-	-	-	-	-	0.0%
	Room AC	67	66	66	65	65	64	-5.0%
	Air-Source Heat Pump	144	143	142	142	142	149	3.7%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
Heating	Air-Source Heat Pump	1,385	1,360	1,353	1,338	1,334	1,386	0.0%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
	Electric Room Heat	9,919	9,910	9,907	9,898	9,884	9,855	-0.6%
	Electric Furnace	6,332	6,287	6,272	6,228	6,156	6,013	-5.0%
Water Heating	Water Heater (<= 55 Gal)	3,688	3,655	3,643	3,615	3,586	3,602	-2.3%
	Water Heater (55 to 75 Gal)	4,720	4,561	4,486	4,265	3,913	3,611	-23.5%
	Water Heater (> 75 Gal)	351	339	334	317	292	270	-23.0%
Interior Lighting	General Service Lighting	3,109	2,978	2,912	2,041	1,435	1,295	-58.4%
	Linear Lighting	633	619	614	602	587	574	-9.3%
	Exempted Lighting	1,121	1,024	982	870	812	799	-28.7%
Ext. Light	Screw-In/Hard-Wire	1,271	1,212	1,191	1,127	1,065	1,032	-18.8%
Appliances	Clothes Washer	221	216	214	210	206	202	-8.5%
	Clothes Dryer	2,764	2,758	2,757	2,756	2,766	2,770	0.2%
	Dishwasher	918	918	919	922	934	939	2.4%
	Refrigerator	2,502	2,450	2,433	2,390	2,337	2,284	-8.7%
	Freezer	1,347	1,323	1,316	1,295	1,268	1,239	-8.0%
	Second Refrigerator	481	473	471	465	458	455	-5.5%
	Stove/Oven	943	939	937	934	929	927	-1.7%
	Microwave	548	521	519	514	508	505	-7.8%
Electronics	Personal Computers	538	536	536	534	533	531	-1.3%
	Monitor	286	285	284	283	283	282	-1.4%
	Laptops	263	273	277	289	311	363	38.1%
	TVs	2,339	2,406	2,428	2,497	2,617	2,875	22.9%
	Printer/Fax/Copier	254	261	264	271	285	317	24.7%
	Set-Top Boxes/DVRs	645	562	521	429	336	289	-55.2%
	Devices and Gadgets	432	479	496	550	653	921	113.2%
Miscella-neous	Electric Vehicles	-	-	-	-	-	-	0.0%
	Pool Pump	236	232	230	227	224	222	-6.0%
	Pool Heater	95	94	93	93	92	91	-4.3%
	Furnace Fan	401	394	392	387	380	373	-7.0%
	Well pump	414	414	414	414	414	414	0.0%
	Miscellaneous	2,136	2,375	2,460	2,735	3,263	4,646	117.5%
Total		**50,502**	**50,062**	**49,865**	**48,706**	**48,067**	**49,294**	**-2.4%**

[13] 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 use in the commercial sector grows 2.9% during the overall forecast horizon, starting at 1,310 GWh in 2015, and increasing to 1,348 in 2037. Table 4-6 and Figure 4-8 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 EISA 2007 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. This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.

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

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	201	205	212	209	209	209	4.3%
Heating	144	146	150	147	146	143	-0.9%
Ventilation	141	141	143	139	136	129	-8.5%
Water Heating	27	28	28	28	28	27	1.6%
Interior Lighting	313	307	308	271	249	220	-29.5%
Exterior Lighting	124	124	126	113	106	100	-19.7%
Refrigeration	98	96	98	93	88	85	-14%
Food Preparation	58	58	60	59	59	60	3.9%
Office Equipment	89	94	98	100	104	111	24%
Miscellaneous	116	139	149	168	201	264	128.3%
Total	**1,310**	**1,340**	**1,373**	**1,327**	**1,327**	**1,348**	**2.9%**

Figure 4-8 Commercial Baseline Projection by End Use

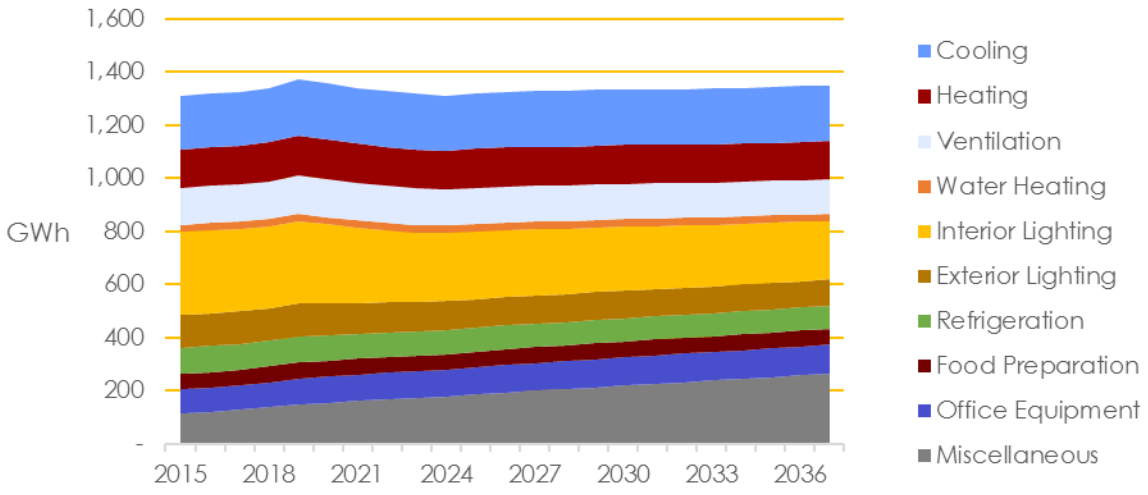


Table 4-7 presents the commercial sector annual forecast by technology for select years. Screw-in lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2015 baseline.

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

End Use	Technology	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	Air-Cooled Chiller	26	26	27	26	26	25	-3.2%
	Water-Cooled Chiller	31	32	33	32	32	31	-0.2%
	RTU	103	107	111	110	111	113	8.9%
	Room AC	19	19	20	19	19	19	-2.3%
	Air-Source Heat Pump	16	16	17	16	17	17	7.1%
	Geothermal Heat Pump	5	5	5	5	5	5	-7.0%
Heating	Air-Source Heat Pump	29	29	30	29	29	28	-3.2%
	Geothermal Heat Pump	13	13	14	13	13	13	-5.1%
	Electric Furnace	18	18	19	18	18	18	3.2%
	Electric Room Heat	84	86	88	86	86	84	-0.2%
Ventilation	Ventilation	141	141	143	139	136	129	-8.5%
Water Heating	Water Heater	27	28	28	28	28	27	1.6%
Interior Lighting	Screw-in/Hard-wire	69	65	63	35	25	21	-69.9%
	Linear Lighting	152	151	152	146	139	122	-20.0%
	High-Bay Fixtures	92	92	93	89	85	78	-15.1%
Exterior Lighting	Screw-in/Hard-wire	31	30	30	20	16	15	-50.8%
	Linear Lighting	32	32	33	32	32	30	-6.4%
	Area Lighting	62	62	63	61	59	55	-11.2%
Refrigeration	Walk-in Refrigerator/Freezer	13	13	13	12	11	10	-24.3%
	Reach-in Refrigerator/Freezer	3	3	3	3	2	2	-38.2%
	Glass Door Display	11	10	10	9	8	7	-38.2%
	Open Display Case	51	51	52	50	49	48	-6.0%
	Icemaker	14	13	14	13	13	12	-8.7%
	Vending Machine	6	6	6	6	6	6	-6.8%
Food Preparation	Oven	18	19	19	19	19	19	4.5%
	Fryer	11	11	12	11	11	12	3.9%
	Dishwasher	23	23	24	23	23	23	3.7%
	Hot Food Container	2	2	2	2	2	2	3.5%
	Steamer	4	4	4	4	4	4	2.0%
Office Equipment	Desktop Computer	54	56	58	59	60	63	16.7%
	Laptop	7	7	7	7	7	8	16.5%
	Monitor	9	11	11	12	13	16	69.4%
	Server	12	13	13	13	13	14	17.4%
	Printer/Copier/Fax	6	7	7	7	8	9	48.3%
	POS Terminal	2	2	2	2	2	2	5.5%
Miscellaneous	Non-HVAC Motors	12	12	13	13	12	12	2.0%
	Pool Pump	0	0	0	0	0	0	0.6%
	Pool Heater	0	0	0	0	0	0	2.5%
	Other Miscellaneous	103	126	136	155	188	251	143.6%
Total		**1,310**	**1,340**	**1,373**	**1,327**	**1,327**	**1,348**	**2.9%**

JBLM Commercial Sector Baseline Projection

Annual electricity use in the JBLM commercial sector grows during the overall forecast horizon, starting at 293 GWh in 2015, and increasing to 304 GWh in 2037, an increase of 3.7%. The increase corresponds to internal JBLM projections provided by Tacoma Power. Table 4-8 and Figure 4-9 present the baseline projection at the end-use level for the JBLM commercial sector as a whole. Refer to Appendix B for additional information on how the JBLM baseline projection was constructed.

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

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	47	47	47	47	47	48	3.2%
Heating	38	38	38	38	38	38	2.2%
Ventilation	33	33	33	33	33	32	-4.0%
Water Heating	6	6	6	6	6	6	5.7%
Interior Lighting	53	52	51	46	42	39	-27%
Exterior Lighting	24	24	24	22	22	21	-12.1%
Refrigeration	13	13	12	12	12	12	-4.2%
Food Preparation	17	17	18	18	19	20	16.5%
Office Equipment	23	26	27	28	30	32	41.0%
Miscellaneous	41	44	45	48	51	56	38.0%
Total	**293**	**299**	**300**	**297**	**299**	**304**	**3.7%**

Figure 4-9 JBLM Commercial Baseline Projection by End Use

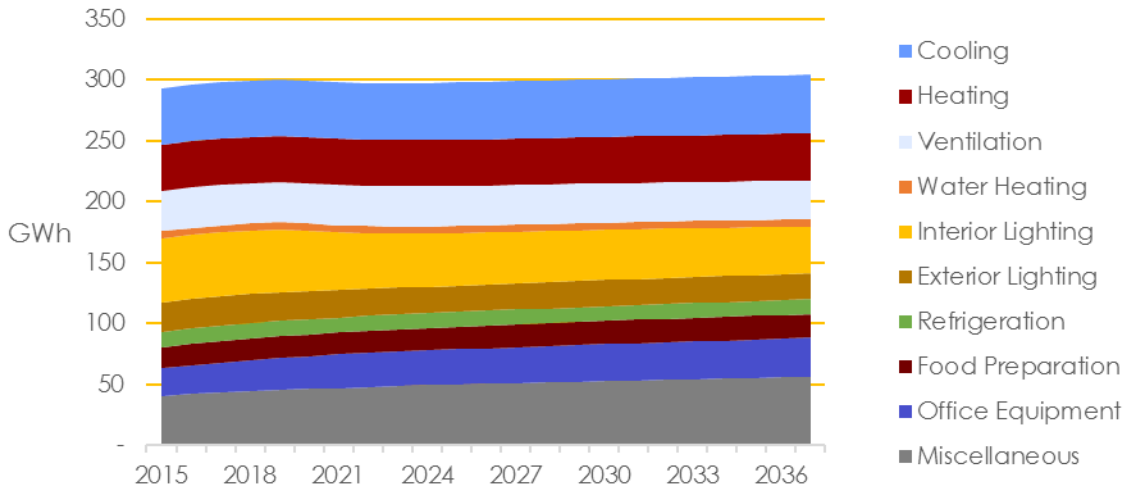


Table 4-9 presents the JBLM commercial sector annual forecast by technology for select years. Screw-in lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2015 baseline.

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

End Use	Technology	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	Air-Cooled Chiller	5	5	5	5	5	5	-0.6%
	Water-Cooled Chiller	12	12	12	12	12	12	0.4%
	RTU	17	18	18	18	18	19	8.0%
	Room AC	7	7	7	7	7	7	-1.6%
	Air-Source Heat Pump	4	4	4	4	4	4	6.0%
	Geothermal Heat Pump	1	1	1	1	1	1	-2.3%
Heating	Air-Source Heat Pump	6	6	6	6	6	6	-0.7%
	Geothermal Heat Pump	3	3	3	3	3	3	-1.0%
	Electric Furnace	3	3	3	3	3	3	1.5%
	Electric Room Heat	26	26	26	26	26	26	3.3%
Ventilation	Ventilation	33	33	33	33	33	32	-4.0%
Water Heating	Water Heater	6	6	6	6	6	6	5.7%
Interior Lighting	Screw-in/Hard-wire	13	13	13	8	6	5	-64.1%
	Linear Lighting	25	25	25	24	23	21	-15.3%
	High-Bay Fixtures	15	14	14	14	13	13	-13.6%
Exterior Lighting	Screw-in/Hard-wire	5	5	5	3	2	2	-53.8%
	Linear Lighting	4	4	4	4	4	4	-3.6%
	Area Lighting	15	15	15	15	15	15	-1.3%
Refrigeration	Walk-in Refrigerator/Freezer	3	3	3	3	3	2	-14.1%
	Reach-in Refrigerator/Freezer	1	1	1	1	1	1	-29.0%
	Glass Door Display	1	1	1	1	1	1	-31.7%
	Open Display Case	3	3	3	3	3	3	0.3%
	Icemaker	4	4	4	4	4	4	7.6%
	Vending Machine	1	2	2	2	2	2	9.7%
Food Preparation	Oven	6	6	6	6	6	7	16.6%
	Fryer	3	3	3	3	3	3	17.1%
	Dishwasher	7	7	7	8	8	8	16.2%
	Hot Food Container	0	0	0	0	1	1	16.4%
	Steamer	1	1	1	1	1	1	16.8%
Office Equipment	Desktop Computer	14	16	16	17	18	20	38.9%
	Laptop	2	2	2	2	2	2	39.1%
	Monitor	3	3	3	3	3	4	51.6%
	Server	3	3	3	3	3	4	39.0%
	Printer/Copier/Fax	2	2	2	2	2	2	51.6%
	POS Terminal	0	0	0	0	0	0	25.8%
Miscellaneous	Non-HVAC Motors	5	5	5	5	5	6	20.9%
	Pool Pump	0	0	0	0	0	0	16.5%
	Pool Heater	0	0	0	0	0	0	16.3%
	Other Miscellaneous	36	39	40	42	45	50	40.3%
Total		**293**	**299**	**300**	**297**	**299**	**304**	**3.7%**

Industrial Sector Baseline Projection

Annual industrial use increases significantly by 2019 then remains relatively flat throughout the remainder of the forecast horizon. The load forecast primarily associates this near-term increase with the addition of a small group of large customers who are moving into the area or expanding their operations considerably. Table 4-10 and Figure 4-10 present the projection at the end-use level. Overall, industrial annual electricity use increases from 1,050 GWh in 2015 to 1,324 GWh in 2037. This comprises an overall increase of 26.1% over the 23-year period. The projection grows sharply in 2018 and 2019 as a result of a few large customers who are planned to come online during that timeframe.

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

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	29	31	33	34	34	36	23.2%
Heating	40	43	46	47	48	51	25.5%
Ventilation	22	22	23	23	23	22	0.5%
Interior Lighting	45	45	47	45	43	40	-11.5%
Exterior Lighting	24	25	26	25	24	24	-0.7%
Motors	653	691	750	763	781	816	24.9%
Process	200	212	230	234	239	250	24.9%
Miscellaneous	37	44	49	55	66	86	135.2%
Total	**1,050**	**1,112**	**1,205**	**1,226**	**1,257**	**1,324**	**26.1%**

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

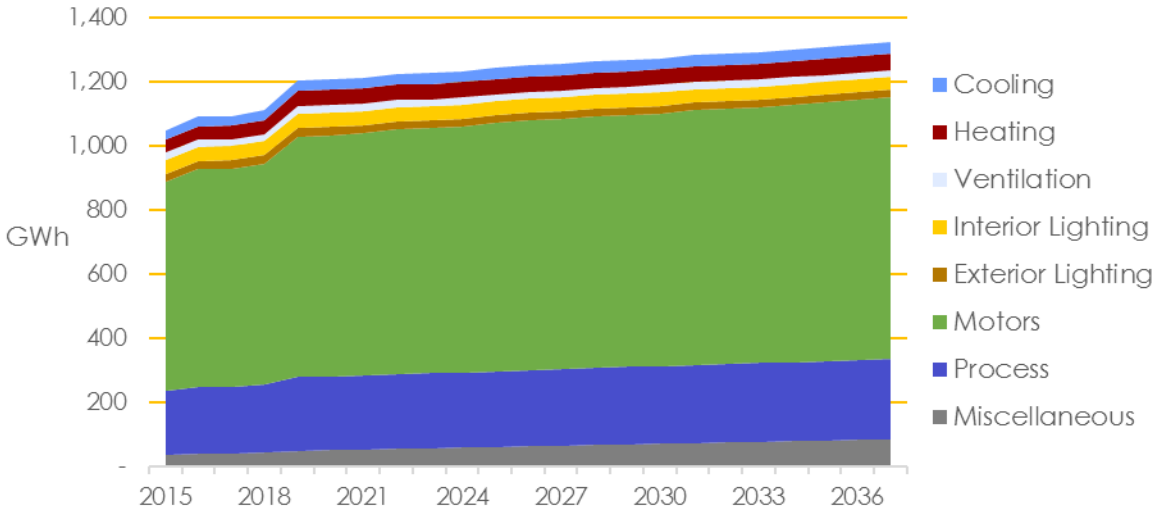


Table 4-11 presents the industrial sector annual forecast by technology for select years. Screw-in lighting technologies decrease significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2015 baseline.

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

End Use	Technology	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
Cooling	Air-Cooled Chiller	4	5	5	5	5	5	20.6%
	Water-Cooled Chiller	5	5	6	5	5	5	3.4%
	RTU	16	17	18	19	19	20	29.4%
	Air-Source Heat Pump	4	4	4	4	5	5	27.6%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
Heating	Air-Source Heat Pump	7	7	8	8	8	9	28.1%
	Geothermal Heat Pump	-	-	-	-	-	-	0.0%
	Electric Room Heat	28	30	32	33	34	35	24.9%
	Electric Furnace	5	6	6	6	7	7	24.9%
Ventilation	Ventilation	22	22	23	23	23	22	0.5%
Interior Lighting	Screw-in-Hard-wire	3	3	3	2	2	1	-52.4%
	Linear Lighting	9	10	10	10	10	9	0.1%
	High-Bay Fixtures	32	32	34	33	31	29	-11.1%
Exterior Lighting	Screw-in-Hard-wire	3	3	4	2	2	2	-42.9%
	Linear Lighting	5	5	6	6	6	6	21.7%
	Area Lighting	16	16	17	16	16	16	1.1%
Motors	Pumps	178	188	204	208	212	222	24.9%
	Fans & Blowers	102	108	118	120	122	128	24.9%
	Compressed Air	87	92	100	102	104	109	24.9%
	Conveyors	271	287	312	317	324	339	24.9%
	Other Motors	15	15	17	17	17	18	24.9%
Process	Process Heating	94	100	108	110	113	118	24.9%
	Process Cooling	25	27	29	30	30	32	24.9%
	Process Refrigeration	25	27	29	30	30	32	24.9%
	Process Electro-Chemical	40	42	46	47	48	50	24.9%
	Process Other	15	16	18	18	18	19	24.9%
Miscellaneous	Miscellaneous	37	44	49	55	66	86	135.2%
Total		**1,050**	**1,112**	**1,205**	**1,226**	**1,257**	**1,324**	**26.1%**

Street Lighting Sector Baseline Projection

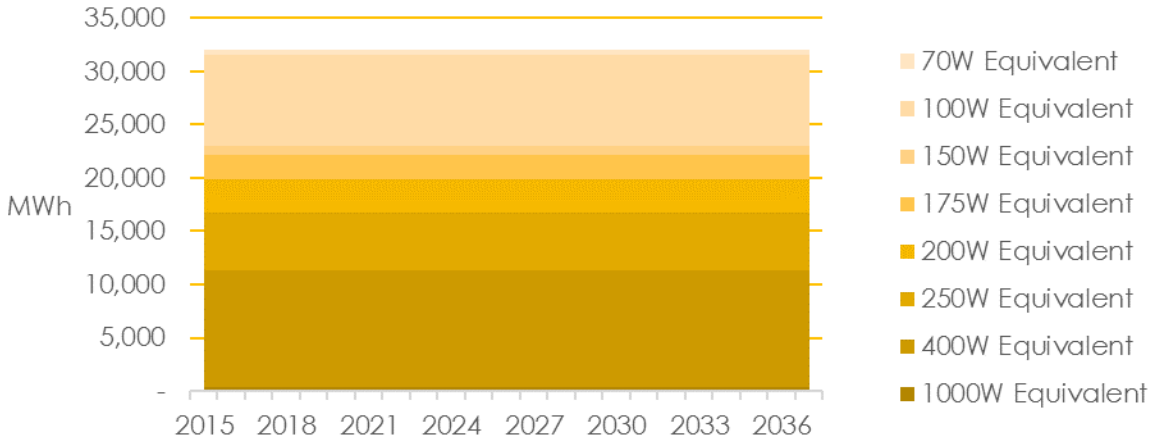
Annual electricity use in the street lighting sector remains flat throughout forecast horizon at 32,024 MWh. Table 4-12 and

Figure 4-11 present the baseline projection at the fixture level for the street lighting sector as a whole. The street lighting baseline projection assumes no street lighting fixture growth over the study period. As discussed in the previous chapter, non-City of Tacoma fixtures are already mostly LEDs in the baseline and City-owned fixture are mostly high intensity discharge (HID) lamps. Due to these factors as well as the "frozen efficiency" baseline assumption, there is no meaningful change in consumption.

Table 4-12 Street Lighting Baseline Projection by End Use (MWh) [14]

End Use	2015	2018	2019	2022	2027	2037	% Change ('15-'37)
70W Equivalent	430	430	430	430	430	430	0.0%
100W Equivalent	8,634	8,634	8,634	8,634	8,634	8,634	0.0%
150W Equivalent	835	835	835	835	835	835	0.0%
175W Equivalent	2,306	2,306	2,306	2,306	2,306	2,306	0.0%
200W Equivalent	3,019	3,019	3,019	3,019	3,019	3,019	0.0%
250W Equivalent	5,493	5,493	5,493	5,493	5,493	5,493	0.0%
400W Equivalent	10,941	10,941	10,941	10,941	10,941	10,941	0.0%
1000W Equivalent	366	366	366	366	366	366	0.0%
Total	**32,024**	**32,024**	**32,024**	**32,024**	**32,024**	**32,024**	**0.0%**

Figure 4-11 Street Lighting Baseline Projection by End Use (GWh)



[14] 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 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, street lighting, and distribution analyses.

Summary of Overall Conservation Potential Table 5-1 and Figure 5-1 summarize the conservation savings in terms of annual energy use for 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, which reflect 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 impact each year of the forecast.

- Technical Potential reflects the adoption of all conservation measures regardless of cost-effectiveness. 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 installed, regardless of achievability. 2018 first-year net savings are 122 GWh, or 2.6% of the baseline projection. Cumulative net savings in 2027 are 717 GWh, or 14.8% of the baseline. By 2037, cumulative savings reach 960 GWh, or 18.6% 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 2018-2037 CPA, unadjusted ramp rates from the Seventh Power Plan were applied. For all Seventh 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 Plan. These ramp rates may be found in Appendix C. 2018 first-year net savings are 59 GWh, or 1.3% of the baseline projection. Cumulative net savings in 2027 are 489 GWh, or 10.1% of the baseline. By 2037 cumulative savings reach 730 GWh, or 14.1% of the baseline.
- Achievable Economic Potential further refines achievable technical potential by applying an economic 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 these costs per the power act. Additional details can be found in Appendix A. 2018 first-year net savings are 31 GWh, or 0.7% of the baseline projection. Cumulative net savings in 2027 are 278 GWh, or 5.7% of the baseline. By 2037 cumulative savings reach 450 GWh, or 8.7% of the baseline.

Table 5-1 Summary of Conservation Potential (Annual Energy, GWh)

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	4,627	4,761	4,732	4,840	5,170
Cumulative Savings (GWh)					
Achievable Economic Potential	31	69	149	278	450
Achievable Technical Potential	59	121	261	489	730
Technical Potential	122	238	421	717	960
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.7%	1.4%	3.1%	5.7%	8.7%
Achievable Technical Potential	1.3%	2.5%	5.5%	10.1%	14.1%
Technical Potential	2.6%	5.0%	8.9%	14.8%	18.6%

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

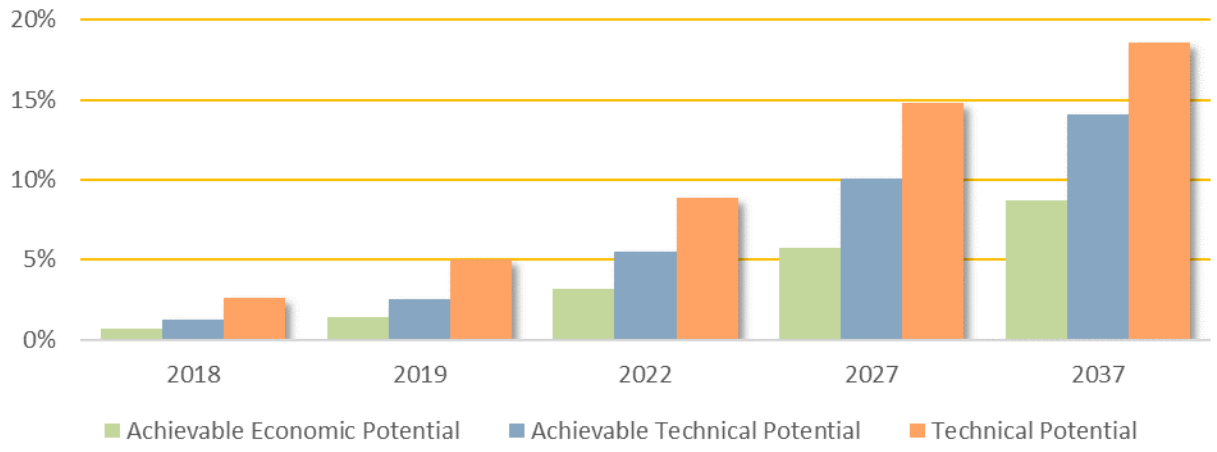


Figure 5-2 Baseline Projection and Conservation Forecast Summary (Annual Energy, GWh)

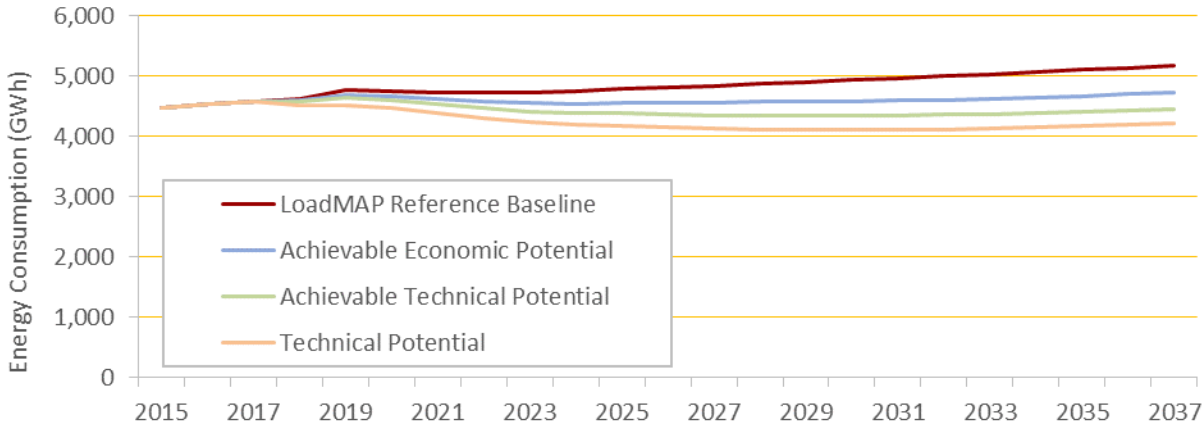


Figure 5-3 and Figure 5-4 show the supply curve of levelized cost per kWh vs. the 10-year cumulative achievable technical potential for all sectors in 2027. The achievable technical curve represents the universe of measures evaluated for this study in the residential, commercial, industrial, JBLM, street lighting, and distribution models. 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.

The dotted blue line represents the cost-effectiveness threshold, determined through a measure-by-measure TRC economic screen utilizing Tacoma Power's adjusted wholesale price forecast to assign monetary value to the energy savings. Savings on the curve to the left of this point reflect the achievable economic potential, or the subset of measures that pass the cost-effectiveness screen.

Note that the first tranche of savings up to around 90 GWh have levelized lifetime energy costs that are zero or negative. This is because lifetime 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. Also, note that while a measure with a high levelized cost could pass the TRC, the utility is ultimately limited to offer incentives no higher than the forecast avoided wholesale cost of power for the measure. This is especially relevant for measures with high non-electric benefits.

Figure 5-3 Supply Curve, All Sectors in 2027 (Annual Energy, MWh)

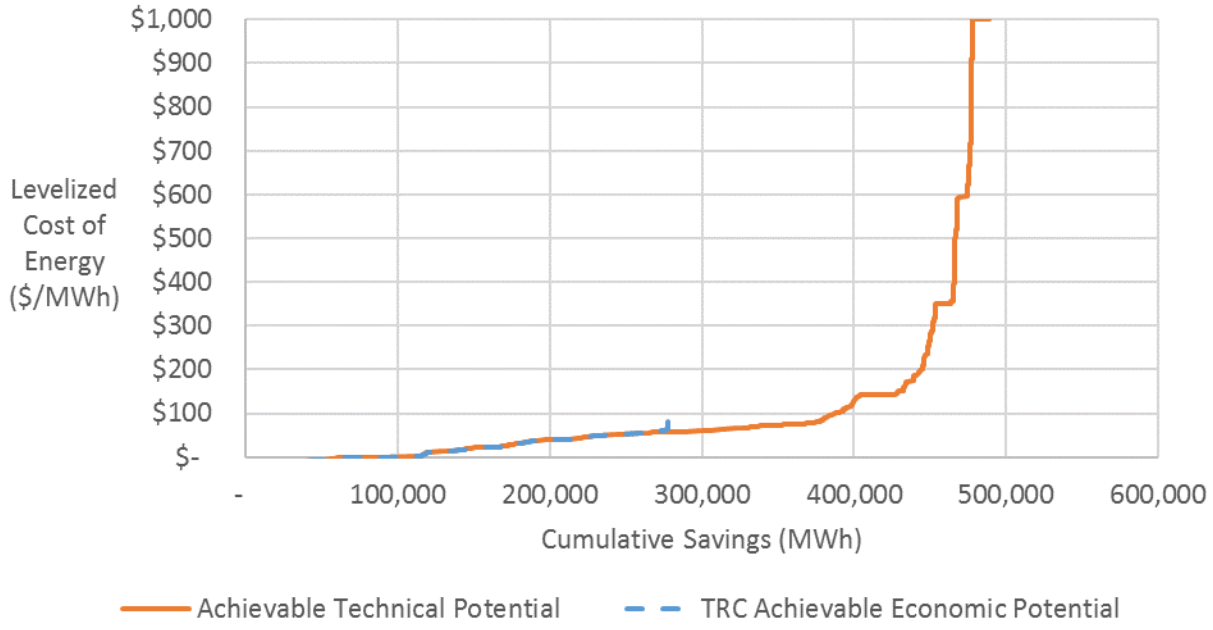


Figure 5-4 Supply Curve, All Sectors in 2027, Limited Axis (Annual Energy, MWh)

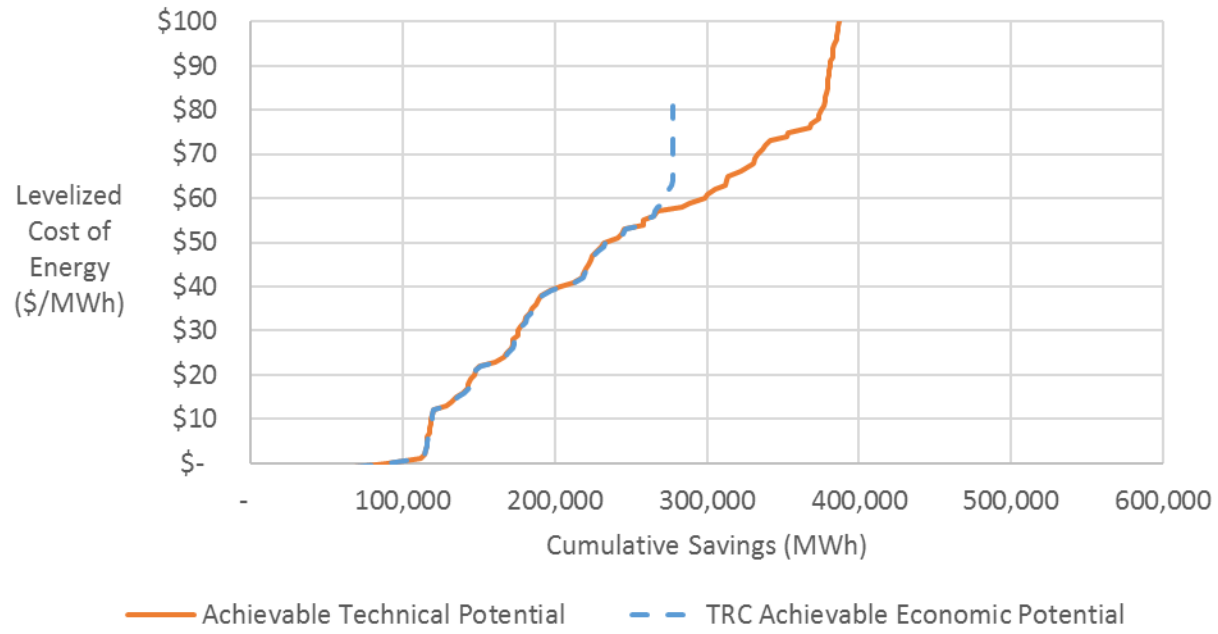


Table 5-2 summarizes achievable economic potential by market sector for selected years. In 2027, the residential and commercial segments make up a majority of the potential, followed by industrial. Distribution efficiency, street lighting, and JBLM round out the mix.

Table 5-2 Achievable Economic Potential by Sector, Selected Years (GWh)

	2018	2019	2022	2027	2037
Achievable Economic Potential	**31.4**	**68.6**	**149.0**	**277.6**	**450.1**
Residential	12.3	26.2	56.5	99.2	158.8
JBLM Residential	0.2	0.4	0.9	1.5	2.2
Commercial	8.4	20.0	41.8	87.9	162.7
JBLM Commercial	0.6	1.4	3.1	7.1	14.1
Industrial	4.2	9.6	26.7	57.6	86.2
Street Lighting	3.1	5.8	6.8	8.6	10.2
Distribution Efficiency	2.6	5.3	13.2	15.8	15.8

6

SECTOR-LEVEL CONSERVATION POTENTIAL

The previous section provided a summary of potential for the territory as a whole. In this section, we provide details for each sector.

Residential Potential

Table 6-1 and Figure 6-2 present estimates for measure-level conservation potential for the residential sector. In 2027, achievable economic potential represents nearly almost half of achievable technical potential. Achievable economic potential is lower than in the prior study. This is mainly due to updated ductless mini split heat pump costs and savings, resulting in this high-potential measure not passing the TRC test. Since the potential forecast period begins in 2018, phase two of the EISA 2007 general service lighting standard takes effect two years into the study. This, along with additional LEDs present in the base-year of the study, lowers lighting potential as well.

Figure 6-1 Residential Home Weatherization (courtesy of Tacoma Power)

Table 6-1 Residential Conservation Potential (Annual Energy, GWh)

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	1,794	1,801	1,800	1,877	2,112
Cumulative Savings (GWh)					
Achievable Economic Potential	12	26	57	99	159
Achievable Technical Potential	31	61	125	235	340
Technical Potential	58	109	194	330	420
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.7%	1.5%	3.1%	5.3%	7.5%
Achievable Technical Potential	1.7%	3.4%	7.0%	12.5%	16.1%
Technical Potential	3.2%	6.0%	10.8%	17.6%	19.9%

Figure 6-2 Residential Savings as a % of the Baseline Projection (Annual Energy)

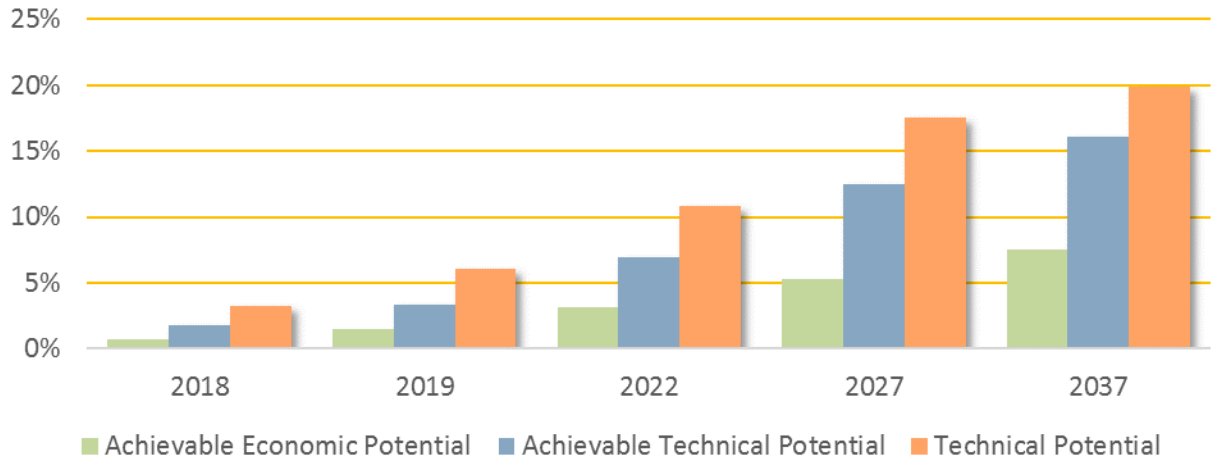


Figure 6-3 and Figure 6-4 show the supply curve of levelized TRC cost per MWh vs. cumulative achievable technical potential for the residential sector in 2027. Interior and exterior LED lighting and weatherization measures comprise the majority of cost effective savings. HVAC and water heating equipment replacements were found not to be cost effective due to a combination of relatively low savings and high equipment costs.

Figure 6-3 Supply Curve, Residential Sector in 2027 (Annual Energy, MWh)

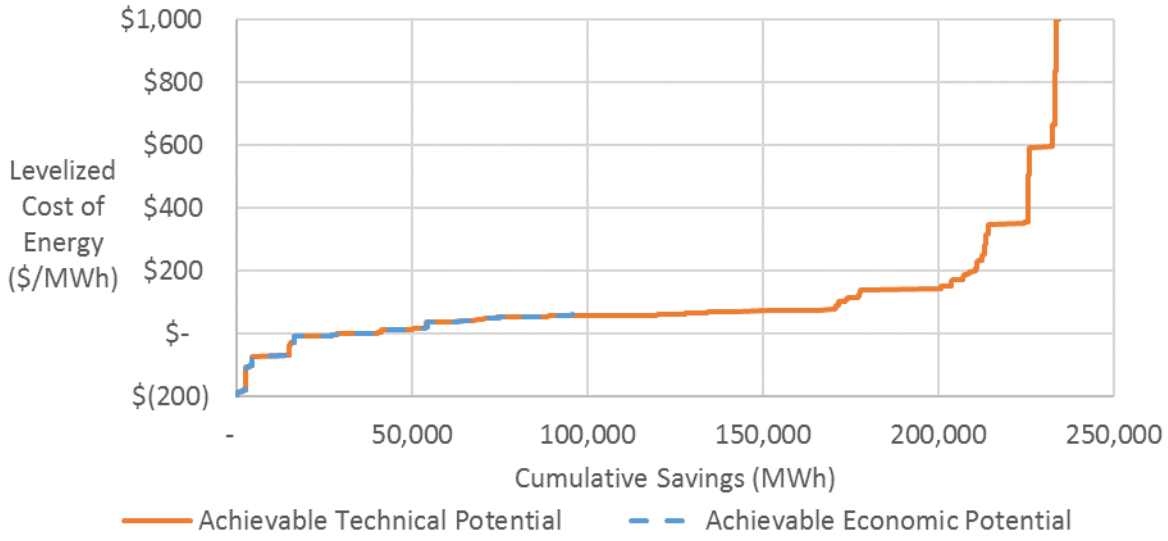


Figure 6-4 Supply Curve, Residential Sector in 2027, Limited Axis (Annual Energy, MWh)

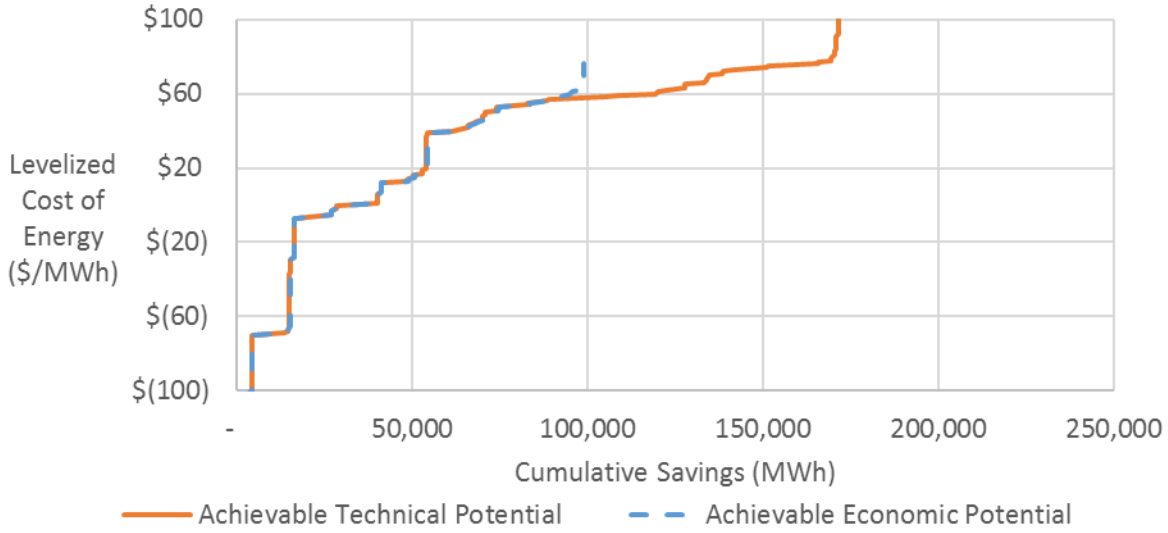


Table 6-2 identifies the top 20 residential measures by cumulative 2027 savings. The top measure is exterior screw in lighting as a result of purchases of LED lamps which are cost effective throughout the forecast horizon. As detailed above, interior LED lamp potential is somewhat lower, due both to the upcoming implementation of EISA 2007, phase two as well as higher LED saturations in the baseline. Weatherization measures present a large space heating savings opportunity in the residential sector.

Table 6-2 Residential Top Measures in 2027 (Annual Energy, MWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (MWh)	% of Total
1	Exterior Lighting - Screw-in/Hard-Wire	11,189	11.3%
2	Interior Lighting - Exempted Lighting	10,732	10.8%
3	Interior Lighting - General Service Lighting	10,503	10.6%
4	Insulation - Wall Cavity Installation	9,138	9.2%
5	Ducting - Repair and Sealing	7,958	8.0%
6	Water Heater - Pipe Insulation	5,573	5.6%
7	Windows - High Efficiency (SP to CI30)	4,360	4.4%
8	Water Heater - Low-Flow Showerheads (1.5 GPM)	3,675	3.7%
9	Insulation - Wall Cavity Installation - LI	3,089	3.1%
10	Furnace - Conversion to Air-Source Heat Pump	3,036	3.1%
11	Insulation - Ceiling Installation	2,939	3.0%
12	Water Heater - Low-Flow Showerheads (1.75 GPM)	2,726	2.7%
13	Water Heater - Faucet Aerators	2,726	2.7%
14	Thermostat - WiFi/Interactive	2,321	2.3%
15	Water Heater - Low-Flow Showerheads (2.0 GPM)	1,846	1.9%
16	Water Heater - Thermostatic Shower Restriction Valve	1,760	1.8%
17	Insulation - Floor Installation	1,751	1.8%
18	Windows - High Efficiency (SP to CI30) - LI	1,524	1.5%
19	Interior Lighting - General Service CFLs	1,451	1.5%
20	Exterior Lighting - Photosensor Control	1,392	1.4%
	Total	**89,687**	**90.4%**
	Total cumulative savings in 2027	**99,164**	**100.0%**

Figure 6-5 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Interior lighting savings account for a substantial portion of the savings throughout the forecast horizon but the share declines over time as the market transforms. Heating represents the largest portion of savings potential and the proportion steadily increases through 2037 as the potential for lighting savings decreases. Space heating potential comes mostly from weatherization measures, such as wall cavity insulation, duct repair and sealing, and high efficiency windows. A furnace to air-source heat pump retrofit measure makes the top ten in 2027.

Figure 6-5 Residential Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)

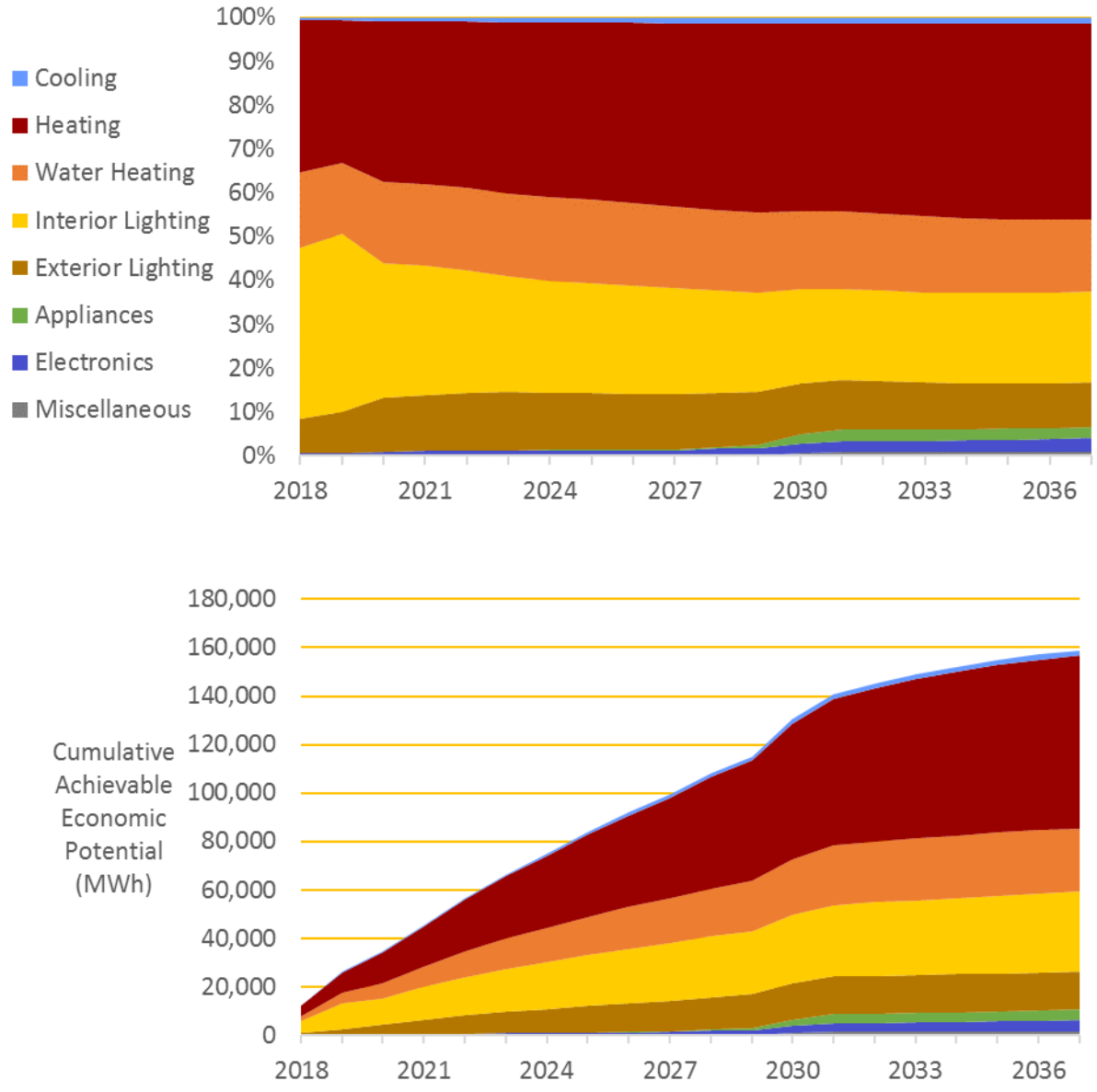


Table 6-3,

Table 6-4, and Table 6-5 summarize Residential sector savings by vintage, replacement type, and end use respectively.

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

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Single Family	Existing	8,980	19,147	41,859	70,469	108,240
	New	57	131	337	818	2,058
Single Family 2-4 units	Existing	331	700	1,537	2,500	3,931
	New	2	4	11	24	57
Low-Rise Multifamily	Existing	2,017	4,202	8,599	17,414	29,174
	New	285	655	1,011	2,284	7,775
High-Rise Multifamily	Existing	42	87	217	404	600
	New	6	14	21	46	157
Manufactured Home	Existing	596	1,244	2,919	5,094	6,654
	New	5	11	32	111	170
Total Residential	**Existing**	**11,966**	**25,379**	**55,131**	**95,881**	**148,599**
	New	**354**	**815**	**1,412**	**3,283**	**10,216**

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

Segment	Replacement Type	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Single Family	Lost Opportunity	2,741	7,306	15,763	27,528	36,285
	Retrofit	6,296	11,972	26,434	43,760	74,013
Single Family 2-4 units	Lost Opportunity	86	232	501	864	1,136
	Retrofit	246	472	1,046	1,660	2,852
Low-Rise Multifamily	Lost Opportunity	561	1,498	2,071	4,486	8,210
	Retrofit	1,741	3,359	7,539	15,212	28,739
High-Rise Multifamily	Lost Opportunity	12	31	42	90	165
	Retrofit	36	70	195	360	591
Manufactured Home	Lost Opportunity	92	245	461	817	1,108
	Retrofit	509	1,011	2,490	4,387	5,716
Total Residential	**Lost Opportunity**	**3,492**	**9,311**	**18,838**	**33,785**	**46,904**
	Retrofit	**8,828**	**16,883**	**37,704**	**65,379**	**111,912**

Table 6-5 Residential Achievable Economic Potential by End Use, 2027

End Use	Single Family	Single Family 2-4 units	Low-Rise Multifamily	High-Rise Multifamily	Manufactured Home	Total Residential
Cooling	1,197	37	25	0	77	1,337
Heating	27,994	1,033	8,811	227	3,362	41,426
Water Heating	11,036	462	5,950	124	859	18,431
Interior Lighting	18,207	572	4,556	92	594	24,020
Exterior Lighting	11,933	381	0	0	268	12,581
Appliances	79	3	17	0	9	109
Electronics	842	36	339	7	35	1,259
Miscellaneous	0	0	0	0	2	2
Total	**71,288**	**2,524**	**19,698**	**451**	**5,204**	**99,164**

Table 6-6 summarizes the risk level of achievable economic potential in 2027 for the residential sector. 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. Small savers come third since the lower potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped. Most RTF measures have a sunset date before 2020. About one-third of this subset has a TRC benefit-to-cost ratio of less than 1.2.

Table 6-6 Residential Achievable Economic Potential by Risk and RTF Category, 2027

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	1,087	1,225	1,086	12,094	15,492
1 - TRC B/C Ratio <1.2	34	0	0	123	157
2 - RTF Sunset before 2020	27,305	31,088	2,342	0	60,735
3 – Higher Risk (combined)	17,200	4,722	857	0	22,780
Total	**45,627**	**37,035**	**4,286**	**12,217**	**99,164**

JBLM Residential Potential

The Joint-Base Lewis-McChord (JBLM) is the largest user 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 Equity Residential. As part of the contract, the homes are required to be maintained at strict energy efficiency standards. 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 significantly lower than in other parts of the service territory.

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

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

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	50.1	49.9	48.7	48.1	49.3
Cumulative Savings (GWh)					
Achievable Economic Potential	0.2	0.4	0.9	1.5	2.2
Achievable Technical Potential	0.5	0.9	1.9	3.5	4.7
Technical Potential	1.6	3.1	5.4	9.0	10.9
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.4%	0.8%	1.8%	3.1%	4.5%
Achievable Technical Potential	0.9%	1.8%	3.9%	7.3%	9.5%
Technical Potential	3.3%	6.2%	11.2%	18.7%	22.1%

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

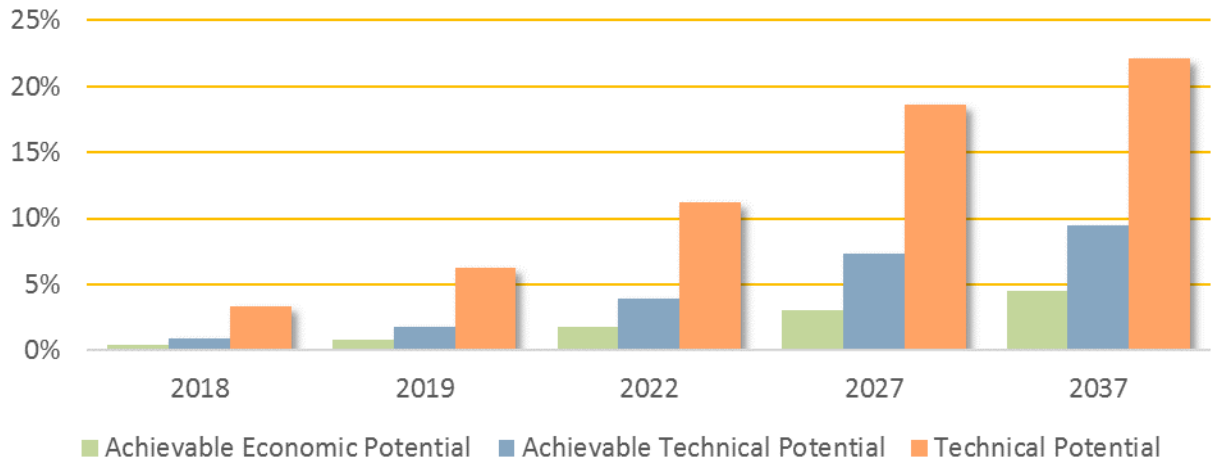


Figure 6-7 and Figure 6-8 show the supply curve of levelized TRC cost per MWh saved vs. cumulative achievable technical potential for the JBLM residential sector in 2025. Similar to the civilian residential sector, interior LED lighting and weatherization measures comprise the majority of cost effective 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 Equity has made in retrofitting existing homes and constructing efficient homes under their contract with JBLM. This reflects a higher efficiency baseline.

Figure 6-7 Supply Curve, JBLM Residential Sector in 2027 (Annual Energy, MWh)

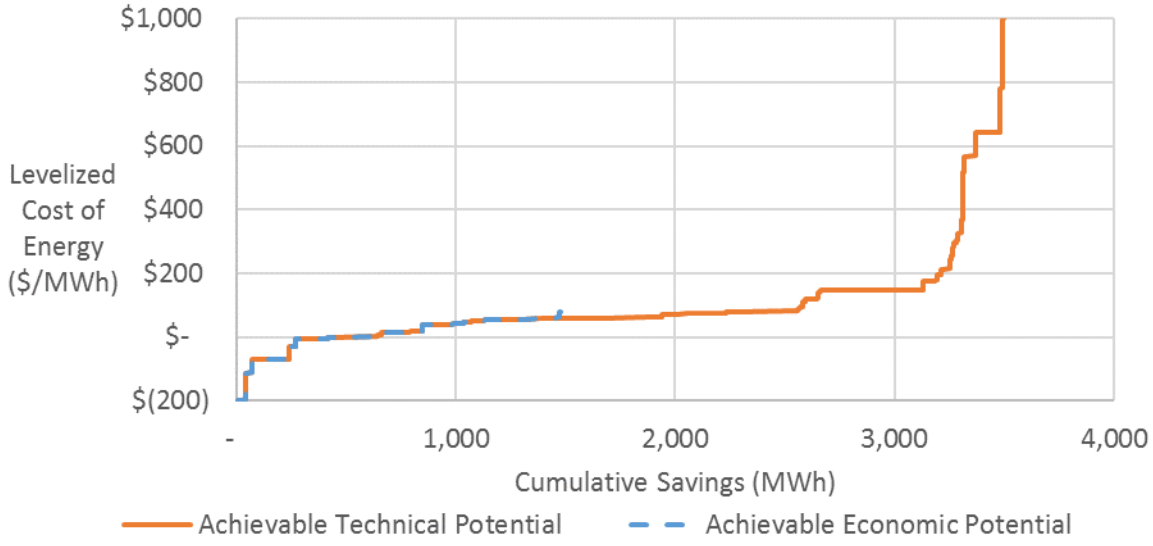


Figure 6-8 Supply Curve, JBLM Residential Sector in 2027, Limited Axis (Annual Energy, MWh)

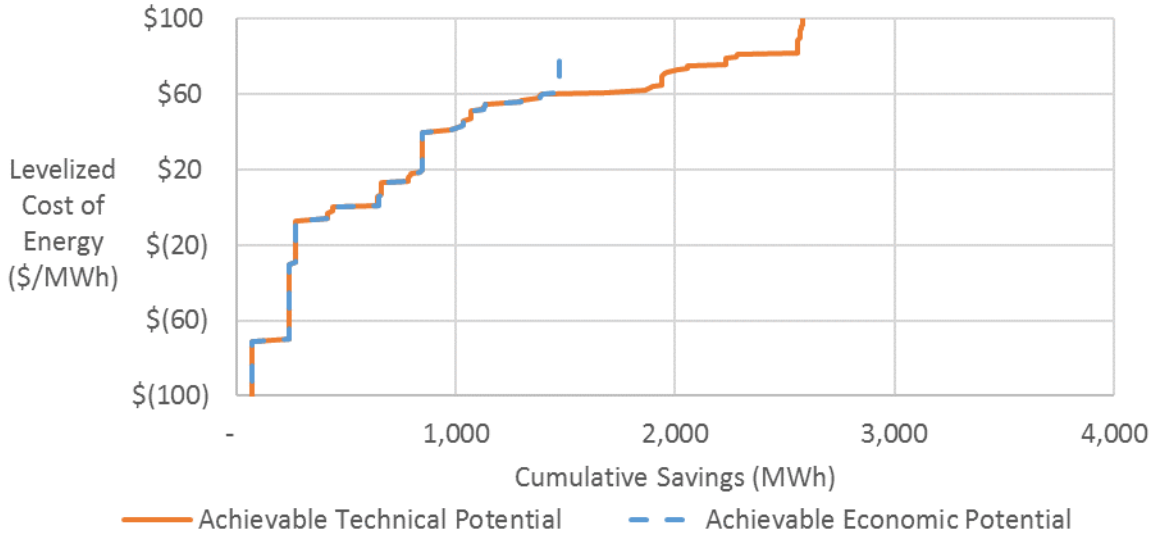


Table 6-8 identifies the top 20 residential measures in 2027. Potential savings are mainly driven by heating and lighting measures. Screw-in lighting is a source of substantial lighting savings as a result of purchases of LED lamps which are cost effective throughout the forecast horizon. Weatherization and water heating measures round out the top measures list.

Table 6-8 JBLM Residential Top Measures in 2027 (Annual Energy, MWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (MWh)	% of Total
1	Exterior Lighting - Screw-in/Hard-Wire	198	13.4%
2	Insulation - Wall Cavity Installation	185	12.5%
3	Interior Lighting - Exempted Lighting	177	12.0%
4	Interior Lighting - General Service Lighting	144	9.7%
5	Ducting - Repair and Sealing	125	8.5%
6	Windows - High Efficiency (SP to CI30)	88	5.9%
7	Water Heater - Pipe Insulation	83	5.6%
8	Insulation - Ceiling Installation	61	4.1%
9	Furnace - Conversion to Air-Source Heat Pump	52	3.5%
10	Water Heater - Low-Flow Showerheads (1.5 GPM)	52	3.5%
11	Water Heater - Faucet Aerators	39	2.6%
12	Water Heater - Low-Flow Showerheads (1.75 GPM)	39	2.6%
13	Exterior Lighting - Photosensor Control	34	2.3%
14	Interior Lighting - Exempted CFLs	27	1.9%
15	Water Heater - Thermostatic Shower Restriction Valve	27	1.9%
16	Interior Lighting - General Service CFLs	27	1.8%
17	Water Heater - Low-Flow Showerheads (2.0 GPM)	26	1.8%
18	Doors - Storm and Thermal	18	1.2%
19	Insulation - Ceiling Upgrade	13	0.9%
20	Windows - High Efficiency (SP to CI22)	11	0.7%
	Total	**1,426**	**96.5%**
	Total cumulative savings in 2027	**1,477**	**100.0%**

Figure 6-9 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Heating savings make up the majority of the savings throughout the forecast horizon. Lighting savings also account for a large portion of the savings but the share declines over time as the market is transformed. Onsite surveys of JBLM residential houses, conducted in 2014, demonstrate that existing lighting stock is already highly efficient, mainly CFL. This explains why interior lighting is a smaller portion of the savings overall compared to the general residential sector. Exterior lighting makes up a smaller portion but also declines over time.

Figure 6-9 JBLM Residential Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)

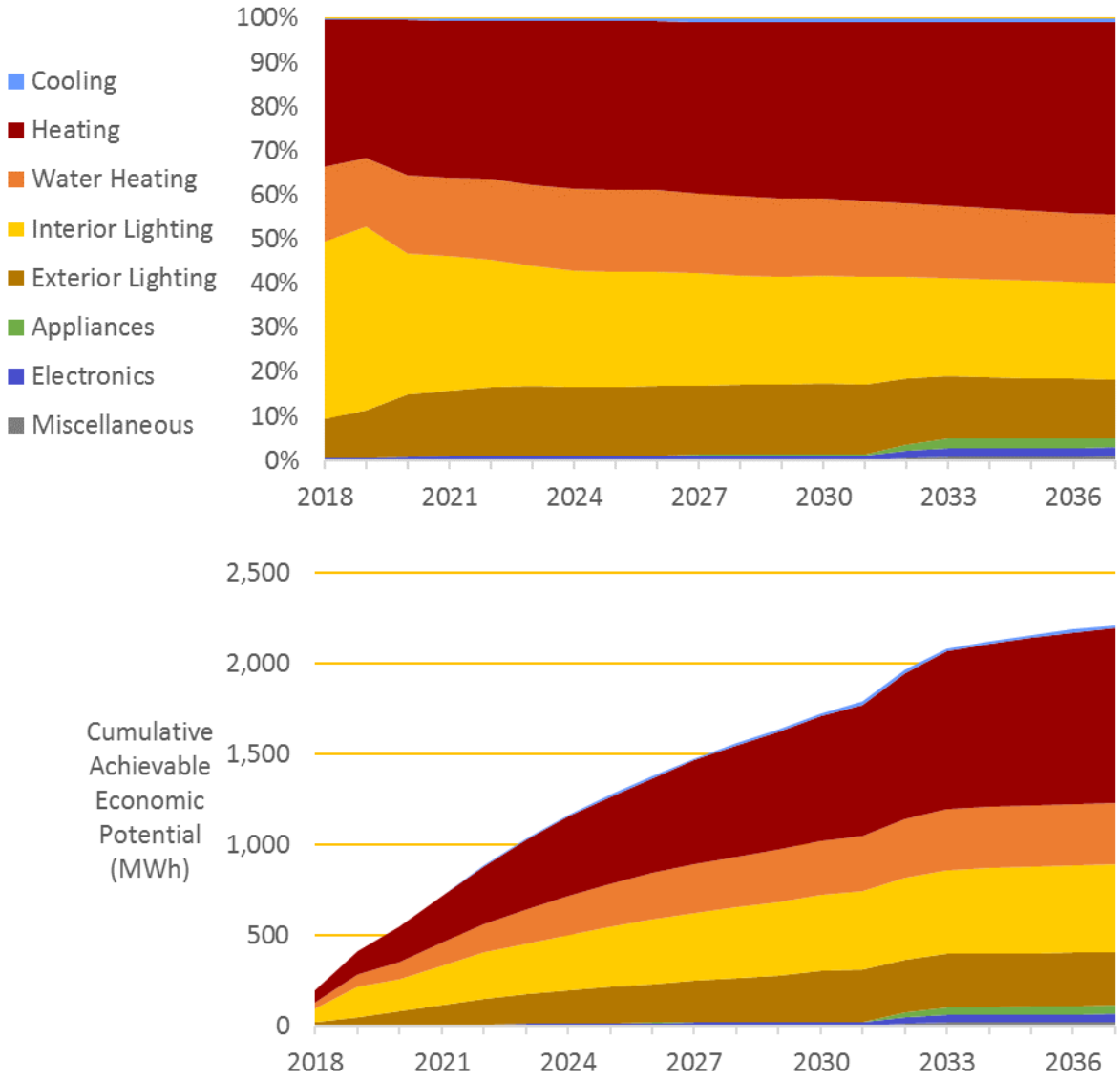


Table 6-9, Table 6-10 and Table 6-11 summarize JBLM Residential sector savings by vintage, replacement type, and end use respectively.

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

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Single Family	Existing	173	367	795	1,320	1,999
	New	1	2	6	14	29
Multifamily	Existing	20	43	86	143	185
	New	0	0	0	1	2
Total JBLM Residential	**Existing**	**193**	**410**	**880**	**1,463**	**2,183**
	New	**1**	**3**	**6**	**15**	**31**

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

Segment	Replacement Type	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Single Family	Lost Opportunity	51	136	293	511	677
	Retrofit	123	234	508	822	1,351
Multifamily	Lost Opportunity	4	11	13	26	38
	Retrofit	16	32	73	118	148
Total JBLM Residential	**Lost Opportunity**	**55**	**147**	**306**	**537**	**715**
	Retrofit	**139**	**266**	**581**	**941**	**1,499**

Table 6-11 JBLM Residential Achievable Economic Potential by End Use, 2027

End Use	Single Family	Multifamily	Total JBLM Residential
Cooling	12	0	12
Heating	523	49	572
Water Heating	203	66	268
Interior Lighting	348	27	375
Exterior Lighting	232	0	232
Appliances	1	0	2
Electronics	15	2	17
Miscellaneous	0	0	0
Total	1,334	144	1,477

Table 6-12 summarizes the risk level of achievable economic potential in 2027 for the JBLM residential sector. 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. Small savers come third since the lower potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped. Similar to the civilian residential sector, most RTF measures have a sunset date before 2020. In this case, over one-half of this subset has a TRC benefit-to-cost ratio of less than 1.2, higher than in the civilian residential sector.

Table 6-12 JBLM Residential Achievable Economic Potential by Risk and RTF Category, 2027

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	0	11	0	183	194
1 - TRC B/C Ratio <1.2	0	0	0	2	2
2 - RTF Sunset before 2020	433	349	32	0	814
3 – Higher Risk (combined)	272	191	5	0	468
Total	**705**	**551**	**36**	**185**	**1,477**

Commercial Potential

Table 6-13 and Figure 6-11 present the annual energy savings estimates for the three levels of conservation potential for the commercial sector. Compared to the residential sector, achievable economic potential is larger as a percent of the baseline. This is because lighting, an end use with high conservation potential, is a larger percent of baseline. The main reason is that the lighting hours of use in commercial buildings are significantly higher than residential dwellings (approximately three to four times higher on average).

Figure 6-10 Lighting at the LeMay - America's Car Museum (courtesy of Tacoma Power)

Table 6-13 Conservation Potential for the Commercial Sector (Energy Savings)

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	1,340	1,373	1,327	1,327	1,348
Cumulative Savings (GWh)					
Achievable Economic Potential	8	20	42	88	163
Achievable Technical Potential	14	32	72	141	237
Technical Potential	39	78	125	213	312
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.6%	1.5%	3.1%	6.6%	12.1%
Achievable Technical Potential	1.1%	2.4%	5.4%	10.7%	17.6%
Technical Potential	2.9%	5.7%	9.4%	16.1%	23.1%

Figure 6-11 Commercial Savings as a % of the Baseline Projection (Annual Energy)

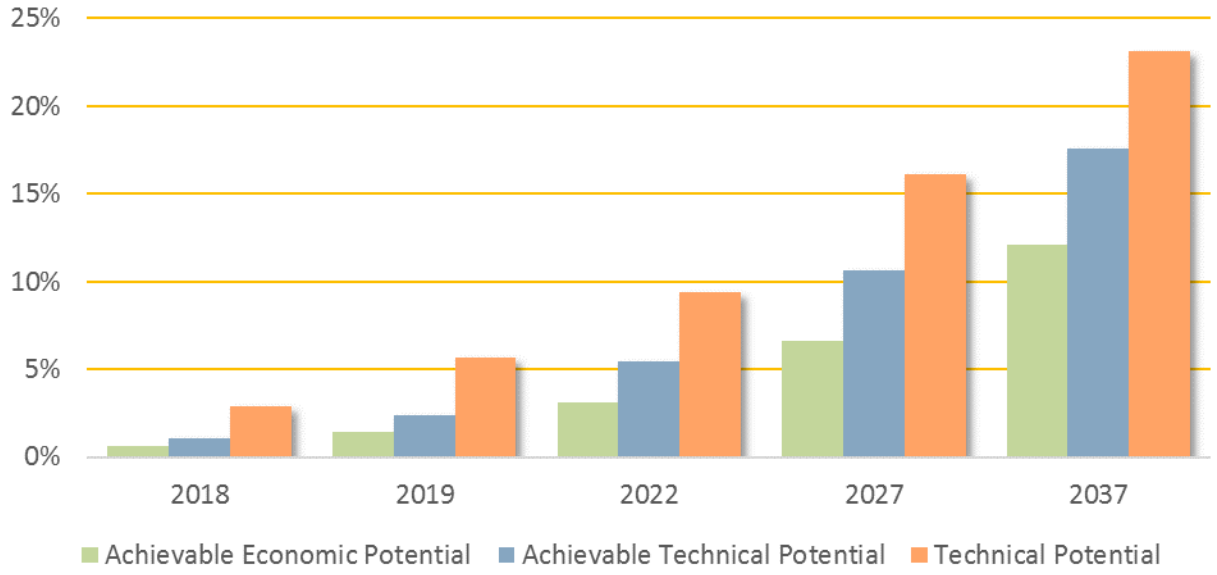


Figure 6-12 and Figure 6-13 show the supply curve of levelized TRC cost per MWh vs. cumulative achievable technical potential for the commercial sector in 2027. LED lighting comprises the vast majority of cost effective savings. Due to recent reductions in fixture costs, the price of linear LED panels has been significantly reduced. This has resulted in LED panels passing the TRC economic screen and contributing highly to the overall potential. Strategic energy management in large, targeted buildings results in sizeable achievable economic potential. Additionally, retrofit HVAC measures and water heating equipment were also found to be sources of cost-effective potential. Overall, achievable economic potential in the commercial sector represents a higher percentage of achievable technical potential when compared to residential savings. Assumptions for lighting controls measures, which were a large source of potential in the prior CPA, have been updated for the Seventh Plan. They have been replaced with two fixture controls measure, which are now assigned to lost opportunity ramp rates, limiting measure applicability to only the subset of the market where new fixtures are installed.

Figure 6-12 Supply Curve, Commercial Sector in 2027 (Annual Energy, MWh)

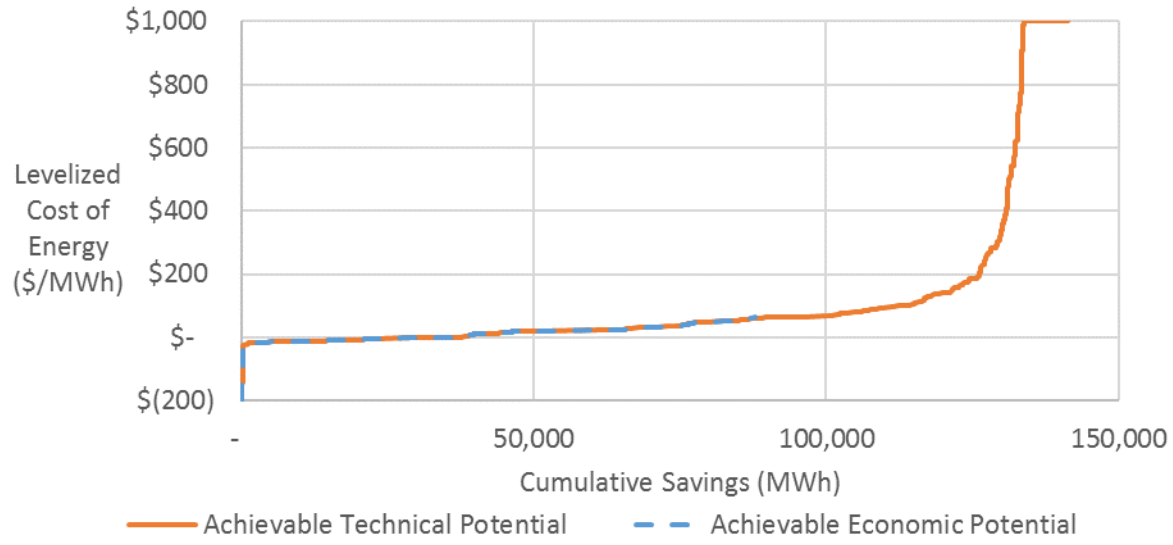


Figure 6-13 Supply Curve, Commercial Sector in 2027, Limited Axis (Annual Energy, MWh)

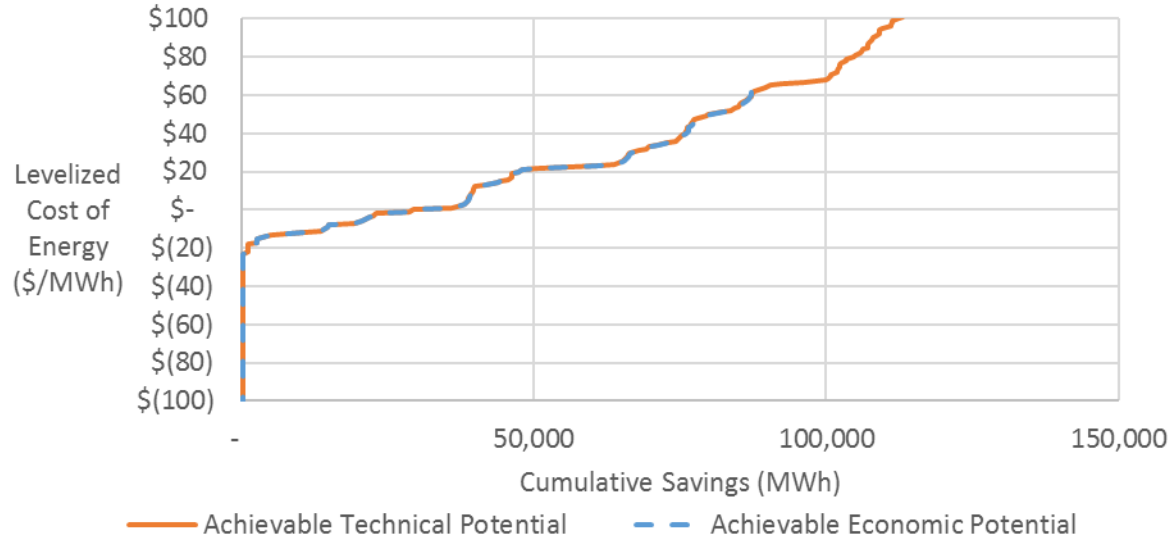


Table 6-14 identifies the top 20 commercial-sector measures in 2027. The top measure is interior LED replacements for linear-fluorescent style lighting applications composing over a quarter of the total potential measure savings. Three other lighting replacements and strategic energy management round out the top five savings measures for the commercial sector.

Table 6-14 Commercial Sector Top Measures in 2027 (Annual Energy, MWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (MWh)	% of Total
1	Interior Lighting - Linear Lighting	15,262	17.4%
2	Interior Lighting - High-Bay Fixtures	11,660	13.3%
3	Exterior Lighting - Area Lighting	9,725	11.1%
4	Strategic Energy Management	5,285	6.0%
5	Exterior Lighting - Linear Lighting	4,266	4.9%
6	Interior Lighting - Screw-in/Hard-wire	3,793	4.3%
7	Office Equipment - Desktop Computer	3,485	4.0%
8	Cooling - Water-Cooled Chiller	3,174	3.6%
9	Exterior Lighting - Screw-in/Hard-wire	3,003	3.4%
10	Refrigeration - Variable Speed Compressor	2,198	2.5%
11	Destratification Fans (HVLS)	2,181	2.5%
12	Retrocommissioning	1,658	1.9%
13	Chiller - Chilled Water Variable-Flow System	1,595	1.8%
14	Chiller - Variable Speed Fans	1,594	1.8%
15	Office Equipment - Server	1,443	1.6%
16	Advanced New Construction Designs	1,404	1.6%
17	Interior Lighting - Interior Lighting - Networked Fixture Controls	1,322	1.5%
18	Refrigeration - Floating Head Pressure	1,252	1.4%
19	Thermostat - WiFi/Interactive	1,103	1.3%
20	Interior Lighting - Interior Lighting - Embedded Fixture Controls	1,101	1.3%
	Total	**76,503**	**87.1%**
	Total cumulative savings in 2027	**87,880**	**100.0%**

Figure 6-14 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Lighting savings from interior and exterior applications account for a substantial portion of the savings throughout the forecast horizon. Cooling and heating savings together make up more than 20% of the total savings potential in 2018 but taper off by 2037 as the proportions begin to favor interior lighting.

Figure 6-14 Commercial Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)

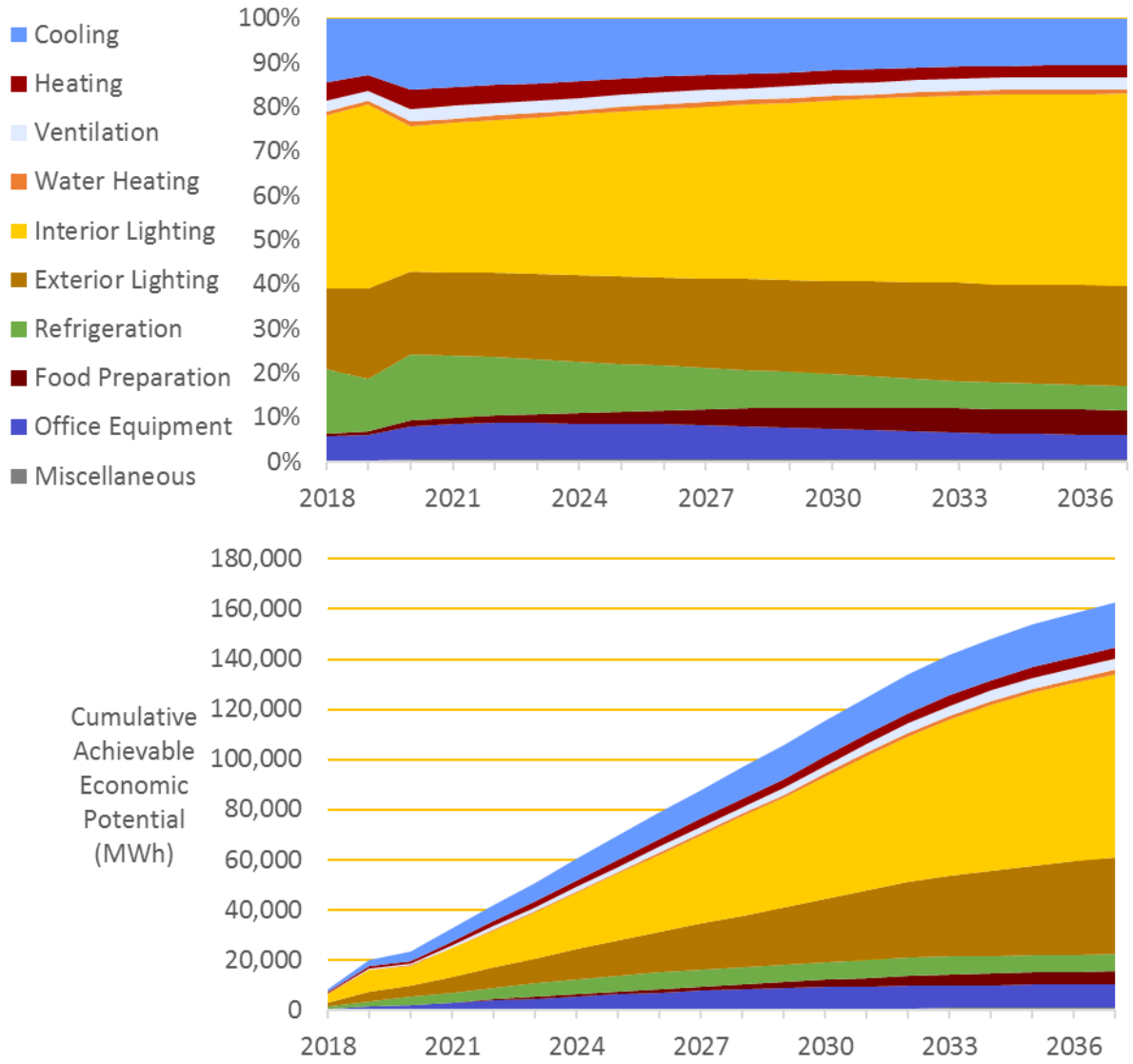


Table 6-15, Table 6-16, and Table 6-17 summarize Commercial sector savings by vintage, replacement type, and end use respectively.

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

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Office	Existing	482	1,136	2,990	6,322	11,598
	New	109	343	742	1,757	3,748
Retail	Existing	1,056	2,646	4,413	10,276	19,673
	New	171	559	992	2,317	5,804
College	Existing	282	635	1,261	2,663	4,716
	New	31	101	213	582	1,594
School	Existing	1,133	2,278	5,214	8,600	11,383
	New	106	303	820	1,637	2,948
Grocery	Existing	775	1,696	3,880	7,838	13,331
	New	110	351	752	1,837	4,408
Hospital	Existing	227	551	1,031	2,404	4,759
	New	34	110	218	540	1,322
Other Health	Existing	325	674	1,690	3,305	5,325
	New	40	122	290	717	1,699
Lodging	Existing	470	1,056	2,607	5,538	10,107
	New	84	270	561	1,348	3,387
Restaurant	Existing	146	353	467	1,065	2,070
	New	21	71	116	274	713
Assembly	Existing	193	468	839	1,884	3,680
	New	30	99	171	399	907
Warehouse	Existing	491	1,080	2,796	5,910	10,398
	New	72	225	490	1,117	2,576
Data Center	Existing	200	431	1,188	2,100	2,846
	New	39	118	277	604	1,067
MF Common Area	Existing	181	446	727	1,767	3,688
	New	36	120	204	477	1,267
Misc. - Classified	Existing	409	964	1,755	3,671	6,669
	New	50	162	286	682	1,584
Misc. - Unclassified	Existing	950	2,247	4,058	8,556	15,623
	New	123	396	705	1,694	3,825
Total Commercial	**Existing**	**7,320**	**16,661**	**34,914**	**71,898**	**125,866**
	New	**1,058**	**3,350**	**6,838**	**15,982**	**36,850**

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

Segment	Replacement Type	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Office	Lost Opportunity	415	1,129	2,888	6,739	13,657
	Retrofit	176	350	844	1,340	1,689
Retail	Lost Opportunity	1,148	3,050	5,038	11,979	24,531
	Retrofit	80	156	367	615	947
College	Lost Opportunity	164	440	766	2,022	4,556
	Retrofit	149	295	708	1,223	1,754
School	Lost Opportunity	193	527	1,253	3,218	7,047
	Retrofit	1,046	2,054	4,781	7,019	7,284
Grocery	Lost Opportunity	406	1,110	2,423	5,972	13,019
	Retrofit	478	937	2,209	3,703	4,719
Hospital	Lost Opportunity	221	582	1,060	2,613	5,567
	Retrofit	40	79	190	332	514
Other Health	Lost Opportunity	91	254	656	1,624	3,581
	Retrofit	274	542	1,324	2,398	3,443
Lodging	Lost Opportunity	298	823	2,008	5,192	11,598
	Retrofit	256	503	1,160	1,694	1,897
Restaurant	Lost Opportunity	154	397	518	1,226	2,616
	Retrofit	14	28	65	113	167
Assembly	Lost Opportunity	181	484	818	1,983	4,240
	Retrofit	42	83	192	300	348
Warehouse	Lost Opportunity	247	682	1,805	4,743	10,447
	Retrofit	315	623	1,481	2,285	2,526
Data Center	Lost Opportunity	99	268	777	1,540	2,397
	Retrofit	140	281	687	1,164	1,517
MF Common Area	Lost Opportunity	208	548	889	2,177	4,719
	Retrofit	10	19	42	66	236
Misc. - Classified	Lost Opportunity	329	872	1,478	3,550	7,426
	Retrofit	131	254	563	803	827
Misc. - Unclassified	Lost Opportunity	787	2,090	3,543	8,530	17,844
	Retrofit	286	553	1,220	1,720	1,604
Total Commercial	**Lost Opportunity**	**4,940**	**13,256**	**25,919**	**63,107**	**133,244**
	Retrofit	**3,438**	**6,755**	**15,833**	**24,774**	**29,471**

Table 6-17 Commercial Achievable Economic Potential by End Use, 2027

End Use	Office	Retail	College	School	Grocery	Hospital
Cooling	1,119	324	1,686	778	510	3,699
Heating	508	34	430	306	28	134
Ventilation	210	33	387	176	116	867
Water Heating	122	120	72	62	28	52
Interior Lighting	2,464	8,076	600	2,547	2,639	2,959
Exterior Lighting	1,683	3,275	497	2,224	728	701
Refrigeration	9	116	9	74	5,891	110
Food Preparation	34	21	80	257	192	426
Office Equipment	1,885	543	240	427	69	651
Miscellaneous	44	52	20	36	35	76
Total	**8,079**	**12,594**	**4,021**	**6,886**	**10,237**	**9,675**

End Use	Other Health	Lodging	Restaurant	Assembly	Warehouse	Data Center
Cooling	281	125	323	248	975	699
Heating	37	27	45	12	1,159	9
Ventilation	34	4	120	9	59	238
Water Heating	25	32	65	39	38	2
Interior Lighting	1,648	417	984	1,145	2,524	195
Exterior Lighting	534	638	675	639	1,959	51
Refrigeration	32	0	475	0	17	0
Food Preparation	69	30	474	56	0	1
Office Equipment	264	48	83	119	259	1,487
Miscellaneous	20	20	0	17	38	23
Total	**2,944**	**1,338**	**3,245**	**2,283**	**7,027**	**2,704**

End Use	MF Common Area	Misc. - Classified	Misc. - Unclassified	Total
Cooling	58	258	530	11,612
Heating	0	128	218	3,075
Ventilation	2	80	145	2,480
Water Heating	63	61	147	929
Interior Lighting	693	2,474	5,913	35,277
Exterior Lighting	1,267	1,029	2,459	18,358
Refrigeration	0	17	41	6,789
Food Preparation	55	26	94	1,815
Office Equipment	89	278	699	7,141
Miscellaneous	17	2	4	405
Total	2,244	4,354	10,250	87,880

Table 6-18 summarizes the risk level of achievable economic potential in 2027 for the commercial sector. 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. Small savers come third since the lower potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped. Most RTF measures have a sunset date before 2020. Very few cost-effective measures have a TRC benefit-to-cost ratio of less than 1.2, lower than in the residential sector. The None/Other category includes a substantial number of Seventh Plan measures which have not been characterized by the RTF.

Table 6-18 Commercial Achievable Economic Potential by Risk and RTF Category, 2027

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	0	381	727	29,787	30,895
1 - TRC B/C Ratio <1.2	0	0	0	5,317	5,317
2 - RTF Sunset before 2020	47,708	340	2,186	0	50,233
3 – Higher Risk (combined)	0	0	1,435	0	1,435
Total	**47,708**	**721**	**4,348**	**35,104**	**87,880**

JBLM Commercial Potential

The JBLM non-residential facilities are not all that dissimilar from 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. There is evidence that this effect may decline in future years, lowering overall costs and increasing measure penetration. AEG recommends revisiting this assumption when assessing potential for the 2020-2021 biennium.

Table 6-19 and Figure 6-15 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)

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	299.4	300.4	297.4	298.8	304.1
Cumulative Savings (GWh)					
Achievable Economic Potential	0.6	1.4	3.1	7.1	14.1
Achievable Technical Potential	1.4	3.0	7.3	14.7	25.3
Technical Potential	7.2	14.1	24.7	43.0	63.1
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.2%	0.5%	1.0%	2.4%	4.7%
Achievable Technical Potential	0.5%	1.0%	2.5%	4.9%	8.3%
Technical Potential	2.4%	4.7%	8.3%	14.4%	20.8%

Figure 6-15 JBLM Commercial Energy Efficiency Savings (Energy)

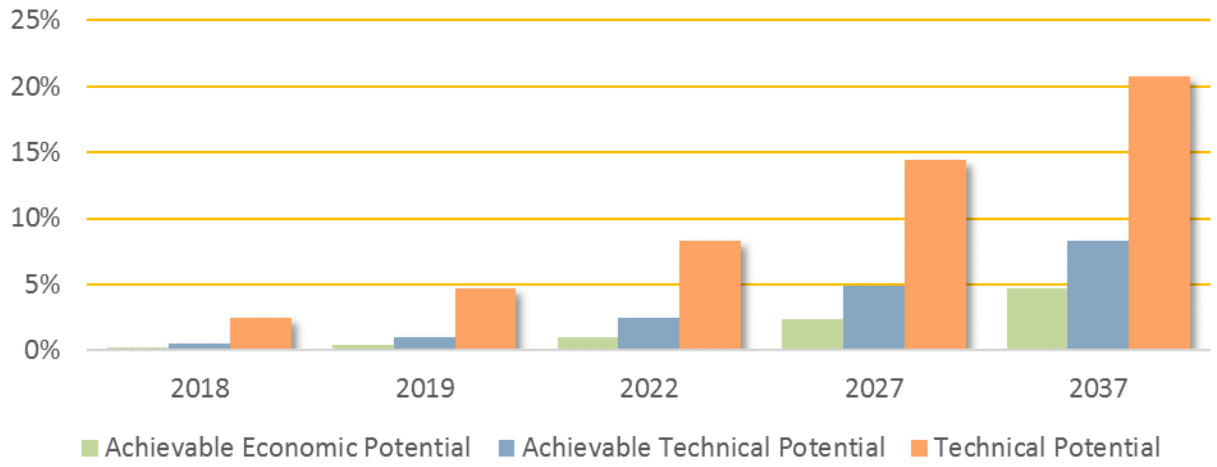


Figure 6-16 and Figure 6-17 show the supply curve of levelized TRC cost per MWh saved vs. cumulative achievable technical potential for the JBLM commercial sector in 2027. LED lighting comprises the vast majority of cost effective savings. Due to recent reductions in fixture costs, the price of linear LED panels has been significantly reduced. This has resulted in LED panels passing the TRC economic screen and contributing highly to the overall potential. In addition, a higher saturation of standard efficiency T8 fixtures was found on base when compared to the civilian sector. This resulted in higher linear LED lighting potential than in the civilian sector. Retrofit HVAC measures were also found to be sources of cost-effective potential. Although higher linear LED savings increases potential, overall achievable economic potential in the JBLM commercial sector is lower than the civilian commercial sector relative to baseline. This is attributable to less measures passing the TRC screen due to the higher costs of doing business at JBLM.

Figure 6-16 Supply Curve, JBLM Commercial Sector in 2027 (Annual Energy, MWh)

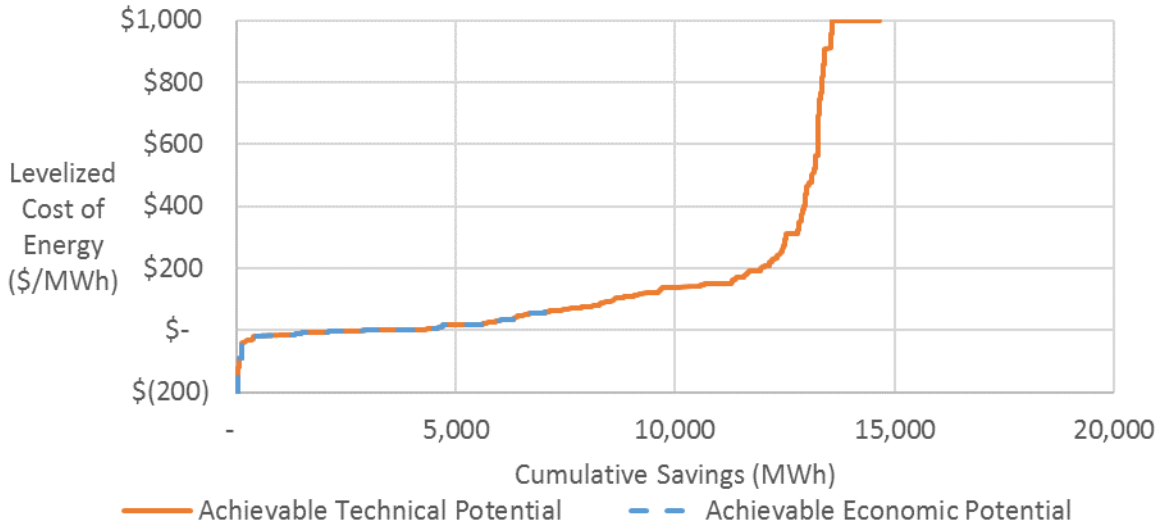


Figure 6-17 Supply Curve, JBLM Commercial Sector in 2027, Limited Axis (Annual Energy, MWh)

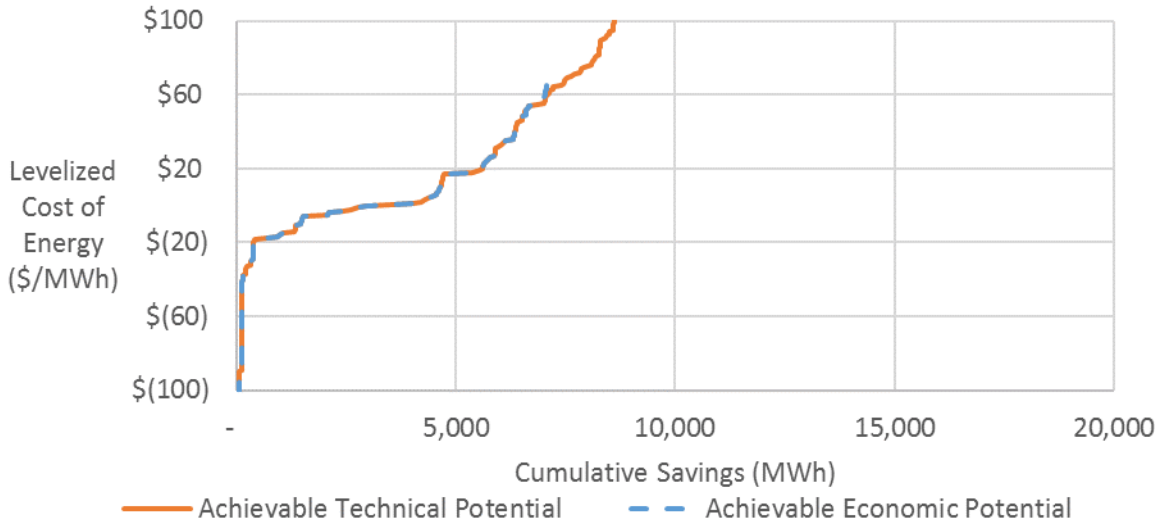


Table 6-20 identifies the top 20 commercial-sector measures in 2027. Lighting measures make up the six of the top eight commercial savings measures. The top measure is exterior LED replacements for area lighting applications. Interior LEDs represent approximately 32% of the total possible savings by 2027.

Table 6-20 JBLM Commercial Sector Top Measures in 2027 (Annual Energy, MWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (MWh)	% of Total
1	Exterior Lighting - Area Lighting	1,289	18.2%
2	Interior Lighting - Linear Lighting	1,043	14.8%
3	Interior Lighting - High-Bay Fixtures	843	11.9%
4	Cooling - Water-Cooled Chiller	552	7.8%
5	Office Equipment - Desktop Computer	509	7.2%
6	Interior Lighting - Screw-in/Hard-wire	392	5.5%
7	Exterior Lighting - Linear Lighting	252	3.6%
8	Exterior Lighting - Screw-in/Hard-wire	214	3.0%
9	Office Equipment - Server	183	2.6%
10	Chiller - Variable Speed Fans	146	2.1%
11	Chiller - Chilled Water Reset	133	1.9%
12	Water-Cooled Chiller - Condenser Water Reset	120	1.7%
13	Water Heater - Solar System	117	1.7%
14	Food Preparation - Steamer	113	1.6%
15	Office Equipment - Printer/Copier/Fax	103	1.5%
16	Cooking - Exhaust Hoods with Sensor Control	97	1.4%
17	Office Equipment - Monitor	71	1.0%
18	Smart Engine Block Heaters	71	1.0%
19	Office Equipment - Smart Power Strips	69	1.0%
20	Food Preparation - Fryer	53	0.8%
	Total	**6,371**	**90.1%**
	Total cumulative savings in 2027	**7,068**	**100.0%**

Figure 6-18 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Lighting savings from interior and exterior applications account for the largest portion of the savings throughout the forecast horizon. Cooling savings are also substantial throughout the forecast but taper off through the forecast.

Figure 6-18 JBLM Commercial Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)

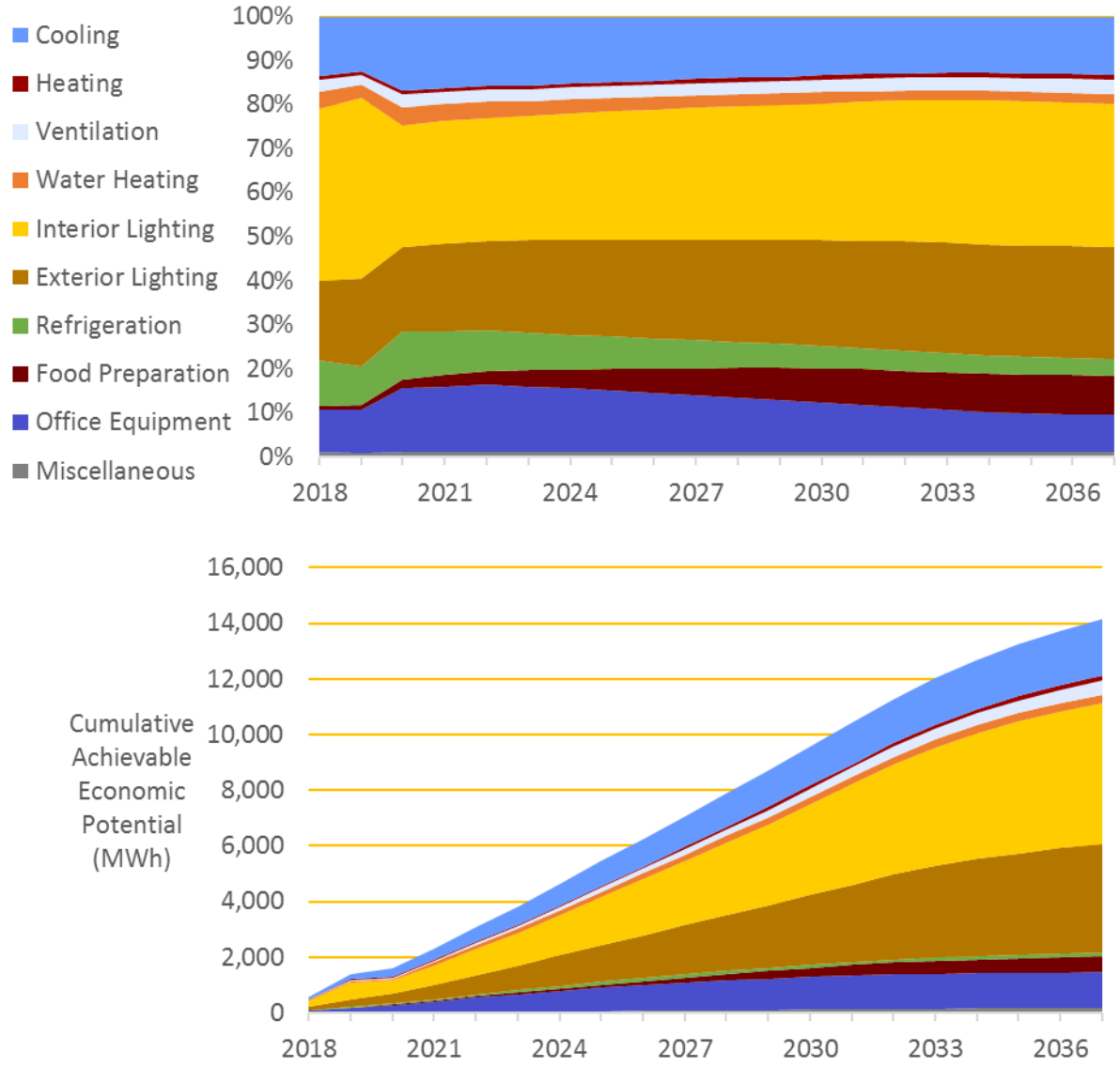


Table 6-21, Table 6-22, and Table 6-23 summarize JBLM Commercial sector savings by vintage, replacement type, and end use respectively.

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

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Office	Existing	74	176	497	1,079	1,978
	New	9	25	97	265	587
Retail	Existing	15	37	52	120	231
	New	1	3	9	25	63
School	Existing	18	44	106	248	483
	New	2	6	22	61	154
Grocery	Existing	8	18	44	86	141
	New	1	2	7	16	57
Lodging	Existing	121	287	622	1,387	2,748
	New	14	37	137	399	1,029
Restaurant	Existing	87	209	286	657	1,270
	New	6	15	49	139	362
Warehouse	Existing	24	56	113	248	454
	New	2	5	18	56	155
Data Center	Existing	16	42	81	189	387
	New	1	4	11	34	82
Health	Existing	41	103	275	690	1,383
	New	5	14	52	146	388
Other	Existing	38	83	231	400	547
	New	4	10	39	95	178
Hangar	Existing	28	69	128	288	580
	New	3	8	25	72	198
Mixed Use	Existing	43	107	132	279	479
	New	3	8	26	72	172
Industrial	Existing	2	4	8	17	34
	New	0	0	1	3	8
Total JBLM Commercial	**Existing**	**515**	**1,235**	**2,575**	**5,687**	**10,715**
	New	**51**	**136**	**493**	**1,381**	**3,434**

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

Segment	Replacement Type	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Office	Lost Opportunity	61	157	489	1,172	2,361
	Retrofit	22	43	106	171	204
Retail	Lost Opportunity	15	37	56	136	281
	Retrofit	1	2	4	9	13
School	Lost Opportunity	15	39	102	268	593
	Retrofit	5	11	26	40	44
Grocery	Lost Opportunity	3	8	22	58	129
	Retrofit	6	11	28	44	69
Lodging	Lost Opportunity	95	245	562	1,428	3,199
	Retrofit	40	79	197	359	578
Restaurant	Lost Opportunity	82	203	282	692	1,468
	Retrofit	11	21	54	104	165
Warehouse	Lost Opportunity	15	38	75	210	481
	Retrofit	11	23	56	95	128
Data Center	Lost Opportunity	15	41	80	199	424
	Retrofit	3	5	12	24	45
Health	Lost Opportunity	39	103	293	782	1,689
	Retrofit	7	14	34	54	83
Other	Lost Opportunity	16	40	139	275	425
	Retrofit	27	53	132	220	299
Hangar	Lost Opportunity	26	68	132	321	720
	Retrofit	4	9	22	39	57
Mixed Use	Lost Opportunity	43	108	139	311	598
	Retrofit	4	7	19	39	53
Industrial	Lost Opportunity	1	3	6	15	32
	Retrofit	0	1	3	5	10
Total JBLM Commercial	**Lost Opportunity**	**426**	**1,092**	**2,376**	**5,866**	**12,400**
	Retrofit	**141**	**280**	**693**	**1,202**	**1,749**

Table 6-23 JBLM Commercial Achievable Economic Potential by End Use, 2027

End Use	Office	Retail	School	Grocery	Lodging
Cooling	159	3	31	5	52
Heating	20	0	3	0	25
Ventilation	35	0	3	0	7
Water Heating	58	4	2	1	51
Interior Lighting	406	88	132	42	250
Exterior Lighting	282	39	101	12	354
Refrigeration	2	2	1	37	0
Food Preparation	6	0	14	3	16
Office Equipment	369	8	21	1	31
Miscellaneous	7	1	0	1	10
Total	1,343	145	309	102	796

End Use	Restaurant	Warehouse	Data Center	Health	Other
Cooling	20	57	118	626	14
Heating	4	5	1	7	4
Ventilation	11	0	60	90	2
Water Heating	14	17	1	19	15
Interior Lighting	81	353	30	590	177
Exterior Lighting	60	348	8	176	91
Refrigeration	54	0	0	14	0
Food Preparation	49	0	0	92	3
Office Equipment	11	50	273	155	42
Miscellaneous	2	6	3	18	3
Total	305	836	495	1,786	350

End Use	Hangar	Mixed Use	Industrial	Total
Cooling	8	6	0	1,099
Heating	1	3	0	73
Ventilation	1	0	0	211
Water Heating	11	26	1	219
Interior Lighting	107	63	9	2,327
Exterior Lighting	67	221	4	1,763
Refrigeration	0	0	0	109
Food Preparation	5	8	0	196
Office Equipment	14	15	1	992
Miscellaneous	7	18	5	80
Total	223	360	20	7,068

Table 6-24 summarizes the risk level of achievable economic potential in 2027 for the JBLM commercial sector. 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. Small savers come third since the lower potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped. Results are very similar to the civilian commercial sector. Most RTF measures have a sunset date before 2020. 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 Seventh Plan measures which have not been characterized by the RTF.

Table 6-24 JBLM Commercial Achievable Economic Potential by Risk and RTF Category, 2027

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	0	71	57	2,465	2,594
1 - TRC B/C Ratio <1.2	0	0	1	128	129
2 - RTF Sunset before 2020	4,013	69	191	0	4,272
3 – Higher Risk (combined)	21	0	53	0	74
Total	**4,034**	**140**	**302**	**2,593**	**7,068**

Industrial Potential

Table 6-25 and Figure 6-20 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. Compared to the other sectors, a larger portion of the achievable technical potential is cost effective. 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 potential. Additionally, strategic energy management programs, which have recently been gaining significant traction in the region, are a large source of potential.

Figure 6-19 WestRock Pulp Mill (courtesy of Rob Green)

Table 6-25 Conservation Potential for the Industrial Sector (Annual Energy, GWh)

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	1,112	1,205	1,226	1,257	1,324
Cumulative Savings (GWh)					
Achievable Economic Potential	4	10	27	58	86
Achievable Technical Potential	6	13	35	70	97
Technical Potential	9	20	47	91	121
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.4%	0.8%	2.2%	4.6%	6.5%
Achievable Technical Potential	0.5%	1.1%	2.8%	5.6%	7.3%
Technical Potential	0.8%	1.6%	3.8%	7.2%	9.2%

Figure 6-20 Industrial Potential as a % of the Baseline Projection (Annual Energy)

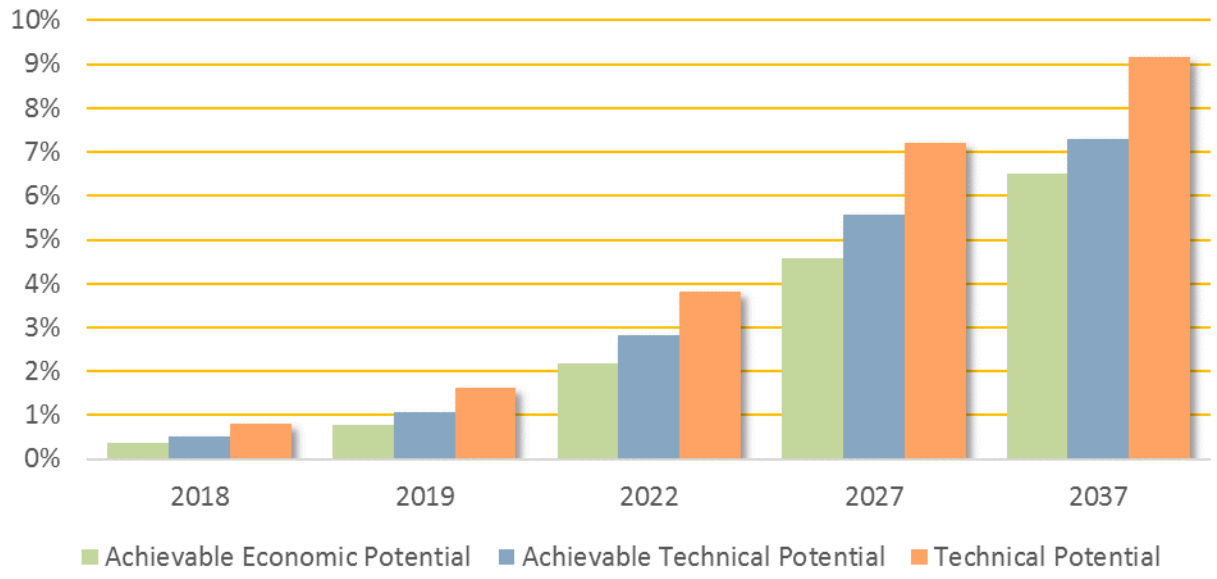


Figure 6-21 and Figure 6-22 show the supply curve of levelized TRC cost per MWh saved vs. cumulative achievable technical potential for the industrial sector in 2027. Energy management measures, motor and process controls, and LED lighting make up a majority of the cost-effective savings potential. Although 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 6-21 Supply Curve, Industrial Sector in 2027 (Annual Energy, MWh)

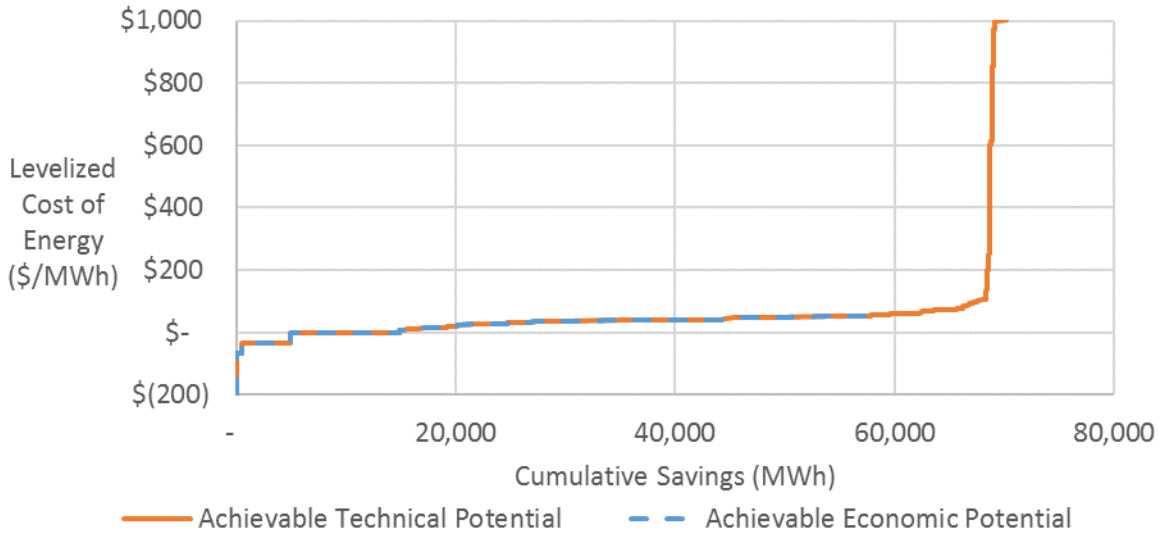


Figure 6-22 Supply Curve, Industrial Sector in 2027, Limited Axis (Annual Energy, MWh)

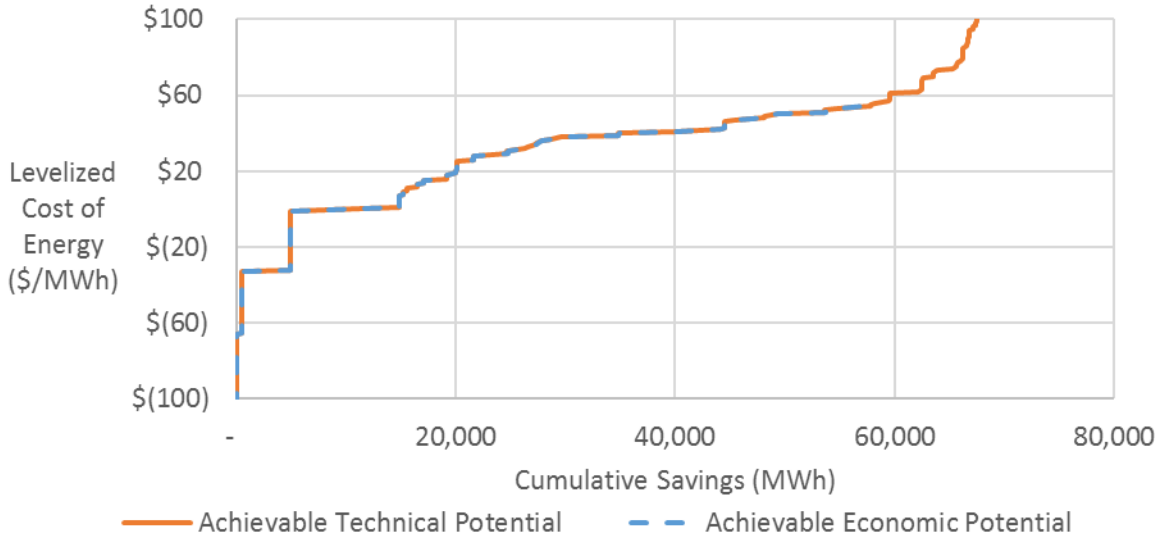


Table 6-26 identifies the top 20 industrial measures in 2027. The top measures are compressed air measures and strategic energy management. Strategic Energy Management encompasses behavioral and low-cost/no-cost opportunities. Interior high bay and exterior area lighting are the eighth and ninth highest measure savings options in the industrial sector.

Table 6-26 Industrial Sector Top Measures in 2027 (Annual Energy, MWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (MWh)	% of Total
1	Compressed Air - Equipment Upgrade	6,226	10.8%
2	Strategic Energy Management	5,112	8.9%
3	Pumping System - System Optimization	4,413	7.7%
4	Compressed Air - Leak Management Program	4,307	7.5%
5	Pumping System - Variable Speed Drive	3,853	6.7%
6	Material Handling - Variable Speed Drive	3,700	6.4%
7	Pumping System - Equipment Upgrade	3,565	6.2%
8	Interior Lighting - High-Bay Fixtures	2,931	5.1%
9	Exterior Lighting - Area Lighting	2,608	4.5%
10	Fan System - Equipment Upgrade	2,488	4.3%
11	Compressed Air - System Controls	1,671	2.9%
12	Fan System - Flow Optimization	1,494	2.6%
13	Panel: Hydraulic Press	1,479	2.6%
14	Interior Lighting - Linear Lighting	995	1.7%
15	Motors - Green Rewind (100 HP+)	950	1.6%
16	Ventilation - Ventilation	834	1.4%
17	Switch from Belt Drive to Direct Drive	818	1.4%
18	Chiller - Chilled Water Variable-Flow System	794	1.4%
19	Exterior Lighting - Linear Lighting	762	1.3%
20	Compressed Air - Zero-Loss Condensate Drain	704	1.2%
	Total	**49,703**	**86.3%**
	Total cumulative savings in 2027	**57,569**	**100.0%**

Figure 6-23 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Motor-related measures account for a substantial portion of the savings throughout the forecast horizon. Savings associated with lighting and cooling measures are also significant throughout the forecast.

Figure 6-23 Industrial Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)

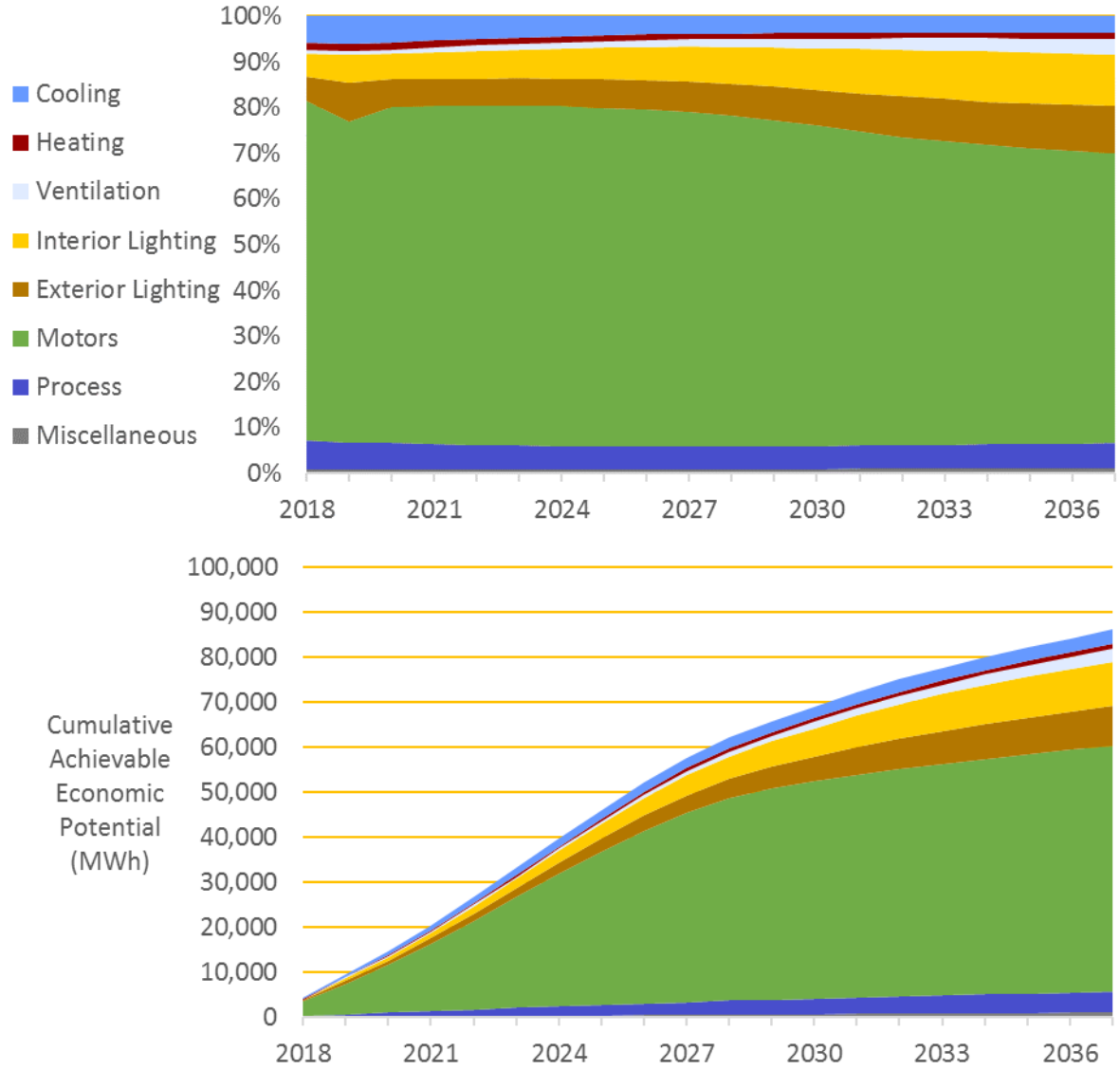


Table 6-27, Table 6-28 and Table 6-29 summarize Industrial sector savings by vintage, replacement type, and end use respectively.

Table 6-27 Industrial Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Paper Mfg.	Existing	1,494	3,099	8,591	17,762	25,751
	New	182	640	2,215	5,857	8,987
Chemical Mfg.	Existing	626	1,282	3,429	6,430	8,416
	New	76	264	876	2,043	2,792
Stone Clay Glass Products	Existing	151	322	887	1,923	3,028
	New	20	81	237	621	1,079
Petroleum Refining	Existing	309	638	1,802	3,863	5,140
	New	37	124	462	1,301	1,805
Lumber Wood Products	Existing	179	383	1,067	2,395	3,584
	New	23	91	282	790	1,266
Food Mfg.	Existing	138	289	762	1,539	2,427
	New	18	71	201	484	851
Rubber and Plastics	Existing	197	407	1,059	2,035	2,905
	New	25	93	275	641	980
Other Industrial	Existing	628	1,354	3,589	7,577	12,825
	New	88	416	995	2,307	4,402
Total Industrial	**Existing**	**3,722**	**7,774**	**21,187**	**43,525**	**64,078**
	New	**468**	**1,779**	**5,542**	**14,044**	**22,163**

Table 6-28 Industrial Achievable Economic Potential by Replacement Type, Select Years

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
Paper Mfg.	Lost Opportunity	102	351	841	2,167	5,144
	Retrofit	1,574	3,387	9,965	21,451	29,595
Chemical Mfg.	Lost Opportunity	41	145	350	903	2,172
	Retrofit	661	1,401	3,955	7,570	9,036
Stone Clay Glass Products	Lost Opportunity	25	88	212	546	1,301
	Retrofit	145	315	912	1,999	2,806
Petroleum Refining	Lost Opportunity	12	42	100	258	619
	Retrofit	334	720	2,165	4,907	6,327
Lumber Wood Products	Lost Opportunity	26	88	210	542	1,270
	Retrofit	176	385	1,139	2,644	3,580
Food Mfg.	Lost Opportunity	21	75	179	460	1,096
	Retrofit	134	285	784	1,563	2,183
Rubber and Plastics	Lost Opportunity	23	79	189	487	1,162
	Retrofit	199	421	1,145	2,189	2,723
Other Industrial	Lost Opportunity	187	654	1,572	4,056	9,744
	Retrofit	530	1,116	3,012	5,829	7,484
Total Industrial	**Lost Opportunity**	**437**	**1,522**	**3,652**	**9,418**	**22,507**
	Retrofit	**3,754**	**8,031**	**23,077**	**48,151**	**63,734**

Table 6-29 Industrial Achievable Economic Potential by End Use, 2027

End Use	Paper Mfg.	Chemical Mfg.	Stone Clay Glass Products	Petroleum Refining	Lumber Wood Products
Cooling	440	232	120	68	74
Heating	143	52	34	21	24
Ventilation	192	96	51	29	32
Interior Lighting	1,056	392	256	118	277
Exterior Lighting	914	347	223	103	240
Motors	19,115	7,139	1,706	4,721	2,438
Process	1,606	187	126	94	59
Miscellaneous	151	28	29	11	41
Total	**23,618**	**8,473**	**2,545**	**5,164**	**3,185**

End Use	Food Mfg.	Rubber and Plastics	Other Industrial	Total
Cooling	100	114	1,080	2,227
Heating	31	34	328	666
Ventilation	43	49	466	959
Interior Lighting	220	228	1,851	4,398
Exterior Lighting	191	199	1,610	3,827
Motors	1,145	1,922	3,960	42,146
Process	259	107	428	2,866
Miscellaneous	33	23	161	478
Total	**2,023**	**2,676**	**9,884**	**57,569**

Table 6-30 summarizes the risk level of achievable economic potential in 2027 for the industrial sector. 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. Small savers come third since the lower potential lowers the research and documentation requirements in the RTF work products. Finally, measures with no category or from other sources are grouped. Since the RTF characterizes very few industrial measures, most potential is in the None/Other category. This includes Seventh Plan measures, strategic energy management, and additional system optimization and controls measures identified by AEG.

Table 6-30 Industrial Achievable Economic Potential by Risk and RTF Category, 2027

Risk Level	Proven	Planning	Small Saver	None/Other	Total
0 - Lower Risk	0	0	145	36,539	36,685
1 - TRC B/C Ratio <1.2	0	0	0	8,392	8,392
2 - RTF Sunset before 2020	7,904	0	950	0	8,853
3 – Higher Risk (combined)	0	3,565	74	0	3,639
Total	**7,904**	**3,565**	**1,169**	**44,931**	**57,569**

Street Lighting Potential

Table 6-31 and Figure 6-25 present estimates for the three levels of conservation potential for the street lighting sector from the perspective of annual energy savings. In 2027, achievable economic potential represents nearly the entirety of achievable technical potential. Street lighting potential ramps up early in the study due to a large H1 - Tacoma retrofit program planned by the City of Tacoma and Tacoma Power. Of the applicable fixtures, 10% were assumed to have been converted to LEDs by the end of 2017, before the study period. An additional 65% were then assumed to be converted between 2018 and 2019. The remaining applicable fixtures were then assumed to phase-in from 2020 through 2027.

Figure 6-24 Tacoma Street Lights (courtesy of Rob Green)

Table 6-31 Conservation Potential for the Street Lighting Sector

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	32.0	32.0	32.0	32.0	32.0
Cumulative Savings (GWh)					
Achievable Economic Potential	3.1	5.8	6.8	8.6	10.2
Achievable Technical Potential	3.2	6.0	7.0	8.8	10.3
Technical Potential	3.9	7.1	8.5	10.7	12.7
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	9.8%	18.2%	21.3%	26.8%	31.7%
Achievable Technical Potential	10.0%	18.6%	21.8%	27.3%	32.3%
Technical Potential	12.2%	22.3%	26.7%	33.5%	39.5%

Figure 6-25 Street Lighting Energy Efficiency Savings

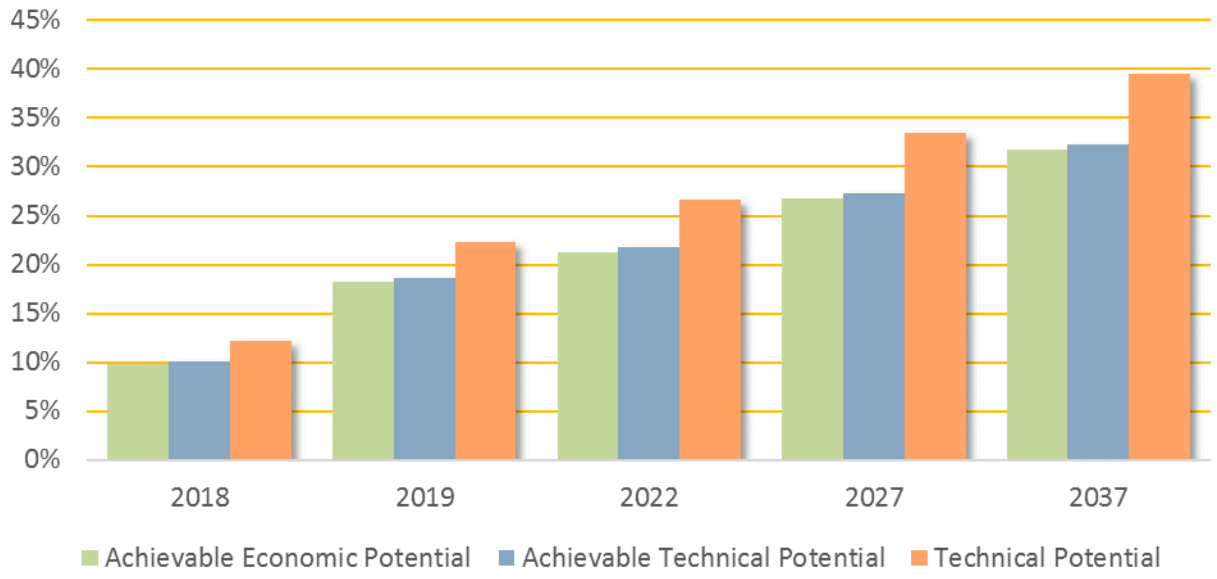


Figure 6-26 shows the supply curve of levelized TRC cost per MWh saved vs. cumulative achievable technical potential for the street lighting sector in 2027. Cost effective potential is mainly attributable to the installation of LED lighting fixtures. Using assumptions provided for labor and O&M of replacing 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 6-26 Supply Curve, Industrial Sector in 2027 (Annual Energy, MWh)

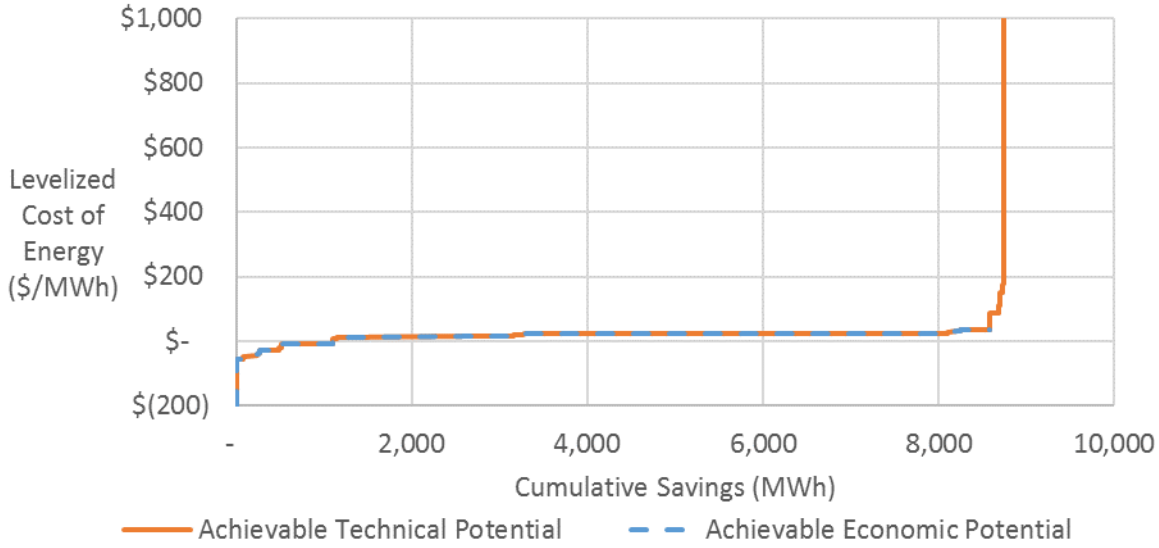


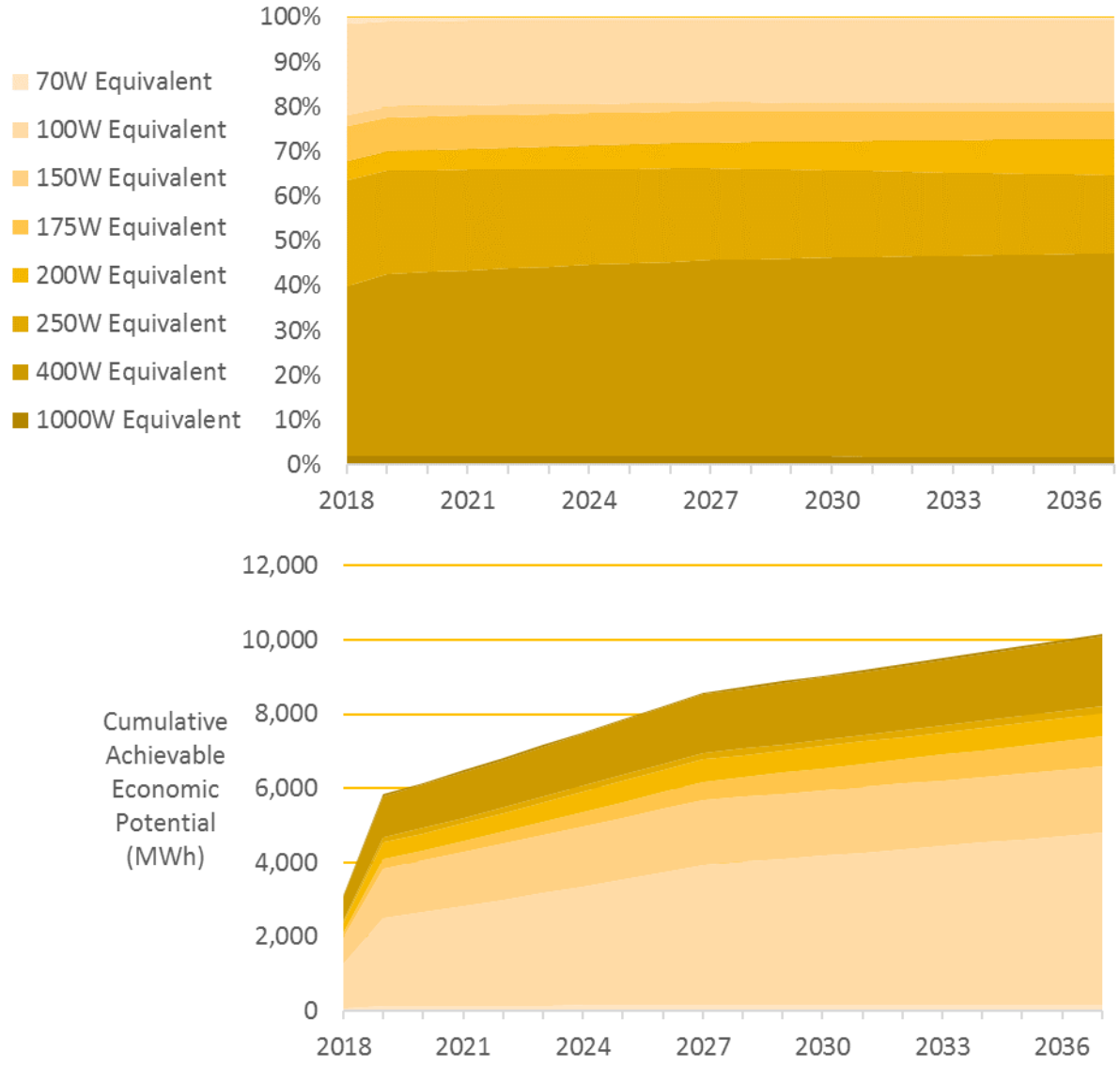
Table 6-32 identifies the top street lighting measures from the perspective of annual energy savings in 2027. A high operations and management savings leads to favorable benefit to cost ratios which allows all LED equipment measures to pass. The "H1 Retrofit" measures refer to the City of Tacoma's planned large retrofit project.

Table 6-32 Street Lighting Sector Top Measures in 2027 (Annual Energy, GWh)

Rank	Measure / Technology	2027 Achievable Economic Cumulative Savings (GWh)	% of Total
1	H1 Retrofit - Cobrahead - 400W Equivalent	2,756	32.1%
2	H1 Retrofit - Cobrahead - 250W Equivalent	1,394	16.2%
3	H1 Retrofit - Cobrahead - 100W Equivalent	1,246	14.5%
4	H2 Service - All - 400W Equivalent	560	6.5%
5	H1 Retrofit - Res Ornamental Retrofit - 175W Equivalent	390	4.5%
6	H1 Retrofit - Shoebox - 400W Equivalent	313	3.7%
7	H1 Retrofit - Cobrahead - 200W Equivalent	281	3.3%
8	H1 Retrofit - Shoebox - 250W Equivalent	253	2.9%
9	H2 Service - All - 200W Equivalent	211	2.5%
10	H1 Retrofit - Com Ornamental Retrofit - 175W Equivalent	174	2.0%
11	H2 Service - All - 100W Equivalent	158	1.8%
12	H1 Retrofit - Flood - 1000W Equivalent	94	1.1%
13	H1 Retrofit - Flood - 400W Equivalent	83	1.0%
14	H1 - Other Fixtures - 100W Equivalent	75	0.9%
15	H1 Retrofit - Res Ornamental Retrofit - 150W Equivalent	72	0.8%
16	H1 Retrofit - Other - 1000W Equivalent	71	0.8%
17	H1 Retrofit - Com Ornamental Retrofit - 100W Equivalent	60	0.7%
18	H1 Retrofit - Shoebox - 150W Equivalent	45	0.5%
19	H1 Retrofit - Flood - 250W Equivalent	41	0.5%
20	H1 Retrofit - Res Ornamental Retrofit - 100W Equivalent	40	0.5%
	Total	**8,315**	**96.9%**
	Total cumulative savings in 2027	**8,582**	**100.0%**

Figure 6-27 presents forecasts of energy savings by street lighting fixture as a percent of total annual savings and cumulative savings. The potential is mainly located in the 100W, 250W, and 400W equivalent fixture sizes.

Figure 6-27 Street Lighting Achievable Economic Case – Cumulative Savings by End Use (% of Total and Annual GWh)



Error! Reference source not found., Table 6-34, and Table 6-35 summarize Street Lighting sector savings by vintage, replacement type, and fixture wattage respectively. Street Lighting potential by end use is not reported here as there is only one end use. 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, it is assumed that these fixtures will be replaced with a high-intensity discharge fixture, such as a high-pressure sodium, in the baseline.

Table 6-33 Street Lighting Achievable Economic Potential by Vintage, Select Years

Segment	Vintage	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
H1 Tacoma	Existing	3,038	5,620	6,276	7,273	7,200
	New	46	101	131	203	210
Other H1	Existing	6	15	58	157	387
	New	1	2	8	21	56
All H2	Existing	30	80	304	821	2,020
	New	4	10	40	107	292
Total Street Lighting	**Existing**	3,074	5,715	6,639	8,252	9,608
	New	**50**	**114**	**178**	**331**	**559**

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

Segment	Replacement Type	2018 Achievable Economic Savings (MWh)	2019 Achievable Economic Savings (MWh)	2022 Achievable Economic Savings (MWh)	2027 Achievable Economic Savings (MWh)	2037 Achievable Economic Savings (MWh)
H1 Tacoma	Lost Opportunity	0	0	0	0	0
	Retrofit	3,084	5,721	6,407	7,476	7,411
Other H1	Lost Opportunity	6	17	66	178	443
	Retrofit	0	0	0	0	0
All H2	Lost Opportunity	34	91	344	928	2,312
	Retrofit	0	0	0	0	0
Total Street Lighting	**Lost Opportunity**	40	108	410	1,106	2,756
	Retrofit	**3,084**	**5,721**	**6,407**	**7,476**	**7,411**

Table 6-35 Street Lighting Achievable Economic Potential by Fixture Wattage, 2027

End Use	H1 Tacoma	H1 Other	H2 All	Total Street Lighting
70W Equivalent	47	7	0	54
100W Equivalent	1,346	75	158	1,578
150W Equivalent	166	7	0	173
175W Equivalent	578	19	0	596
200W Equivalent	281	7	211	499
250W Equivalent	1,722	32	0	1,755
400W Equivalent	3,172	30	560	3,762
1000W Equivalent	165	1	0	165
Total	**7,476**	**178**	**928**	**8,582**

Due to the large O&M benefits, LED street lighting potential is considered to of low risk.

Distribution Efficiency Potential

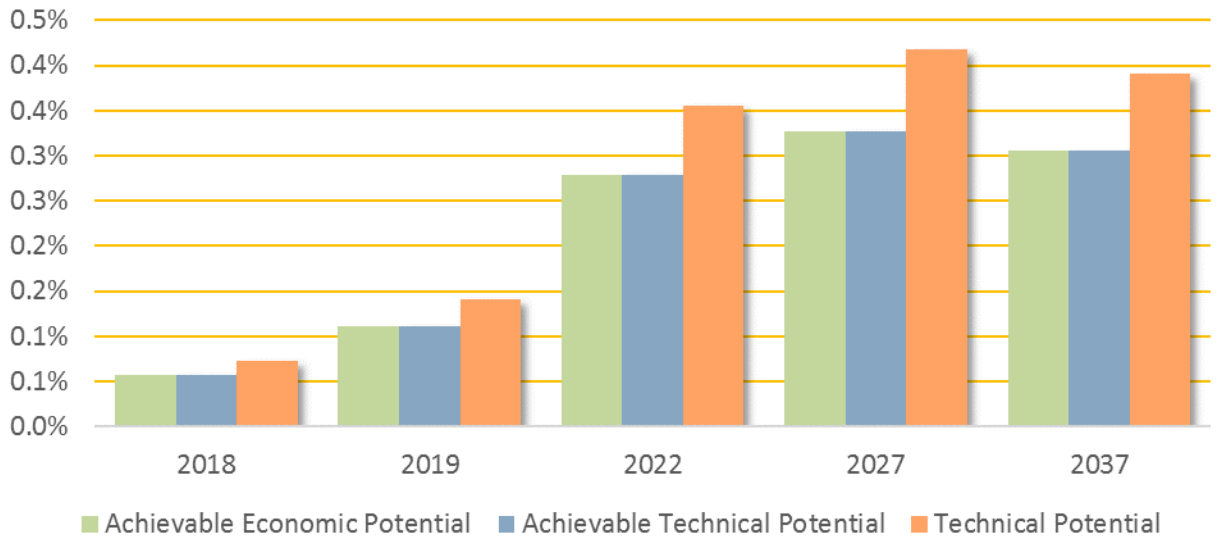
Table 6-36 and Figure 6-29 present estimates for the three levels of conservation potential for the distribution efficiency analysis from the perspective of annual energy savings. Based on a utility specific three sub-station study conducted by RW Beck for Tacoma Power, this measure set was found to be highly cost effective. For this reason, all achievable technical potential is economic as well. 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 accomplishment in recent years. Through 2016, Tacoma Power has upgraded seven substations within the territory and plans to upgrade three more in 2017. To estimate potential, AEG assumed that 18 out of the remaining 23 substations could be achievably upgraded over the next six years. As such, potential remains flat after 2023.

Figure 6-28 Electrical Substation in Tacoma (courtesy of Tacoma Power)

Table 6-36 Conservation Potential for Distribution Efficiency

	2018	2019	2022	2027	2037
Baseline Forecast (GWh)	4,627	4,761	4,732	4,840	5,170
Cumulative Savings (GWh)					
Achievable Economic Potential	2.6	5.3	13.2	15.8	15.8
Achievable Technical Potential	2.6	5.3	13.2	15.8	15.8
Technical Potential	3.4	6.7	16.8	20.2	20.2
Cumulative Savings as a % of Baseline					
Achievable Economic Potential	0.1%	0.1%	0.3%	0.3%	0.3%
Achievable Technical Potential	0.1%	0.1%	0.3%	0.3%	0.3%
Technical Potential	0.1%	0.1%	0.4%	0.4%	0.4%

Figure 6-29 Distribution Efficiency Energy Efficiency Savings



7

COMPARISON WITH PRIOR STUDY

Compared to the prior CPA, which estimated potential for the 2016-2017 biennium, several key assumptions and methodologies used in the region have been updated. These include:

- Referencing the Council's Seventh Power Plan instead of the Sixth Power Plan, which includes new measures, major revisions to previous measures, and substantial modifications to ramp rates
- Updates to Regional Technical Forum (RTF) unit energy savings (UES) measures and standard protocols – two additional years of analysis
- Updates to Tacoma Power programs – most recent results from Tacoma's implementation database
- Updates to the avoided cost of energy – migration to a shaped BPA block pricing from Tacoma's forecasted wholesale price

Compared to the previous study, TRC achievable economic potential has decreased by about one-third. Differences in potential affect primarily the residential and commercial sectors and are mainly due to:

- Increased saturation of efficient technologies in the baseline. For example, the baseline saturation of linear LEDs in the Seventh Plan approaches nearly 20% by 2018, whereas these fixtures were not yet commercially viable during development of the Sixth Plan so none were considered in the baseline for the previous study.
- Updating ramp rates to the Seventh Plan reduced achievable potential in the early years.
- In the residential sector, additional CFLs and LEDs in the baseline, as well as the second phase of the EISA 2007 general service lighting standard in 2020 substantially lowers potential.

Table 7-1 compares 10-year potential between the two studies at a sector level. Although the residential and commercial sector results declined between the two studies as noted above, savings potential for the JBLM residential, industrial, and street lighting market sectors is very similar to that of the previous CPA.

Table 7-1 Comparison of 10-Year Economic Achievable Potential with Prior Study (excl. Distribution Efficiency)

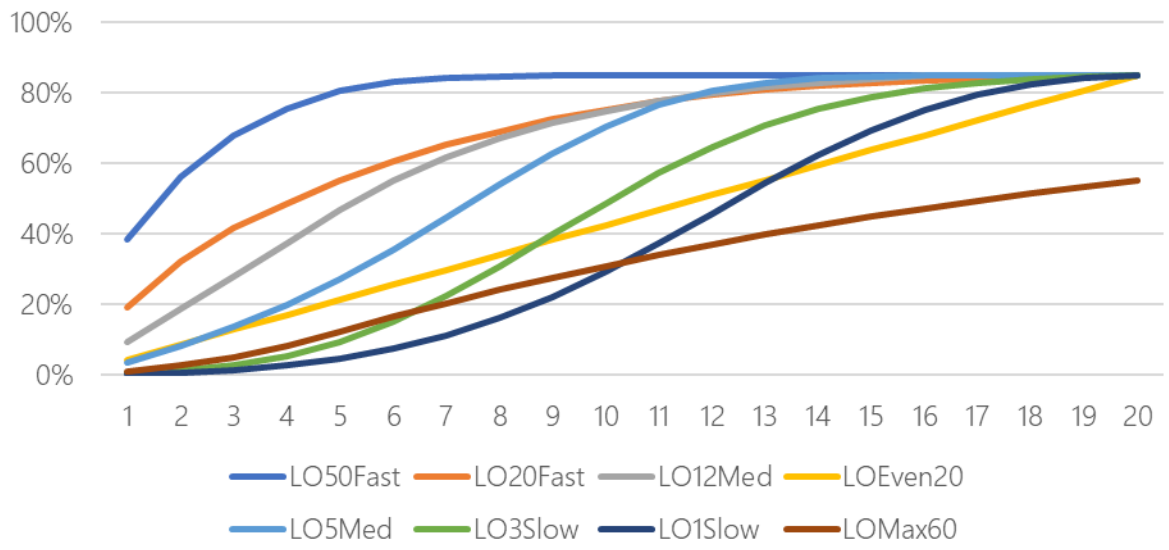
Market Sector	Current Study: 2018-2027 Potential (MWh)	*Prior Study: 2016-2025 Potential (MWh)*	Change from Prior Study (MWh)
Residential	99,164	*160,903*	-61,738
JBLM Residential	1,477	*1,495*	-18
Commercial	87,880	*144,579*	-56,698
JBLM Commercial	7,068	*14,164*	-7,096
Industrial	57,569	*60,183*	-2,613
Street Lighting	8,582	*6,792*	1,790
Total	**261,742**	***388,116***	**-126,374**

A more detailed explanation of differences between the two studies is presented below.

Updates to the Council's Ramp Rates

As part of the Seventh Power Plan, the Council updated the ramp rates used to estimate achievable potential. In addition to changing the starting points for each ramp rate, the shape of each curve, for both lost opportunity and retrofit measures, were adjusted. Unlike the linear ramp rates of the Sixth Plan, which maintain a constant slope until reaching the 85% achievability limit, the Seventh Plan ramp rates display a quadratic behavior. In general, ramp rates in the Seventh Plan begin at a lower penetration percentage, but increase rapidly before leveling off by the end of the study period. The Seventh Plan achievable ramp rates are shown in Figure 7-1 below. More details on the rates used in this analysis can be found in Appendix C.

Figure 7-1 Seventh Plan Ramp Rates



Residential Sector Comparison

Table 7-2 compares 10-year potential between the current and prior studies for the residential market sector. The largest differences are in the space heating and interior lighting end uses. Due to updated assumptions, ductless mini split heat pumps are no longer passing the cost-effectiveness screening. These measures, when applied to both zonal and electric forced-air systems, were two of the top three measures in the prior CPA, accounting for approximately 42,400 MWh of additional potential. This explains most of the difference between the studies.

Differences are also significant in interior lighting, but the magnitude of the change is not as great. The main drivers of this difference are the presence of additional CFLs and LEDs in the baseline and the number of years before the second EISA 2007 general service standard takes effect in 2020. Exterior lighting is not affected by these trends.

Note that these space heating and lighting trends do not affect the JBLM residential sector in the same way. Homes on the base are built to meet higher efficiency requirements than the civilian sector. This means that high-efficiency lighting (CFLs and LEDs) are ubiquitous in the baseline.

Water heating measures comprise greater potential than in the prior study, due high savings per unit assumptions on low-flow showerheads and other water-saving measures. Heat pump water heaters do

not pass until later in the study period.

Table 7-2 Comparison of Residential Potential with Prior Study

End Use	Current Study: 2018-2027 Potential (MWh)	*Prior Study: 2016-2025 Potential (MWh)*	Change from Prior Study (MWh)
Cooling	1,337	626	710
Heating	41,426	*87,442*	-46,015
Water Heating	18,431	*9,308*	9,123
Interior Lighting	24,020	*42,916*	-18,896
Exterior Lighting	12,581	*11,407*	1,174
Appliances	109	*6,477*	-6,368
Electronics	1,259	*2,274*	-1,015
Miscellaneous	2	*454*	-452
Total	**99,164**	***160,903***	**-61,738**

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 Residential Potential with Prior Study

End Use	Current Study: 2018-2027 Potential (MWh)	*Prior Study: 2016-2025 Potential (MWh)*	Change from Prior Study (MWh)
Cooling	11,612	15,950	-4,338
Heating	3,075	*9,306*	-6,231
Ventilation	2,480	*5,121*	-2,641
Water Heating	929	*4,576*	-3,648
Interior Lighting	35,277	*65,257*	-29,980
Exterior Lighting	18,358	*25,750*	-7,393
Refrigeration	6,789	*8,358*	-1,569
Food Preparation	1,815	*4,425*	-2,610
Office Equipment	7,141	*4,310*	2,831
Miscellaneous	405	*1,525*	-1,121
Total	**87,880**	***144,579***	**-56,698**

The lighting end uses are the biggest drivers of differences between the studies. Similar to the residential sector, this is mostly due to the increased penetration of efficient lighting technologies in the baseline. In the prior study, linear LED fixtures were just beginning to become cost effective in commercial applications. As a result, their baseline saturation was very low. In the current study, based on trends found in the Seventh Plan's analysis of the US Department of Energy's LED penetration, linear

LEDs are already installed in nearly 20% of the fixtures. This substantially reduces potential available, since the baseline is already more efficient. Also, based two years of additional data on commercially installed fixtures, linear LED efficacies have also been revised downwards from a projected 125 lumens per watt (lm/W) to 110.2 lm/W. Lower efficacy results in lower savings from these lamps compared to the baseline. Based on these two factors alone, linear LED potential dropped by more than half.

Additionally, potential from lighting control measures also decreased as a result of assumption changes. Previously, occupancy sensors were considered a retrofit measure, applicable to all lighting fixtures in a building. In the Seventh Plan, this measure, and others, were replaced by two-fixture control measures, which achieve deeper savings. The caveat is that these measures are now considered a lost opportunity and only apply to replace on burnout or major retrofit fixtures. As such, they are also installed mainly on efficient technologies, so the incremental savings are smaller.

As buildings become more efficient and the building code has been on the books longer, potential for savings from economizers on HVAC systems has also reduced. Although this measure still has potential, the applicable market has been decreasing over time.

One new commercial measure that increases potential is the implementation of strategic energy management for large buildings. This measure is currently confined to large buildings and campuses, such as hospitals, colleges, and schools, but shows promise for future potential.

The JBLM commercial market is affected in similar ways to the civilian market, but differences are more pronounced. The first issue is that measures have a more difficult time achieving cost effectiveness due to costs of doing business on base and low cooling usage. This means that any measures that were marginally cost effective in the civilian commercial sector will not pass for JBLM.

A

CONSISTENCY WITH SEVENTH PLAN METHODOLOGY

This appendix presents information about how the Tacoma Power 2018-2037 conservation potential assessment complies with Washington State Initiative 937.

Background

In mid-2016, Tacoma Power contracted with Applied Energy Group to conduct this Conservation Potential Assessment. A primary objective of the study was to establish Tacoma's 2018-2019 biennium 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 Analytical Methodology

The CPA completed by AEG for Tacoma Power established a ten-year potential from 2018-2027 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 Energy Analysis & Planning 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, Project Director in Power Management, Conservation Planning Research and Evaluation Division.

The development of the CPA and publication of the final report took place in 2016 and 2017. The base year of the study was 2015, the most recent period for which full, calendar-year data was available. The consultant was provided with the following information which was current as of 2015:

- Utility 2015 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.
- 2011 Residential Building Stock Assessment (RBSA) and 2011 Residential Appliance Saturation Survey (RASS) reports, residential saturation surveys
    - Please note that the Tacoma Power Oversample of the 2011 RBSA was deemed to not be statistically significant and excluded from this analysis
- Load forecasts of energy and customer growth by rate class
- Facility information by building for the Joint-Base Lewis-McChord military base
- 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)
- 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 Seventh Power Plan. When a measure was present in both RTF and Seventh Plan datasets, we prioritized RTF measures if they had been updated after adoption of the Seventh Power Plan on February 10, 2016. Other sources, such as NEEA, BPA, U.S. DOE, and AEG's own internally developed tools and databases, were also utilized, as described in Section 2 of this report.

AEG's modeling approach for the 2018-2037 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 analysis is conducted with AEG's Load Management Analysis and Planning (LoadMAP) tool[15].

In response to requests from stakeholders and regulators in the region for greater transparency into CPAs, AEG has updated the LoadMAP tool to version 5.0, 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 including Jeremy Stewart, Bruce Carter, Mark Percy, Nancy Oakley, Roger Peery, Gary Johnson, Bryan Russo, and Peter Meyer reviewed the data for reasonableness. Specifically, they 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 2018-19 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 2017-2018 conservation target. All four procedures in WAC 194-37-070 (5) (a-d) were followed.

[15] 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.

(a) Technical Potential.

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

The 2018-2037 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.

(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 2018-2037 CPA applied the Seventh 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.

(c) Economic Achievable Potential

Establish the economic achievable potential, which is the conservation potential that is cost-effective, reliable, and feasible, by comparing the total resource cost of conservation measures to the cost of other resources available to meet expected demand for electricity and capacity. A utility may use either of the following approaches to identify economic achievable potential:

AEG utilized approach (ii) as described below for the Tacoma Power 2018-2037 CPA.

(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. Economic achievable 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 non-energy costs and benefits.

Not applicable, AEG used approach (ii) below.

(ii) Benefit-cost ratio approach. A utility may establish economic achievable 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 Economic achievable potential in the 2018-2037 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 economic achievable potential as provided in (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.

(i) Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits;

LoadMAP performs this total resource cost (TRC) test 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 2018-2037 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 (2018 through 2037) 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 Seventh 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.

(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[16]. 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.

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

[16] 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.

Tacoma Power reviewed the basis of utility specific T&D upgrades and that needed work was 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 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.

(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 Seventh 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 plus avoided costs Tacoma were 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 (2013). The market profiles are given for average, existing buildings.

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

- Residential market profiles by segment (Table B-1 through Table B-5)
- JBLM Residential market profiles by segment (Table B-6 through Table B-7)
- Commercial market profiles by building type (Table B-8 through Table B-22)
- 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's larger customers.
- JBLM Commercial market profiles (Table B-23 through Table B-35)
- Street Lighting market profiles (Table B-36 through Table B-38)

Table B-1 Residential Single Family, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	8.3%	595	50	5.3
Cooling	Room AC	8.1%	386	31	3.3
Cooling	Air-Source Heat Pump	6.1%	613	37	3.9
Cooling	Geothermal Heat Pump	0.4%	540	2	0.2
Heating	Air-Source Heat Pump	6.1%	5,896	358	38.0
Heating	Geothermal Heat Pump	0.4%	2,708	11	1.2
Heating	Electric Room Heat	25.9%	8,835	2,288	242.3
Heating	Electric Furnace	14.0%	11,639	1,626	172.2
Water Heating	Water Heater (<= 55 Gal)	58.0%	3,051	1,769	187.3
Water Heating	Water Heater (55 to 75 Gal)	9.3%	3,186	297	31.5
Water Heating	Water Heater (> 75 Gal)	0.8%	3,339	27	2.9
Interior Lighting	General Service Lighting	100.0%	705	705	74.6
Interior Lighting	Linear Lighting	100.0%	158	158	16.7
Interior Lighting	Exempted Lighting	100.0%	282	282	29.9
Exterior Lighting	Screw-In/Hard-Wire	100.0%	329	329	34.8
Appliances	Clothes Washer	97.2%	52	51	5.4
Appliances	Clothes Dryer	95.2%	689	656	69.5
Appliances	Dishwasher	92.8%	227	211	22.3
Appliances	Refrigerator	100.0%	574	574	60.8
Appliances	Freezer	63.6%	578	368	39.0
Appliances	Second Refrigerator	19.4%	669	130	13.7
Appliances	Stove/Oven	71.2%	298	212	22.5
Appliances	Microwave	104.2%	122	127	13.4
Electronics	Personal Computers	80.2%	165	132	14.0
Electronics	Monitor	101.7%	70	71	7.5
Electronics	Laptops	142.9%	43	62	6.6
Electronics	TVs	234.0%	240	562	59.5
Electronics	Printer/Fax/Copier	110.7%	56	62	6.6
Electronics	Set-Top Boxes/DVRs	147.5%	103	152	16.1
Electronics	Devices and Gadgets	100.0%	99	99	10.5
Miscellaneous	Electric Vehicles	0.2%	4,324	8	0.8
Miscellaneous	Pool Pump	3.1%	2,087	65	6.8
Miscellaneous	Pool Heater	0.8%	3,341	26	2.7
Miscellaneous	Furnace Fan	54.5%	199	109	11.5
Miscellaneous	Well Pump	21.2%	533	113	12.0
Miscellaneous	Miscellaneous	100.0%	261	261	27.7
Total				**12,020**	**1,272.9**

Table B-2 Residential Single Family 2-4 Units, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	8.3%	417	35	0.2
Cooling	Room AC	8.1%	270	22	0.1
Cooling	Air-Source Heat Pump	6.1%	429	26	0.1
Cooling	Geothermal Heat Pump	0.4%	378	2	0.0
Heating	Air-Source Heat Pump	6.1%	4,127	251	1.1
Heating	Geothermal Heat Pump	0.4%	1,896	8	0.0
Heating	Electric Room Heat	25.9%	6,184	1,602	7.2
Heating	Electric Furnace	14.0%	8,147	1,138	5.1
Water Heating	Water Heater (<= 55 Gal)	58.0%	2,746	1,592	7.1
Water Heating	Water Heater (55 to 75 Gal)	9.3%	2,867	268	1.2
Water Heating	Water Heater (> 75 Gal)	0.0%	3,005	0	0.0
Interior Lighting	General Service Lighting	100.0%	509	509	2.3
Interior Lighting	Linear Lighting	100.0%	114	114	0.5
Interior Lighting	Exempted Lighting	100.0%	215	215	1.0
Exterior Lighting	Screw-In/Hard-Wire	100.0%	238	238	1.1
Appliances	Clothes Washer	97.2%	52	51	0.2
Appliances	Clothes Dryer	95.2%	689	656	2.9
Appliances	Dishwasher	92.8%	227	211	0.9
Appliances	Refrigerator	100.0%	574	574	2.6
Appliances	Freezer	63.6%	578	368	1.7
Appliances	Second Refrigerator	19.4%	669	130	0.6
Appliances	Stove/Oven	71.2%	298	212	1.0
Appliances	Microwave	104.2%	122	127	0.6
Electronics	Personal Computers	80.2%	165	132	0.6
Electronics	Monitor	101.7%	70	71	0.3
Electronics	Laptops	142.9%	43	62	0.3
Electronics	TVs	234.0%	240	562	2.5
Electronics	Printer/Fax/Copier	110.7%	56	62	0.3
Electronics	Set-Top Boxes/DVRs	147.5%	103	152	0.7
Electronics	Devices and Gadgets	100.0%	99	99	0.4
Miscellaneous	Electric Vehicles	0.1%	4,324	4	0.0
Miscellaneous	Pool Pump	3.1%	2,087	65	0.3
Miscellaneous	Pool Heater	0.8%	3,341	26	0.1
Miscellaneous	Furnace Fan	54.5%	199	109	0.5
Miscellaneous	Well Pump	21.2%	533	113	0.5
Miscellaneous	Miscellaneous	100.0%	377	377	1.7
Total				**10,179**	**45.7**

Table B-3 Residential Low-Rise Multifamily, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	2.3%	98	2	0.1
Cooling	Room AC	22.9%	107	24	0.9
Cooling	Air-Source Heat Pump	1.6%	98	2	0.1
Cooling	Geothermal Heat Pump	0.0%	86	0	0.0
Heating	Air-Source Heat Pump	1.6%	1,906	30	1.1
Heating	Geothermal Heat Pump	0.0%	875	0	0.0
Heating	Electric Room Heat	89.8%	3,647	3,275	118.1
Heating	Electric Furnace	2.0%	4,805	98	3.5
Water Heating	Water Heater (<= 55 Gal)	81.9%	2,655	2,174	78.4
Water Heating	Water Heater (55 to 75 Gal)	6.4%	2,773	178	6.4
Water Heating	Water Heater (> 75 Gal)	0.0%	2,906	0	0.0
Interior Lighting	General Service Lighting	100.0%	548	548	19.8
Interior Lighting	Linear Lighting	100.0%	32	32	1.2
Interior Lighting	Exempted Lighting	100.0%	45	45	1.6
Exterior Lighting	Screw-In/Hard-Wire	0.0%	0	0	0.0
Appliances	Clothes Washer	42.0%	54	23	0.8
Appliances	Clothes Dryer	43.7%	573	250	9.0
Appliances	Dishwasher	59.0%	238	140	5.1
Appliances	Refrigerator	100.0%	601	601	21.7
Appliances	Freezer	0.0%	607	0	0.0
Appliances	Second Refrigerator	1.4%	701	10	0.4
Appliances	Stove/Oven	98.9%	253	250	9.0
Appliances	Microwave	98.3%	128	126	4.5
Electronics	Personal Computers	45.8%	174	80	2.9
Electronics	Monitor	54.2%	73	40	1.4
Electronics	Laptops	116.8%	46	53	1.9
Electronics	TVs	156.9%	269	422	15.2
Electronics	Printer/Fax/Copier	68.8%	59	41	1.5
Electronics	Set-Top Boxes/DVRs	122.7%	109	133	4.8
Electronics	Devices and Gadgets	100.0%	104	104	3.8
Miscellaneous	Electric Vehicles	0.0%	4,324	0	0.0
Miscellaneous	Pool Pump	0.0%	2,197	0	0.0
Miscellaneous	Pool Heater	0.0%	3,517	0	0.0
Miscellaneous	Furnace Fan	6.5%	75	5	0.2
Miscellaneous	Well Pump	0.0%	556	0	0.0
Miscellaneous	Miscellaneous	100.0%	258	258	9.3
Total				**8,945**	**322.5**

Table B-4 Residential High-Rise Multifamily, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	3.0%	98	3	0.0
Cooling	Room AC	11.8%	107	13	0.0
Cooling	Air-Source Heat Pump	1.6%	98	2	0.0
Cooling	Geothermal Heat Pump	0.0%	86	0	0.0
Heating	Air-Source Heat Pump	1.6%	2,682	42	0.0
Heating	Geothermal Heat Pump	0.0%	1,232	0	0.0
Heating	Electric Room Heat	89.8%	5,133	4,609	3.3
Heating	Electric Furnace	2.0%	6,762	138	0.1
Water Heating	Water Heater (<= 55 Gal)	86.6%	2,788	2,415	1.7
Water Heating	Water Heater (55 to 75 Gal)	6.8%	2,911	198	0.1
Water Heating	Water Heater (> 75 Gal)	0.0%	3,051	0	0.0
Interior Lighting	General Service Lighting	100.0%	561	561	0.4
Interior Lighting	Linear Lighting	100.0%	38	38	0.0
Interior Lighting	Exempted Lighting	100.0%	45	45	0.0
Exterior Lighting	Screw-In/Hard-Wire	0.0%	0	0	0.0
Appliances	Clothes Washer	65.6%	57	37	0.0
Appliances	Clothes Dryer	67.8%	602	408	0.3
Appliances	Dishwasher	83.5%	250	209	0.2
Appliances	Refrigerator	100.0%	632	632	0.5
Appliances	Freezer	0.4%	638	3	0.0
Appliances	Second Refrigerator	1.0%	736	8	0.0
Appliances	Stove/Oven	98.9%	265	263	0.2
Appliances	Microwave	98.3%	134	132	0.1
Electronics	Personal Computers	45.8%	182	84	0.1
Electronics	Monitor	54.2%	77	42	0.0
Electronics	Laptops	116.8%	48	56	0.0
Electronics	TVs	156.9%	282	443	0.3
Electronics	Printer/Fax/Copier	68.8%	62	43	0.0
Electronics	Set-Top Boxes/DVRs	122.7%	114	140	0.1
Electronics	Devices and Gadgets	100.0%	109	109	0.1
Miscellaneous	Electric Vehicles	0.0%	4,324	0	0.0
Miscellaneous	Pool Pump	0.0%	2,306	0	0.0
Miscellaneous	Pool Heater	0.0%	3,693	0	0.0
Miscellaneous	Furnace Fan	6.5%	78	5	0.0
Miscellaneous	Well Pump	0.0%	584	0	0.0
Miscellaneous	Miscellaneous	100.0%	512	512	0.4
Total				**11,188**	**8.1**

Table B-5 Residential Manufactured Home, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	2.1%	517	11	0.1
Cooling	Room AC	9.7%	380	37	0.2
Cooling	Air-Source Heat Pump	9.7%	517	50	0.3
Cooling	Geothermal Heat Pump	0.0%	455	0	0.0
Heating	Air-Source Heat Pump	9.7%	6,759	653	3.7
Heating	Geothermal Heat Pump	0.0%	3,117	0	0.0
Heating	Electric Room Heat	4.4%	9,426	415	2.4
Heating	Electric Furnace	56.7%	12,418	7,037	40.4
Water Heating	Water Heater (<= 55 Gal)	75.8%	3,051	2,314	13.3
Water Heating	Water Heater (55 to 75 Gal)	13.3%	3,186	423	2.4
Water Heating	Water Heater (> 75 Gal)	0.0%	3,339	0	0.0
Interior Lighting	General Service Lighting	100.0%	539	539	3.1
Interior Lighting	Linear Lighting	100.0%	87	87	0.5
Interior Lighting	Exempted Lighting	100.0%	144	144	0.8
Exterior Lighting	Screw-In/Hard-Wire	100.0%	136	136	0.8
Appliances	Clothes Washer	99.3%	52	52	0.3
Appliances	Clothes Dryer	90.4%	859	777	4.5
Appliances	Dishwasher	79.0%	227	180	1.0
Appliances	Refrigerator	100.0%	571	571	3.3
Appliances	Freezer	42.6%	580	247	1.4
Appliances	Second Refrigerator	20.4%	665	136	0.8
Appliances	Stove/Oven	90.4%	362	327	1.9
Appliances	Microwave	104.2%	122	127	0.7
Electronics	Personal Computers	37.4%	165	62	0.4
Electronics	Monitor	44.3%	70	31	0.2
Electronics	Laptops	71.2%	43	31	0.2
Electronics	TVs	211.6%	273	577	3.3
Electronics	Printer/Fax/Copier	68.8%	56	39	0.2
Electronics	Set-Top Boxes/DVRs	168.0%	103	173	1.0
Electronics	Devices and Gadgets	100.0%	99	99	0.6
Miscellaneous	Electric Vehicles	0.1%	4,324	4	0.0
Miscellaneous	Pool Pump	0.0%	2,087	0	0.0
Miscellaneous	Pool Heater	0.0%	3,341	0	0.0
Miscellaneous	Furnace Fan	65.5%	151	99	0.6
Miscellaneous	Well Pump	0.0%	428	0	0.0
Miscellaneous	Miscellaneous	100.0%	386	386	2.2
Total				**15,761**	**90.5**

Table B-6 JBLM Residential Single Family, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	0.0%	595	0	0.0
Cooling	Room AC	4.3%	386	16	0.1
Cooling	Air-Source Heat Pump	6.1%	613	37	0.1
Cooling	Geothermal Heat Pump	0.0%	540	0	0.0
Heating	Air-Source Heat Pump	6.1%	5,896	358	1.4
Heating	Geothermal Heat Pump	0.0%	2,708	0	0.0
Heating	Electric Room Heat	25.9%	8,835	2,288	8.8
Heating	Electric Furnace	14.0%	11,639	1,626	6.3
Water Heating	Water Heater (<= 55 Gal)	28.0%	2,746	768	3.0
Water Heating	Water Heater (55 to 75 Gal)	34.7%	2,867	996	3.8
Water Heating	Water Heater (> 75 Gal)	3.0%	3,005	91	0.4
Interior Lighting	General Service Lighting	100.0%	705	705	2.7
Interior Lighting	Linear Lighting	100.0%	158	158	0.6
Interior Lighting	Exempted Lighting	100.0%	282	282	1.1
Exterior Lighting	Screw-In/Hard-Wire	100.0%	329	329	1.3
Appliances	Clothes Washer	97.2%	50	48	0.2
Appliances	Clothes Dryer	95.2%	652	621	2.4
Appliances	Dishwasher	92.8%	215	199	0.8
Appliances	Refrigerator	100.0%	544	544	2.1
Appliances	Freezer	63.6%	548	349	1.3
Appliances	Second Refrigerator	19.4%	634	123	0.5
Appliances	Stove/Oven	71.2%	283	201	0.8
Appliances	Microwave	104.2%	115	120	0.5
Electronics	Personal Computers	80.2%	156	125	0.5
Electronics	Monitor	101.7%	66	67	0.3
Electronics	Laptops	142.9%	41	59	0.2
Electronics	TVs	234.0%	228	533	2.1
Electronics	Printer/Fax/Copier	110.7%	53	59	0.2
Electronics	Set-Top Boxes/DVRs	147.5%	98	144	0.6
Electronics	Devices and Gadgets	100.0%	94	94	0.4
Miscellaneous	Electric Vehicles	0.0%	4,324	0	0.0
Miscellaneous	Pool Pump	3.1%	1,977	61	0.2
Miscellaneous	Pool Heater	0.8%	3,165	24	0.1
Miscellaneous	Furnace Fan	54.5%	189	103	0.4
Miscellaneous	Well Pump	21.2%	505	107	0.4
Miscellaneous	Miscellaneous	100.0%	481	481	1.9
Total				**11,716**	**45.3**

Table B-7 JBLM Residential Multifamily, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	0.0%	88	0	0.0
Cooling	Room AC	4.3%	96	4	0.0
Cooling	Air-Source Heat Pump	0.0%	88	0	0.0
Cooling	Geothermal Heat Pump	0.0%	77	0	0.0
Heating	Air-Source Heat Pump	0.0%	1,200	0	0.0
Heating	Geothermal Heat Pump	0.0%	551	0	0.0
Heating	Electric Room Heat	59.9%	2,296	1,375	1.1
Heating	Electric Furnace	2.0%	3,025	62	0.0
Water Heating	Water Heater (<= 55 Gal)	40.9%	2,257	922	0.7
Water Heating	Water Heater (55 to 75 Gal)	47.3%	2,357	1,114	0.9
Water Heating	Water Heater (> 75 Gal)	0.0%	2,470	0	0.0
Interior Lighting	General Service Lighting	100.0%	493	493	0.4
Interior Lighting	Linear Lighting	100.0%	29	29	0.0
Interior Lighting	Exempted Lighting	100.0%	40	40	0.0
Exterior Lighting	Screw-In/Hard-Wire	100.0%	0	0	0.0
Appliances	Clothes Washer	97.2%	46	45	0.0
Appliances	Clothes Dryer	95.2%	487	464	0.4
Appliances	Dishwasher	92.8%	202	188	0.1
Appliances	Refrigerator	100.0%	511	511	0.4
Appliances	Freezer	0.0%	516	0	0.0
Appliances	Second Refrigerator	1.4%	596	9	0.0
Appliances	Stove/Oven	98.9%	215	213	0.2
Appliances	Microwave	98.3%	109	107	0.1
Electronics	Personal Computers	45.8%	148	68	0.1
Electronics	Monitor	54.2%	62	34	0.0
Electronics	Laptops	116.8%	39	45	0.0
Electronics	TVs	156.9%	229	359	0.3
Electronics	Printer/Fax/Copier	68.8%	50	35	0.0
Electronics	Set-Top Boxes/DVRs	122.7%	92	113	0.1
Electronics	Devices and Gadgets	100.0%	89	89	0.1
Miscellaneous	Electric Vehicles	0.0%	4,324	0	0.0
Miscellaneous	Pool Pump	0.0%	1,867	0	0.0
Miscellaneous	Pool Heater	0.0%	2,989	0	0.0
Miscellaneous	Furnace Fan	6.5%	63	4	0.0
Miscellaneous	Well Pump	0.0%	473	0	0.0
Miscellaneous	Miscellaneous	100.0%	354	354	0.3
Total				**6,676**	**5.2**

Table B-8 Commercial Office, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	15.1%	3.15	0.48	4.6
Cooling	Water-Cooled Chiller	9.3%	3.80	0.35	3.4
Cooling	RTU	49.0%	3.05	1.49	14.4
Cooling	Room AC	2.6%	2.87	0.08	0.7
Cooling	Air-Source Heat Pump	8.8%	3.05	0.27	2.6
Cooling	Geothermal Heat Pump	6.7%	1.86	0.12	1.2
Heating	Electric Furnace	1.6%	5.52	0.09	0.8
Heating	Electric Room Heat	30.5%	5.26	1.60	15.5
Heating	Air-Source Heat Pump	8.8%	4.71	0.42	4.0
Heating	Geothermal Heat Pump	6.7%	3.96	0.27	2.6
Ventilation	Ventilation	100.0%	2.01	2.01	19.3
Water Heating	Water Heater	45.2%	0.99	0.45	4.3
Interior Lighting	Screw-in/Hard-wire	100.0%	0.42	0.42	4.0
Interior Lighting	High-Bay Fixtures	100.0%	0.37	0.37	3.6
Interior Lighting	Linear Lighting	100.0%	1.89	1.89	18.2
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.18	0.18	1.7
Exterior Lighting	Area Lighting	100.0%	0.79	0.79	7.6
Exterior Lighting	Linear Lighting	100.0%	0.23	0.23	2.2
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	1.06	0.02	0.2
Refrigeration	Reach-in Refrigerator/Freezer	14.0%	0.24	0.03	0.3
Refrigeration	Glass Door Display	4.0%	0.24	0.01	0.1
Refrigeration	Open Display Case	4.0%	1.44	0.06	0.6
Refrigeration	Icemaker	4.0%	0.40	0.02	0.2
Refrigeration	Vending Machine	2.1%	0.19	0.00	0.0
Food Preparation	Oven	10.0%	0.58	0.06	0.6
Food Preparation	Fryer	1.0%	0.84	0.01	0.1
Food Preparation	Dishwasher	12.0%	1.16	0.14	1.3
Food Preparation	Steamer	1.0%	0.85	0.01	0.1
Food Preparation	Hot Food Container	1.0%	0.16	0.00	0.0
Office Equipment	Desktop Computer	100.0%	1.92	1.92	18.5
Office Equipment	Laptop	100.0%	0.20	0.20	1.9
Office Equipment	Server	100.0%	0.23	0.23	2.2
Office Equipment	Monitor	100.0%	0.34	0.34	3.3
Office Equipment	Printer/Copier/Fax	100.0%	0.21	0.21	2.0
Office Equipment	POS Terminal	37.4%	0.02	0.01	0.1
Miscellaneous	Non-HVAC Motors	65.7%	0.24	0.16	1.5
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.99	0.99	9.5
Total				**15.90**	**153.4**

Table B-9 Commercial Retail, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.8%	2.76	0.02	0.3
Cooling	Water-Cooled Chiller	0.5%	3.27	0.02	0.2
Cooling	RTU	57.2%	2.17	1.24	17.0
Cooling	Room AC	5.4%	2.33	0.13	1.7
Cooling	Air-Source Heat Pump	3.1%	2.17	0.07	0.9
Cooling	Geothermal Heat Pump	2.0%	1.32	0.03	0.4
Heating	Electric Furnace	0.9%	4.67	0.04	0.6
Heating	Electric Room Heat	10.1%	4.45	0.45	6.2
Heating	Air-Source Heat Pump	3.1%	3.61	0.11	1.5
Heating	Geothermal Heat Pump	2.0%	2.63	0.05	0.7
Ventilation	Ventilation	100.0%	0.91	0.91	12.4
Water Heating	Water Heater	38.2%	0.82	0.31	4.3
Interior Lighting	Screw-in/Hard-wire	100.0%	1.36	1.36	18.6
Interior Lighting	High-Bay Fixtures	100.0%	1.84	1.84	25.1
Interior Lighting	Linear Lighting	100.0%	1.70	1.70	23.3
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.45	0.45	6.1
Exterior Lighting	Area Lighting	100.0%	0.94	0.94	12.9
Exterior Lighting	Linear Lighting	100.0%	0.30	0.30	4.0
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	2.11	0.04	0.6
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.47	0.00	0.0
Refrigeration	Glass Door Display	16.3%	0.49	0.08	1.1
Refrigeration	Open Display Case	14.0%	2.88	0.40	5.5
Refrigeration	Icemaker	7.1%	0.79	0.06	0.8
Refrigeration	Vending Machine	22.8%	0.37	0.09	1.2
Food Preparation	Oven	4.0%	2.56	0.10	1.4
Food Preparation	Fryer	0.0%	3.71	0.00	0.0
Food Preparation	Dishwasher	2.0%	5.10	0.10	1.4
Food Preparation	Steamer	0.0%	3.74	0.00	0.0
Food Preparation	Hot Food Container	1.0%	0.70	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.24	0.24	3.3
Office Equipment	Laptop	100.0%	0.05	0.05	0.7
Office Equipment	Server	82.0%	0.09	0.08	1.1
Office Equipment	Monitor	100.0%	0.04	0.04	0.6
Office Equipment	Printer/Copier/Fax	100.0%	0.04	0.04	0.6
Office Equipment	POS Terminal	73.8%	0.05	0.04	0.5
Miscellaneous	Non-HVAC Motors	40.2%	0.22	0.09	1.2
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.81	0.81	11.1
Total				**12.22**	**167.3**

Table B-10 Commercial College, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	26.1%	6.99	1.82	4.4
Cooling	Water-Cooled Chiller	6.0%	10.11	0.61	1.5
Cooling	RTU	52.6%	4.25	2.23	5.4
Cooling	Room AC	3.4%	4.00	0.14	0.3
Cooling	Air-Source Heat Pump	5.1%	4.24	0.22	0.5
Cooling	Geothermal Heat Pump	0.9%	2.58	0.02	0.1
Heating	Electric Furnace	0.0%	15.67	0.00	0.0
Heating	Electric Room Heat	17.9%	14.92	2.67	6.5
Heating	Air-Source Heat Pump	5.1%	10.04	0.51	1.2
Heating	Geothermal Heat Pump	0.9%	8.15	0.07	0.2
Ventilation	Ventilation	100.0%	3.89	3.89	9.5
Water Heating	Water Heater	15.1%	3.54	0.53	1.3
Interior Lighting	Screw-in/Hard-wire	100.0%	0.17	0.17	0.4
Interior Lighting	High-Bay Fixtures	100.0%	0.37	0.37	0.9
Interior Lighting	Linear Lighting	100.0%	1.51	1.51	3.7
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	0.8
Exterior Lighting	Area Lighting	100.0%	0.20	0.20	0.5
Exterior Lighting	Linear Lighting	100.0%	0.71	0.71	1.7
Refrigeration	Walk-in Refrigerator/Freezer	7.7%	0.48	0.04	0.1
Refrigeration	Reach-in Refrigerator/Freezer	13.4%	0.22	0.03	0.1
Refrigeration	Glass Door Display	8.0%	0.11	0.01	0.0
Refrigeration	Open Display Case	4.8%	0.65	0.03	0.1
Refrigeration	Icemaker	28.2%	0.36	0.10	0.2
Refrigeration	Vending Machine	8.8%	0.17	0.01	0.0
Food Preparation	Oven	24.7%	0.62	0.15	0.4
Food Preparation	Fryer	1.1%	0.90	0.01	0.0
Food Preparation	Dishwasher	16.3%	1.24	0.20	0.5
Food Preparation	Steamer	11.9%	0.91	0.11	0.3
Food Preparation	Hot Food Container	10.6%	0.17	0.02	0.0
Office Equipment	Desktop Computer	100.0%	0.76	0.76	1.8
Office Equipment	Laptop	100.0%	0.04	0.04	0.1
Office Equipment	Server	100.0%	0.09	0.09	0.2
Office Equipment	Monitor	100.0%	0.13	0.13	0.3
Office Equipment	Printer/Copier/Fax	100.0%	0.10	0.10	0.3
Office Equipment	POS Terminal	95.6%	0.03	0.03	0.1
Miscellaneous	Non-HVAC Motors	88.8%	0.31	0.28	0.7
Miscellaneous	Pool Pump	58.8%	0.02	0.01	0.0
Miscellaneous	Pool Heater	58.8%	0.03	0.01	0.0
Miscellaneous	Other Miscellaneous	100.0%	1.40	1.40	3.4
Total				**19.55**	**47.5**

Table B-11 Commercial School, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	16.1%	2.58	0.42	4.3
Cooling	Water-Cooled Chiller	5.0%	3.73	0.19	1.9
Cooling	RTU	34.7%	1.57	0.54	5.6
Cooling	Room AC	2.3%	1.48	0.03	0.3
Cooling	Air-Source Heat Pump	5.3%	1.57	0.08	0.8
Cooling	Geothermal Heat Pump	9.5%	0.95	0.09	0.9
Heating	Electric Furnace	0.0%	10.66	0.00	0.0
Heating	Electric Room Heat	1.8%	10.15	0.19	1.9
Heating	Air-Source Heat Pump	5.3%	6.83	0.36	3.7
Heating	Geothermal Heat Pump	9.5%	5.54	0.53	5.4
Ventilation	Ventilation	100.0%	1.03	1.03	10.5
Water Heating	Water Heater	13.6%	0.99	0.13	1.4
Interior Lighting	Screw-in/Hard-wire	100.0%	0.16	0.16	1.6
Interior Lighting	High-Bay Fixtures	100.0%	0.90	0.90	9.2
Interior Lighting	Linear Lighting	100.0%	0.88	0.88	9.0
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.29	0.29	2.9
Exterior Lighting	Area Lighting	100.0%	0.52	0.52	5.4
Exterior Lighting	Linear Lighting	100.0%	0.68	0.68	7.0
Refrigeration	Walk-in Refrigerator/Freezer	19.0%	0.31	0.06	0.6
Refrigeration	Reach-in Refrigerator/Freezer	33.0%	0.14	0.05	0.5
Refrigeration	Glass Door Display	19.7%	0.07	0.01	0.1
Refrigeration	Open Display Case	11.9%	0.42	0.05	0.5
Refrigeration	Icemaker	69.7%	0.23	0.16	1.7
Refrigeration	Vending Machine	21.8%	0.11	0.02	0.2
Food Preparation	Oven	61.4%	0.20	0.12	1.2
Food Preparation	Fryer	2.6%	0.28	0.01	0.1
Food Preparation	Dishwasher	40.4%	0.39	0.16	1.6
Food Preparation	Steamer	29.6%	0.28	0.08	0.9
Food Preparation	Hot Food Container	26.3%	0.05	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.29	0.29	3.0
Office Equipment	Laptop	100.0%	0.02	0.02	0.2
Office Equipment	Server	100.0%	0.07	0.07	0.7
Office Equipment	Monitor	100.0%	0.05	0.05	0.5
Office Equipment	Printer/Copier/Fax	100.0%	0.03	0.03	0.3
Office Equipment	POS Terminal	11.5%	0.01	0.00	0.0
Miscellaneous	Non-HVAC Motors	43.7%	0.13	0.06	0.6
Miscellaneous	Pool Pump	32.9%	0.01	0.00	0.0
Miscellaneous	Pool Heater	32.9%	0.01	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.65	0.65	6.7
Total				**8.95**	**91.4**

Table B-12 Commercial Grocery, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.5%	6.08	0.03	0.1
Cooling	Water-Cooled Chiller	0.3%	7.22	0.02	0.0
Cooling	RTU	74.3%	4.80	3.56	6.8
Cooling	Room AC	3.4%	4.52	0.16	0.3
Cooling	Air-Source Heat Pump	4.3%	3.96	0.17	0.3
Cooling	Geothermal Heat Pump	0.5%	1.54	0.01	0.0
Heating	Electric Furnace	9.0%	7.18	0.64	1.2
Heating	Electric Room Heat	1.7%	6.84	0.11	0.2
Heating	Air-Source Heat Pump	4.3%	3.15	0.13	0.3
Heating	Geothermal Heat Pump	0.5%	2.02	0.01	0.0
Ventilation	Ventilation	100.0%	2.31	2.31	4.4
Water Heating	Water Heater	17.5%	2.29	0.40	0.8
Interior Lighting	Screw-in/Hard-wire	100.0%	1.13	1.13	2.1
Interior Lighting	High-Bay Fixtures	100.0%	2.76	2.76	5.2
Interior Lighting	Linear Lighting	100.0%	4.95	4.95	9.4
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.46	0.46	0.9
Exterior Lighting	Area Lighting	100.0%	1.37	1.37	2.6
Exterior Lighting	Linear Lighting	100.0%	0.61	0.61	1.2
Refrigeration	Walk-in Refrigerator/Freezer	16.0%	5.72	0.92	1.7
Refrigeration	Reach-in Refrigerator/Freezer	83.1%	0.37	0.30	0.6
Refrigeration	Glass Door Display	95.6%	3.76	3.60	6.8
Refrigeration	Open Display Case	95.6%	22.31	21.33	40.5
Refrigeration	Icemaker	66.6%	0.31	0.21	0.4
Refrigeration	Vending Machine	36.5%	0.29	0.11	0.2
Food Preparation	Oven	11.0%	0.64	0.07	0.1
Food Preparation	Fryer	87.0%	0.92	0.80	1.5
Food Preparation	Dishwasher	54.9%	1.27	0.70	1.3
Food Preparation	Steamer	20.0%	0.93	0.19	0.4
Food Preparation	Hot Food Container	73.0%	0.17	0.13	0.2
Office Equipment	Desktop Computer	100.0%	0.16	0.16	0.3
Office Equipment	Laptop	64.0%	0.02	0.02	0.0
Office Equipment	Server	100.0%	0.09	0.09	0.2
Office Equipment	Monitor	100.0%	0.03	0.03	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.0
Office Equipment	POS Terminal	95.9%	0.06	0.06	0.1
Miscellaneous	Non-HVAC Motors	34.6%	0.94	0.32	0.6
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	3.95	3.95	7.5
Total				**51.83**	**98.4**

Table B-13 Commercial Hospital, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	14.1%	4.15	0.58	2.4
Cooling	Water-Cooled Chiller	56.3%	6.34	3.57	14.5
Cooling	RTU	9.2%	4.52	0.42	1.7
Cooling	Room AC	0.3%	4.25	0.01	0.1
Cooling	Air-Source Heat Pump	2.0%	4.51	0.09	0.4
Cooling	Geothermal Heat Pump	1.8%	2.75	0.05	0.2
Heating	Electric Furnace	1.4%	18.41	0.26	1.1
Heating	Electric Room Heat	0.0%	17.54	0.01	0.0
Heating	Air-Source Heat Pump	2.0%	11.44	0.23	0.9
Heating	Geothermal Heat Pump	1.8%	8.65	0.15	0.6
Ventilation	Ventilation	100.0%	3.88	3.88	15.8
Water Heating	Water Heater	4.7%	4.56	0.21	0.9
Interior Lighting	Screw-in/Hard-wire	100.0%	1.48	1.48	6.0
Interior Lighting	High-Bay Fixtures	100.0%	0.88	0.88	3.6
Interior Lighting	Linear Lighting	100.0%	2.98	2.98	12.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.13	0.13	0.5
Exterior Lighting	Area Lighting	100.0%	0.61	0.61	2.5
Exterior Lighting	Linear Lighting	100.0%	0.24	0.24	1.0
Refrigeration	Walk-in Refrigerator/Freezer	33.0%	1.29	0.42	1.7
Refrigeration	Reach-in Refrigerator/Freezer	50.0%	0.29	0.14	0.6
Refrigeration	Glass Door Display	8.6%	0.30	0.03	0.1
Refrigeration	Open Display Case	6.7%	1.76	0.12	0.5
Refrigeration	Icemaker	21.1%	0.49	0.10	0.4
Refrigeration	Vending Machine	27.9%	0.46	0.13	0.5
Food Preparation	Oven	62.2%	3.08	1.91	7.8
Food Preparation	Fryer	14.2%	4.45	0.63	2.6
Food Preparation	Dishwasher	30.9%	6.12	1.89	7.7
Food Preparation	Steamer	3.6%	4.49	0.16	0.7
Food Preparation	Hot Food Container	12.3%	0.84	0.10	0.4
Office Equipment	Desktop Computer	100.0%	1.07	1.07	4.3
Office Equipment	Laptop	100.0%	0.07	0.07	0.3
Office Equipment	Server	100.0%	0.25	0.25	1.0
Office Equipment	Monitor	100.0%	0.19	0.19	0.8
Office Equipment	Printer/Copier/Fax	100.0%	0.12	0.12	0.5
Office Equipment	POS Terminal	51.0%	0.08	0.04	0.2
Miscellaneous	Non-HVAC Motors	74.1%	0.38	0.28	1.1
Miscellaneous	Pool Pump	3.9%	0.01	0.00	0.0
Miscellaneous	Pool Heater	5.7%	0.01	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	4.01	4.01	16.3
Total				**27.44**	**111.5**

Table B-14 Commercial Other Health, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	1.0%	2.54	0.03	0.1
Cooling	Water-Cooled Chiller	4.2%	3.89	0.16	0.8
Cooling	RTU	33.5%	2.77	0.93	4.6
Cooling	Room AC	32.8%	2.61	0.85	4.2
Cooling	Air-Source Heat Pump	4.9%	2.76	0.13	0.7
Cooling	Geothermal Heat Pump	4.4%	1.68	0.07	0.4
Heating	Electric Furnace	0.0%	5.26	0.00	0.0
Heating	Electric Room Heat	48.5%	5.01	2.43	11.9
Heating	Air-Source Heat Pump	4.9%	4.00	0.19	1.0
Heating	Geothermal Heat Pump	4.4%	2.84	0.12	0.6
Ventilation	Ventilation	100.0%	2.78	2.78	13.7
Water Heating	Water Heater	9.7%	1.80	0.17	0.9
Interior Lighting	Screw-in/Hard-wire	100.0%	0.96	0.96	4.7
Interior Lighting	High-Bay Fixtures	100.0%	0.57	0.57	2.8
Interior Lighting	Linear Lighting	100.0%	1.93	1.93	9.5
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.10	0.10	0.5
Exterior Lighting	Area Lighting	100.0%	0.44	0.44	2.2
Exterior Lighting	Linear Lighting	100.0%	0.18	0.18	0.9
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	2.55	0.05	0.3
Refrigeration	Reach-in Refrigerator/Freezer	14.0%	0.57	0.08	0.4
Refrigeration	Glass Door Display	4.0%	0.59	0.02	0.1
Refrigeration	Open Display Case	4.0%	3.48	0.14	0.7
Refrigeration	Icemaker	4.0%	0.96	0.04	0.2
Refrigeration	Vending Machine	2.1%	0.45	0.01	0.0
Food Preparation	Oven	10.0%	2.15	0.22	1.1
Food Preparation	Fryer	1.0%	3.11	0.03	0.2
Food Preparation	Dishwasher	12.0%	4.28	0.51	2.5
Food Preparation	Steamer	1.0%	3.14	0.03	0.2
Food Preparation	Hot Food Container	1.0%	0.59	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.32	0.32	1.6
Office Equipment	Laptop	100.0%	0.05	0.05	0.2
Office Equipment	Server	100.0%	0.19	0.19	0.9
Office Equipment	Monitor	100.0%	0.06	0.06	0.3
Office Equipment	Printer/Copier/Fax	100.0%	0.04	0.04	0.2
Office Equipment	POS Terminal	51.0%	0.05	0.03	0.1
Miscellaneous	Non-HVAC Motors	74.1%	0.21	0.16	0.8
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.87	0.87	4.3
Total				**14.90**	**73.3**

Table B-15 Commercial Lodging, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.4%	1.40	0.03	0.1
Cooling	Water-Cooled Chiller	8.7%	2.04	0.18	0.6
Cooling	RTU	18.8%	3.29	0.62	2.1
Cooling	Room AC	46.7%	3.10	1.45	4.8
Cooling	Air-Source Heat Pump	8.0%	3.29	0.26	0.9
Cooling	Geothermal Heat Pump	3.4%	2.76	0.09	0.3
Heating	Electric Furnace	1.8%	5.67	0.10	0.3
Heating	Electric Room Heat	63.0%	5.40	3.40	11.4
Heating	Air-Source Heat Pump	8.0%	5.31	0.42	1.4
Heating	Geothermal Heat Pump	3.4%	3.15	0.11	0.4
Ventilation	Ventilation	100.0%	1.84	1.84	6.2
Water Heating	Water Heater	10.5%	3.20	0.34	1.1
Interior Lighting	Screw-in/Hard-wire	100.0%	1.06	1.06	3.5
Interior Lighting	High-Bay Fixtures	100.0%	0.20	0.20	0.7
Interior Lighting	Linear Lighting	100.0%	0.57	0.57	1.9
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.26	0.26	0.9
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	3.4
Exterior Lighting	Linear Lighting	100.0%	0.04	0.04	0.1
Refrigeration	Walk-in Refrigerator/Freezer	3.0%	0.55	0.02	0.1
Refrigeration	Reach-in Refrigerator/Freezer	19.0%	0.12	0.02	0.1
Refrigeration	Glass Door Display	40.0%	0.13	0.05	0.2
Refrigeration	Open Display Case	0.0%	0.75	0.00	0.0
Refrigeration	Icemaker	88.9%	0.41	0.37	1.2
Refrigeration	Vending Machine	57.8%	0.19	0.11	0.4
Food Preparation	Oven	24.0%	0.35	0.08	0.3
Food Preparation	Fryer	4.0%	0.50	0.02	0.1
Food Preparation	Dishwasher	39.0%	0.69	0.27	0.9
Food Preparation	Steamer	4.0%	0.51	0.02	0.1
Food Preparation	Hot Food Container	10.0%	0.09	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.08	0.08	0.3
Office Equipment	Laptop	100.0%	0.01	0.01	0.0
Office Equipment	Server	100.0%	0.05	0.05	0.2
Office Equipment	Monitor	100.0%	0.01	0.01	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.0
Office Equipment	POS Terminal	38.9%	0.01	0.01	0.0
Miscellaneous	Non-HVAC Motors	91.3%	0.19	0.18	0.6
Miscellaneous	Pool Pump	66.7%	0.03	0.02	0.1
Miscellaneous	Pool Heater	2.9%	0.04	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.98	0.98	3.3
Total				**14.30**	**47.8**

Table B-16 Commercial Restaurant, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.5%	5.39	0.03	0.0
Cooling	Water-Cooled Chiller	0.0%	5.93	0.00	0.0
Cooling	RTU	71.2%	6.56	4.67	6.7
Cooling	Room AC	5.9%	6.18	0.36	0.5
Cooling	Air-Source Heat Pump	7.4%	6.56	0.49	0.7
Cooling	Geothermal Heat Pump	4.0%	4.00	0.16	0.2
Heating	Electric Furnace	2.5%	11.82	0.30	0.4
Heating	Electric Room Heat	0.2%	11.26	0.03	0.0
Heating	Air-Source Heat Pump	7.4%	7.39	0.55	0.8
Heating	Geothermal Heat Pump	4.0%	5.57	0.22	0.3
Ventilation	Ventilation	100.0%	3.57	3.57	5.1
Water Heating	Water Heater	15.1%	7.04	1.07	1.5
Interior Lighting	Screw-in/Hard-wire	100.0%	2.14	2.14	3.1
Interior Lighting	High-Bay Fixtures	100.0%	1.33	1.33	1.9
Interior Lighting	Linear Lighting	100.0%	2.18	2.18	3.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.64	0.64	0.9
Exterior Lighting	Area Lighting	100.0%	1.64	1.64	2.4
Exterior Lighting	Linear Lighting	100.0%	0.47	0.47	0.7
Refrigeration	Walk-in Refrigerator/Freezer	74.0%	5.25	3.88	5.6
Refrigeration	Reach-in Refrigerator/Freezer	7.0%	2.35	0.16	0.2
Refrigeration	Glass Door Display	77.6%	1.21	0.94	1.3
Refrigeration	Open Display Case	26.0%	7.16	1.86	2.7
Refrigeration	Icemaker	75.9%	1.98	1.50	2.2
Refrigeration	Vending Machine	0.0%	0.93	0.00	0.0
Food Preparation	Oven	21.0%	3.59	0.75	1.1
Food Preparation	Fryer	82.0%	5.19	4.26	6.1
Food Preparation	Dishwasher	52.5%	3.57	1.88	2.7
Food Preparation	Steamer	16.0%	2.62	0.42	0.6
Food Preparation	Hot Food Container	84.0%	0.49	0.41	0.6
Office Equipment	Desktop Computer	100.0%	0.28	0.28	0.4
Office Equipment	Laptop	100.0%	0.03	0.03	0.0
Office Equipment	Server	50.0%	0.33	0.16	0.2
Office Equipment	Monitor	100.0%	0.05	0.05	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.06	0.06	0.1
Office Equipment	POS Terminal	65.0%	0.09	0.06	0.1
Miscellaneous	Non-HVAC Motors	20.0%	0.70	0.14	0.2
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	3.10	3.10	4.4
Total				**39.79**	**56.9**

Table B-17 Commercial Assembly, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	10.5%	2.70	0.28	1.7
Cooling	Water-Cooled Chiller	4.2%	3.20	0.13	0.8
Cooling	RTU	48.6%	2.13	1.03	6.4
Cooling	Room AC	2.7%	2.00	0.05	0.3
Cooling	Air-Source Heat Pump	7.9%	2.13	0.17	1.0
Cooling	Geothermal Heat Pump	1.5%	1.30	0.02	0.1
Heating	Electric Furnace	2.3%	5.78	0.13	0.8
Heating	Electric Room Heat	2.7%	5.50	0.15	0.9
Heating	Air-Source Heat Pump	7.9%	4.76	0.38	2.3
Heating	Geothermal Heat Pump	1.5%	3.89	0.06	0.4
Ventilation	Ventilation	100.0%	0.79	0.79	4.9
Water Heating	Water Heater	23.7%	0.95	0.22	1.4
Interior Lighting	Screw-in/Hard-wire	100.0%	0.40	0.40	2.4
Interior Lighting	High-Bay Fixtures	100.0%	0.40	0.40	2.5
Interior Lighting	Linear Lighting	100.0%	1.06	1.06	6.5
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	1.9
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	1.2
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	1.7
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.28	0.02	0.2
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.06	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.06	0.01	0.1
Refrigeration	Open Display Case	0.0%	0.38	0.00	0.0
Refrigeration	Icemaker	41.6%	0.10	0.04	0.3
Refrigeration	Vending Machine	28.6%	0.05	0.01	0.1
Food Preparation	Oven	46.1%	0.43	0.20	1.2
Food Preparation	Fryer	4.1%	0.63	0.03	0.2
Food Preparation	Dishwasher	4.1%	0.86	0.04	0.2
Food Preparation	Steamer	4.1%	0.63	0.03	0.2
Food Preparation	Hot Food Container	10.0%	0.12	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.14	0.14	0.9
Office Equipment	Laptop	100.0%	0.02	0.02	0.1
Office Equipment	Server	66.0%	0.08	0.05	0.3
Office Equipment	Monitor	100.0%	0.02	0.02	0.2
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.1
Office Equipment	POS Terminal	22.7%	0.02	0.01	0.0
Miscellaneous	Non-HVAC Motors	59.9%	0.15	0.09	0.5
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.59	0.59	3.6
Total				**7.39**	**45.5**

Table B-18 Commercial Warehouse, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.5%	5.18	0.13	1.5
Cooling	Water-Cooled Chiller	2.5%	6.15	0.15	1.8
Cooling	RTU	10.3%	4.09	0.42	5.0
Cooling	Room AC	1.0%	3.85	0.04	0.5
Cooling	Air-Source Heat Pump	2.7%	4.09	0.11	1.3
Cooling	Geothermal Heat Pump	0.0%	2.49	0.00	0.0
Heating	Electric Furnace	1.9%	8.28	0.16	1.9
Heating	Electric Room Heat	10.5%	7.88	0.82	9.7
Heating	Air-Source Heat Pump	2.7%	7.17	0.19	2.3
Heating	Geothermal Heat Pump	0.0%	5.85	0.00	0.0
Ventilation	Ventilation	100.0%	0.65	0.65	7.7
Water Heating	Water Heater	38.3%	0.26	0.10	1.2
Interior Lighting	Screw-in/Hard-wire	100.0%	0.14	0.14	1.6
Interior Lighting	High-Bay Fixtures	100.0%	1.49	1.49	17.6
Interior Lighting	Linear Lighting	100.0%	0.43	0.43	5.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.16	0.16	1.9
Exterior Lighting	Area Lighting	100.0%	0.71	0.71	8.4
Exterior Lighting	Linear Lighting	100.0%	0.23	0.23	2.8
Refrigeration	Walk-in Refrigerator/Freezer	1.1%	4.88	0.05	0.6
Refrigeration	Reach-in Refrigerator/Freezer	2.0%	1.10	0.02	0.3
Refrigeration	Glass Door Display	0.0%	1.12	0.00	0.0
Refrigeration	Open Display Case	0.0%	6.67	0.00	0.0
Refrigeration	Icemaker	8.3%	1.84	0.15	1.8
Refrigeration	Vending Machine	6.9%	0.87	0.06	0.7
Food Preparation	Oven	0.0%	0.12	0.00	0.0
Food Preparation	Fryer	0.0%	0.18	0.00	0.0
Food Preparation	Dishwasher	2.0%	0.24	0.00	0.1
Food Preparation	Steamer	0.0%	0.18	0.00	0.0
Food Preparation	Hot Food Container	0.0%	0.03	0.00	0.0
Office Equipment	Desktop Computer	100.0%	0.10	0.10	1.1
Office Equipment	Laptop	100.0%	0.01	0.01	0.1
Office Equipment	Server	89.0%	0.11	0.10	1.2
Office Equipment	Monitor	100.0%	0.02	0.02	0.2
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.1
Office Equipment	POS Terminal	6.1%	0.03	0.00	0.0
Miscellaneous	Non-HVAC Motors	49.9%	0.18	0.09	1.0
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.69	0.69	8.1
Total				**7.25**	**85.7**

Table B-19 Commercial Data Center, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	15.1%	34.67	5.25	1.2
Cooling	Water-Cooled Chiller	24.3%	43.20	10.51	2.4
Cooling	RTU	34.0%	45.58	15.51	3.6
Cooling	Room AC	2.6%	42.93	1.14	0.3
Cooling	Air-Source Heat Pump	8.8%	45.58	4.03	0.9
Cooling	Geothermal Heat Pump	6.7%	27.78	1.86	0.4
Heating	Electric Furnace	1.6%	4.08	0.06	0.0
Heating	Electric Room Heat	30.5%	3.89	1.19	0.3
Heating	Air-Source Heat Pump	8.8%	3.75	0.33	0.1
Heating	Geothermal Heat Pump	6.7%	3.34	0.22	0.1
Ventilation	Ventilation	100.0%	27.46	27.46	6.3
Water Heating	Water Heater	45.2%	0.69	0.31	0.1
Interior Lighting	Screw-in/Hard-wire	100.0%	0.99	0.99	0.2
Interior Lighting	High-Bay Fixtures	100.0%	0.45	0.45	0.1
Interior Lighting	Linear Lighting	100.0%	4.66	4.66	1.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.17	0.17	0.0
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	0.2
Exterior Lighting	Linear Lighting	100.0%	0.30	0.30	0.1
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	0.72	0.01	0.0
Refrigeration	Reach-in Refrigerator/Freezer	14.0%	0.16	0.02	0.0
Refrigeration	Glass Door Display	4.0%	0.17	0.01	0.0
Refrigeration	Open Display Case	4.0%	0.98	0.04	0.0
Refrigeration	Icemaker	4.0%	0.27	0.01	0.0
Refrigeration	Vending Machine	2.1%	0.26	0.01	0.0
Food Preparation	Oven	10.0%	0.41	0.04	0.0
Food Preparation	Fryer	1.0%	0.59	0.01	0.0
Food Preparation	Dishwasher	12.0%	0.81	0.10	0.0
Food Preparation	Steamer	1.0%	0.59	0.01	0.0
Food Preparation	Hot Food Container	1.0%	0.11	0.00	0.0
Office Equipment	Desktop Computer	100.0%	49.05	49.05	11.2
Office Equipment	Laptop	100.0%	7.57	7.57	1.7
Office Equipment	Server	100.0%	4.81	4.81	1.1
Office Equipment	Monitor	100.0%	8.66	8.66	2.0
Office Equipment	Printer/Copier/Fax	100.0%	4.48	4.48	1.0
Office Equipment	POS Terminal	57.6%	0.64	0.37	0.1
Miscellaneous	Non-HVAC Motors	65.7%	4.82	3.17	0.7
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	21.21	21.21	4.9
Total				**175.00**	**40.1**

Table B-20 Commercial MF Common Area, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.4%	0.50	0.01	0.1
Cooling	Water-Cooled Chiller	8.7%	0.73	0.06	0.4
Cooling	RTU	18.8%	1.18	0.22	1.5
Cooling	Room AC	46.7%	1.11	0.52	3.4
Cooling	Air-Source Heat Pump	8.0%	1.18	0.09	0.6
Cooling	Geothermal Heat Pump	3.4%	0.99	0.03	0.2
Heating	Electric Furnace	1.8%	2.04	0.04	0.2
Heating	Electric Room Heat	63.0%	1.94	1.22	8.1
Heating	Air-Source Heat Pump	8.0%	1.90	0.15	1.0
Heating	Geothermal Heat Pump	3.4%	1.13	0.04	0.3
Ventilation	Ventilation	100.0%	0.66	0.66	4.4
Water Heating	Water Heater	10.5%	3.20	0.34	2.2
Interior Lighting	Screw-in/Hard-wire	100.0%	0.53	0.53	3.5
Interior Lighting	High-Bay Fixtures	100.0%	0.20	0.20	1.3
Interior Lighting	Linear Lighting	100.0%	0.57	0.57	3.8
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.26	0.26	1.7
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	6.7
Exterior Lighting	Linear Lighting	100.0%	0.04	0.04	0.3
Refrigeration	Walk-in Refrigerator/Freezer	3.0%	0.81	0.02	0.2
Refrigeration	Reach-in Refrigerator/Freezer	19.0%	0.18	0.03	0.2
Refrigeration	Glass Door Display	40.0%	0.19	0.07	0.5
Refrigeration	Open Display Case	0.0%	1.10	0.00	0.0
Refrigeration	Icemaker	88.9%	0.30	0.27	1.8
Refrigeration	Vending Machine	57.8%	0.29	0.17	1.1
Food Preparation	Oven	24.0%	0.35	0.08	0.6
Food Preparation	Fryer	4.0%	0.50	0.02	0.1
Food Preparation	Dishwasher	39.0%	0.69	0.27	1.8
Food Preparation	Steamer	4.0%	0.51	0.02	0.1
Food Preparation	Hot Food Container	10.0%	0.09	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.09	0.09	0.6
Office Equipment	Laptop	100.0%	0.01	0.01	0.1
Office Equipment	Server	66.0%	0.06	0.04	0.2
Office Equipment	Monitor	100.0%	0.02	0.02	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.1
Office Equipment	POS Terminal	22.7%	0.01	0.00	0.0
Miscellaneous	Non-HVAC Motors	91.3%	0.09	0.08	0.5
Miscellaneous	Pool Pump	66.7%	0.01	0.01	0.1
Miscellaneous	Pool Heater	2.9%	0.02	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.44	0.44	2.9
Total				**7.66**	**50.9**

Table B-21 Commercial Miscellaneous-Classified, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.7%	2.35	0.18	1.7
Cooling	Water-Cooled Chiller	4.0%	2.79	0.11	1.0
Cooling	RTU	45.5%	1.85	0.84	7.8
Cooling	Room AC	4.1%	1.74	0.07	0.7
Cooling	Air-Source Heat Pump	7.7%	1.85	0.14	1.3
Cooling	Geothermal Heat Pump	1.9%	1.13	0.02	0.2
Heating	Electric Furnace	7.3%	5.14	0.37	3.5
Heating	Electric Room Heat	8.6%	4.89	0.42	3.9
Heating	Air-Source Heat Pump	7.7%	4.24	0.33	3.0
Heating	Geothermal Heat Pump	1.9%	3.46	0.07	0.6
Ventilation	Ventilation	100.0%	0.77	0.77	7.1
Water Heating	Water Heater	12.4%	1.39	0.17	1.6
Interior Lighting	Screw-in/Hard-wire	100.0%	0.54	0.54	5.0
Interior Lighting	High-Bay Fixtures	100.0%	0.55	0.55	5.1
Interior Lighting	Linear Lighting	100.0%	1.44	1.44	13.4
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	2.9
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	1.8
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	2.5
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.52	0.05	0.4
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.12	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.12	0.02	0.2
Refrigeration	Open Display Case	0.0%	0.70	0.00	0.0
Refrigeration	Icemaker	41.6%	0.19	0.08	0.7
Refrigeration	Vending Machine	28.6%	0.18	0.05	0.5
Food Preparation	Oven	46.1%	0.20	0.09	0.9
Food Preparation	Fryer	4.1%	0.29	0.01	0.1
Food Preparation	Dishwasher	4.1%	0.40	0.02	0.2
Food Preparation	Steamer	2.4%	0.29	0.01	0.1
Food Preparation	Hot Food Container	10.0%	0.05	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.20	0.20	1.8
Office Equipment	Laptop	100.0%	0.03	0.03	0.3
Office Equipment	Server	66.0%	0.12	0.08	0.7
Office Equipment	Monitor	100.0%	0.04	0.04	0.3
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.2
Office Equipment	POS Terminal	22.7%	0.03	0.01	0.1
Miscellaneous	Non-HVAC Motors	59.9%	0.12	0.07	0.6
Miscellaneous	Pool Pump	11.6%	0.02	0.00	0.0
Miscellaneous	Pool Heater	5.6%	0.02	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.61	0.61	5.6
Total				**8.19**	**75.7**

Table B-22 Commercial Miscellaneous-Unclassified, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.7%	1.90	0.15	3.3
Cooling	Water-Cooled Chiller	4.0%	2.26	0.09	2.0
Cooling	RTU	45.5%	1.50	0.68	15.1
Cooling	Room AC	4.1%	1.41	0.06	1.3
Cooling	Air-Source Heat Pump	7.7%	1.50	0.12	2.5
Cooling	Geothermal Heat Pump	1.9%	0.91	0.02	0.4
Heating	Electric Furnace	7.3%	4.16	0.30	6.7
Heating	Electric Room Heat	8.6%	3.96	0.34	7.6
Heating	Air-Source Heat Pump	7.7%	3.43	0.26	5.8
Heating	Geothermal Heat Pump	1.9%	2.80	0.05	1.2
Ventilation	Ventilation	100.0%	0.62	0.62	13.7
Water Heating	Water Heater	12.4%	1.39	0.17	3.8
Interior Lighting	Screw-in/Hard-wire	100.0%	0.54	0.54	11.9
Interior Lighting	High-Bay Fixtures	100.0%	0.55	0.55	12.2
Interior Lighting	Linear Lighting	100.0%	1.44	1.44	31.9
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	6.9
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	4.3
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	6.0
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.52	0.05	1.0
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.12	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.12	0.02	0.4
Refrigeration	Open Display Case	0.0%	0.70	0.00	0.0
Refrigeration	Icemaker	41.6%	0.19	0.08	1.8
Refrigeration	Vending Machine	28.6%	0.18	0.05	1.2
Food Preparation	Oven	46.1%	0.19	0.09	2.0
Food Preparation	Fryer	4.1%	0.28	0.01	0.3
Food Preparation	Dishwasher	4.1%	0.38	0.02	0.3
Food Preparation	Steamer	4.1%	0.28	0.01	0.3
Food Preparation	Hot Food Container	10.0%	0.05	0.01	0.1
Office Equipment	Desktop Computer	100.0%	0.20	0.20	4.4
Office Equipment	Laptop	100.0%	0.03	0.03	0.7
Office Equipment	Server	66.0%	0.12	0.08	1.7
Office Equipment	Monitor	100.0%	0.04	0.04	0.8
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.5
Office Equipment	POS Terminal	22.7%	0.03	0.01	0.2
Miscellaneous	Non-HVAC Motors	59.9%	0.10	0.06	1.3
Miscellaneous	Pool Pump	11.6%	0.02	0.00	0.0
Miscellaneous	Pool Heater	5.6%	0.02	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.53	0.53	11.6
Total				**7.47**	**165.0**

Table B-23 JBLM Commercial Office, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	15.1%	3.15	0.48	1.5
Cooling	Water-Cooled Chiller	9.3%	3.80	0.35	1.2
Cooling	RTU	49.0%	3.05	1.49	4.9
Cooling	Room AC	2.6%	2.87	0.08	0.2
Cooling	Air-Source Heat Pump	8.8%	3.05	0.27	0.9
Cooling	Geothermal Heat Pump	6.7%	1.86	0.12	0.4
Heating	Electric Furnace	1.6%	5.52	0.09	0.3
Heating	Electric Room Heat	30.5%	5.26	1.60	5.2
Heating	Air-Source Heat Pump	8.8%	4.71	0.42	1.4
Heating	Geothermal Heat Pump	6.7%	3.96	0.27	0.9
Ventilation	Ventilation	100.0%	2.01	2.01	6.5
Water Heating	Water Heater	45.2%	0.99	0.45	1.4
Interior Lighting	Screw-in/Hard-wire	100.0%	0.42	0.42	1.4
Interior Lighting	High-Bay Fixtures	100.0%	0.37	0.37	1.2
Interior Lighting	Linear Lighting	100.0%	1.89	1.89	6.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.18	0.18	0.6
Exterior Lighting	Area Lighting	100.0%	0.79	0.79	2.6
Exterior Lighting	Linear Lighting	100.0%	0.23	0.23	0.8
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	1.06	0.02	0.1
Refrigeration	Reach-in Refrigerator/Freezer	14.0%	0.24	0.03	0.1
Refrigeration	Glass Door Display	4.0%	0.24	0.01	0.0
Refrigeration	Open Display Case	4.0%	1.44	0.06	0.2
Refrigeration	Icemaker	4.0%	0.40	0.02	0.1
Refrigeration	Vending Machine	2.1%	0.19	0.00	0.0
Food Preparation	Oven	10.0%	0.58	0.06	0.2
Food Preparation	Fryer	1.0%	0.84	0.01	0.0
Food Preparation	Dishwasher	12.0%	1.16	0.14	0.5
Food Preparation	Steamer	1.0%	0.85	0.01	0.0
Food Preparation	Hot Food Container	1.0%	0.16	0.00	0.0
Office Equipment	Desktop Computer	100.0%	1.92	1.92	6.2
Office Equipment	Laptop	100.0%	0.20	0.20	0.6
Office Equipment	Server	100.0%	0.23	0.23	0.7
Office Equipment	Monitor	100.0%	0.34	0.34	1.1
Office Equipment	Printer/Copier/Fax	100.0%	0.21	0.21	0.7
Office Equipment	POS Terminal	37.4%	0.02	0.01	0.0
Miscellaneous	Non-HVAC Motors	65.7%	0.24	0.16	0.5
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.99	0.99	3.2
Total				**15.90**	**51.6**

Table B-24 JBLM Commercial Retail, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.8%	2.76	0.02	0.0
Cooling	Water-Cooled Chiller	0.5%	3.27	0.02	0.0
Cooling	RTU	57.2%	2.17	1.24	0.4
Cooling	Room AC	5.4%	2.33	0.13	0.0
Cooling	Air-Source Heat Pump	3.1%	2.17	0.07	0.0
Cooling	Geothermal Heat Pump	2.0%	1.32	0.03	0.0
Heating	Electric Furnace	0.9%	4.67	0.04	0.0
Heating	Electric Room Heat	10.1%	4.45	0.45	0.2
Heating	Air-Source Heat Pump	3.1%	3.61	0.11	0.0
Heating	Geothermal Heat Pump	2.0%	2.63	0.05	0.0
Ventilation	Ventilation	100.0%	0.91	0.91	0.3
Water Heating	Water Heater	38.2%	0.82	0.31	0.1
Interior Lighting	Screw-in/Hard-wire	100.0%	1.36	1.36	0.5
Interior Lighting	High-Bay Fixtures	100.0%	1.84	1.84	0.6
Interior Lighting	Linear Lighting	100.0%	1.70	1.70	0.6
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.45	0.45	0.2
Exterior Lighting	Area Lighting	100.0%	0.94	0.94	0.3
Exterior Lighting	Linear Lighting	100.0%	0.30	0.30	0.1
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	2.11	0.04	0.0
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.47	0.00	0.0
Refrigeration	Glass Door Display	16.3%	0.49	0.08	0.0
Refrigeration	Open Display Case	14.0%	2.88	0.40	0.1
Refrigeration	Icemaker	7.1%	0.79	0.06	0.0
Refrigeration	Vending Machine	22.8%	0.37	0.09	0.0
Food Preparation	Oven	4.0%	2.56	0.10	0.0
Food Preparation	Fryer	0.0%	3.71	0.00	0.0
Food Preparation	Dishwasher	2.0%	5.10	0.10	0.0
Food Preparation	Steamer	0.0%	3.74	0.00	0.0
Food Preparation	Hot Food Container	1.0%	0.70	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.24	0.24	0.1
Office Equipment	Laptop	100.0%	0.05	0.05	0.0
Office Equipment	Server	82.0%	0.09	0.08	0.0
Office Equipment	Monitor	100.0%	0.04	0.04	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.04	0.04	0.0
Office Equipment	POS Terminal	73.8%	0.05	0.04	0.0
Miscellaneous	Non-HVAC Motors	40.2%	0.22	0.09	0.0
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.81	0.81	0.3
Total				**12.22**	**4.1**

Table B-25 JBLM Commercial School, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	16.1%	2.58	0.42	0.4
Cooling	Water-Cooled Chiller	5.0%	3.73	0.19	0.2
Cooling	RTU	34.7%	1.57	0.54	0.6
Cooling	Room AC	2.3%	1.48	0.03	0.0
Cooling	Air-Source Heat Pump	5.3%	1.57	0.08	0.1
Cooling	Geothermal Heat Pump	9.5%	0.95	0.09	0.1
Heating	Electric Furnace	0.0%	10.66	0.00	0.0
Heating	Electric Room Heat	1.8%	10.15	0.19	0.2
Heating	Air-Source Heat Pump	5.3%	6.83	0.36	0.4
Heating	Geothermal Heat Pump	9.5%	5.54	0.53	0.6
Ventilation	Ventilation	100.0%	1.03	1.03	1.1
Water Heating	Water Heater	13.6%	0.99	0.13	0.1
Interior Lighting	Screw-in/Hard-wire	100.0%	0.16	0.16	0.2
Interior Lighting	High-Bay Fixtures	100.0%	0.90	0.90	1.0
Interior Lighting	Linear Lighting	100.0%	0.88	0.88	0.9
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.29	0.29	0.3
Exterior Lighting	Area Lighting	100.0%	0.52	0.52	0.6
Exterior Lighting	Linear Lighting	100.0%	0.68	0.68	0.7
Refrigeration	Walk-in Refrigerator/Freezer	19.0%	0.31	0.06	0.1
Refrigeration	Reach-in Refrigerator/Freezer	33.0%	0.14	0.05	0.0
Refrigeration	Glass Door Display	19.7%	0.07	0.01	0.0
Refrigeration	Open Display Case	11.9%	0.42	0.05	0.1
Refrigeration	Icemaker	69.7%	0.23	0.16	0.2
Refrigeration	Vending Machine	21.8%	0.11	0.02	0.0
Food Preparation	Oven	61.4%	0.20	0.12	0.1
Food Preparation	Fryer	2.6%	0.28	0.01	0.0
Food Preparation	Dishwasher	40.4%	0.39	0.16	0.2
Food Preparation	Steamer	29.6%	0.28	0.08	0.1
Food Preparation	Hot Food Container	26.3%	0.05	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.29	0.29	0.3
Office Equipment	Laptop	100.0%	0.02	0.02	0.0
Office Equipment	Server	100.0%	0.07	0.07	0.1
Office Equipment	Monitor	100.0%	0.05	0.05	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.03	0.03	0.0
Office Equipment	POS Terminal	11.5%	0.01	0.00	0.0
Miscellaneous	Non-HVAC Motors	43.7%	0.13	0.06	0.1
Miscellaneous	Pool Pump	32.9%	0.01	0.00	0.0
Miscellaneous	Pool Heater	32.9%	0.01	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.65	0.65	0.7
Total				**8.95**	**9.5**

Table B-26 JBLM Commercial Grocery, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.5%	6.08	0.03	0.0
Cooling	Water-Cooled Chiller	0.3%	7.22	0.02	0.0
Cooling	RTU	74.3%	4.80	3.56	0.2
Cooling	Room AC	3.4%	4.52	0.16	0.0
Cooling	Air-Source Heat Pump	4.3%	3.96	0.17	0.0
Cooling	Geothermal Heat Pump	0.5%	1.54	0.01	0.0
Heating	Electric Furnace	9.0%	7.18	0.64	0.0
Heating	Electric Room Heat	1.7%	6.84	0.11	0.0
Heating	Air-Source Heat Pump	4.3%	3.15	0.13	0.0
Heating	Geothermal Heat Pump	0.5%	2.02	0.01	0.0
Ventilation	Ventilation	100.0%	2.31	2.31	0.2
Water Heating	Water Heater	17.5%	2.29	0.40	0.0
Interior Lighting	Screw-in/Hard-wire	100.0%	1.13	1.13	0.1
Interior Lighting	High-Bay Fixtures	100.0%	2.76	2.76	0.2
Interior Lighting	Linear Lighting	100.0%	4.95	4.95	0.3
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.46	0.46	0.0
Exterior Lighting	Area Lighting	100.0%	1.37	1.37	0.1
Exterior Lighting	Linear Lighting	100.0%	0.61	0.61	0.0
Refrigeration	Walk-in Refrigerator/Freezer	16.0%	5.72	0.92	0.1
Refrigeration	Reach-in Refrigerator/Freezer	83.1%	0.37	0.30	0.0
Refrigeration	Glass Door Display	95.6%	3.76	3.60	0.2
Refrigeration	Open Display Case	95.6%	22.31	21.33	1.4
Refrigeration	Icemaker	66.6%	0.31	0.21	0.0
Refrigeration	Vending Machine	36.5%	0.29	0.11	0.0
Food Preparation	Oven	11.0%	0.64	0.07	0.0
Food Preparation	Fryer	87.0%	0.92	0.80	0.1
Food Preparation	Dishwasher	54.9%	1.27	0.70	0.0
Food Preparation	Steamer	20.0%	0.93	0.19	0.0
Food Preparation	Hot Food Container	73.0%	0.17	0.13	0.0
Office Equipment	Desktop Computer	100.0%	0.16	0.16	0.0
Office Equipment	Laptop	64.0%	0.02	0.02	0.0
Office Equipment	Server	100.0%	0.09	0.09	0.0
Office Equipment	Monitor	100.0%	0.03	0.03	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.0
Office Equipment	POS Terminal	95.9%	0.06	0.06	0.0
Miscellaneous	Non-HVAC Motors	34.6%	0.94	0.32	0.0
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	3.95	3.95	0.3
Total				**51.83**	**3.4**

Table B-27 JBLM Commercial Lodging, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.4%	1.40	0.03	0.1
Cooling	Water-Cooled Chiller	8.7%	2.04	0.18	0.7
Cooling	RTU	18.8%	3.29	0.62	2.3
Cooling	Room AC	46.7%	3.10	1.45	5.5
Cooling	Air-Source Heat Pump	8.0%	3.29	0.26	1.0
Cooling	Geothermal Heat Pump	3.4%	2.76	0.09	0.4
Heating	Electric Furnace	1.8%	5.67	0.10	0.4
Heating	Electric Room Heat	63.0%	5.40	3.40	12.8
Heating	Air-Source Heat Pump	8.0%	5.31	0.42	1.6
Heating	Geothermal Heat Pump	3.4%	3.15	0.11	0.4
Ventilation	Ventilation	100.0%	1.84	1.84	6.9
Water Heating	Water Heater	10.5%	3.20	0.34	1.3
Interior Lighting	Screw-in/Hard-wire	100.0%	1.06	1.06	4.0
Interior Lighting	High-Bay Fixtures	100.0%	0.20	0.20	0.8
Interior Lighting	Linear Lighting	100.0%	0.57	0.57	2.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.26	0.26	1.0
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	3.8
Exterior Lighting	Linear Lighting	100.0%	0.04	0.04	0.1
Refrigeration	Walk-in Refrigerator/Freezer	3.0%	0.55	0.02	0.1
Refrigeration	Reach-in Refrigerator/Freezer	19.0%	0.12	0.02	0.1
Refrigeration	Glass Door Display	40.0%	0.13	0.05	0.2
Refrigeration	Open Display Case	0.0%	0.75	0.00	0.0
Refrigeration	Icemaker	88.9%	0.41	0.37	1.4
Refrigeration	Vending Machine	57.8%	0.19	0.11	0.4
Food Preparation	Oven	24.0%	0.35	0.08	0.3
Food Preparation	Fryer	4.0%	0.50	0.02	0.1
Food Preparation	Dishwasher	39.0%	0.69	0.27	1.0
Food Preparation	Steamer	4.0%	0.51	0.02	0.1
Food Preparation	Hot Food Container	10.0%	0.09	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.08	0.08	0.3
Office Equipment	Laptop	100.0%	0.01	0.01	0.0
Office Equipment	Server	100.0%	0.05	0.05	0.2
Office Equipment	Monitor	100.0%	0.01	0.01	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.0
Office Equipment	POS Terminal	38.9%	0.01	0.01	0.0
Miscellaneous	Non-HVAC Motors	91.3%	0.19	0.18	0.7
Miscellaneous	Pool Pump	66.7%	0.03	0.02	0.1
Miscellaneous	Pool Heater	2.9%	0.04	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.98	0.98	3.7
Total				**14.30**	**53.9**

Table B-28 JBLM Commercial Restaurant, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	0.5%	5.39	0.03	0.0
Cooling	Water-Cooled Chiller	0.0%	5.93	0.00	0.0
Cooling	RTU	71.2%	6.56	4.67	1.5
Cooling	Room AC	5.9%	6.18	0.36	0.1
Cooling	Air-Source Heat Pump	7.4%	6.56	0.49	0.2
Cooling	Geothermal Heat Pump	4.0%	4.00	0.16	0.1
Heating	Electric Furnace	2.5%	11.82	0.30	0.1
Heating	Electric Room Heat	0.2%	11.26	0.03	0.0
Heating	Air-Source Heat Pump	7.4%	7.39	0.55	0.2
Heating	Geothermal Heat Pump	4.0%	5.57	0.22	0.1
Ventilation	Ventilation	100.0%	3.57	3.57	1.1
Water Heating	Water Heater	15.1%	7.04	1.07	0.3
Interior Lighting	Screw-in/Hard-wire	100.0%	2.14	2.14	0.7
Interior Lighting	High-Bay Fixtures	100.0%	1.33	1.33	0.4
Interior Lighting	Linear Lighting	100.0%	2.18	2.18	0.7
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.64	0.64	0.2
Exterior Lighting	Area Lighting	100.0%	1.64	1.64	0.5
Exterior Lighting	Linear Lighting	100.0%	0.47	0.47	0.1
Refrigeration	Walk-in Refrigerator/Freezer	74.0%	5.25	3.88	1.2
Refrigeration	Reach-in Refrigerator/Freezer	7.0%	2.35	0.16	0.1
Refrigeration	Glass Door Display	77.6%	1.21	0.94	0.3
Refrigeration	Open Display Case	26.0%	7.16	1.86	0.6
Refrigeration	Icemaker	75.9%	1.98	1.50	0.5
Refrigeration	Vending Machine	0.0%	0.93	0.00	0.0
Food Preparation	Oven	21.0%	3.59	0.75	0.2
Food Preparation	Fryer	82.0%	5.19	4.26	1.3
Food Preparation	Dishwasher	52.5%	3.57	1.88	0.6
Food Preparation	Steamer	16.0%	2.62	0.42	0.1
Food Preparation	Hot Food Container	84.0%	0.49	0.41	0.1
Office Equipment	Desktop Computer	100.0%	0.28	0.28	0.1
Office Equipment	Laptop	100.0%	0.03	0.03	0.0
Office Equipment	Server	50.0%	0.33	0.16	0.1
Office Equipment	Monitor	100.0%	0.05	0.05	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.06	0.06	0.0
Office Equipment	POS Terminal	65.0%	0.09	0.06	0.0
Miscellaneous	Non-HVAC Motors	20.0%	0.70	0.14	0.0
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	3.10	3.10	1.0
Total				**39.79**	**12.5**

Table B-29 JBLM Commercial Warehouse, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.5%	5.18	0.13	0.6
Cooling	Water-Cooled Chiller	2.5%	6.15	0.15	0.7
Cooling	RTU	10.3%	4.09	0.42	1.8
Cooling	Room AC	1.0%	3.85	0.04	0.2
Cooling	Air-Source Heat Pump	2.7%	4.09	0.11	0.5
Cooling	Geothermal Heat Pump	0.0%	2.49	0.00	0.0
Heating	Electric Furnace	1.9%	8.28	0.16	0.7
Heating	Electric Room Heat	10.5%	7.88	0.82	3.5
Heating	Air-Source Heat Pump	2.7%	7.17	0.19	0.8
Heating	Geothermal Heat Pump	0.0%	5.85	0.00	0.0
Ventilation	Ventilation	100.0%	0.65	0.65	2.8
Water Heating	Water Heater	38.3%	0.26	0.10	0.4
Interior Lighting	Screw-in/Hard-wire	100.0%	0.14	0.14	0.6
Interior Lighting	High-Bay Fixtures	100.0%	1.49	1.49	6.3
Interior Lighting	Linear Lighting	100.0%	0.43	0.43	1.9
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.16	0.16	0.7
Exterior Lighting	Area Lighting	100.0%	0.71	0.71	3.0
Exterior Lighting	Linear Lighting	100.0%	0.23	0.23	1.0
Refrigeration	Walk-in Refrigerator/Freezer	1.1%	4.88	0.05	0.2
Refrigeration	Reach-in Refrigerator/Freezer	2.0%	1.10	0.02	0.1
Refrigeration	Glass Door Display	0.0%	1.12	0.00	0.0
Refrigeration	Open Display Case	0.0%	6.67	0.00	0.0
Refrigeration	Icemaker	8.3%	1.84	0.15	0.7
Refrigeration	Vending Machine	6.9%	0.87	0.06	0.3
Food Preparation	Oven	0.0%	0.12	0.00	0.0
Food Preparation	Fryer	0.0%	0.18	0.00	0.0
Food Preparation	Dishwasher	2.0%	0.24	0.00	0.0
Food Preparation	Steamer	0.0%	0.18	0.00	0.0
Food Preparation	Hot Food Container	0.0%	0.03	0.00	0.0
Office Equipment	Desktop Computer	100.0%	0.10	0.10	0.4
Office Equipment	Laptop	100.0%	0.01	0.01	0.1
Office Equipment	Server	89.0%	0.11	0.10	0.4
Office Equipment	Monitor	100.0%	0.02	0.02	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.0
Office Equipment	POS Terminal	6.1%	0.03	0.00	0.0
Miscellaneous	Non-HVAC Motors	49.9%	0.18	0.09	0.4
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.69	0.69	2.9
Total				**7.25**	**30.9**

Table B-30 JBLM Commercial Data Center, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	15.1%	34.67	5.25	0.4
Cooling	Water-Cooled Chiller	24.3%	43.20	10.51	0.8
Cooling	RTU	34.0%	45.58	15.51	1.2
Cooling	Room AC	2.6%	42.93	1.14	0.1
Cooling	Air-Source Heat Pump	8.8%	45.58	4.03	0.3
Cooling	Geothermal Heat Pump	6.7%	27.78	1.86	0.1
Heating	Electric Furnace	1.6%	4.08	0.06	0.0
Heating	Electric Room Heat	30.5%	3.89	1.19	0.1
Heating	Air-Source Heat Pump	8.8%	3.75	0.33	0.0
Heating	Geothermal Heat Pump	6.7%	3.34	0.22	0.0
Ventilation	Ventilation	100.0%	27.46	27.46	2.0
Water Heating	Water Heater	45.2%	0.69	0.31	0.0
Interior Lighting	Screw-in/Hard-wire	100.0%	0.99	0.99	0.1
Interior Lighting	High-Bay Fixtures	100.0%	0.45	0.45	0.0
Interior Lighting	Linear Lighting	100.0%	4.66	4.66	0.3
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.17	0.17	0.0
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	0.1
Exterior Lighting	Linear Lighting	100.0%	0.30	0.30	0.0
Refrigeration	Walk-in Refrigerator/Freezer	2.0%	0.72	0.01	0.0
Refrigeration	Reach-in Refrigerator/Freezer	14.0%	0.16	0.02	0.0
Refrigeration	Glass Door Display	4.0%	0.17	0.01	0.0
Refrigeration	Open Display Case	4.0%	0.98	0.04	0.0
Refrigeration	Icemaker	4.0%	0.27	0.01	0.0
Refrigeration	Vending Machine	2.1%	0.26	0.01	0.0
Food Preparation	Oven	10.0%	0.41	0.04	0.0
Food Preparation	Fryer	1.0%	0.59	0.01	0.0
Food Preparation	Dishwasher	12.0%	0.81	0.10	0.0
Food Preparation	Steamer	1.0%	0.59	0.01	0.0
Food Preparation	Hot Food Container	1.0%	0.11	0.00	0.0
Office Equipment	Desktop Computer	100.0%	49.05	49.05	3.6
Office Equipment	Laptop	100.0%	7.57	7.57	0.6
Office Equipment	Server	100.0%	4.81	4.81	0.4
Office Equipment	Monitor	100.0%	8.66	8.66	0.6
Office Equipment	Printer/Copier/Fax	100.0%	4.48	4.48	0.3
Office Equipment	POS Terminal	57.6%	0.64	0.37	0.0
Miscellaneous	Non-HVAC Motors	65.7%	4.82	3.17	0.2
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	21.21	21.21	1.6
Total				**175.00**	**13.0**

Table B-31 JBLM Commercial Health, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	14.1%	4.15	0.58	1.3
Cooling	Water-Cooled Chiller	56.3%	6.34	3.57	7.7
Cooling	RTU	9.2%	4.52	0.42	0.9
Cooling	Room AC	0.3%	4.25	0.01	0.0
Cooling	Air-Source Heat Pump	2.0%	4.51	0.09	0.2
Cooling	Geothermal Heat Pump	1.8%	2.75	0.05	0.1
Heating	Electric Furnace	1.4%	18.41	0.26	0.6
Heating	Electric Room Heat	0.0%	17.54	0.01	0.0
Heating	Air-Source Heat Pump	2.0%	11.44	0.23	0.5
Heating	Geothermal Heat Pump	1.8%	8.65	0.15	0.3
Ventilation	Ventilation	100.0%	3.88	3.88	8.4
Water Heating	Water Heater	4.7%	4.56	0.21	0.5
Interior Lighting	Screw-in/Hard-wire	100.0%	1.48	1.48	3.2
Interior Lighting	High-Bay Fixtures	100.0%	0.88	0.88	1.9
Interior Lighting	Linear Lighting	100.0%	2.98	2.98	6.4
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.13	0.13	0.3
Exterior Lighting	Area Lighting	100.0%	0.61	0.61	1.3
Exterior Lighting	Linear Lighting	100.0%	0.24	0.24	0.5
Refrigeration	Walk-in Refrigerator/Freezer	33.0%	1.29	0.42	0.9
Refrigeration	Reach-in Refrigerator/Freezer	50.0%	0.29	0.14	0.3
Refrigeration	Glass Door Display	8.6%	0.30	0.03	0.1
Refrigeration	Open Display Case	6.7%	1.76	0.12	0.3
Refrigeration	Icemaker	21.1%	0.49	0.10	0.2
Refrigeration	Vending Machine	27.9%	0.46	0.13	0.3
Food Preparation	Oven	62.2%	3.08	1.91	4.1
Food Preparation	Fryer	14.2%	4.45	0.63	1.4
Food Preparation	Dishwasher	30.9%	6.12	1.89	4.1
Food Preparation	Steamer	3.6%	4.49	0.16	0.3
Food Preparation	Hot Food Container	12.3%	0.84	0.10	0.2
Office Equipment	Desktop Computer	100.0%	1.07	1.07	2.3
Office Equipment	Laptop	100.0%	0.07	0.07	0.1
Office Equipment	Server	100.0%	0.25	0.25	0.5
Office Equipment	Monitor	100.0%	0.19	0.19	0.4
Office Equipment	Printer/Copier/Fax	100.0%	0.12	0.12	0.3
Office Equipment	POS Terminal	51.0%	0.08	0.04	0.1
Miscellaneous	Non-HVAC Motors	74.1%	0.38	0.28	0.6
Miscellaneous	Pool Pump	3.9%	0.01	0.00	0.0
Miscellaneous	Pool Heater	5.7%	0.01	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	4.01	4.01	8.7
Total				**27.44**	**59.3**

Table B-32 JBLM Commercial Other, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.7%	2.35	0.18	0.4
Cooling	Water-Cooled Chiller	4.0%	2.79	0.11	0.2
Cooling	RTU	45.5%	1.85	0.84	1.8
Cooling	Room AC	4.1%	1.74	0.07	0.2
Cooling	Air-Source Heat Pump	7.7%	1.85	0.14	0.3
Cooling	Geothermal Heat Pump	1.9%	1.13	0.02	0.0
Heating	Electric Furnace	7.3%	5.14	0.37	0.8
Heating	Electric Room Heat	8.6%	4.89	0.42	0.9
Heating	Air-Source Heat Pump	7.7%	4.24	0.33	0.7
Heating	Geothermal Heat Pump	1.9%	3.46	0.07	0.1
Ventilation	Ventilation	100.0%	0.77	0.77	1.7
Water Heating	Water Heater	12.4%	1.39	0.17	0.4
Interior Lighting	Screw-in/Hard-wire	100.0%	0.54	0.54	1.2
Interior Lighting	High-Bay Fixtures	100.0%	0.55	0.55	1.2
Interior Lighting	Linear Lighting	100.0%	1.44	1.44	3.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	0.7
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	0.4
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	0.6
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.52	0.05	0.1
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.12	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.12	0.02	0.0
Refrigeration	Open Display Case	0.0%	0.70	0.00	0.0
Refrigeration	Icemaker	41.6%	0.19	0.08	0.2
Refrigeration	Vending Machine	28.6%	0.18	0.05	0.1
Food Preparation	Oven	46.1%	0.20	0.09	0.2
Food Preparation	Fryer	4.1%	0.29	0.01	0.0
Food Preparation	Dishwasher	4.1%	0.40	0.02	0.0
Food Preparation	Steamer	2.4%	0.29	0.01	0.0
Food Preparation	Hot Food Container	10.0%	0.05	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.20	0.20	0.4
Office Equipment	Laptop	100.0%	0.03	0.03	0.1
Office Equipment	Server	66.0%	0.12	0.08	0.2
Office Equipment	Monitor	100.0%	0.04	0.04	0.1
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.0
Office Equipment	POS Terminal	22.7%	0.03	0.01	0.0
Miscellaneous	Non-HVAC Motors	59.9%	0.12	0.07	0.2
Miscellaneous	Pool Pump	11.6%	0.02	0.00	0.0
Miscellaneous	Pool Heater	5.6%	0.02	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.61	0.61	1.3
Total				**8.19**	**17.8**

Table B-33 JBLM Commercial Hangar, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	10.5%	2.70	0.28	0.4
Cooling	Water-Cooled Chiller	4.2%	3.20	0.13	0.2
Cooling	RTU	48.6%	2.13	1.03	1.3
Cooling	Room AC	2.7%	2.00	0.05	0.1
Cooling	Air-Source Heat Pump	7.9%	2.13	0.17	0.2
Cooling	Geothermal Heat Pump	1.5%	1.30	0.02	0.0
Heating	Electric Furnace	2.3%	5.78	0.13	0.2
Heating	Electric Room Heat	2.7%	5.50	0.15	0.2
Heating	Air-Source Heat Pump	7.9%	4.76	0.38	0.5
Heating	Geothermal Heat Pump	1.5%	3.89	0.06	0.1
Ventilation	Ventilation	100.0%	0.79	0.79	1.0
Water Heating	Water Heater	23.7%	0.95	0.22	0.3
Interior Lighting	Screw-in/Hard-wire	100.0%	0.40	0.40	0.5
Interior Lighting	High-Bay Fixtures	100.0%	0.40	0.40	0.5
Interior Lighting	Linear Lighting	100.0%	1.06	1.06	1.3
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	0.4
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	0.2
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	0.3
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.28	0.02	0.0
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.06	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.06	0.01	0.0
Refrigeration	Open Display Case	0.0%	0.38	0.00	0.0
Refrigeration	Icemaker	41.6%	0.10	0.04	0.1
Refrigeration	Vending Machine	28.6%	0.05	0.01	0.0
Food Preparation	Oven	46.1%	0.43	0.20	0.3
Food Preparation	Fryer	4.1%	0.63	0.03	0.0
Food Preparation	Dishwasher	4.1%	0.86	0.04	0.0
Food Preparation	Steamer	4.1%	0.63	0.03	0.0
Food Preparation	Hot Food Container	10.0%	0.12	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.14	0.14	0.2
Office Equipment	Laptop	100.0%	0.02	0.02	0.0
Office Equipment	Server	66.0%	0.08	0.05	0.1
Office Equipment	Monitor	100.0%	0.02	0.02	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.0
Office Equipment	POS Terminal	22.7%	0.02	0.01	0.0
Miscellaneous	Non-HVAC Motors	59.9%	0.67	0.40	0.5
Miscellaneous	Pool Pump	0.0%	1.00	0.00	0.0
Miscellaneous	Pool Heater	0.0%	1.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	2.72	2.72	3.5
Total				**9.84**	**12.5**

Table B-34 JBLM Commercial Mixed Use, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.4%	0.50	0.01	0.0
Cooling	Water-Cooled Chiller	8.7%	0.73	0.06	0.1
Cooling	RTU	18.8%	1.18	0.22	0.4
Cooling	Room AC	46.7%	1.11	0.52	1.0
Cooling	Air-Source Heat Pump	8.0%	1.18	0.09	0.2
Cooling	Geothermal Heat Pump	3.4%	0.99	0.03	0.1
Heating	Electric Furnace	1.8%	2.04	0.04	0.1
Heating	Electric Room Heat	63.0%	1.94	1.22	2.4
Heating	Air-Source Heat Pump	8.0%	1.90	0.15	0.3
Heating	Geothermal Heat Pump	3.4%	1.13	0.04	0.1
Ventilation	Ventilation	100.0%	0.66	0.66	1.3
Water Heating	Water Heater	10.5%	3.20	0.34	0.7
Interior Lighting	Screw-in/Hard-wire	100.0%	0.53	0.53	1.0
Interior Lighting	High-Bay Fixtures	100.0%	0.20	0.20	0.4
Interior Lighting	Linear Lighting	100.0%	0.57	0.57	1.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.26	0.26	0.5
Exterior Lighting	Area Lighting	100.0%	1.01	1.01	2.0
Exterior Lighting	Linear Lighting	100.0%	0.04	0.04	0.1
Refrigeration	Walk-in Refrigerator/Freezer	3.0%	0.81	0.02	0.0
Refrigeration	Reach-in Refrigerator/Freezer	19.0%	0.18	0.03	0.1
Refrigeration	Glass Door Display	40.0%	0.19	0.07	0.1
Refrigeration	Open Display Case	0.0%	1.10	0.00	0.0
Refrigeration	Icemaker	88.9%	0.30	0.27	0.5
Refrigeration	Vending Machine	57.8%	0.29	0.17	0.3
Food Preparation	Oven	24.0%	0.35	0.08	0.2
Food Preparation	Fryer	4.0%	0.50	0.02	0.0
Food Preparation	Dishwasher	39.0%	0.69	0.27	0.5
Food Preparation	Steamer	4.0%	0.51	0.02	0.0
Food Preparation	Hot Food Container	10.0%	0.09	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.09	0.09	0.2
Office Equipment	Laptop	100.0%	0.01	0.01	0.0
Office Equipment	Server	66.0%	0.06	0.04	0.1
Office Equipment	Monitor	100.0%	0.02	0.02	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.01	0.01	0.0
Office Equipment	POS Terminal	22.7%	0.01	0.00	0.0
Miscellaneous	Non-HVAC Motors	91.3%	0.65	0.59	1.2
Miscellaneous	Pool Pump	66.7%	0.10	0.07	0.1
Miscellaneous	Pool Heater	2.9%	0.13	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	3.29	3.29	6.4
Total				**11.09**	**21.8**

Table B-35 JBLM Commercial Industrial, 2015 Average Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Cooling	Air-Cooled Chiller	7.7%	1.90	0.15	0.0
Cooling	Water-Cooled Chiller	4.0%	2.26	0.09	0.0
Cooling	RTU	45.5%	1.50	0.68	0.1
Cooling	Room AC	4.1%	1.41	0.06	0.0
Cooling	Air-Source Heat Pump	7.7%	1.50	0.12	0.0
Cooling	Geothermal Heat Pump	1.9%	0.91	0.02	0.0
Heating	Electric Furnace	7.3%	4.16	0.30	0.0
Heating	Electric Room Heat	8.6%	3.96	0.34	0.0
Heating	Air-Source Heat Pump	7.7%	3.43	0.26	0.0
Heating	Geothermal Heat Pump	1.9%	2.80	0.05	0.0
Ventilation	Ventilation	100.0%	0.62	0.62	0.0
Water Heating	Water Heater	12.4%	1.39	0.17	0.0
Interior Lighting	Screw-in/Hard-wire	100.0%	0.54	0.54	0.0
Interior Lighting	High-Bay Fixtures	100.0%	0.55	0.55	0.0
Interior Lighting	Linear Lighting	100.0%	1.44	1.44	0.1
Exterior Lighting	Screw-in/Hard-wire	100.0%	0.31	0.31	0.0
Exterior Lighting	Area Lighting	100.0%	0.19	0.19	0.0
Exterior Lighting	Linear Lighting	100.0%	0.27	0.27	0.0
Refrigeration	Walk-in Refrigerator/Freezer	9.0%	0.52	0.05	0.0
Refrigeration	Reach-in Refrigerator/Freezer	0.0%	0.12	0.00	0.0
Refrigeration	Glass Door Display	15.0%	0.12	0.02	0.0
Refrigeration	Open Display Case	0.0%	0.70	0.00	0.0
Refrigeration	Icemaker	41.6%	0.19	0.08	0.0
Refrigeration	Vending Machine	28.6%	0.18	0.05	0.0
Food Preparation	Oven	46.1%	0.19	0.09	0.0
Food Preparation	Fryer	4.1%	0.28	0.01	0.0
Food Preparation	Dishwasher	4.1%	0.38	0.02	0.0
Food Preparation	Steamer	4.1%	0.28	0.01	0.0
Food Preparation	Hot Food Container	10.0%	0.05	0.01	0.0
Office Equipment	Desktop Computer	100.0%	0.20	0.20	0.0
Office Equipment	Laptop	100.0%	0.03	0.03	0.0
Office Equipment	Server	66.0%	0.12	0.08	0.0
Office Equipment	Monitor	100.0%	0.04	0.04	0.0
Office Equipment	Printer/Copier/Fax	100.0%	0.02	0.02	0.0
Office Equipment	POS Terminal	22.7%	0.03	0.01	0.0
Miscellaneous	Non-HVAC Motors	59.9%	5.37	3.21	0.2
Miscellaneous	Pool Pump	11.6%	0.81	0.09	0.0
Miscellaneous	Pool Heater	5.6%	1.05	0.06	0.0
Miscellaneous	Other Miscellaneous	100.0%	28.18	28.18	2.1
Total				**38.43**	**2.9**

Table B-36 Street Lighting H1 - Tacoma Street and Highway, 2015 Average Market Profile

Technology	Saturation	EUI (kWh)	Intensity (kWh/fixt.)	Usage (GWh)
70W Fixture	3.7%	350	13	0.3
100W Fixture	45.7%	504	230	5.0
150W Fixture	3.9%	753	30	0.6
175W Fixture	9.8%	880	86	1.9
200W Fixture	4.6%	1,007	46	1.0
250W Fixture	17.2%	1,261	217	4.8
400W Fixture	14.8%	2,015	299	6.5
1000W Fixture	0.3%	5,037	16	0.4
Total			**937**	**20.5**

Table B-37 Street Lighting H1 - Other Fixtures, 2015 Average Market Profile

Technology	Saturation	EUI (kWh)	Intensity (kWh/fixt.)	Usage (GWh)
70W Fixture	7.4%	144	11	0.1
100W Fixture	63.3%	259	164	2.3
150W Fixture	3.6%	370	13	0.2
175W Fixture	7.8%	388	30	0.4
200W Fixture	3.2%	523	17	0.2
250W Fixture	9.5%	559	53	0.7
400W Fixture	5.1%	812	42	0.6
1000W Fixture	0.0%	2,219	1	0.0
Total			**331**	**4.6**

Table B-38 Street Lighting H2 Service - All, 2015 Average Market Profile

Technology	Saturation	EUI (kWh)	Intensity (kWh/fixt.)	Usage (GWh)
100W Fixture	37.7%	624	235	1.3
200W Fixture	29.4%	1,080	317	1.8
400W Fixture	32.9%	2,064	680	3.8
Total			**1,232**	**6.9**

C

CUSTOMER ADOPTION FACTORS

As described in Chapter 1, 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 values of either 85% or 55% 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 either 85% or 55% and are intended to phase in potential throughout the study period. The faster ramp rates (e.g. summing up to 85% sooner) will phase potential in over a shorter timeframe.

Note that the "CustomBehav" ramp rate was developed with guidance from Tacoma Power and is intended to reflect deployment of a pilot program in year 1 and full implementation in year 2.

Table C-1 Ramp Rates used in CPA Analysis

Ramp Rate	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
LO12Med	9%	19%	28%	37%	47%	55%	62%	67%	71%	75%	78%	80%	82%	83%	84%	85%	85%	85%	85%	85%
LO5Med	4%	8%	13%	20%	27%	35%	45%	54%	63%	71%	76%	81%	83%	84%	85%	85%	85%	85%	85%	85%
LO1Slow	0%	1%	1%	3%	5%	7%	11%	16%	22%	29%	37%	46%	54%	62%	69%	75%	79%	82%	84%	85%
LO50Fast	38%	56%	68%	76%	81%	83%	84%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
LO20Fast	19%	32%	42%	49%	55%	61%	65%	69%	72%	75%	78%	79%	81%	82%	83%	84%	84%	84%	85%	85%
LOEven20	4%	9%	13%	17%	21%	26%	30%	34%	38%	43%	47%	51%	55%	60%	64%	68%	72%	77%	81%	85%
LOMax60	1%	3%	5%	8%	12%	16%	20%	24%	28%	31%	34%	37%	40%	42%	45%	47%	49%	51%	53%	55%
LO3Slow	0%	1%	3%	5%	9%	15%	22%	31%	40%	49%	57%	65%	71%	75%	79%	81%	83%	84%	85%	85%
Retro12Med	9%	9%	9%	9%	9%	8%	7%	5%	4%	3%	3%	2%	2%	1%	1%	1%	0%	0%	0%	0%
Retro5Med	4%	4%	5%	6%	7%	8%	9%	9%	9%	8%	6%	4%	2%	1%	1%	0%	0%	0%	0%	0%
Retro1Slow	0%	0%	1%	1%	2%	3%	4%	5%	6%	7%	8%	8%	9%	8%	7%	6%	4%	3%	2%	1%
Retro50Fast	38%	18%	12%	8%	5%	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Retro20Fast	19%	13%	9%	7%	6%	5%	5%	4%	3%	3%	2%	2%	1%	1%	1%	1%	1%	0%	0%	0%
RetroEven20	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
RetroMax60	1%	2%	3%	3%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%	2%	2%	2%	2%	2%	2%
Retro3Slow	0%	1%	1%	3%	4%	6%	7%	8%	9%	9%	8%	7%	6%	5%	3%	2%	2%	1%	1%	0%
CustomBehav[17]	53%	32%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
LightingPPA	28%	23%	17%	11%	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

[17] Since behavioral programs are deployed by the utility and not a traditional energy efficiency measure, achievability is not constrained to traditional participation curves. Through discussions with Tacoma Power staff on the design of both pilot and full-scale behavioral programs, it was determined that if the program was cost-effective, it could be effectively deployed within the 2018-2019 biennium period.

D

MEASURE LIST

Here we summarize the list of measures evaluated in the 2018-2037 CPA. These tables include sample baseline definitions and efficient options from a selected large segment. Full details may be found in the "Measure Summary" spreadsheets in any of the "LoadMAP Results" files provided to Tacoma Power alongside this report.

Table D-1 summarizes the residential equipment measures analyzed in this study. The civilian and JBLM residential market sectors share a common measure list.

Table D-1 Residential Equipment Measures, Single Family

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
Cooling	Central AC	SEER 13.0	SEER 14.0
Cooling	Room AC	EER 11.0	EER 12.1 (ENERGY STAR 2016)
Cooling/Heating	Air-Source Heat Pump	SEER 14.0 / HSPF 8.2	SEER 16.0 / HSPF 9.0 (CEE)
Cooling/Heating	Geothermal Heat Pump	EER 13.4 / COP 3.1	EER 16.1 / COP 3.5
Heating	Electric Room Heat	Standard	Standard
Heating	Electric Furnace	Standard	Standard
Water Heating	Water Heater (<= 55 Gal)	EF 0.91	NEEA Tier 2 Heat Pump (EF 2.0)
Water Heating	Water Heater (55 to 75 Gal)	EF 0.885	NEEA Tier 2 Heat Pump (EF 2.0)
Water Heating	Water Heater (> 75 Gal)	EF 0.885	NEEA Tier 2 Heat Pump (EF 2.0)
Interior Lighting	General Service Lighting	EISA Compliant (17.4 lm/W)	LED 2017 (89.2 lm/W)
Interior Lighting	Linear Lighting	T8 - F32 (69.0 lm/W lm/W system)	LED 2017 (110.2 lm/W system)
Interior Lighting	Exempted Lighting	Incandescent (9.7 lm/W)	LED 2017 (77.7 lm/W)
Exterior Lighting	Screw-in/Hard-Wire	EISA Compliant (17.4 lm/W)	LED 2017 (86.9 lm/W)
Appliances	Clothes Washer	Standard 2015 (IMEF 1.84 / WF 4.7)	CEE Tier 1 (IMEF 2.38 / WF 3.7)
Appliances	Clothes Dryer	Standard 2015 (EF 3.73)	Heat Pump Tier 2 (UCEF 3.4)
Appliances	Dishwasher	Standard 2013 (180-307 kWh)	ENERGY STAR (180-295 kWh)
Appliances	Refrigerator	Standard 2014	CEE Tier 3 (20% above standard)
Appliances	Freezer	Standard 2014	ENERGY STAR
Appliances	Second Refrigerator	Standard 2014	CEE Tier 3 (20% above standard)
Appliances	Stove/Oven	Standard	High Efficiency
Appliances	Microwave	2016 Code	2016 Efficient (LEVEL 3)
Electronics	Personal Computers	Standard	ENERGY STAR (6.1)
Electronics	Monitor	Standard	ENERGY STAR (6.0)
Electronics	Laptops	Standard	ENERGY STAR (6.1)

Electronics	TVs	Standard	ENERGY STAR (6.0)
Electronics	Printer/Fax/Copier	Standard	ENERGY STAR
Electronics	Set-top Boxes/DVRs	Standard	2017 Agreement
Electronics	Devices and Gadgets	Standard	Standard
Miscellaneous	Electric Vehicles	Standard	Level 2
Miscellaneous	Pool Pump	Standard	ENERGY STAR Variable Speed
Miscellaneous	Pool Heater	Electric Resistance	Heat Pump
Miscellaneous	Furnace Fan	Standard	ECM
Miscellaneous	Well Pump	Standard	Standard
Miscellaneous	Miscellaneous	Standard	Standard

Table D-2 summarizes the residential non-equipment measures analyzed in this study. Many of the weatherization and heat pump measures have both regular and low-income permutations.

Table D-2 Residential Non-Equipment Measures, Single Family

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
Cooling/Heating	Insulation - Ceiling Installation	R-0	R-49
Cooling/Heating	Insulation - Ceiling Upgrade	R-11	R-49
Cooling/Heating	Insulation - Radiant Barrier	None	Installed
Cooling/Heating	Insulation - Wall Cavity Installation	R-0	R-11
Cooling/Heating	Insulation - Wall Sheathing	None	Install R-5 Rigid
Cooling/Heating	Insulation - Floor Installation	R-0	R-30
Cooling/Heating	Insulation - Floor Upgrade	R-11	R-30
Cooling/Heating	Insulation - Foundation	R-0	R-10
Cooling/Heating	Insulation - Ducting	R-4	R-8
Cooling/Heating	Ducting - Repair and Sealing	20% Leakage	Sealed
Cooling/Heating	Building Shell - Infiltration Control	None	0.1 ACH Reduction
Cooling/Heating	Windows - High Efficiency (SP to CI30)	Single Pane	Class 30
Cooling/Heating	Windows - High Efficiency (SP to CI22)	Single Pane	Class 22
Cooling/Heating	Windows - High Efficiency (DP to CI30)	Double Pane	Class 30
Cooling/Heating	Windows - High Efficiency (DP to CI22)	Double Pane	Class 22
Cooling/Heating	Ducting - Repair and Sealing	20% Leakage	Sealed
Cooling/Heating	Building Shell - Infiltration Control	None	0.1 ACH Reduction
Cooling/Heating	Windows - High Efficiency (SP to CI30)	Single Pane	Class 30
Cooling/Heating	Windows - High Efficiency (SP to CI22)	Single Pane	Class 22

Cooling/Heating	Windows - High Efficiency (DP to CI30)	Double Pane	Class 30
Cooling/Heating	Windows - High Efficiency (DP to CI22)	Double Pane	Class 22
Cooling/Heating	Doors - Storm and Thermal	R-2.5 Door	R-5 Door
Cooling/Heating	Ductless Mini Split Heat Pump (Zonal)	None	Installed
Cooling/Heating	Ductless Mini Split Heat Pump (Ducted Forced Air)	None	Installed
Cooling/Heating	Space Heating - Heat Recovery Ventilator	None	Installed
Cooling/Heating	Furnace - Conversion to Air-Source Heat Pump	Central Forced Air Furnace	Central Air-Source Heat Pump
Cooling	Room AC - Removal of Second Unit	Unit Installed	Unit Removed
Cooling	Central AC - Maintenance and Tune-Up	Standard Unit	Tuned Up Unit
Cooling/Heating	Central Heat Pump - Controls and Commissioning	Standard Unit	Properly Sized and Installed Unit
Cooling	Ceiling Fan - ENERGY STAR	Standard Unit	ENERGY STAR Unit
Cooling	Whole-House Fan - Installation	None	Installed
Cooling/Heating	Thermostat - WiFi/Interactive	Standard Unit	Smart/WiFi Enabled Unit
Water Heating	Water Heater - Drainwater Heat Recovery	None	Installed
Water Heating	Water Heater - Faucet Aerators	2.5 GPM Faucet	1.0-1.5 GPM Faucet
Water Heating	Water Heater - Low-Flow Showerheads (2.0 GPM)	2.2 GPM Showerhead	2.0 GPM Showerhead
Water Heating	Water Heater - Low-Flow Showerheads (1.75 GPM)	2.2 GPM Showerhead	1.75 GPM Showerhead
Water Heating	Water Heater - Low-Flow Showerheads (1.5 GPM)	2.2 GPM Showerhead	1.5 GPM Showerhead
Water Heating	Water Heater - Pipe Insulation	Uninsulated Pipe	R-3.5 Insulation Installed
Water Heating	Water Heater - Desuperheater	None	Installed
Water Heating	Water Heater - Temperature Setback	Water Set at 135°F	Water Set at 120°F
Water Heating	Water Heater - Thermostatic Shower Restriction Valve	None	Installed
Water Heating	Water Heater - Solar System	Standard Electric Unit	SEF 2.5 Solar Unit
Interior Lighting	Interior Lighting - Occupancy Sensors	Manual Controls	Occupancy-Based Controls
Exterior Lighting	Exterior Lighting - Photosensor Control	Manual Controls	Light-Sensing Controls
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	None	Solar-Powered Unit Installed
Exterior Lighting	Exterior Lighting - Timeclock Installation	Manual Controls	Motion-Sensing Controls

Appliances	Refrigerator - Decommissioning and Recycling	Unit Installed	Unit Removed
Appliances	Freezer - Decommissioning and Recycling	Unit Installed	Unit Removed
Electronics	Advanced Power Strips - Tier 1	Standard Unit	Load Sensing Strip
Electronics	Advanced Power Strips - Tier 2	Standard Unit	IR or Occupancy Sensing Strip
Miscellaneous	Pool Pump - Timer	Manual Controls	Scheduled Controls
Miscellaneous	Pool Heater - Solar Water Heating System	Standard Electric Unit	Passive Solar Unit
Cooling/Heating /Water Heating/Interior Lighting	ENERGY STAR Home Design	Code-Compliant Home Design	ENERGY STAR Home Design
All End Uses	Behavioral Programs	Code-Compliant Home Design	Program Participation
Interior Lighting	Interior Lighting - General Service CFLs	EISA Compliant (17.4 lm/W)	CFL (64.3 lm/W)
Interior Lighting	Interior Lighting - Exempted CFLs	Incandescent (9.7 lm/W)	CFL (61.5 lm/W)

Table D-3 summarizes the commercial equipment measures analyzed in this study. The civilian and JBLM commercial market sectors share a common measure list.

Table D-3 Commercial Equipment Measures, Office

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
Cooling	Air-Cooled Chiller	COP 3.06 (EER 10.4)	COP 4.40 (EER 15.0)
Cooling	Water-Cooled Chiller	COP 5.78 (EER 19.7)	COP 10.66 (EER 36.4)
Cooling	RTU	EER 11.2	EER 11.7
Cooling	Room AC	EER 11.0	EER 13.0
Cooling/Heating	Air-Source Heat Pump	EER 11.0 (COP 3.3)	EER 12 (COP 3.4)
Cooling/Heating	Geothermal Heat Pump	EER 14.0 (COP 3.5)	EER 20.6 (COP 4.0)
Heating	Electric Furnace	Standard	Standard
Heating	Electric Room Heat	Standard	Standard
Ventilation	Ventilation	Constant Volume	Variable Air Volume
Water Heating	Water Heater	Resistance Heater, Standard Standby Wattage	NEEA Tier 2 Heat Pump (EF 2.0)
Interior Lighting	Screw-in/Hard-wire	EISA Compliant (13.6 lm/W)	LED 2017 (86.4 lm/W)
Interior Lighting	Linear Lighting	T8 - F32 Standard (69.0 lm/W lm/W system)	LED 2017 (110.2 lm/W system)
Interior Lighting	High-Bay Fixtures	Metal Halide (44.3 lm/W)	LED 2017 (97.3 lm/W)
Exterior Lighting	Screw-in/Hard-wire	EISA Compliant (17.4 lm/W)	LED 2017 (86.4 lm/W)

Exterior Lighting	Linear Lighting	T8 - F32 Standard (69.0 lm/W lm/W system)	LED 2017 (110.2 lm/W system)
Exterior Lighting	Area Lighting	Metal Halide (44.3 lm/W)	LED 2017 (97.3 lm/W)
Refrigeration	Walk-in Refrigerator/Freezer	Current Standard	Standard 2017
Refrigeration	Reach-in Refrigerator/Freezer	Current Standard	Standard 2017
Refrigeration	Glass Door Display	Current Standard	Standard 2017
Refrigeration	Open Display Case	Current Standard	Standard 2017
Refrigeration	Icemaker	Current Standard	ENERGY STAR
Refrigeration	Vending Machine	Standard	ENERGY STAR
Food Preparation	Oven	Standard	ENERGY STAR
Food Preparation	Fryer	Standard	ENERGY STAR
Food Preparation	Dishwasher	Standard	ENERGY STAR
Food Preparation	Hot Food Container	Standard	ENERGY STAR
Food Preparation	Steamer	Standard	ENERGY STAR
Office Equipment	Desktop Computer	Standard	ENERGY STAR
Office Equipment	Laptop	Standard	ENERGY STAR
Office Equipment	Monitor	Standard	ENERGY STAR
Office Equipment	Server	Standard	ENERGY STAR
Office Equipment	Printer/Copier/Fax	Standard	ENERGY STAR
Office Equipment	POS Terminal	Standard	ENERGY STAR
Miscellaneous	Non-HVAC Motors	Standard (NEMA Premium)	Standard (NEMA Premium)
Miscellaneous	Pool Pump	Standard	Variable Speed
Miscellaneous	Pool Heater	Electric Resistance	Heat Pump
Miscellaneous	Other Miscellaneous	Standard	Standard

Table D-4 summarizes the commercial equipment measures analyzed in this study.

Table D-4 Commercial Non-Equipment Measures, Office

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
HVAC	Insulation - Ceiling	R-13	R-38
HVAC	Insulation - Ducting	R-4	R-8
HVAC	Insulation - Wall Cavity	R-9	R-23
HVAC	HVAC - Duct Leakage Reduction	20% Leakage	Sealed
HVAC	Windows - High Efficiency Glazing	Single Glaze	High Efficiency Glaze
Cooling	Chiller - Chilled Water Reset	None	Enabled
Cooling	Chiller - Chilled Water Variable-Flow System	Constant Flow	Variable Flow
Cooling	Chiller - Variable Speed Fans	On/Off Operation	Part-Load Operation
Cooling	Water-Cooled Chiller - Condenser Water Reset	Constant Temperature	Variable Temperature
Cooling	HVAC - Economizer	None	Installed
Heating	Space Heating - Heat Recovery Ventilator	None	Installed
Ventilation	Ventilation - ECM on VAV Boxes	None	Installed
Ventilation	Ventilation - Variable Speed Control	None	Installed
Ventilation	Ventilation - Demand Controlled	Standard	Demand-Controlled Fans
Cooling/Heating	Destratification Fans (HVLS)	None	Installed
Cooling	RTU - Advanced Controls	RTU with Constant Speed Fan	Advanced Rooftop Controller
Cooling/Heating	Ductless Mini Split Heat Pump	None	Installed
HVAC	Thermostat - WiFi/Interactive	Standard Unit	Smart/WiFi Enabled Unit
Water Heating	Water Heater - Faucet Aerators/Low Flow Nozzles	1.39 GPM Average Baseline	0.94 GPM Unit
Water Heating	Water Heater - Low-Flow Showerheads	2.2 GPM Showerhead	1.5 GPM Showerhead
Water Heating	Water Heater - Pipe Insulation	Uninsulated Pipe	1" Insulation
Water Heating	Water Heater - Pre-Rinse Spray Valve	1.33 GPM Kitchen Spray Valve	0.81-1.00 GPM Kitchen Spray Valve
Water Heating	Water Heater - Solar System	Heat Pump Water Heater	SEF 3.0 Solar Unit
Interior Lighting	Interior Lighting - Embedded Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - Networked Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - LEC Exit Lighting	Baseline LED Sign	Light Emitting Capacitor Sign
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls

Exterior Lighting	Exterior Lighting - Enhanced Controls	Standard Controls	Photocell and/or Motion Based Controls
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Grid-Tied LED Lighting System	Solar Powered Area LED Lighting
Refrigeration	Refrigeration - Anti-Sweat Heater	No Anti-Sweat Heater Controls	Anti Sweat Heater Controls
Refrigeration	Refrigeration - Door Gasket Replacement	Leaky Case Doors	Sealed Case Doors
Refrigeration	Refrigeration - Evaporator Fan Controls	Standard Controls	Load-Based Fan Controls
Refrigeration	Refrigeration - Floating Head Pressure	Fixed Discharge Pressure Controls	Wetbulb Reset Controls
Refrigeration	Refrigeration - Strip Curtain	No Strip Curtains	Strip Curtains Installed
Refrigeration	Refrigeration - High Efficiency Compressor	Standard Efficiency Compressor	High Efficiency Compressor
Refrigeration	Refrigeration - Variable Speed Compressor	Inefficient Compressor Loading	Variable Speed Compressor Loading
Refrigeration	Grocery - Display Case - LED Lighting	Fluorescent Case Lighting	LED Case Lighting
Refrigeration	Grocery - Display Case Motion Sensors	Manual Controls	Motion Based Controls
Refrigeration	Grocery - Open Display Case - Night Covers	No Covers	Night Covers
Refrigeration	Grocery - ECMs for Display Cases	Standard Motors	ECM Motors
Refrigeration	Vending Machine - Occupancy Sensor	None	Lighting and Compressor Controls
Ventilation	Cooking - Exhaust Hoods with Sensor Control	Constant Speed Hoods	Demand-Controlled Hoods
Office Equipment	Office Equipment - Smart Power Strips	Standard Unit	Load Sensing Strip
Cooling	Lodging - Guest Room Controls	Manual Controls	Occupancy Controls
Heating	Lodging - Guest Room Controls	Manual Controls	Occupancy Controls
Office Equipment	Data Center - Best Practice Measures	Baseline Data Center	Best Practice Measures Installed
Cool/Vent/Int. Ltg./Office Equipment	Data Center - Commercially Available Measures	Baseline Data Center	Commercially Available Measures Installed
Cooling/Office Equipment	Data Center - Cutting Edge Measures	Baseline Data Center	Cutting Edge Measures Installed
Ventilation	Optimized Variable Volume Lab Hood Design	Constant Speed Hoods	Demand-Controlled Hoods
Miscellaneous	Smart Engine Block Heaters	Standard Timer	Smart Timer
All	Advanced New Construction Designs	Standard Building Practices	LEED Average Design
All	Strategic Energy Management	None	Implemented
All	Retrocommissioning	None	Commissioned

Table D-5 summarizes the industrial equipment measures analyzed in this study.

Table D-5 Industrial Equipment Measures, All

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
Cooling	Air-Cooled Chiller	COP 3.06 (EER 10.4)	COP 4.40 (EER 15.0)
Cooling	Water-Cooled Chiller	COP 5.78 (EER 19.7)	COP 10.66 (EER 36.4)
Cooling	RTU	EER 11.2	EER 11.7
Cooling/Heating	Air-Source Heat Pump	EER 11.0 (COP 3.3)	EER 12 (COP 3.4)
Cooling/Heating	Geothermal Heat Pump	EER 14.0 (COP 3.5)	EER 20.6 (COP 4.0)
Heating	Electric Furnace	Standard	Standard
Heating	Electric Room Heat	Standard	Standard
Ventilation	Ventilation	Constant Volume	Variable Air Volume
Interior Lighting	Screw-in/Hard-wire	EISA Compliant (13.6 lm/W)	LED 2017 (86.4 lm/W)
Interior Lighting	Linear Lighting	T8 - F32 Standard (69.0 lm/W lm/W system)	LED 2017 (110.2 lm/W system)
Interior Lighting	High-Bay Fixtures	Metal Halide (44.3 lm/W)	LED 2017 (97.3 lm/W)
Exterior Lighting	Screw-in/Hard-wire	EISA Compliant (17.4 lm/W)	LED 2017 (86.4 lm/W)
Exterior Lighting	Linear Lighting	T8 - F32 Standard (69.0 lm/W lm/W system)	LED 2017 (110.2 lm/W system)
Exterior Lighting	Area Lighting	Metal Halide (44.3 lm/W)	LED 2017 (97.3 lm/W)
Motors	Pumps	Standard NEMA Premium	Standard NEMA Premium
Motors	Fans & Blowers	Standard NEMA Premium	Standard NEMA Premium
Motors	Compressed Air	Standard NEMA Premium	Standard NEMA Premium
Motors	Material Handling	Standard NEMA Premium	Standard NEMA Premium
Motors	Other Motors	Standard NEMA Premium	Standard NEMA Premium
Process	Process Heating	Standard	Standard
Process	Process Cooling	Standard	Standard
Process	Process Refrigeration	Standard	Standard
Process	Process Electrochemical	Standard	Standard
Process	Process Other	Standard	Standard
Miscellaneous	Other Miscellaneous	Standard	Standard

Table D-6 summarizes the industrial non-equipment measures analyzed in this study.

Table D-6 Industrial Non-Equipment Measures, All

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
HVAC	Insulation - Ceiling	R-13	R-38
HVAC	Insulation - Ducting	R-4	R-8
HVAC	Insulation - Wall Cavity	R-9	R-23
HVAC	HVAC - Duct Leakage Reduction	20% Leakage	Sealed
Cooling	Chiller - Chilled Water Reset	None	Enabled
Cooling	Chiller - Chilled Water Variable-Flow System	Constant Flow	Variable Flow
Cooling	Chiller - Variable Speed Fans	On/Off Operation	Part-Load Operation
HVAC	HVAC - Economizer	None	Installed
Ventilation	Ventilation - Demand Controlled	Standard	Demand-Controlled Fans
Ventilation	Destratification Fans (HVLS)	None	Installed
HVAC	Thermostat - WiFi/Interactive	Standard Unit	Smart/WiFi Enabled Unit
Interior Lighting	Interior Lighting - Embedded Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - Networked Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - LEC Exit Lighting	Baseline LED Sign	Light Emitting Capacitor Sign
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls
Exterior Lighting	Exterior Lighting - Enhanced Controls	Standard Controls	Photocell and/or Motion Based Controls
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Grid-Tied LED Lighting System	Solar Powered Area LED Lighting
Miscellaneous	Smart Engine Block Heaters	Standard Timer	Smart Timer
Process	Refrigeration - Floating Head Pressure	Fixed Discharge Pressure Controls	Wetbulb Reset Controls
Process	Refrigeration - System Optimization	Standard System	Optimized System
Motors	Pumping System - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Pumping System - System Optimization	Standard System	Optimized System
Motors	Pumping System - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Fan System - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Fan System - Flow Optimization	Standard System	Optimized System

Motors	Fan System - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Compressed Air - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Compressed Air - Heat of Compression Desiccant Dryer	Standard Desiccant Dryer	Heat of Compression Desiccant Dryer
Motors	Compressed Air - Refrigerated Cycling Dryers	Non-Cycling Refrigerated Dryer	Cycling Refrigerated Dryer
Motors	Compressed Air - System Controls	Standard Controls	Advanced Controls and Sequencing
Motors	Compressed Air - Leak Management Program	No Annual Leak Detection Program	Annual Leak Detection Program
Motors	Compressed Air - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Compressed Air - Low Pressure-Drop Filters	Standard Filters	Low Pressure-Drop Filters
Motors	Compressed Air - Zero-Loss Condensate Drain	Timed Drains	Zero-Loss Drains
Motors	Compressed Air - Outside Air Intake	Engine Room Air	Outside Air
Motors	Compressed Air - Receiver Capacity Addition	Undersized Receivers	Oversized Receivers
Motors	Material Handling - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Motors - Green Rewind (<100 HP)	Standard Motor Rewind	Green Motor Rewind
Motors	Motors - Green Rewind (100 HP+)	Standard Motor Rewind	Green Motor Rewind
Motors	Switch from Belt Drive to Direct Drive	Belt Drive	Direct Drive
Motors	Motors - Synchronous Belts	Standard Belts	Synchronous Belts
Miscellaneous	Agriculture - Engine Block Timer	No Timer	Timer Installed
Motors	Agriculture - Live Stock Waterer	Standard Waterer	Waterer Heater Controls
Process	Dairy - Milk Precoolers	No Precooler	Precooler Installed
Process	Clean Room: Change Filter Strategy	Standard	Installed
Process	Clean Room: Chiller Optimize	Standard	Installed
Process	Clean Room: Clean Room HVAC	Standard	Installed
Process	Elec Chip Fab: Solid-state Chiller	Standard	Installed
Process	Elec Chip Fab: Eliminate Exhaust	Standard	Installed
Process	Elec Chip Fab: Exhaust Injector	Standard	Installed
Process	Elec Chip Fab: Reduce Gas Pressure	Standard	Installed

Motors	Panel: Hydraulic Press	Standard	Installed
Motors	Wood: Replace Pneumatic Conveyor	Standard	Installed
Process	Metal: New Arc Furnace	Standard	Installed
Process	Paper: Premium Control Large Material	Standard	Installed
Process	Paper: Efficient Pulp Screen	Standard	Installed
Process	Kraft: Effluent Treatment System	Standard	Installed
Motors	Kraft: Efficient Agitator	Standard	Installed
Process	Mech. Pulp: Premium Process	Standard	Installed
Motors	Mech. Pulp: Refiner Plate Improvement	Standard	Installed
All	Transformer - High Efficiency	Standard Transformer	High Efficiency Transformer
All	Strategic Energy Management	None	Implemented
All	Retrocommissioning	None	Commissioned
Motors	Municipal Sewage Treatment	Standard Sewage Treatment	Optimal Sewage Treatment
Motors	Municipal Water Supply Treatment	Standard Water Treatment	Optimal Water Treatment
HVAC	Insulation - Ceiling	R-13	R-38
HVAC	Insulation - Ducting	R-4	R-8
HVAC	Insulation - Wall Cavity	R-9	R-23
HVAC	HVAC - Duct Leakage Reduction	20% Leakage	Sealed
Cooling	Chiller - Chilled Water Reset	None	Enabled
Cooling	Chiller - Chilled Water Variable-Flow System	Constant Flow	Variable Flow
Cooling	Chiller - Variable Speed Fans	On/Off Operation	Part-Load Operation
HVAC	HVAC - Economizer	None	Installed
Ventilation	Ventilation - Demand Controlled	Standard	Demand-Controlled Fans
Ventilation	Destratification Fans (HVLS)	None	Installed
HVAC	Thermostat - WiFi/Interactive	Standard Unit	Smart/WiFi Enabled Unit
Interior Lighting	Interior Lighting - Embedded Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - Networked Fixture Controls	Standard Controls	Enhanced Controls
Interior Lighting	Interior Lighting - LEC Exit Lighting	Baseline LED Sign	Light Emitting Capacitor Sign
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Single Level Lighting Controls	Two Level Lighting Controls
Exterior Lighting	Exterior Lighting - Enhanced Controls	Standard Controls	Photocell and/or Motion Based Controls
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Grid-Tied LED Lighting System	Solar Powered Area LED Lighting

Miscellaneous	Smart Engine Block Heaters	Standard Timer	Smart Timer
Process	Refrigeration - Floating Head Pressure	Fixed Discharge Pressure Controls	Wetbulb Reset Controls
Process	Refrigeration - System Optimization	Standard System	Optimized System
Motors	Pumping System - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Pumping System - System Optimization	Standard System	Optimized System
Motors	Pumping System - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Fan System - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Fan System - Flow Optimization	Standard System	Optimized System
Motors	Fan System - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Compressed Air - Equipment Upgrade	Standard Equipment	High Efficiency Equipment
Motors	Compressed Air - Heat of Compression Desiccant Dryer	Standard Desiccant Dryer	Heat of Compression Desiccant Dryer
Motors	Compressed Air - Refrigerated Cycling Dryers	Non-Cycling Refrigerated Dryer	Cycling Refrigerated Dryer
Motors	Compressed Air - System Controls	Standard Controls	Advanced Controls and Sequencing
Motors	Compressed Air - Leak Management Program	No Annual Leak Detection Program	Annual Leak Detection Program
Motors	Compressed Air - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Compressed Air - Low Pressure-Drop Filters	Standard Filters	Low Pressure-Drop Filters
Motors	Compressed Air - Zero-Loss Condensate Drain	Timed Drains	Zero-Loss Drains
Motors	Compressed Air - Outside Air Intake	Engine Room Air	Outside Air
Motors	Compressed Air - Receiver Capacity Addition	Undersized Receivers	Oversized Receivers
Motors	Material Handling - Variable Speed Drive	Standard Motor Starter	Variable Frequency Drive
Motors	Motors - Green Rewind (<100 HP)	Standard Motor Rewind	Green Motor Rewind
Motors	Motors - Green Rewind (100 HP+)	Standard Motor Rewind	Green Motor Rewind
Motors	Switch from Belt Drive to Direct Drive	Belt Drive	Direct Drive
Motors	Motors - Synchronous Belts	Standard Belts	Synchronous Belts
Miscellaneous	Agriculture - Engine Block Timer	No Timer	Timer Installed

Motors	Agriculture - Live Stock Waterer	Standard Waterer	Waterer Heater Controls
Process	Dairy - Milk Precoolers	No Precooler	Precooler Installed
Process	Clean Room: Change Filter Strategy	Standard	Installed
Process	Clean Room: Chiller Optimize	Standard	Installed
Process	Clean Room: Clean Room HVAC	Standard	Installed
Process	Elec Chip Fab: Solid-state Chiller	Standard	Installed
Process	Elec Chip Fab: Eliminate Exhaust	Standard	Installed
Process	Elec Chip Fab: Exhaust Injector	Standard	Installed

Table D-7 summarizes the street lighting measures analyzed in this study. Note that there were multiple permutations of the LED measure based on fixture type (ornamental, cobra head, shoebox, wallpack, flood, and other), which affected measure costs.

Table D-7 Street Lighting Measures, All

End-Use	Measure	2018 Baseline Definition	2018 Efficient Option
Street Lighting	70W Equivalent	HID	LED
Street Lighting	100W Equivalent	HID	LED
Street Lighting	150W Equivalent	HID	LED
Street Lighting	175W Equivalent	HID	LED
Street Lighting	200W Equivalent	HID	LED
Street Lighting	250W Equivalent	HID	LED
Street Lighting	400W Equivalent	HID	LED
Street Lighting	1000W Equivalent	HID	LED

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