Applied Energy Group

2020 CASCADE NATURAL GAS CPA UPDATE

Phase 1 Final Report

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Report prepared for:
CASCADE NATURAL GAS CORPORATION

Energy Solutions. Delivered.

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EXECUTIVE SUMMARY

In the summer of 2020, Cascade Natural Gas Corporation (Cascade) contracted with Applied Energy Group (AEG) to conduct this update to Cascade's 2018 Conservation Potential Assessment (CPA) in support of their conservation and resource planning activities. This report documents this effort and provides estimates of the potential reductions in annual energy usage for natural gas customers in Cascade's Washington service territory from energy conservation efforts from 2021 to 2040. To produce a reliable and transparent estimate of energy efficiency (EE) resource potential, the AEG team performed the following tasks to meet Cascade's key objectives:

- Used information and data from Cascade, as well as secondary data sources, to describe how customers currently use gas by sector, segment, end use and technology.
- Developed a baseline projection of how customers are likely to use gas in absence of future EE 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 efficiency potential.
- Estimated the technical, achievable technical, and achievable economic energy efficiency potential at the measure level within Cascade's service territory over the 2021 to 2040 planning horizon.
- Delivered a fully configured end-use conservation planning model, LoadMAP, for Cascade to use in future potential and resource planning initiatives.

In summary, the potential study provided a solid foundation for the development of Cascade's energy savings targets. Table ES-1 summarizes the results of this study at a high level. AEG analyzed potential for the residential, commercial, and industrial market sectors. First-year utility cost test (UCT) achievable economic potential is 1,049 thousand therms. This increases to a cumulative total of 2,065 thousand therms in the second year and 22,482 thousand therms by the tenth year. As part of this study, AEG also estimated achievable economic potential using the total resource cost (TRC) test, with the focus of fully balancing non-energy impacts. This includes the use of full measure costs as well as quantified and monetizable non-energy impacts and non-gas fuel impacts (e.g. electric cooling or wood secondary heating) consistent with methodology within the Northwest Power and Conservation Council's Draft 2021 Power Plan (2021 Plan).

Table ES-1 Conservation Potential by Case, Selected Years (thousand therms)

Scenario	2021	2022	2023	2025	2030	2040
Baseline Projection (thousand therms)	263,245	266,084	268,957	274,202	288,705	319,662
Cumulative Savings (thousand therms)						
UCT Achievable Economic Potential	1,049	2,065	3,258	6,958	22,482	44,864
Achievable Technical Potential	2,170	4,293	6,621	12,800	35,416	67,266
Technical Potential	4,801	8,927	13,168	21,928	51,264	86,762
Cumulative Savings (% of Baseline)						
UCT Achievable Economic Potential	0.4%	0.8%	1.2%	2.5%	7.8%	14.0%
Achievable Technical Potential	0.8%	1.6%	2.5%	4.7%	12.3%	21.0%
Technical Potential	1.8%	3.4%	4.9%	8.0%	17.8%	27.1%

Key opportunities for savings include residential furnace and water heating equipment upgrades and weatherization as well as ENERGY STAR® homes savings in later years.

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INTRODUCTION

This report documents the results of the Cascade Natural Gas Corporation 2021-2040 Conservation Potential Assessment (CPA) update as well as the steps followed its completion. Throughout this study, AEG worked with Cascade to understand the baseline characteristics of their Washington service territory, including a detailed understanding of energy consumption in the territory, the assumptions and methodologies used in Cascade's official load forecast, and recent programmatic accomplishments. Adapting methodologies consistent with the Northwest Power and Conservation Council's (Council's) Draft 2021 Power Plan[1] for natural gas studies, AEG then developed an independent estimate of achievable, cost-effective energy efficiency potential within Cascade's service territory between 2021 and 2040.

Goals of the Conservation Potential Assessment

The first primary objective of this study was to develop independent and credible estimates of energy efficiency potential achievably available within Cascade's service territory using accepted regional inputs and methodologies. This included estimating technical, achievable technical, then achievable economic potential, using the Council's ramp rates as the starting point for all achievability assumptions, leveraging Northwest Energy Efficiency Alliance's (NEEA's) market research initiatives, and utilizing assumptions consistent with 2021 Plan supply curves and RTF measure workbooks when appropriate for use in natural gas planning studies.

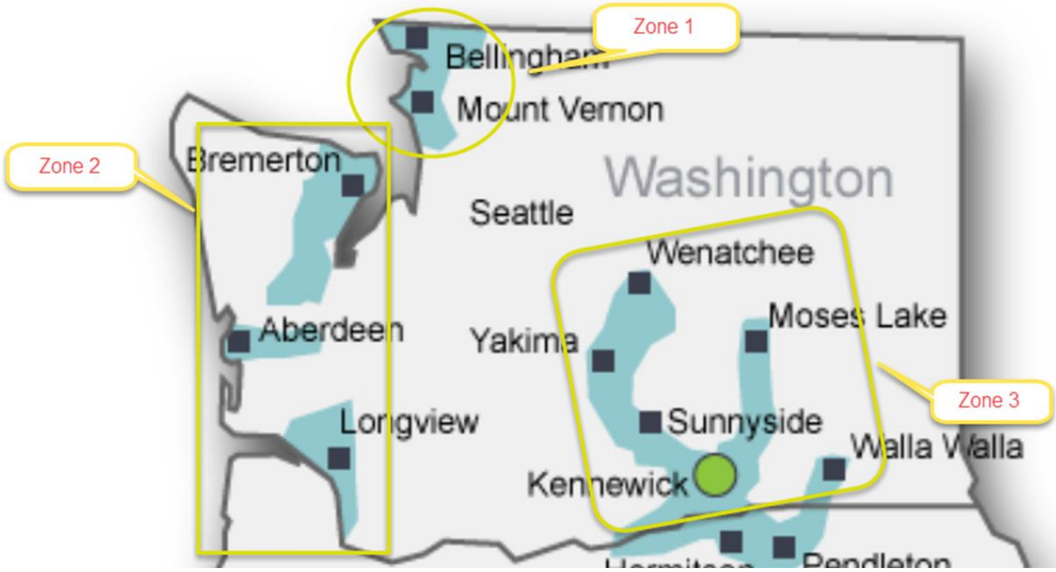
The second primary objective was to deliver a fully configured end-use model for Cascade to use in future energy efficiency planning initiatives. AEG has customized its LoadMAP end-use planning tool with data specific to Cascade's territory and the Northwest. This includes a detailed snapshot of how Cascade's customers use energy in the base year of the study, 2019, assumptions on future customer growth from Cascade's load forecasting team, and measure assumptions using Cascade primary data, regional research, and well-vetted sources from around the nation. AEG has also facilitated training sessions with the Cascade team to ensure a smooth handoff of the model.

Additionally, the CPA is intended to support the design of programs to be implemented by Cascade during the upcoming years. One output of the LoadMAP model is a comprehensive summary of measures. This summary documents input assumptions and sources on a per-unit value, program applicability and achievability (ramp rates), and potential results (units, incremental potential, and cumulative potential) as well as cost-effectiveness at the TRC, UCT, and RVT levels. This summary was developed in collaboration with Cascade and refined throughout the project.

Finally, this study was developed to provide energy efficiency inputs into Cascade's Integrated Resource Planning (IRP) process. To this end, AEG developed detailed achievable economic potential inputs by measure for use in Cascade's SENDOUT planning model. These inputs are highly customizable and provide potential estimates at the Washington-territory level, Cascade climate zone, and city-gate level. We present a map of Cascade's Washington climate zones in Figure 1-1, to summarize the terms we reference throughout this study.

[1] "The 2021 Northwest Power Plan." Northwest Power & Conservation Council,. https://www.nwcouncil.org/2021-northwest-power-plan/

Figure 1-1 Cascade's Washington Service Territory (courtesy Cascade)



Summary of Report Contents

The document is divided into seven additional chapters, summarizing the approach, assumptions, and results of the EE potential analysis, with additional detail provide in Volume 2 appendices:

Volume 1, Final Report:

- Analysis Approach and Data Development. Detailed description of AEG's approach to conducting Cascade's 2021-2040 CPA and documentation of primary and secondary sources used.
- Market Characterization and Market Profiles. Characterization of Cascade's Washington service territory in the base year of the study, 2019, including total consumption, number of customers and market units, and energy intensity. This also includes a breakdown of the energy consumption for residential, commercial, and core industrial customers by end use and technology.
- Baseline Projection. Projection of baseline energy consumption under a naturally occurring efficiency case, described at the end-use level. The LoadMAP models were first aligned with actual sales and Cascade's official, weather-normalized econometric forecast and then varied to include the impacts of future federal standards, ongoing impacts of the 2015 Washington State Energy Code on new construction, and future technology purchasing decisions.
- Overall Energy Efficiency Potential. Summary of energy efficiency potential for Cascade's entire Washington service territory for selected years between 2021 and 2040.
- Sector-Level Energy Efficiency Potential. Summary of energy efficiency potential for each market sector within Cascade's service territory, including residential, commercial, core industrial customers. This section includes a more detailed breakdown of potential by measure type, vintage, market segment, end use, and Cascade climate zone in the case of residential.
- Comparison with Current Programs and Ramp Rate Adjustments Detailed comparison of potential with current Cascade programs, including new opportunities for energy savings. Also describes AEG's

recommended process for adapting the Council's 2021 Plan ramp rates for use with natural gas EE measures.

- Phase 1 Summary and Next Steps: Summary of items included in this 2020 CPA update and goals for Phase 2 beginning in 2021.

Volume 2, Appendices:

- Alignment with the Council's Methodology. Discussion on how this study aligns with Council electric-centric methodologies, including ramp rates, regional data, and measure assumptions.
- Market Profiles. Detailed market profiles for each market segment. 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. These were adapted from the 2021 Power Plan electric conservation supply curve workbooks for use in the estimation of achievable natural gas potential.
- Measure List. Contained in a separate spreadsheet accompanying delivery of this report. List of measures, along with example baseline definitions and efficiency options by market sector analyzed.
- Detailed Measure Assumptions. Contained in a separate spreadsheet accompanying delivery of this report. This dataset provides input assumptions, measure characteristics, cost-effectiveness results, and potential estimates for each measure permutation analyzed within the study.

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
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
CBSA	NEEA's 2014 Commercial Building Stock Assessment
Council	Northwest Power and Conservation Council (NWPCC)
DHW	Domestic Hot Water
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Energy Information Administration
EUL	Estimated Useful Life
EUI	Energy Usage Index
HVAC	Heating Ventilation and Air Conditioning
IFSA	NEEA's 2014 Industrial Facilities Site Assessment
IRP	Integrated Resource Plan
LoadMAP	AEG's Load Management Analysis and Planning™ tool
NEEA	Northwest Energy Efficiency Alliance
O&M	Operations and Maintenance
RBSA	NEEA's Residential Building Stock Assessment
RTF	Regional Technical Forum
RVT	Resource Value Test
TRC	Total Resource Cost
UCT	Utility Cost Test
UEC	Unit Energy Consumption
UES	Unit Energy Savings
WSEC	2015 Washington State Energy Code

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. These analysis steps are described in more detail throughout the remainder of this chapter.

1. Performed a market characterization to describe sector-level natural gas use for the residential, commercial, and industrial sectors for the base year, 2019. This included extensive use of Cascade data and other secondary data sources from NEEA and the Energy Information Administration (EIA).
2. Developed a baseline projection of energy consumption by sector, segment, end use, and technology for 2021 through 2040.
3. Defined and characterized several hundred EE measures to be applied to all sectors, segments, and end uses.
4. Estimated technical, achievable technical, and achievable economic energy savings at the measure level for 2021-2040. Achievable economic potential was assessed using both the UCT and TRC screens.

Comparison with Northwest Power & Conservation Council Methodology

Cascade's Washington Conservation Advisory Group (CAG) strongly recommended the Council's methodology to assess potential and develop ramp rates. It is important to note that the Council's methodology was developed for, and used, in electric CPAs. Natural gas impacts are typically assessed when they overlap with electricity measures (e.g., gas water heating impacts in an electrically heated "Built Green Washington" home). The Council's ramp rates were also developed with electric utility DSM programs in mind, as electricity is the primary focus of the regionwide potential assessed in the Council's Plans. For these reasons, AEG adapted Council methodologies in some cases, rather than using them directly from the source. This is especially relevant in the development of ramp rates when achievability was determined to not be applicable to a specific natural gas measure or program. We discuss this in Section 7 of this report.

A primary objective of the study was to estimate natural gas potential consistent with the Council's analytical methodologies and procedures for electric utilities. While developing Cascade's 2021-2040 CPA, the AEG team relied on an approach vetted and adapted through the successful completion of CPAs under the Council's prior and current Power Plans. Among other aspects, this approach involves using consistent:

- Data sources: regional surveys, market research, and assumptions
- Measures and assumptions: 2021 Plan supply curves and RTF work products
- Potential factors: 2021 Plan ramp rates
- Levels of potential: technical, achievable technical, and achievable economic

- Cost-effectiveness approaches: assessed potential under the UCT as well as the Council's TRC test, including non-energy impacts which may be quantified and monetized and O&M impacts within the TRC
- Conservation credits: applied a 10% conservation credit to avoided energy costs for energy benefits

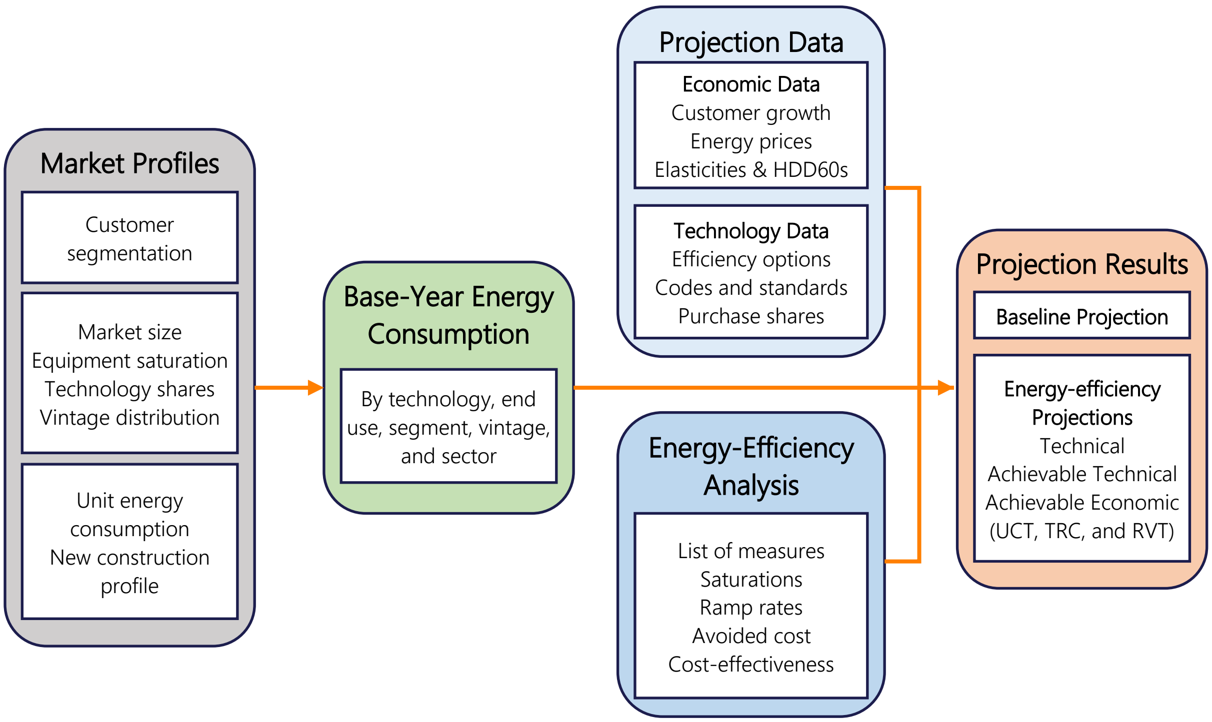
LoadMAP Model

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 Residential End-Use Energy Planning System (REEPS) and Commercial End-Use Planning System (COMMEND)) but in a simplified, more 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. This is especially relevant in the state of Washington where the 2015 WSEC substantially enhances the efficiency of the new construction market.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex customer 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 water heating is distinct from furnaces and fireplaces.
- 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, climate zone, 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. Also allows for the development of IRP supply curves, both at the achievable technical and achievable economic potential levels.

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.[2]

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 energy efficiency potential. In this study, the savings estimates are developed for three types of potential: technical potential, economic potential, and achievable potential. These are developed at the measure level, and results are provided as savings impacts over the 21-year forecasting horizon. The various levels are described below.

- Technical Potential is defined as the *theoretical* upper limit of energy efficiency potential. It assumes 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 technically feasible. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with installed furnaces. 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.

[2] The model computes energy forecasts for each type of potential for each end use as an intermediate calculation. Annual-energy 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).

- 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 Council's 2021 Plan based on the electric-utility model, tailored for use in natural gas EE programs.
- UCT Achievable Economic Potential further refines achievable technical potential by applying an economic cost-effectiveness screen. In this analysis, primary cost-effectiveness is measured by the utility cost test (UCT), which assesses cost-effectiveness from the utility's perspective. This test compares lifetime energy benefits to the costs of delivering the measure through a utility program, excluding monetized non-energy impacts. These costs are the assumed incentive, represented as a percent of incremental cost of the given efficiency measure, relative to the relevant baseline course of action (e.g. federal standard for lost opportunity and no action for retrofits), plus any administrative costs that are incurred by the program to deliver and implement the measure. If the benefits outweigh the costs, a given measure is included in the economic potential. Note that we set the measure-level cost-effectiveness threshold at 0.9 for this analysis since Cascade is allowed to include non-cost-effective measures as long as the entire portfolio is cost effective. This is important because a portfolio considers more than just energy savings. Cascade may include popular measures that are on the cusp of cost-effectiveness, accommodate variance between climate zones, maintain a robust portfolio, or include a measure that improves customer outreach and communication.
- TRC Achievable Economic Potential is similar to UCT achievable economic potential in that it refines achievable technical potential through cost-effectiveness analysis. The total resource cost (TRC) test assesses cost-effectiveness from a combined utility and participant perspective. As such, this test includes full measure costs but also includes non-energy impacts realized by the customer if quantifiable and monetized. In addition to non-energy impacts, we assessed the impacts of non-gas impacts following Council methodology. This includes a calibration credit for space heating equipment consumption to account for secondary heating equipment present in an average home as well as other electric end-use impacts such as cooling and interior lighting as applicable on a measure-by-measure basis. As a secondary screen, we include TRC results for comparative purposes.
- RVT Achievable Economic Potential is similar to the UCT and TRC achievable economic potential but assesses cost-effectiveness from a regional perspective. The resource value test (RVT) reframes the analysis around accomplishing a jurisdiction's regional policy goals and includes hard-to-quantify impacts through quantitative or qualitative approaches. This test allows jurisdictions to define policy goals which may include additional impacts beyond the traditional utility-customer TRC approach. In May of 2017, the National Efficiency Screening Project (NESP) released a National Standard Practice Manual[3] (2017 NSPM) which details an approach for conducting screening measures under the RVT. AEG assessed preliminary estimates of potential under the RVT as part of this study, but since policy goals are defined at the regional level under this test, we are awaiting recommendations on non-energy impacts and values from the Washington Utilities and Transportation Commission (WUTC). The model has been configured to accommodate these future updates as they become available.

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. To estimate the savings potential from

[3] National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, May 18, 2017 https://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf

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 Cascade's natural gas footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies in use. For this we rely primarily on information from Cascade, augmenting with secondary sources as necessary.

Segmentation for Modeling Purposes

This assessment first defined the market segments (climate zones, building types, end uses, and other dimensions) that are relevant in Cascade's service territory. The segmentation scheme for this project is presented in Table 2-1.

Table 2-1 Overview of Cascade Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
1	Sector	Residential, Commercial, Industrial (core customers only)
2	Segment	Residential: Climate Zones 1 through 3 Single Family, Climate Zones 1 through 3 Multifamily Commercial: Office, Retail, Restaurant, Grocery, Education, Healthcare, Lodging, Warehouse, Miscellaneous Industrial: Food Products, Agriculture, Primary Metals, Stone Clay & Glass, Petroleum, Paper & Printing, Instruments, Wood & Lumber Products, Other Industrial
3	Vintage	Existing and new construction
4	End uses	Heating, secondary heating, water heating, food preparation, process, and miscellaneous (as appropriate by sector)
5	Appliances/end uses and technologies	Technologies such as furnaces, water heaters, and process heating 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 natural gas sales in the base year, 2019. We used detailed Cascade 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 Cascade's system totals in 2019. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year. Please note that due to a very low number of mobile homes with natural gas service in Cascade's territory, as identified from billing data and supported by the 2016 RBSA II, we included consumption for these dwellings within the single-family market segment.

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.

- Saturations indicate the share of the market that is served by a particular end-use technology. Three types of saturation definitions are commonly used:
  - The conditioned space approach accounts for the fraction of each building that is conditioned by the end use. This applies to cooling and heating end uses.
  - The whole-building approach measures shares of space in a building with an end use regardless of the portion of each building that is served by the end use. Examples are commercial refrigeration and food service, and domestic water heating and appliances.
  - The 100% saturation approach applies to end uses that are generally present in every building or home and are simply set to 100% in the base year.
- UEC (Unit Energy Consumption) or EUI (Energy Usage Index) define consumption for a given technology. UEC represents the amount of energy a given piece of equipment is expected to use in one year. EUI is a UEC indexed to a non-building market unit, such as per square foot or per employee)
  - These are indices that refer to a measure of average annual energy use per market unit (home, floor space, or employee in the residential, commercial, and industrial sector, respectively) that are served by an end-use technology. UECs and EUIs embody an average level of service and average equipment efficiency for the market segment.
- Annual energy intensity for the residential sector represents the average energy use for the technology across all homes in 2019. It is computed as the product of the saturation and the UEC and is defined as therms/household for natural gas. 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 therms or thousand therms.

The market characterization results and the market profiles are presented in Section 3 and Appendix D.

Baseline Projection

The next step was to develop the baseline projection of annual natural gas use for 2020 through 2040 by customer segment and end use in the absence of new utility energy efficiency programs.

We first aligned with Cascade's official forecast. AEG worked with Cascade's load forecasting group to incorporate assumptions and data utilized in the official utility forecast. Cascade's heating degree days (base 60°F) were incorporated into the LoadMAP model to align the baseline projection with the official utility forecast.

The end-use projection includes impacts of future federal standards that were effective as of July 2020, which drive energy consumption down through the study period.

Naturally occurring energy conservation, that is, energy conservation that is realized within the service area independent of utility-sponsored programs, is incorporated into the baseline projection consistent with the US Energy Information Administration's Annual Energy Outlook for the Pacific region. Results of the primary market research were used to calibrate these assumptions to ensure the secondary sources were relevant to Cascade customers. For example, some customers will purchase and install energy conservation measures that are available in the market without a utility incentive. Please note this is not the “Frozen Efficiency” case defined by the Council, which is used for comparison with electricity savings from the Seventh Plan. After discussions with the Cascade team and review of the load forecast, AEG determined that a naturally occurring baseline is appropriate and would align better with the official forecast, whose econometric approach includes impacts of naturally occurring efficiency embedded within natural gas sales for the last few years.

As such, the baseline projection is the foundation for the analysis of savings in future conservation cases and scenarios as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- Current economic growth forecasts (i.e., customer growth, changes in weather (Heating Degree Day, base-60°F (HDD60) normalization))
- 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 Section 4.

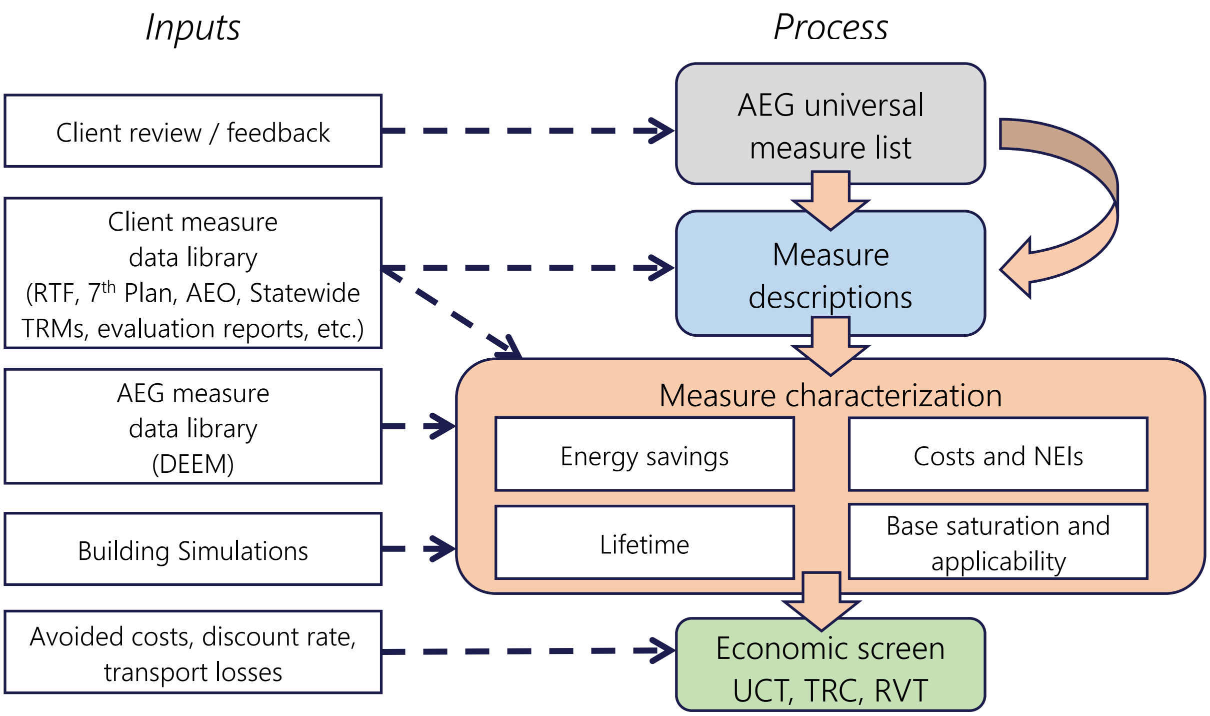
Energy Efficiency Measure Development

This section describes the framework used to assess the savings, costs, and other attributes of energy efficiency measures. 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. This information combined with Cascade’s avoided cost data informs the economic screens that determine economically feasible measures. In this section, AEG would like to acknowledge the work of the Cascade team in analyzing actual implementation data to provide territory-specific costs for many of the measures assessed within this CPA.

Figure 2-2 outlines the framework for measure characterization analysis. First, the list of measures is identified; each measure is then assigned an applicability for each market sector and segment and characterized with appropriate savings, costs and other attributes; then the cost-effectiveness screening is performed. Cascade 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 conservation measures for each customer sector, drawing upon Cascade’s program experience, AEG’s own measure databases and building simulation models, and secondary sources, primarily the Regional Technical Forum’s (RTF) UES measure workbooks and the Seventh Plan’s electric power conservation supply curves. This universal list of measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption.

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® residential water heater (UEF 0.64) that replaces a standard efficiency water heater (UEF 0.58). For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by a code or standard) up to the most efficient product commercially available. These measures are applied on a stock-turnover basis, and in general, are referred to as lost opportunity (LO) measures by the Council because once a purchase decision is made, there will not be another opportunity to improve the efficiency of that equipment item until its end of useful life (EUL) is reached once 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 furnace or water heater). Measure installation is not tied to a piece of equipment reaching end of useful life, so these are generally categorized as "retrofit" measures. An example would be insulation that modifies a household's space heating consumption, but does not change the efficiency of the furnace. The existing insulation can be achievably upgraded without waiting any existing equipment to malfunction, and saves energy used by the furnace. Non-equipment measures typically fall into one of the following categories:
  - Building shell (windows, insulation, roofing material)
  - Equipment controls (smart thermostats, water heater setback)
  - Whole-building design (Built Green homes)

- Retrocommissioning

In the 2017 CPA, AEG developed a preliminary list of efficient measures, which was distributed to Cascade's project team for review as well as Cascade's nonresidential implementer, TRC Companies, Inc.. Once we assembled the list of measures, the AEG team assessed their energy-saving characteristics. For each measure, we also characterized incremental cost, service life, non-energy impacts, and other performance factors.

As this first phase is primarily an update to the baseline, the measure list from the 2017 study has been generally preserved, with some high priority measure characterizations reassessed. In phase two of this study, all measures will be reassessed, and some new measures that were identified during the measure list review process will be added and characterized as well.

Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential scenarios.

Representative Measure Data Inputs

To provide an example of 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 direct-fuel furnaces in single-family homes in Climate Zone 1. Table 2-2 displays the various efficiency levels available as equipment measures, as well as the corresponding effective 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 Direct Fuel Furnace – Single-Family Home, Climate Zone 1

Efficiency Level	Useful Life (years)	Equipment Cost	Energy Usage (therms/yr)	On Market	Off Market
AFUE 80%	18	$3,288	579	2016	2023
AFUE 90%	18	$3,451	520	2016	2023
AFUE 92%	18	$3,510	508	2016	n/a
AFUE 95%	18	$4,776	490	2016	n/a
AFUE 98%	18	$6,220	474	2016	n/a
Convert to Natural Gas Heat Pump	21	$11,507	415	2016	n/a

Table 2-3 lists some of the non-equipment measures applicable to a direct-fuel furnace 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 of the measure, and the savings as a percentage of the relevant energy end uses. We model two flavors of most shell insulations measures. The first is the installation of insulation where there is none (or very little). This applies to a small subset of the population (roughly 6% of the population is eligible for this measure per RBSA) but has large savings impacts. This percentage is low due to the impacts of current Cascade programs, strict Washington building codes, and naturally occurring efficiency. The second is an insulation upgrade measure where homes with existing insulation below the threshold, but not classified as no insulation, may be upgraded to higher R-values. This applies to a much larger percentage of the market.

Table 2-3 Example Non-Equipment Measures – Existing Single Family Home, Climate Zone[4]

End Use	Measure	Saturation in 2016[5]	Applicability	Lifetime (yrs)	Measure Installed Cost	Energy Savings (%)
Heating	Insulation - Ceiling Installation	0%	6%	45	$1,739	29.9%
Heating	Insulation – Ceiling Upgrade	20%	88%	45	$1,739	7.6%
Heating	Ducting Repair and Sealing	15%	50%	20	$794	5.5%
Heating	Windows - High Efficiency/ENERGY STAR	89%	100%	45	$4,689	25.3%

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	44	88	792
Commercial	53	106	954
Industrial	43	86	774
Total Measures Evaluated	**140**	**280**	**2,520**

Calculation of Energy Conservation Potential

The approach we used for this study to calculate the energy conservation potential adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) *Guide for Conducting Energy Efficiency Potential Studies*.[6] This document represents credible and comprehensive industry best practices for specifying energy conservation potential. Three types of potential were developed as part of this effort: technical potential, achievable technical potential, and achievable economic potential (using UCT and TRC). The calculation of technical potential is a straightforward algorithm which, as described above, assumes that customers adopt all feasible measures regardless of their cost.

Stacking of Measures and Interactive Effects

An important factor when estimating potential is to consider interactions between measures when they are applied within the same space. This is important to avoid double counting and could feasibly result in savings at greater than 100% of equipment consumption if not properly accounted for.

This occurs at the population- or system- level, where multiple DSM actions must be stacked or layered on top of each other in succession, rather than simply summed arithmetically. These interactions are

[4] The applicability factors consider whether the measure is applicable to a particular building type and whether it is feasible to install the measure. For instance, duct repair and sealing is not applicable to homes with zonal heating systems since there is no ductwork present to repair.

[5] Note that saturation levels reflected increase from their base year saturation as more measures are adopted.

[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.

automatically handled within the LoadMAP models where measure impacts are stacked on top of each other, modifying the baseline for each subsequent measure. We first compute the total savings of each measure on a standalone basis, then also assign a stacking priority, based on levelized cost, to the measures such that "integrated" or "stacked" savings will be calculated as a percent reduction to the running total of baseline energy remaining in each end use after the previous measures have been applied. This ensures that the available pie of baseline energy shrinks in proportion to the number of DSM measures applied, as it would in reality. The loading order is based on the levelized cost of conserved energy, such that the more economical measures that are more likely to be selected from a resource planning perspective will be the first to be applied to the modeled population.

We also account for exclusivity of certain measure options when defining measure assumptions. For instance, if an AFUE 95% furnace is installed in a single-family home, the model will not allow that same home to install an AFUE 98% furnace, or any other furnace, until the newly installed AFUE 95% option has reached its end of useful life. For non-equipment measures, which do not have a native applicability limit, we define base saturations and applicabilities such that measures do not overlap. For example, we model two applications of ceiling insulation. The first assumes the installation of insulation where there previously was none. The second upgrades pre-existing insulation if it falls under a certain threshold. We used regional market research data to ensure exclusivity of these two options. NEEA's RBSA contains information on average R-values of insulation installed. The AEG team used these data to define the percent of homes that could install one measure, but not the other.

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 potential phases 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 resource planning does not overstep acquisition capabilities. We adapted the Northwest Power and Conservation Council's 2021 Plan ramp rates to develop these achievability factors for each measure. Applying these ramp rates as factors leads directly to the achievable technical potential. More details on this process can be found in Section 7.

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.

LoadMAP performs an economic screen for each individual measure in each year of the planning horizon. This study uses the UCT test as the primary cost-effectiveness metric, which compares the lifetime hourly energy benefits of each applicable measure with the incentive and administrative costs incurred by the utility. The lifetime benefits are calculated by multiplying the annual energy savings for each measure by Cascade's avoided costs and discounting the dollar savings to the present value equivalent. 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, considering 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 therm savings potential of a measure, consumption with the measure applied must be compared to the 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 as a separate 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:

- Cascade-provided data
- AEG's databases and analysis tools
- Other secondary data and reports

Cascade Data

Our highest priority data sources for this study were those that were specific to Cascade, including the primary market research conducted specifically for this study. This data are specific to Cascade's service territory and are an important consideration when customizing the model for Cascade's market. This is best practice when developing CPA baselines when the data are available.

- Cascade customer account database. Cascade 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. This also included equipment flags, identifying the presence of a substantial number of gas-consuming technologies. This data were very useful in developing a detailed estimate of energy consumption within Cascade's service territory.
- Load forecasts. Cascade provided forecasts, by sector and climate zone, of energy consumption, customer counts, weather actuals for 2019, as well as weather-normal HDD60s.
- Economic information. Cascade provided a discount rate as well as avoided cost forecasts and transportation loss factors.
- Cascade program data. Cascade provided information about past and current programs, including program descriptions, goals, and measure achievements to date. Cascade also provided a

comprehensive list of measure costs, developed from measure installations within actual Cascade conservation programs as per guidance they received from a previous third-party program evaluation.

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 2021 Plan and Regional Technical Forum workbooks. To develop its Power Plan, the Council maintains workbooks with detailed information about measures. This was used as a primary data source when Cascade-specific program data was not available, and the data was determined to be applicable to natural gas conservation measures. The most recent data and workbooks available were used at the time of this study.
- Northwest Energy Efficiency Alliance, 2016-2017 Residential Building Stock Assessment II, https://neea.org/data/residential-building-stock-assessment
- Northwest Energy Efficiency Alliance, 2011 Residential Building Stock Assessment, https://neea.org/resources/washington-state-report
- Northwest Energy Efficiency Alliance, 2019 Commercial Building Stock Assessment, https://neea.org/resources/cbsa-4-2019-final-report
- Northwest Energy Efficiency Alliance, 2014 Commercial Building Stock Assessment, https://neea.org/resources/2014-cbsa-final-report
- Northwest Energy Efficiency Alliance, 2014 Industrial Facilities Site Assessment, https://neea.org/resources/2014-ifsa-final-report

Since Cascade's billing data included information on appliance saturations at the customer-level, the NEEA surveys were used more for benchmarking and comparative purposes, rather than as a primary source of data. The NEEA surveys were used extensively to develop base saturation and applicability assumptions for many of the non-equipment measures within the study

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 (natural gas and electricity), 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 Conservation 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 more than 60 studies of EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, both within the region and across the country.

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 2019 AEO.
- American Community Survey. The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. http://www.census.gov/acs/www/
- Local Weather Data. Weather from NOAA's National Climatic Data Center for Bellingham (Cascade climate zone 1), Bremerton (Cascade climate zone 2), and Yakima (Cascade climate zone 3) were used where applicable. For the commercial and industrial sectors, where analysis was not done at the climate zone-level, we used a weighted average of the three weather stations based on Cascade's billing data within each zone.
- EPRI End-Use Models (REEPS and COMMEND). These models provide the energy-use elasticities we apply to prices, household income, home size, 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. This also includes technical reference manuals (TRMs) from other states. When using data from outside the region, especially weather-sensitive data, AEG adapted assumptions for use within Cascade's Washington territory.

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 natural gas consumption and market size units (households for residential, floor space for commercial, and employees for industrial), we primarily used Cascade's 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. Develop control totals for each segment. These include market size, segment-level annual natural gas use, and annual intensity. Control totals were based on Cascade's actual sales and customer-level information found in Cascade's customer billing database.
2. Develop existing appliance saturations and the energy characteristics of appliances, equipment, and buildings using equipment flags within Cascade's billing data, NEEA's 2016 RBSA, 2019 CBSA, and 2014 IFSA, DOE's 2015 RECS, the 2019 edition of the Annual Energy Outlook, AEG's Energy Market Profile (EMP) for the Pacific region, and the American Housing Survey.
3. Ensure calibration to Cascade control totals for annual natural gas sales in each sector and segment.
4. Compare and cross-check with other recent AEG studies.
5. Work with Cascade staff to verify the data aligns with 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	Cascade 2019 actual sales Cascade customer account database
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee	Cascade customer account database AEG's Energy Market Profiles AEO 2019 – Pacific Region Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Cascade equipment flags in customer account database 2016 RBSA, 2019 CBSA and 2014 IFSA 2014 American Community Survey AEG's Energy Market Profiles
UEC/EUI for each end-use technology	UEC: Annual natural gas use in homes and buildings that have the technology EUI: Annual natural gas use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for Cascade Engineering analysis AEG DEEM AEO 2019 – Pacific Region Recent AEG studies
Appliance/equipment age distribution	Age distribution for each technology	2011 RBSA, 2014 CBSA, and recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Cascade current program offerings AEG DEEM AEO 2019 CA DEER Recent AEG studies

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	Cascade load forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO and ENERGY STAR AEO 2019 regional forecast assumptions[7] Appliance/efficiency standards analysis
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models

In addition, assumptions were incorporated for known future equipment standards as of July 2020, as shown in Table 2-7 and Table 2-8. The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

[7] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2017), 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.

Table 2-7 Residential Natural Gas Equipment Federal Standards[8]

End Use	Technology	2019	2020	2021	2022	2023	2024	2025
Space Heating	Furnace – Direct Fuel	AFUE 80%					AFUE 92%*	
	Boiler – Direct Fuel	AFUE 82%	AFUE 84%					
Secondary Heating	Fireplace	N/A						
Water Heating	Water Heater <= 55 gal.	UEF 0.58						
	Water Heater > 55 gal.	UEF 0.76						
Appliances	Clothes Dryer	CEF 3.30						
	Stove/Oven	N/A						
Miscellaneous	Pool Heater	TE 0.82						
	Miscellaneous	N/A						

* This code was originally set to take effect in 2021 but exempts smaller systems. The comment period lasted through 2017 with the standard not expected to take effect until at least 5 years after that time. There has been no update since the comment period expired, so the analysis retains the previous assumption that this standard will come online officially in 2024.

Table 2-8 Commercial and Industrial Natural Gas Equipment Standards

End Use	Technology	2019	2020	2021	2022	2023	2024	2025
Cooling	Furnace	AFUE 80% / TE 0.80						
	Boiler	Average around AFUE 80% / TE 0.80 (varies by size)						
	Unit Heater	Standard (intermittent ignition and power venting or automatic flue damper)						
Water Heater	Water Heating	TE 0.80						

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

Energy Conservation Measure Data Application

Table 2-9 details the energy-efficiency data inputs to the LoadMAP model. It describes each input and identifies the key sources used in the Cascade analysis.

Additional updates to measure characteristics will occur in Phase 2 of the study, starting in 2021.

Table 2-9 Data Inputs 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.	Cascade program data NWPCC workbooks, RTF AEG BEST AEG DEEM AEO 2017 CA DEER Other secondary sources
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.	Cascade program data NWPCC workbooks, RTF AEG DEEM AEO 2017 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 2017 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.	2011/2016 RBSA, 2014/2019 CBSA; 2021 Plan applicability guidelines 2015 WSEC for limitations on new construction AEG DEEM CA DEER Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	AEG appliance standards and building codes analysis

Data Application for Cost-Effectiveness Screening

To perform the cost-effectiveness screening, a number of economic assumptions were needed. All cost and benefit values were analyzed in real dollars. The analysis applied Cascade's long-term real discount rate of 3.40%. This rate was based off the average 30-year mortgage value rather than weighted average cost of capital (WACC) to maintain consistency with the IRP. LoadMAP is configured to vary this by market sector (e.g. residential and commercial) if Cascade develops alternative values in the future. All impacts in this report are presented at the customer meter, but transportation losses were provided by Cascade and were included for cost-effectiveness screening.

Estimates of Customer Adoption

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

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

The ramp rates referenced above were adapted for use for assessing natural gas measure potential, as described in Section 7. The customer adoption rates used in this study are available in Appendix E.

3

MARKET CHARACTERIZATION AND MARKET PROFILES

In this section, we describe how customers in Cascade's Washington service territory use natural gas in the base year of the study, 2019, Beginning with a high-level summary of energy use across all sectors and then delving into each sector in more detail.

Overall Energy Use Summary

Total natural gas consumption for core customers all sectors for Cascade in 2019 was 244,473 thousand therms. As shown in Figure 3-1 and Table 3-1, the residential sector accounts for the largest share of annual energy use at 52.2%, followed by the commercial sector at 38.1%. Core customers within the industrial sector (non-transport) account for 9.7% of usage. Transportation-only customers were excluded from consideration in the potential study, as they are not eligible for participation in demand-side programs. This left only core industrial customers in the study.

Figure 3-1 Sector-Level Natural Gas Use in Base Year 2019 (annual therms, percent)

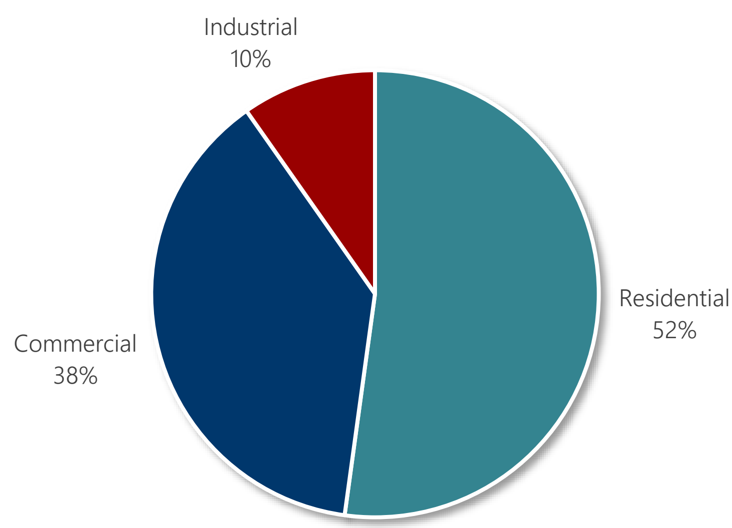


Table 3-1 Cascade Sector Control Totals, 2019

Sector	Number of Customers/Buildings	Natural Gas Use (thousand therms)
Residential	212,827	127,538
Commercial	25,039	93,122
Industrial	450	23,814
Total		**244,473**

Residential Sector

The total number of households and gas sales for the service territory were obtained from Cascade's actual sales for 2019. Details, including number of households and 2019 natural gas consumption for the residential sector can be found in Table 3-2 below. In 2019, there were over 200,000 households in the Cascade territory that used a total of over 127 million therms, resulting in an average use per household of 599 therms per year. This is an important number for the calibration process.

One adjustment made to Cascade customer counts was in the multifamily segments. A common trend in billing data is master accounts that represent multiple units within the same floor or building. When natural gas usage is shared in that way, we do not use the data directly. To account for this, we used 2016 RBSA data on multifamily usage per customer, then scaled it based on the relative usage within the three climate zones. For example, multifamily homes used comparatively more natural gas in climate zone 1 compared to zone 3, so the RBSA intensities were scaled upward in zone[9] 1 and downward in zone 3. In future updates to the LoadMAP model, Cascade may substitute the RBSA data for a more targeted local source if additional research is done into this topic.

These values have been weather normalized to account for differences in the actual heating degree days for 2019 compared to normal weather. Degree days for the conversion were provided by Cascade's forecast department.

Table 3-2 Residential Sector Control Totals, 2016

Segment	Households	Natural Gas Use (thousand therms)	Annual Use/Customer (therms/HH)
CZ1 - Single Family	71,590	51,737	723
CZ1 - Multi Family	27,076	8,487	313
CZ2 - Single Family	37,443	25,519	682
CZ2 - Multi Family	4,736	1,266	267
CZ3 - Single Family	57,136	36,151	633
CZ3 - Multi Family	14,846	4,377	295
Total	**212,827**	**127,538**	**599**

[9] Refer to Chapter 1 for the geographic definition of CNGC climate zones

Figure 3-2 Residential Natural Gas Use by Segment, 2019

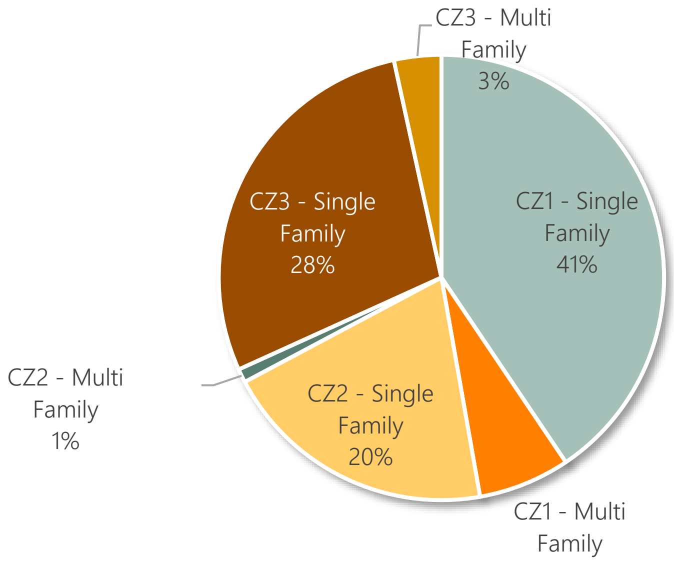
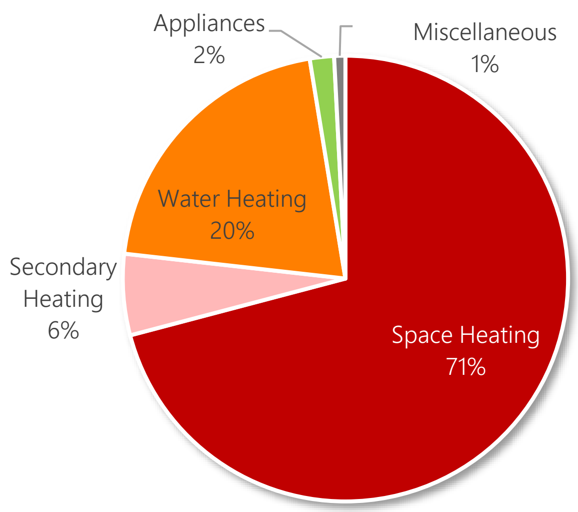


Figure 3-3 shows the distribution of annual natural gas consumption by end use for an average residential household. Space heating (primary and secondary) comprises a majority of the load at 77% followed by water heating at 20%. Miscellaneous loads make up a very small portion of the total. This is expected for a natural gas profile as there are few miscellaneous technologies. One example is natural gas barbecues.

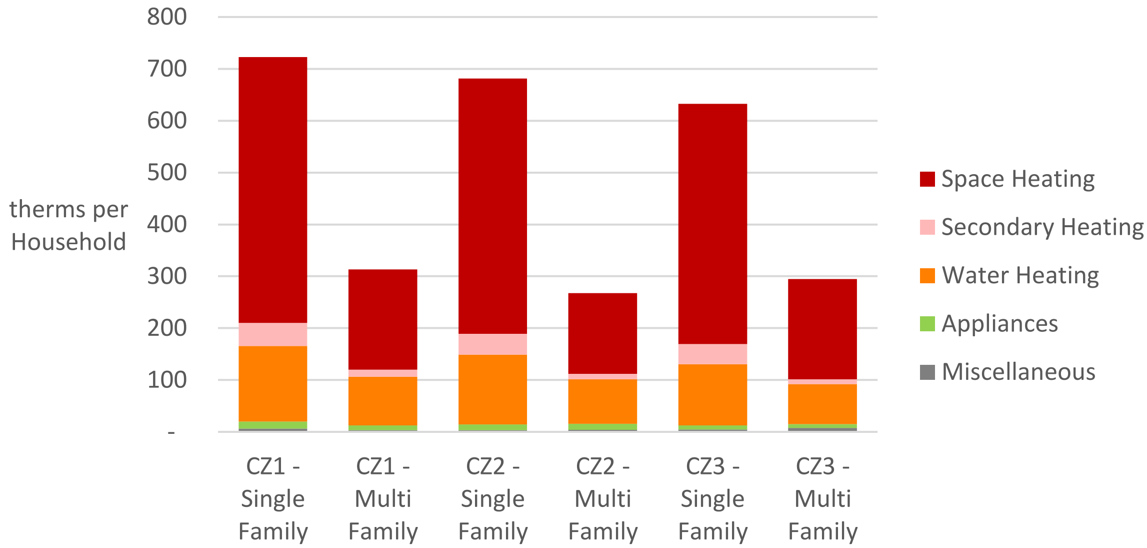
Figure 3-3 Residential Natural Gas Use by End Use, 2019



Equipment flags within Cascade's billing data informed estimates of the saturation of key equipment types, which were used to distribute usage at the technology and end use level.

Figure 3-4 presents average natural gas intensities by end use and housing type. Single family homes consume substantially more energy in space heating, primarily due to two factors. The first is that single family homes are larger. The second is that more walls are exposed to the outside environment, compared to multifamily dwellings with many shared walls. This increases heat transfer, resulting in greater heating loads. Water heating consumption is higher in single family homes as well. This is due to a greater number of occupants, which increases the demand for hot water.

Figure 3-4 Residential Energy Intensity by End Use and Segment, 2019 (Annual Therms/HH)



The market profile for an average home in the residential sector is presented in Table 3-3 below. An important step in the profile development process is model calibration. All consumption within an average home must sum up to the intensity extracted from billing data. This is necessary so estimates of consumption for a piece of equipment do not exceed the actual usage in a home.

Table 3-3 Average Market Profile for the Residential Sector, 2016

End Use	Technology	Saturation	UEC (therms)	Intensity (therms/HH)	Usage (thousand therms)
Space Heating	Furnace - Direct Fuel	82.8%	502	416	88,530
	Boiler - Direct Fuel	2.1%	428	9	1,893
Secondary Heating	Fireplace	29.1%	121	35	7,508
Water Heating	Water Heater <= 55 gal.	64.7%	165	107	22,710
	Water Heater > 55 gal.	10.3%	165	17	3,619
Appliances	Clothes Dryer	9.4%	21	2	427
	Stove/Oven	27.6%	31	9	1,816
Miscellaneous	Pool Heater	1.0%	106	1	232
	Miscellaneous	100.0%	4	4	804
Total				**599**	**127,538**

Commercial Sector

The total number of nonresidential accounts and natural gas sales for the service territory were obtained from Cascade's customer account database.

AEG first separated the Commercial accounts from Industrial by analyzing the SIC codes and rate codes assigned in the company's billing system. Prior to using the data, AEG inspected individual accounts to confirm proper assignment. This was done on the top accounts within each segment, but also via spot checks when reviewing the database. By doing this, AEG was able to positively classify about 90% of energy use from nonresidential (core) customers. Energy use from accounts where the customer type could not be identified were distributed proportionally to all C&I segments.

Once the billing data was analyzed, the final segment control totals were derived by distributing the total 2019 nonresidential load to the sectors and segments according to the proportions in the billing data.

Table 3-4 below shows the final allocation of energy to each segment in the commercial sector, as well as the energy intensity on a square-foot basis. Intensities for each segment were derived from a combination of the 2019 CBSA and equipment saturations extracted from Cascade's database. The CBSA intensities corresponded to spaces with slightly lower natural gas saturations than Cascade's database, so AEG increased intensities proportionally based on the additional presence of natural gas-consuming equipment.

Table 3-4 Commercial Sector Control Totals, 2019

Segment	Description	Intensity (therms/Sq Ft)	2016 Natural Gas Use (thousand therms)
Office	Traditional office-based businesses including finance, insurance, law, government buildings, etc.	0.25	11,279
Retail	Department stores, services, boutiques, strip malls etc.	0.40	16,068
Restaurant	Sit-down, fast food, coffee shop, food service, etc.	2.74	14,653
Grocery	Supermarkets, convenience stores, market, etc.	1.83	5,383
Education	College, university, trade schools, etc.as well as day care, pre-school, elementary, secondary schools	0.34	15,154
Health	Health practitioner office, hospital, urgent care centers, etc.	1.84	6,567
Lodging	Hotel, motel, bed and breakfast, etc.	1.38	5,095
Warehouse	Large storage facility, refrigerated/unrefrigerated warehouse	0.21	4,709
Miscellaneous	Catchall for buildings not included in other segments, includes churches, recreational facilities, public assembly, correctional facilities, etc.	0.49	14,212
Total		**0.47**	**93,122**

Figure 3-5 shows each segments' natural gas consumption as a percentage of the entire commercial sector energy consumption. The four segments with the highest natural gas usage in 2019 are retail, education, restaurant, and miscellaneous, in descending order. As expected, the highest intensity segment is restaurant. This is based on the high presence of food preparation equipment.

Figure 3-5 Commercial Natural Gas Use by Segment, 2019

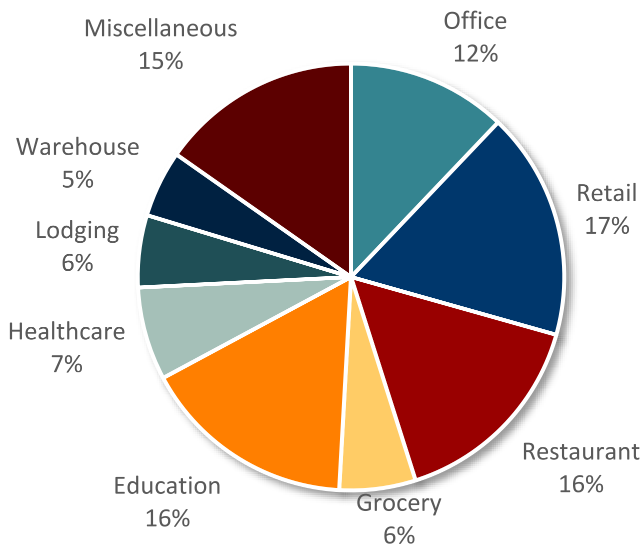


Figure 3-6 shows the distribution of natural gas consumption by end use for the entire commercial sector. Space heating is the largest end use, followed closely by food preparation and water heating. The miscellaneous end use is quite small, as expected.

Figure 3-6 Commercial Sector Natural Gas Use by End Use, 2019

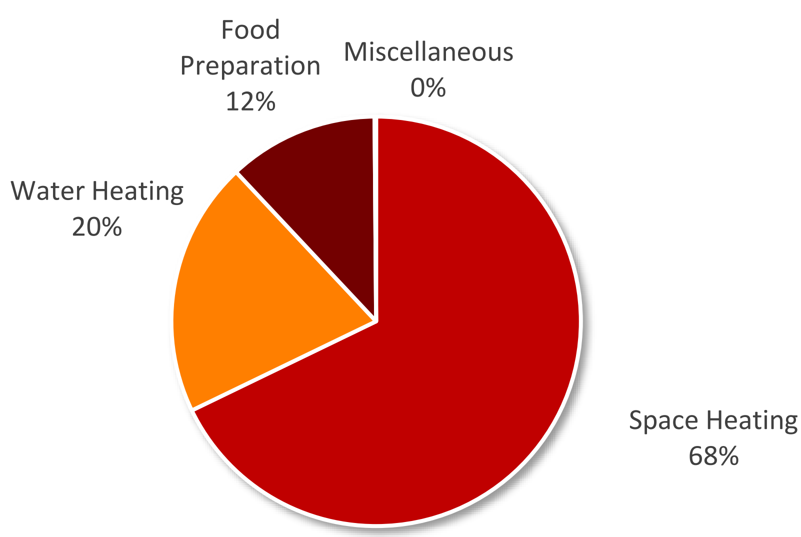
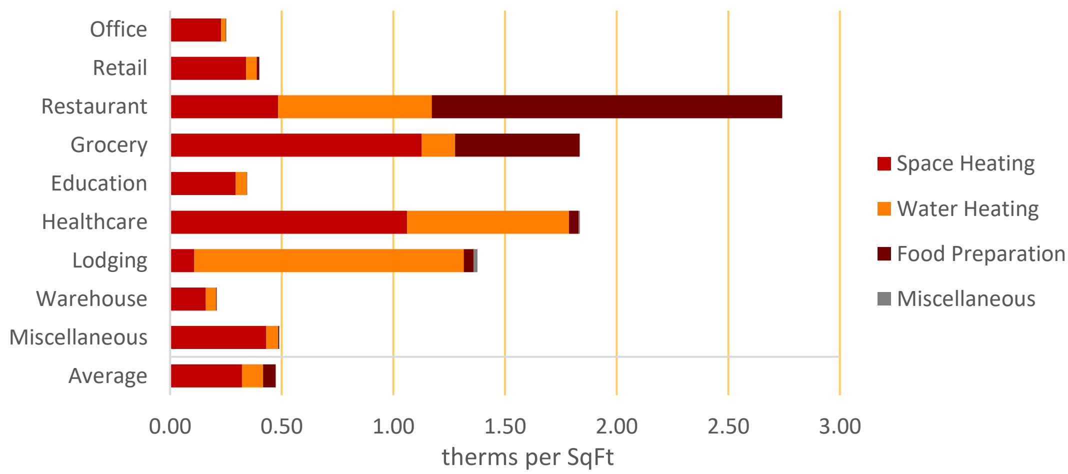


Figure 3-7 presents average natural gas intensities by end use and segment.

Figure 3-7 Commercial Energy Usage Intensity by End Use and Segment, 2019 (Annual Therms/Sq. Ft)



The total market profile for an average building in the commercial sector is presented in Table 3-5 below. Cascade customer account data informed the market profile by providing information on saturation of key equipment types. Secondary data was used to develop estimates of energy intensity and square footage and to fill in saturations for any equipment types not included in the database.

Table 3-5 Average Market Profile for the Commercial Sector, 2019

End Use	Technology	Saturation	EUI (therms/ Sq Ft)	Intensity (therms/ Sq Ft)	Usage (thousand therms)
Heating	Furnace	68.5%	0.19	0.13	25,572
	Boiler	23.0%	0.46	0.11	20,803
	Unit Heater	23.7%	0.36	0.09	16,790
Water Heating	Water Heater	49.5%	0.19	0.10	18,789
Food Preparation	Oven	3.8%	0.09	0.00	663
	Conveyor Oven	1.9%	0.15	0.00	567
	Double Rack Oven	1.9%	0.23	0.00	861
	Fryer	6.7%	0.26	0.02	3,446
	Broiler	2.3%	0.26	0.01	1,151
	Griddle	3.7%	0.17	0.01	1,248
	Range	11.5%	0.10	0.01	2,297
	Steamer	2.0%	0.12	0.00	473
	Commercial Food Prep Other	2.1%	0.08	0.00	340
Miscellaneous	Pool Heater	2.4%	0.01	0.00	42
	Miscellaneous	100.0%	0.00	0.00	72
Total				**0.47**	**93,121,548**

Industrial Sector

The total sum of natural gas used in 2019 by Cascade's core industrial customers was 23,814 thousand therms. The industrial sector total natural gas usage does not include transport-only customers as they are not eligible for DSM programs. As in the commercial sector, customer account data were used to allocate usage among segments. Energy intensity was derived from AEG's Energy Market Profiles database. We cross-referenced this data with Bureau of Labor Statistics employment data by industry. Number of employees is calculated by dividing total usage by intensity. For the industrial sector, the unit of measure chosen is employment. This is because floor area is not as indicative of process loads, which may be constrained to one portion of a larger warehouse/storage facility. We chose to capture usage on an employment basis rather than customer since NEEA's 2014 IFSA reports in a similar metric and it allows us to compare intensities with those estimated for the region as a whole. Most industrial measures are installed through custom programs, where the unit of measure is not as necessary to estimate potential.

Table 3-6 Industrial Sector Control Totals, 2019

Segment	Intensity (therms/employee)	Natural Gas Usage (thousand therms)	Employees
Food Products	3,055	7,243	2,371
Agriculture	215	3,721	17,279
Primary Metals	10,135	2,780	274
Stone, Clay, and Glass	6,298	2,223	353
Petroleum	75,573	1,454	19
Paper and Printing	6,854	429	63
Instruments	246	1,831	7,458
Wood and Lumber Products	1,029	854	830
Other Industrial	215	3,278	15,222
Total	**543**	**23,814**	**43,869**

Figure 3-8 summarizes core-customer industrial natural gas consumption by industry type.

Figure 3-8 Industrial Natural Gas Use by Segment, 2019

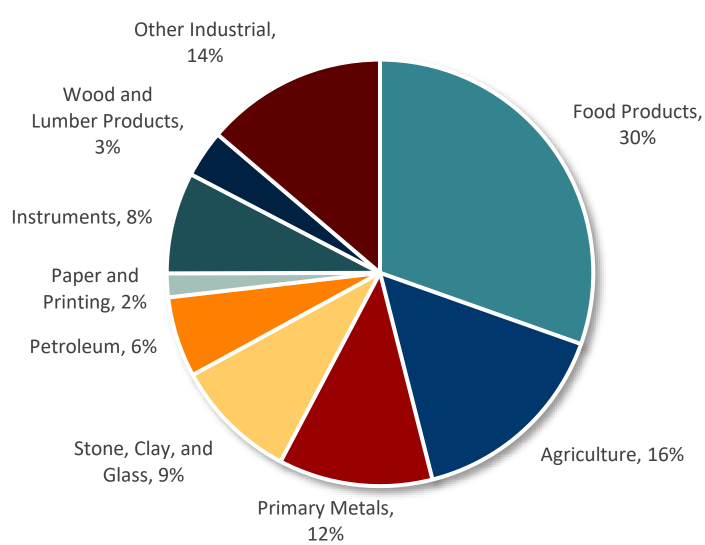


Figure 3-9 shows the distribution of annual natural gas consumption by end use for all industrial customers. Two major sources were used to develop this consumption profile. The first was AEG's analysis of warehouse usage as part of the commercial sector. We begin with this prototype as a starting point to represent non-process loads. We then added in process loads using our Energy Market Profiles database, which summarizes usage by end use and process type. Accordingly, process is the largest overall end use for the industrial sector, accounting for 80% of energy use. Heating is the second largest end use, and miscellaneous, non-process industrial uses round out consumption.

Figure 3-9 Industrial Natural Gas Use by End Use, 2019, All Industries

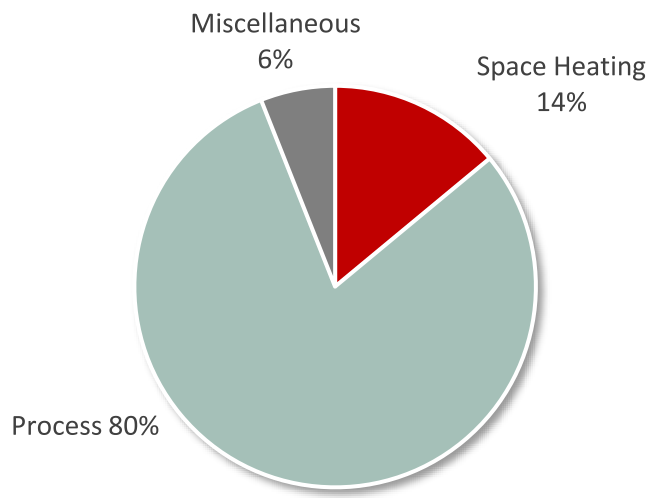


Figure 3-10 summarizes industrial energy intensities by industry type. Petroleum is presented on a separate axis due to the much higher per-employee usage estimate.

Figure 3-10 Industrial Energy Usage Intensity by End Use and Segment, 2019 (Annual Therms/Employee)

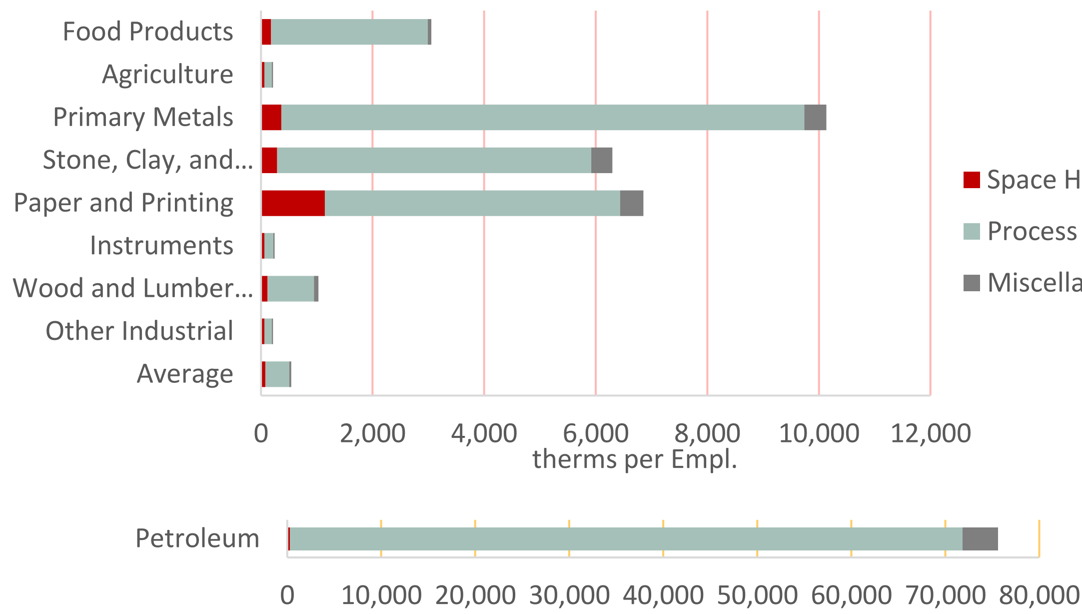


Table 3-7 shows the composite market profile for the industrial sector. Process cooling is very small and represents technologies such as gas-driven absorption chillers.

Table 3-7 Average Natural Gas Market Profile for the Industrial Sector, 2019

End Use	Technology	Saturation	EUI (therms/ employee)	Intensity (therms/ employee)	Usage (thousand therms)
Heating	Furnace	35.8%	92.63	33.21	1,457
	Boiler	10.6%	57.35	6.10	267
	Unit Heater	31.5%	116.28	36.62	1,607
Process	Process Boiler	100.0%	186.97	186.97	8,202
	Process Heating	100.0%	238.37	238.37	10,457
	Process Cooling	100.0%	0.88	0.88	39
	Other Process	100.0%	8.06	8.06	354
Miscellaneous	Miscellaneous	100.0%	32.63	32.63	1,432
Total				**542.83**	**23,814**

4

BASELINE PROJECTION

Prior to developing estimates of energy conservation potential, we developed a baseline end-use projection to quantify what the consumption is likely to be in the future in absence of any energy conservation 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.

The baseline projection incorporates assumptions about:

- 2019 energy consumption based on the market profiles
- Customer population growth
- Appliance/equipment standards and building codes already mandated
- Appliance/equipment purchase decisions
- Cascade's customer forecast
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous natural gas growth

Although it aligns closely, the baseline projection is not Cascade's official load forecast. Rather it was developed as an integral component of our modeling construct to serve as the metric against which energy 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 thousand therms. We also present a summary across all sectors.

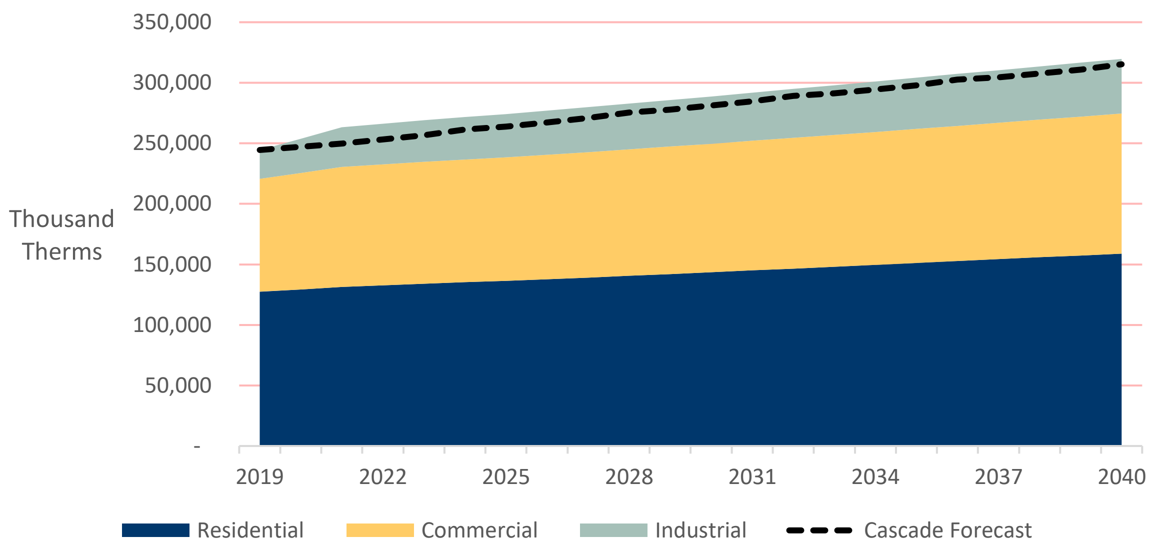
Summary of Overall Baseline Projection

Table 4-1 and Figure 4-1 provide a summary of the baseline projection for annual use by sector for the entire Cascade service territory. Base year (2019) values are weather normalized using HDD data provided by Cascade's load forecast department. Years 2020 forward assume normal weather. Overall, the forecast shows modest growth in natural gas consumption, at an average rate of about 1.3% per year.

Table 4-1 Baseline Projection Summary by Sector, Selected Years (thousand therms)

Sector	2021	2022	2023	2025	2030	2040	% Change ('19-'40)	Avg. Growth
Residential	131,264	132,686	134,142	136,500	143,497	158,861	24.6%	1.0%
Commercial	99,158	99,869	100,573	102,030	106,127	115,760	24.3%	1.0%
Industrial	32,823	33,530	34,242	35,672	39,080	45,042	89.1%	3.0%
Total	**263,245**	**266,084**	**268,957**	**274,202**	**288,705**	**319,662**	**30.8%**	**1.3%**

Figure 4-1 Baseline Projection Summary by Sector (thousand therms)



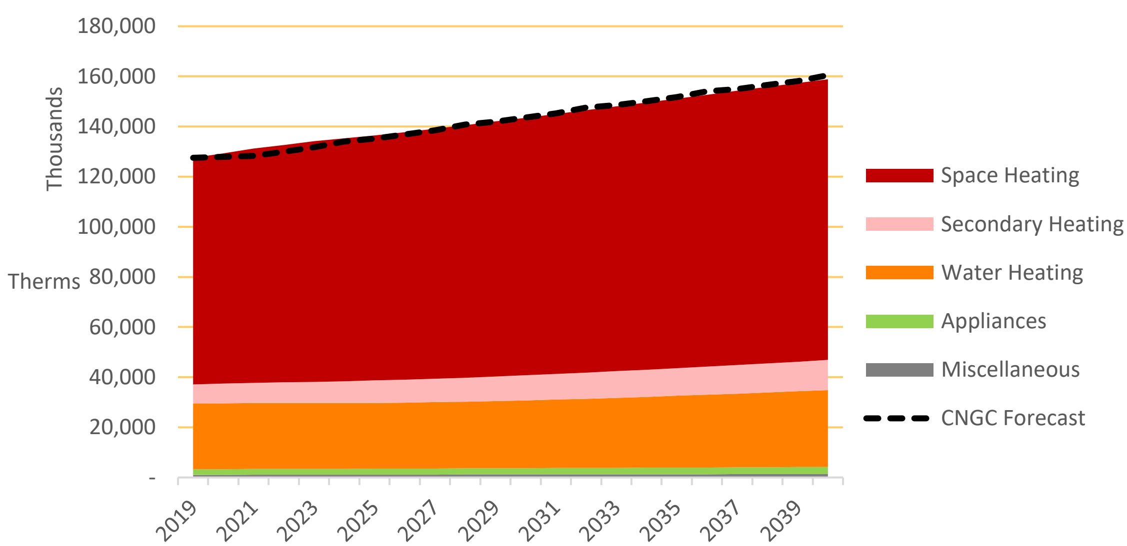
Residential Sector Baseline Projection

Table 4-2 and Figure 4-2 present the baseline projection for natural gas at the end-use level for the residential sector, as a whole. Overall, residential use increases from 127,538 thousand therms in 2019 to 158,861 thousand therms in 2040, an increase of 21%. There are two high-level factors affecting growth. The first is a moderate increase in number of households and customers. The second is a decrease in equipment consumption due to future standards and naturally occurring efficiency improvements (notably the AFUE upcoming 92% furnace standard). We model gas-fired fireplaces as secondary heating, because these units consume energy and may heat a space but are rarely relied on to be a primary heating technology. As such, they are estimated to be more aesthetic and less weather-dependent than gas furnaces. This end use grows faster than others since new homes are more likely to install a unit, increasing fireplace stock. Miscellaneous is a very small end use in natural gas studies and includes technologies with low penetration, such as gas barbeques.

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

End Use	2021	2022	2023	2025	2030	2040	% Change ('21-'40)	Avg. Growth
Space Heating	93,489	94,726	95,975	97,800	102,744	111,993	19.8%	1.0%
Secondary Heating	8,087	8,305	8,518	8,946	10,006	12,028	48.7%	2.1%
Water Heating	26,318	26,250	26,211	26,245	27,033	30,666	16.5%	0.8%
Appliances	2,288	2,305	2,322	2,363	2,489	2,801	22.4%	1.1%
Miscellaneous	1,083	1,099	1,115	1,146	1,225	1,373	26.8%	1.3%
Total	**131,264**	**132,686**	**134,142**	**136,500**	**143,497**	**158,861**	**21.0%**	**1.0%**

Figure 4-2 Residential Baseline Projection by End Use



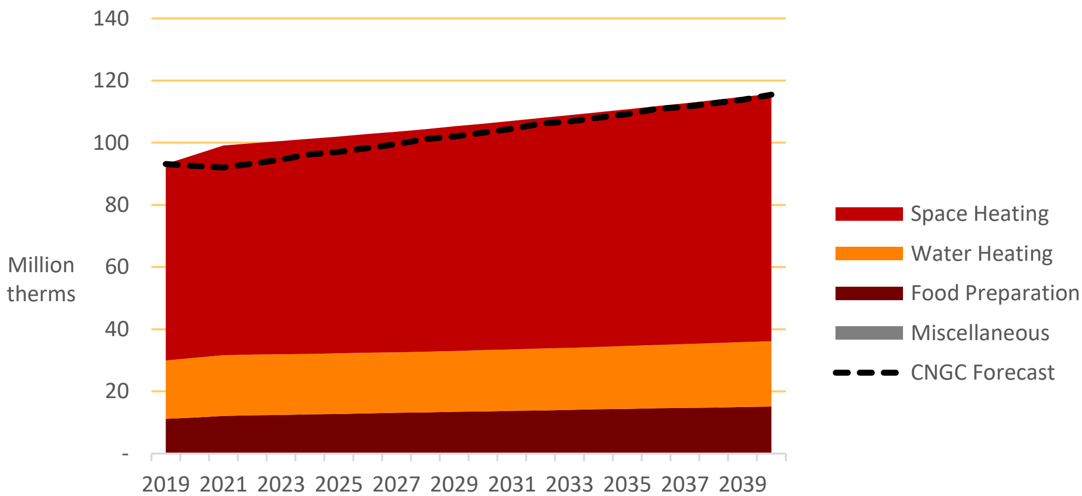
Commercial Sector Baseline Projection

Annual natural gas use in the commercial sector grows 16.7% during the overall forecast horizon, starting at 93,122 thousand therms in 2019, and increasing to 115,760 thousand therms in 2040. Table 4-3 and Figure 4-3 present the baseline projection at the end-use level for the commercial sector, as a whole. Similar to the residential sector, market size is increasing and usage per square foot is decreasing slightly.

Table 4-3 Commercial Baseline Projection by End Use (thousand therms)

End Use	2021	2022	2023	2025	2030	2040	% Change ('19-'40)	Avg. Growth Rate
Heating	67,471	68,047	68,617	69,776	72,859	79,548	17.9%	0.9%
Water Heating	19,581	19,547	19,516	19,484	19,680	21,078	7.6%	0.4%
Food Preparation	11,981	12,148	12,312	12,639	13,448	14,978	25.0%	1.2%
Miscellaneous	125	126	128	131	140	156	25.0%	1.2%
Total	**99,158**	**99,869**	**100,573**	**102,030**	**106,127**	**115,760**	**16.7%**	**0.8%**

Figure 4-3 Commercial Baseline Projection by End Use



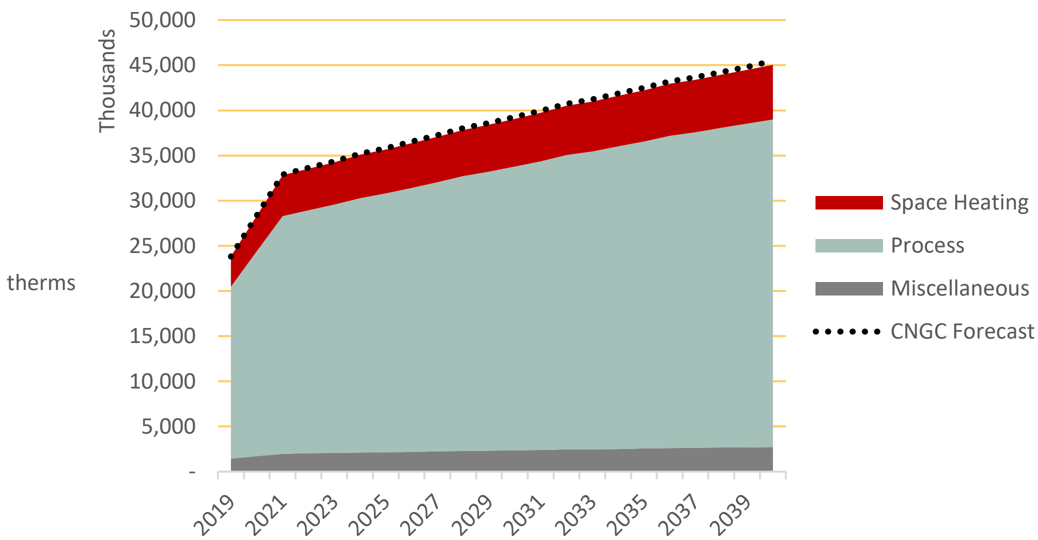
Industrial Sector Baseline Projection

Industrial sector usage increases throughout the planning horizon. Table 4-4 and Figure 4-4 present the projection at the end-use level. Overall, industrial annual natural gas use increases from 23,814 thousand therms in 2019 to 45,042 thousand therms in 2040. Growth in most end uses is consistent at around 1.7% per year but impacts of naturally occurring efficiency lowers consumption slightly in the space heating end use.

Table 4-4 Industrial Baseline Projection by End Use (thousand therms)

End Use	2021	2022	2023	2025	2030	2040	% Change ('19-'40)	Avg. Growth
Heating	4,514	4,599	4,686	4,860	5,282	6,039	33.8%	1.5%
Process	26,331	26,908	27,490	28,658	31,436	36,277	37.8%	1.7%
Miscellaneous	1,979	2,022	2,066	2,154	2,363	2,726	37.8%	1.7%
Total	**32,823**	**33,530**	**34,242**	**35,672**	**39,080**	**45,042**	**37.2%**	**1.7%**

Figure 4-4 Industrial Baseline Projection by End Use



5

OVERALL ENERGY EFFICIENCY 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 and measure assumption summary, which were provided to Cascade at the conclusion of the study. Note that all savings are provided at the customer site. This section includes potential from the residential, commercial, and industrial analyses.

Summary of Overall Energy Efficiency Potential

Table 5-1 and Figure 5-1 summarize the energy conservation savings in terms of annual energy use for all measures for four levels of potential relative to the baseline projection. Figure 5-2 displays the energy conservation forecasts. Savings are represented in cumulative terms, reflecting the effects of persistent savings in prior years in addition to new savings. This allows for the reporting of annual savings impacts as they actually impact each year of the forecast.

- Technical Potential reflects the adoption of all conservation measures regardless of cost-effectiveness. In this potential case, efficient equipment makes up all lost opportunity installations and all retrofit measures are installed, regardless of achievability. 2021 first-year savings are 4,801 thousand therms, or 1.8% of the baseline projection. Cumulative savings in 2030 are 51,264 thousand therms, or 17.8% of the baseline. By 2040, cumulative savings reach 86,762 thousand therms, or 27.1% of the baseline. Technical potential is useful as a theoretical construct, applying an upper bound to the potential that may be realized in any one year. Other levels of potential are based off this level which makes it an important component in the estimation of potential.
- 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 2021-2040 CPA, ramp rates from the 2021 Power Plan were customized for use in natural gas programs and applied in a manner similar to the 2017 CPA.[10] Since the 2021 Plan does not explicitly assign ramp rates for the majority of natural gas measures, we assigned these based on similar electric technologies present in the 2021 Plan as a starting point. These ramp rates are provided in Appendix E. 2021 first-year net savings are 2,170 thousand therms, or 0.8% of the baseline projection. Cumulative net savings in 2030 are 35,416 thousand therms, or 12.3% of the baseline. By 2040 cumulative savings reach 67,266 thousand therms, or 21.0% of the baseline.
- UCT 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 utility cost test (UCT), which compares lifetime energy benefits to the total utility costs of delivering the measure through a utility program, excluding monetized non-energy impacts. Avoided costs of energy were provided by Cascade. A 10% conservation credit was applied to these costs per Council methodologies. Additional details can be found in Appendix A. 2021 first-year savings are 1,049 thousand therms, or 0.4% of the baseline projection. Cumulative savings in 2030 are 22,482 thousand

[10] Note that the 2017 CPA use ramp rates from the Seventh Power Plan, but the methodology is the same

therms, or 7.8% of the baseline. By 2040 cumulative savings reach 44,864 thousand therms, or 14.0% of the baseline.

- TRC 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 benefits to the total customer and utility costs of delivering the measure through a utility program, including monetized non-energy impacts. AEG also applied benefits for non-gas energy savings, such as electric HVAC savings for weatherization and lighting savings for retrocommissioning. We also applied the Council's calibration credit to space heating savings to reflect the fact that additional fuels may be used as a supplemental heat source within an average home and may be accounted for within the TRC. Avoided costs of energy were provided by Cascade. A 10% conservation credit was applied to these costs per the Council methodologies. 2021 first-year savings are 622 thousand therms, or 0.2% of the baseline projection. Cumulative net savings in 2030 are 13,514 thousand therms, or 4.7% of the baseline. By 2040 cumulative savings reach 26,069 thousand therms, or 8.2% of the baseline. Potential under the TRC test is lower than UCT due to the inclusion of full measure costs rather than the utility portion. For most measures, these far outweigh the quantified and monetized non-energy impacts included in the TRC.

Table 5-1 Summary of Energy Efficiency Potential (thousand therms)

Scenario	2021	2022	2023	2025	2030	2040
Baseline Projection (thousand therms)	263,245	266,084	268,957	274,202	288,705	319,662
Cumulative Savings (thousand therms)						
TRC Achievable Economic Potential	622	1,175	1,818	4,263	13,514	26,069
UCT Achievable Economic Potential	1,049	2,065	3,258	6,958	22,482	44,864
Achievable Technical Potential	2,170	4,293	6,621	12,800	35,416	67,266
Technical Potential	4,801	8,927	13,168	21,928	51,264	86,762
Cumulative Savings (% of Baseline)						
TRC Achievable Economic Potential	0.2%	0.4%	0.7%	1.6%	4.7%	8.2%
UCT Achievable Economic Potential	0.4%	0.8%	1.2%	2.5%	7.8%	14.0%
Achievable Technical Potential	0.8%	1.6%	2.5%	4.7%	12.3%	21.0%
Technical Potential	1.8%	3.4%	4.9%	8.0%	17.8%	27.1%

Figure 5-1 Summary of Energy Efficiency Potential as % of Baseline Projection (thousand therms)

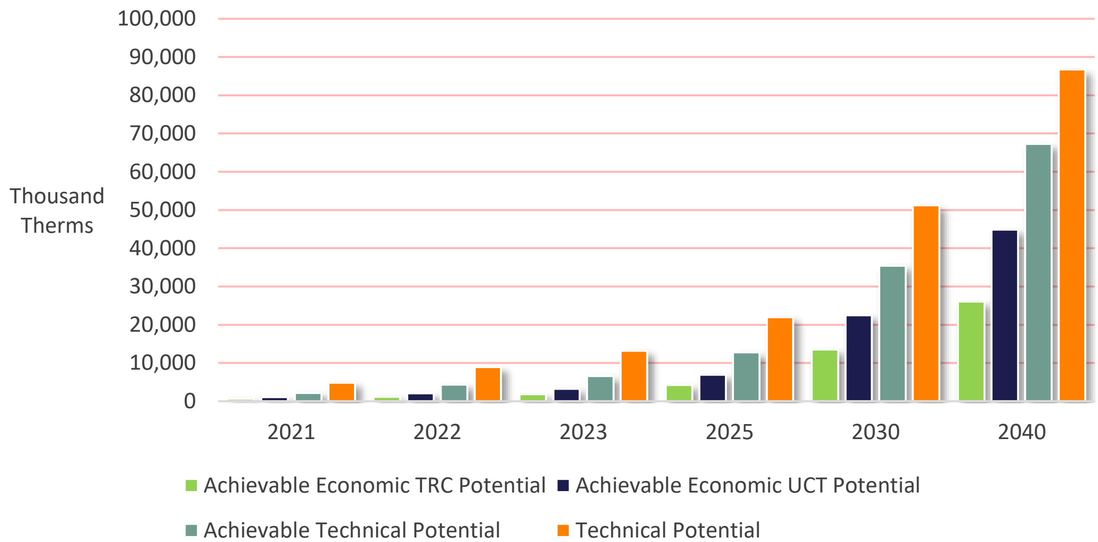
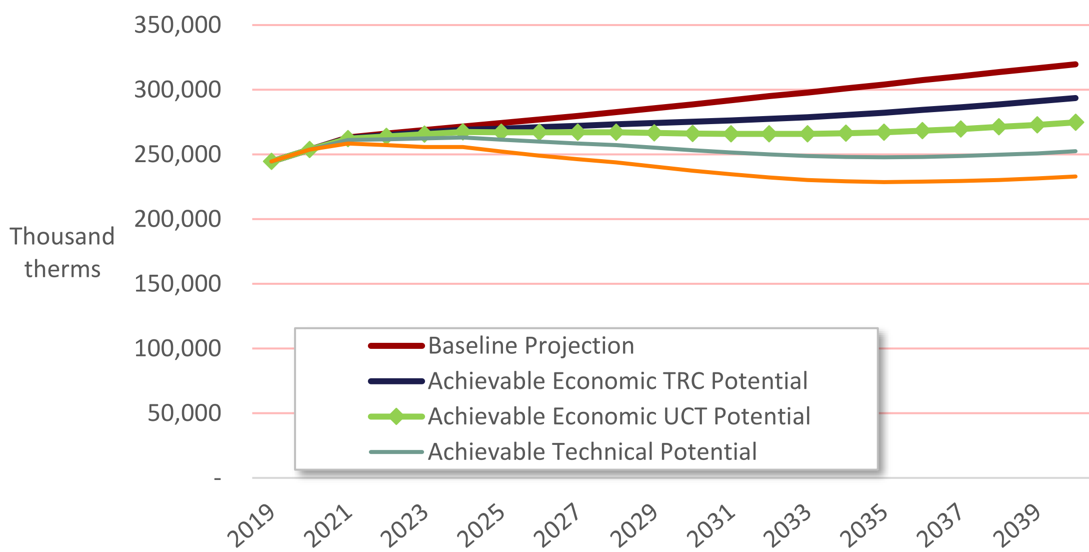


Figure 5-2 Baseline Projection and Energy Efficiency Forecasts (thousand therms)



Summary of Overall UCT Achievable Economic Potential

Figure 5-3 shows the cumulative UCT achievable potential by sector for the full timeframe of the analysis as a percent of total savings. Table 5-2 summarizes UCT achievable potential by market sector for selected years.

While the precise distribution of savings among sectors shifts slightly over the course of the study, in general residential and commercial potential are well balanced. Since industrial consumption is such a low percentage of the baseline once large customers have been excluded, potential for this sector makes up a lower percentage of the total. While residential and commercial potential ramps up, industrial potential is mainly retrofit in nature, and is much flatter. This is because process equipment is highly custom and most potential comes from controls modifications or process adjustments rather than high-efficiency equipment upgrades. Additionally, we model retrocommissioning to phase in evenly over the next twenty years. This measure has a maintenance component, and not all existing facilities may be old enough to require the tune-up immediately but will be eligible at some point over the course of the study.

There is a notable downtick in residential savings around 2024. This is due to the impacts of the residential forced-air furnace standard, which raises the baseline from AFUE 80% to AFUE 92%, which is a substantial increase when the efficient option is an AFUE 95% unit.

Figure 5-3 Cumulative UCT Achievable Economic Potential by Sector (% of Total)

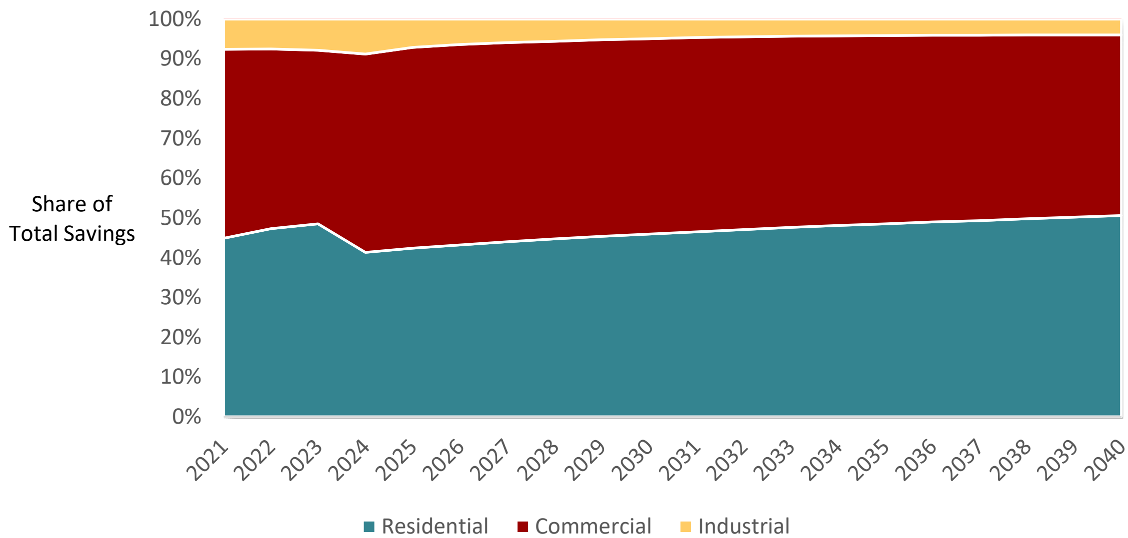


Table 5-2 Cumulative UCT Achievable Economic Potential by Sector, Selected Years (thousand therms)

Sector	2021	2022	2023	2025	2030	2040
Residential	471	974	1,579	2,844	10,067	22,120
Commercial	499	931	1,420	3,388	10,784	19,851
Industrial	80	155	254	480	1,075	1,734
Total	**1,050**	**2,060**	**3,253**	**6,712**	**21,926**	**43,705**

6

SECTOR-LEVEL ENERGY EFFICIENCY POTENTIAL

The previous section provided a summary of potential for Cascade's Washington territory as a whole. This section provides details for each sector.

Residential Sector Potential

Table 6-1 and Figure 6-1 summarize the energy efficiency potential for the residential sector. In 2021, UCT achievable economic potential is 470 thousand therms, or 0.4% of the baseline projection. By 2030, cumulative savings are 10,623 thousand therms, or 7.4% of the baseline.

Table 6-1 Residential Energy Conservation Potential Summary (thousand therms)

Scenario	2021	2022	2023	2025	2030	2040
Baseline Forecast (thousand therms)	131,264	132,686	134,142	136,500	143,497	158,861
Cumulative Savings (thousand therms)						
UCT Achievable Economic Potential	470	979	1,584	3,091	10,623	23,279
TRC Achievable Economic Potential	119	240	370	802	2,499	5,757
Achievable Technical Potential	902	1,841	2,911	5,548	17,495	38,230
Technical Potential	2,167	4,205	6,293	9,700	24,647	46,685
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.4%	0.7%	1.2%	2.3%	7.4%	14.7%
TRC Achievable Economic Potential	0.1%	0.2%	0.3%	0.6%	1.7%	3.6%
Achievable Technical Potential	0.7%	1.4%	2.2%	4.1%	12.2%	24.1%
Technical Potential	1.7%	3.2%	4.7%	7.1%	17.2%	29.4%

Figure 6-1 Residential Energy Conservation by Case (thousand therms)

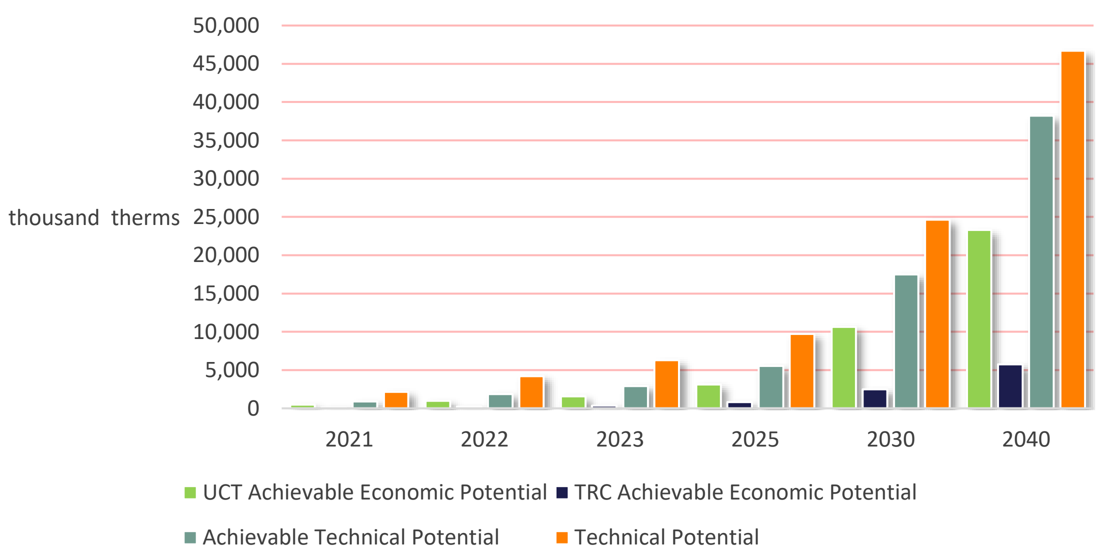
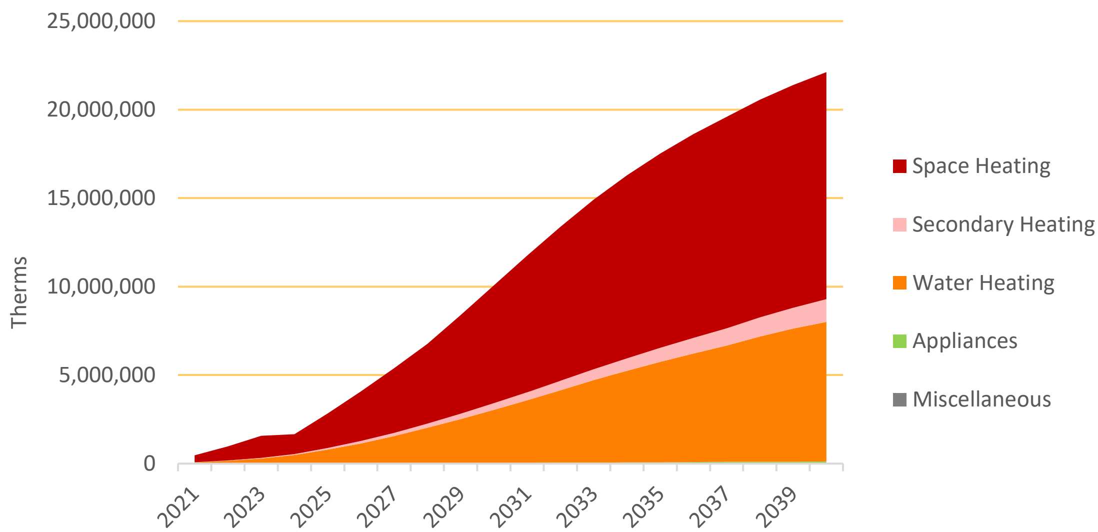


Figure 6-2 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Space heating makes up a majority of potential throughout the study.

Figure 6-2 Residential UCT Achievable Economic Potential – Cumulative Savings by End Use (therms, % of total)



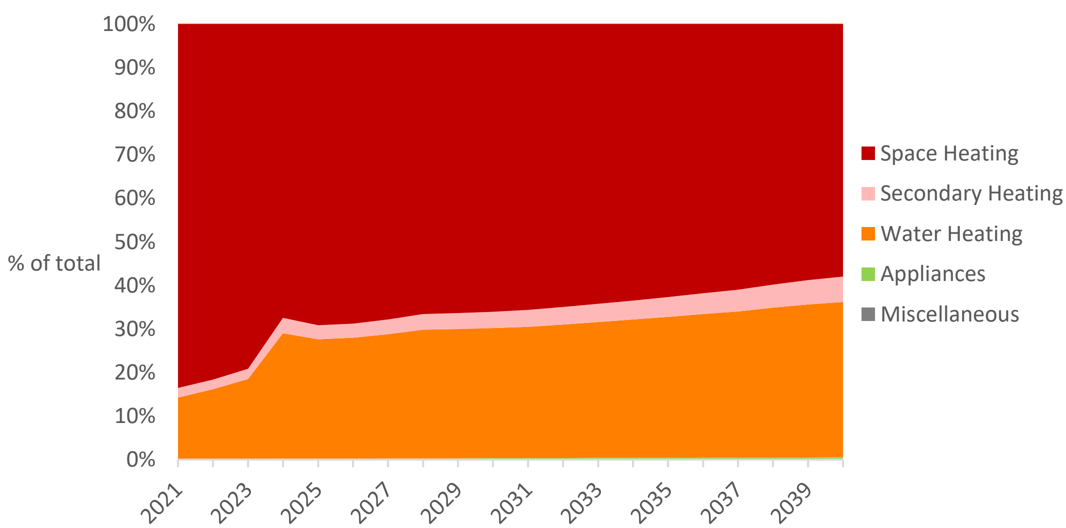


Table 6-2 identifies the top 20 residential measures by cumulative 2021 and 2022 savings. Furnaces, weatherization, Built Green homes, and tankless water heaters are the top measures.

Table 6-2 Residential Top Measures in 2021 and 2022, UCT Achievable Economic Potential (thousand therms)

Rank	Measure / Technology	2021 Cumulative Potential Savings (thousand therms)	% of Total	2022 Cumulative Potential Savings (thousand therms)	% of Total
1	Furnace - Direct Fuel - AFUE 92%	143	14.6%	298	30.5%
2	Insulation - Infiltration Control (Air Sealing) - 20% reduction in ACH50	83	8.5%	168	17.1%
3	Insulation - Ceiling, Installation - R-38 (Retro only)	75	7.6%	149	15.2%
4	Water Heater <= 55 gal. - Instantaneous - Condensing (UEF 0.91)	42	4.3%	103	10.5%
5	Doors - Storm and Thermal - R-5 door	37	3.8%	75	7.6%
6	ENERGY STAR Connected Thermostat - Interactive/learning thermostat (ie, NEST)	18	1.9%	36	3.7%
7	Built Green homes - Built Green spec (NC Only)	16	1.6%	34	3.5%
8	Fireplace - Tier 1 (70% FE Rating)	11	1.1%	23	2.4%
9	Water Heater > 55 gal. - Instantaneous - Condensing (UEF 0.91)	8	0.8%	18	1.9%
10	Ducting - Repair and Sealing - 50% reduction in duct leakage	7	0.7%	15	1.5%
11	Water Heater - Pipe Insulation - Insulated 5' of pipe between unit and conditioned space	5	0.5%	9	0.9%
12	Insulation - Basement Sidewall - R-15	4	0.4%	8	0.8%
13	Insulation - Ducting - duct thermal losses reduced 50%	4	0.4%	8	0.8%
14	Windows - U-.22 or better - Double Pane LowE CL22	3	0.3%	6	0.6%
15	Combined Boiler + DHW System (Storage Tank) - Combined tankless boiler unit for space and DHW	2	0.2%	6	0.6%
16	Combined Boiler + DHW System (Tankless) - Combined tankless boiler unit for space and DHW	2	0.2%	6	0.6%
17	Gas Boiler - Hot Water Reset - Reset control installed	3	0.3%	5	0.6%
18	Windows - U-.30 - Double Pane LowE U30	2	0.3%	5	0.5%
19	Thermostat - Programmable - Programmed thermostat	2	0.2%	4	0.4%
20	Boiler - Direct Fuel - AFUE 95%	1	0.1%	2	0.2%
Subtotal		**469**	**47.9%**	**977**	**99.8%**
Total Savings in Year		**470**	**48.0%**	**979**	**100%**

Commercial Sector Potential

Table 6-3 and Figure 6-3 summarize the energy conservation potential for the commercial sector. In 2021, UCT achievable economic potential is 499 thousand therms, or 0.5% of the baseline projection. By 2030, cumulative savings are 10,784 thousand therms, or 10.2% of the baseline.

Table 6-3 Commercial Energy Conservation Potential Summary

Scenario	2021	2022	2023	2025	2030	2040
Baseline Forecast (thousand therms)	99,158	99,869	100,573	102,030	106,127	115,760
Cumulative Savings (thousand therms)						
UCT Achievable Economic Potential	499	931	1,420	3,388	10,784	19,851
TRC Achievable Economic Potential	424	782	1,197	2,987	9,952	18,599
Achievable Technical Potential	1,183	2,285	3,439	6,747	16,801	27,233
Technical Potential	2,457	4,428	6,439	11,481	25,094	37,737
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.5%	0.9%	1.4%	3.3%	10.2%	17.1%
TRC Achievable Economic Potential	0.4%	0.8%	1.2%	2.9%	9.4%	16.1%
Achievable Technical Potential	1.2%	2.3%	3.4%	6.6%	15.8%	23.5%
Technical Potential	2.5%	4.4%	6.4%	11.3%	23.6%	32.6%

Figure 6-3 Commercial Energy Conservation by Case

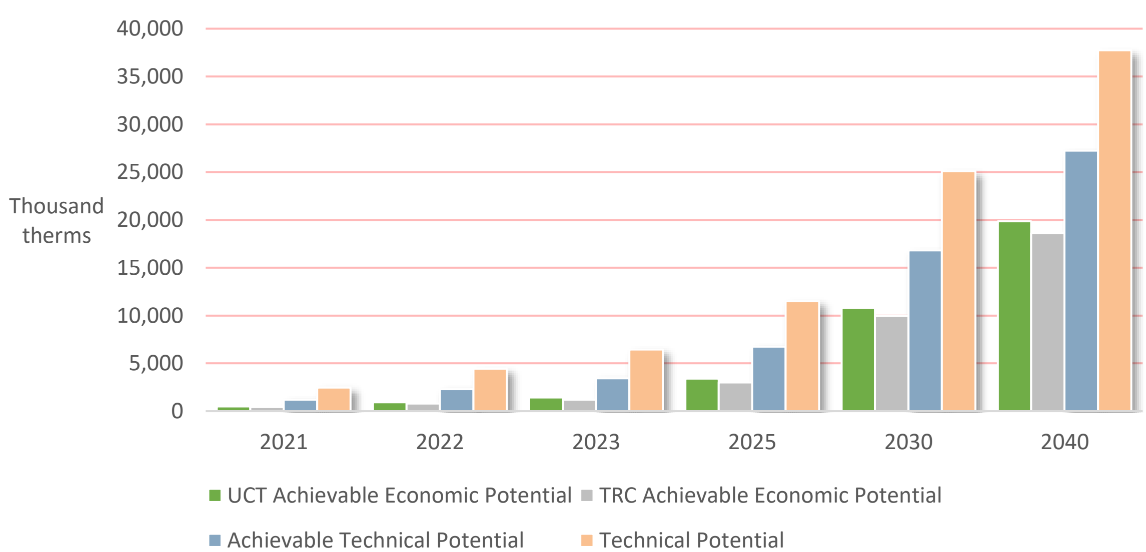
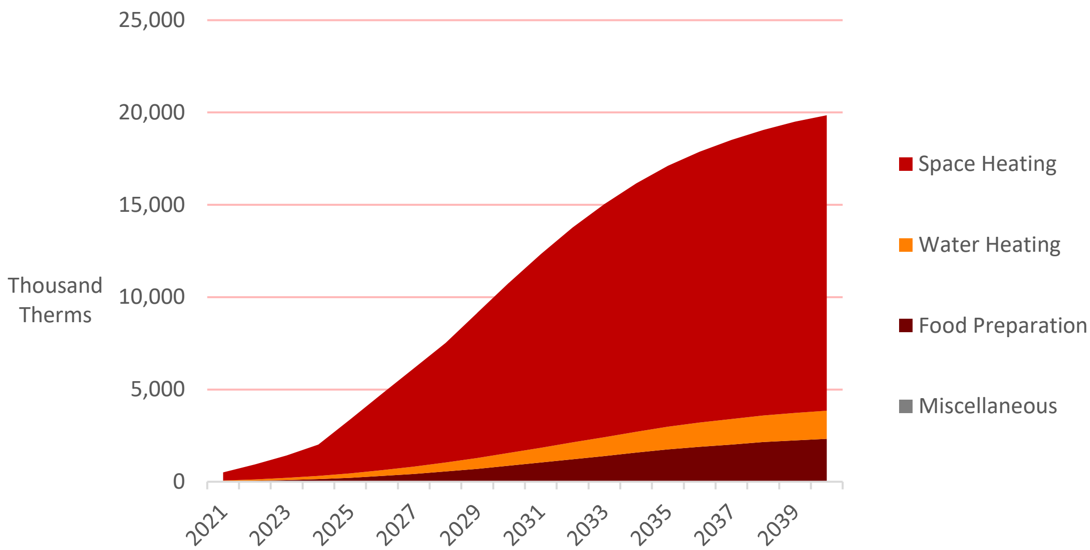


Figure 6-4 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Space heating makes up a majority of the potential early, but food preparation equipment upgrades provide substantial savings opportunities in the later years.

Figure 6-4 Commercial UCT Achievable Economic Potential – Cumulative Savings by End Use (therms, % of total)



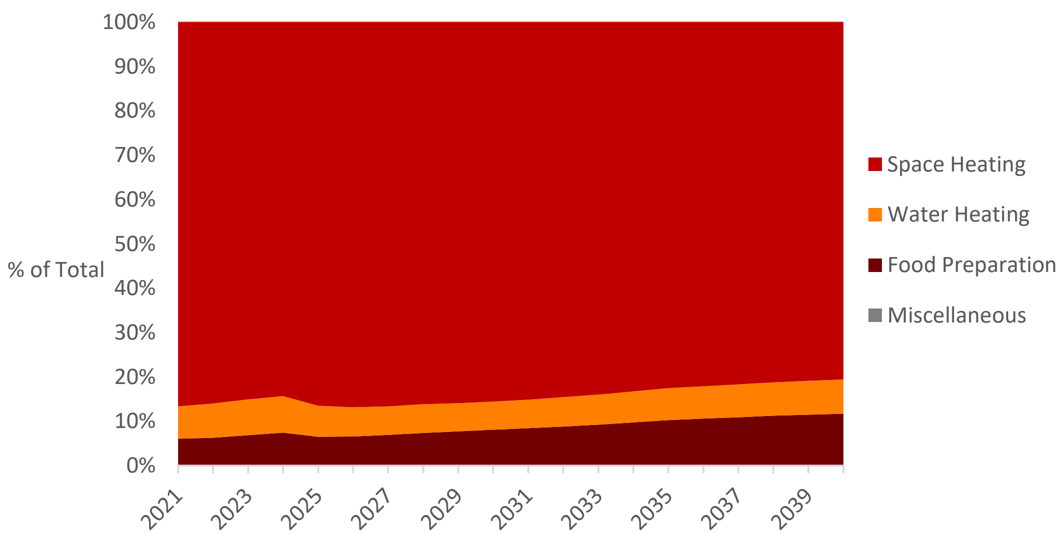


Table 6-4 identifies the top 20 commercial measures by cumulative savings in 2021 and 2022. Boilers are the top measure, followed by weatherization and food preparation. Retrocommissioning potential is present in the top measures but is a smaller contributor due to revised savings assumptions. RCx in the commercial sector is a restoration of HVAC systems to their original, or better, conditions.

Table 6-4 Commercial Top Measures in 2021 and 2022, UCT Achievable Economic Potential (thousand therms)

Rank	Measure / Technology	2021 Cumulative Potential Savings (thousand therms)	% of Total	2022 Cumulative Potential Savings (thousand therms)	% of Total
1	Boiler - AFUE 98%	152.8	16.4%	258.3	27.8%
2	Insulation - Roof/Ceiling - R-38	38.0	4.1%	74.9	8.1%
3	Gas Boiler - Insulate Steam Lines/Condensate Tank - Lines and condensate tank insulated	29.8	3.2%	58.7	6.3%
4	Gas Furnace - Maintenance - General cleaning and maintenance	26.2	2.8%	44.3	4.8%
5	Fryer - ENERGY STAR	21.8	2.3%	40.3	4.3%
6	Insulation - Wall Cavity - R-21	20.4	2.2%	40.1	4.3%
7	Water Heater - TE 0.94	20.1	2.2%	39.5	4.2%
8	Gas Boiler - Insulate Hot Water Lines - Insulated water lines	19.9	2.1%	39.2	4.2%
9	Gas Boiler - High Turndown - Turndown control installed	18.5	2.0%	36.4	3.9%
10	Gas Boiler - Hot Water Reset - Reset control installed	15.6	1.7%	30.7	3.3%
11	Gas Boiler - Stack Economizer - Economizer installed	11.8	1.3%	23.5	2.5%
12	Retrocommissioning - HVAC - Optimized HVAC flow and controls	11.9	1.3%	23.4	2.5%
13	Steam Trap Maintenance - Cleaning and maintenance	11.4	1.2%	22.7	2.4%
14	Kitchen Hood - DCV/MUA - DCV/HUA vent hood	10.9	1.2%	21.8	2.3%
15	ENERGY STAR Connected Thermostat - Wi-Fi/interactive thermostat installed	10.7	1.1%	21.4	2.3%
16	Strategic Energy Management - Energy management system installed and programmed	10.2	1.1%	20.5	2.2%
17	Gas Boiler - Maintenance - General cleaning and maintenance	9.5	1.0%	16.1	1.7%
18	Furnace - AFUE 90%	6.1	0.7%	12.4	1.3%
19	Space Heating - Heat Recovery Ventilator - HRV installed	6.3	0.7%	12.3	1.3%
20	Water Heater - Pre-Rinse Spray Valve - 2 GPM sprayer nozzle	5.3	0.6%	10.5	1.1%
Subtotal		**457.3**	**91.7%**	**847.0**	**91.0%**
Total Savings in Year		**498.9**	**100%**	**930.6**	**100%**

Industrial Sector Potential

Table 6-5 and Figure 6-5 summarize the energy conservation potential for the core industrial sector. In 2021, UCT achievable economic potential is 80 thousand therms, or 0.2% of the baseline projection. By 2030, cumulative savings reach 1,075 thousand therms, or 2.8% of the baseline. Industrial potential is a lower percentage of overall baseline compared to the residential and commercial sectors. While large, custom process optimization and controls measures are present in potential, these are not applicable to all applications which limits potential at the technical level. Additionally, since the largest customers were excluded from this analysis due to their status as transport-only customers making them ineligible to participate in energy efficiency programs for the utility, the remaining customers are smaller and tend to have lower process end-use shares, further lowering industrial potential. As seen in the figure below, industrial potential is substantially lower due to the smaller sector size and process uses.

Table 6-5 Industrial Energy Conservation Potential Summary (thousand therms)

Scenario	2021	2022	2023	2025	2030	2040
Baseline Forecast (thousand therms)	32,823	33,530	34,242	35,672	39,080	45,042
Cumulative Savings (thousand therms)						
UCT Achievable Economic Potential	80	155	254	480	1,075	1,734
TRC Achievable Economic Potential	78	153	251	474	1,064	1,713
Achievable Technical Potential	85	166	271	506	1,120	1,803
Technical Potential	178	294	436	747	1,523	2,340
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.2%	0.5%	0.7%	1.3%	2.8%	3.9%
TRC Achievable Economic Potential	0.2%	0.5%	0.7%	1.3%	2.7%	3.8%
Achievable Technical Potential	0.3%	0.5%	0.8%	1.4%	2.9%	4.0%
Technical Potential	0.5%	0.9%	1.3%	2.1%	3.9%	5.2%

Figure 6-5 Industrial Energy Conservation Potential (thousand therms)

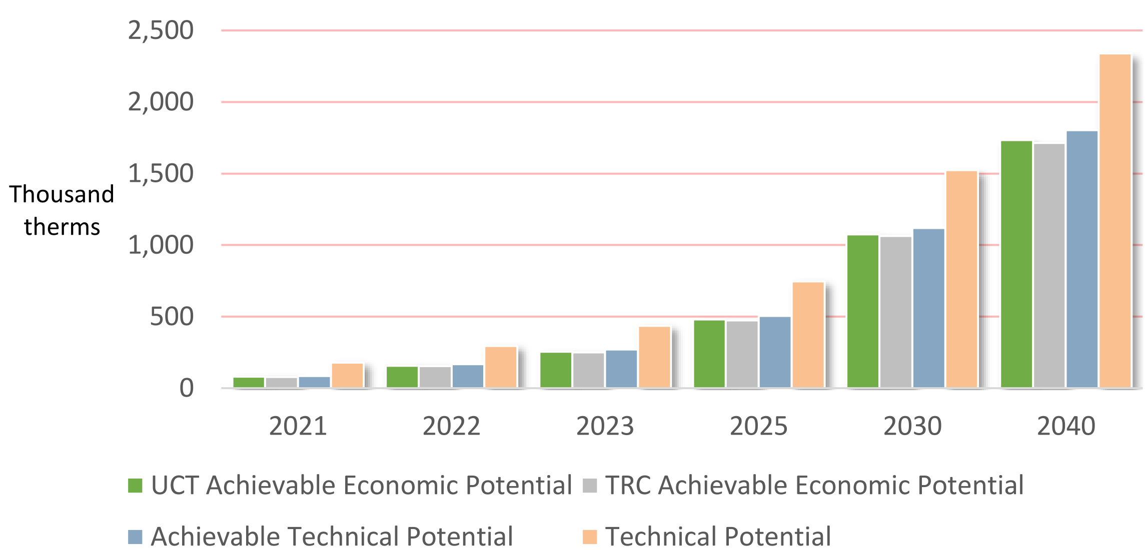
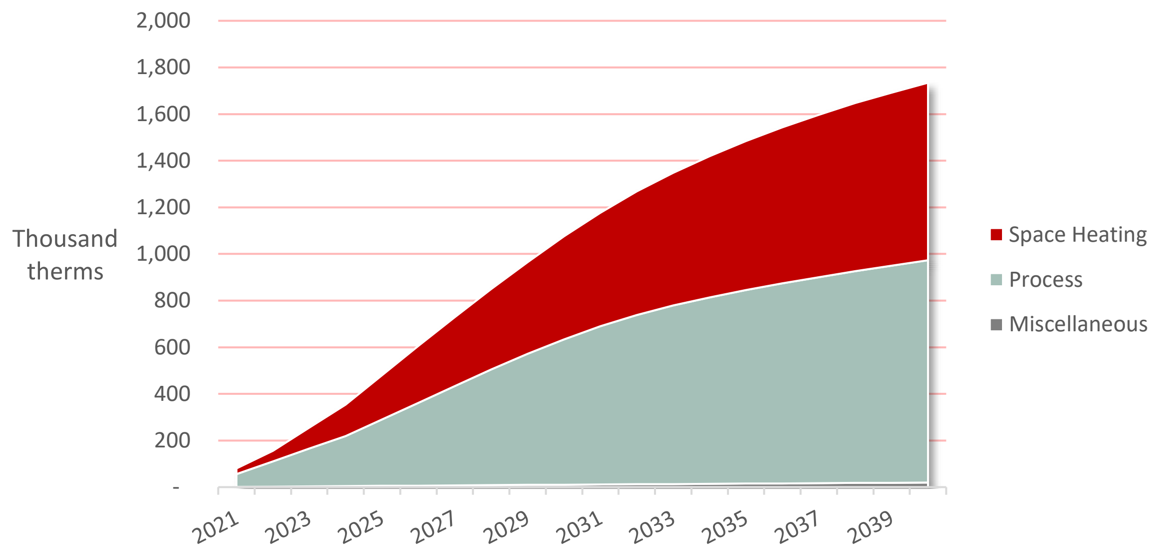


Figure 6-6 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings.

Figure 6-6 Industrial UCT Achievable Economic Potential – Cumulative Savings by End Use (thousand therms, % of total)



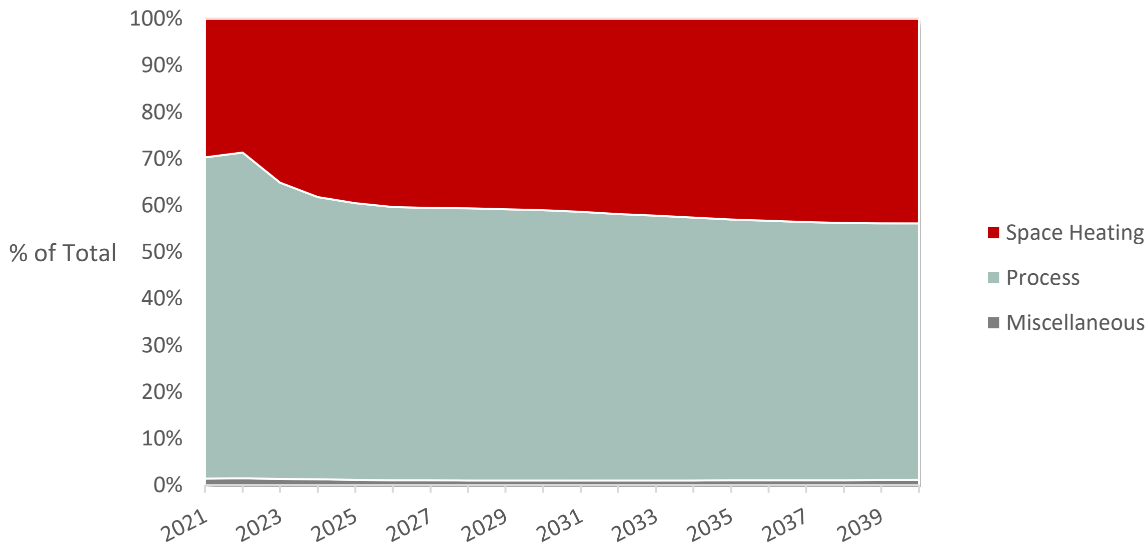


Table 6-6 identifies the top 20 industrial measures by cumulative 2021 and 2022 savings. Strategic energy management and retrocommissioning are top measures in the industrial sector. Strategic energy management of industrial process applications is the highest measure by total savings. For smaller industrial customers, this measure typically involves a cohort of between five to ten customers who form a working group facilitated by an energy management expert. One or more employees at each facility are designated an energy conservation "champion" who work to integrate efficient energy-consuming behavior into the company's culture. Many of these measures are more custom in nature, such as strategic energy management and retrocommissioning. This results in behavior-based and low-cost/no-cost measures but also results in larger custom projects. We estimate that this potential will be captured within these measures/delivery mechanisms.

Table 6-6 Industrial Top Measures in 2021 and 2022, UCT Achievable Economic Potential (thousand therms)

Rank	Measure / Technology	2021 Cumulative Potential Savings (thousand therms)	% of Total	2022 Cumulative Potential Savings (thousand therms)	% of Total
1	Strategic Energy Management - Energy management system installed and programmed	18.9	12.2%	37.3	24.1%
2	Retrocommissioning - Optimized HVAC flow and controls	16.1	10.3%	31.8	20.5%
3	Gas Boiler - Hot Water Reset - Reset control installed	9.2	5.9%	18.6	12.0%
4	Gas Boiler - Stack Economizer - Economizer installed	6.2	4.0%	12.5	8.1%
5	Gas Boiler - High Turndown - Turndown control installed	5.3	3.4%	10.6	6.8%
6	Insulation - Roof/Ceiling - R-38	3.9	2.5%	9.1	5.9%
7	Boiler - AFUE 98%	5.1	3.3%	7.1	4.6%
8	Insulation - Wall Cavity - R-21	3.0	1.9%	7.1	4.6%
9	Gas Boiler - Maintenance - General cleaning and maintenance	3.6	2.3%	6.2	4.0%
10	Unit Heater - Infrared Radiant	2.8	1.8%	3.8	2.5%
11	Steam Trap Maintenance - Cleaning and maintenance	1.6	1.0%	3.2	2.1%
12	Gas Boiler - Insulate Steam Lines/Condensate Tank - Lines and condenstate tank insulated	1.5	1.0%	3.1	2.0%
13	Gas Boiler - Insulate Hot Water Lines - Insulated water lines	1.0	0.7%	2.0	1.3%
14	Gas Boiler - Burner Control Optimization - Optimized burner controls	0.4	0.3%	0.8	0.5%
15	Building Automation System - Automation system installed and programmed	0.4	0.3%	0.8	0.5%
16	Furnace - AFUE 95%	0.4	0.2%	0.5	0.4%
17	Windows - High Efficiency - U-.22 or better	0.2	0.1%	0.4	0.2%
18	HVAC - Demand Controlled Ventilation - DCV enabled	0.1	0.1%	0.2	0.2%
Subtotal		**79.6**	**100%**	**155.2**	**100%**
Total Savings in Year		**79.6**	**100%**	**155.2**	**100%**

7

COMPARISON WITH CURRENT PROGRAMS AND RAMP RATE ADJUSTMENTS

One of the goals of this study is to inform targets for future programs, including the current calendar-year, 2020. As such, AEG conducted an in-depth comparison of the CPA's 2018 UCT Achievable Economic Potential with Cascade's 2019 accomplishments at the sector-level. This involved assigning each measure within the CPA to an existing Cascade program or a new "Other" bundle to be considered. Compared to 2019 accomplishments, AEG estimates higher future cost effective potential in all sectors relative to Cascade's 2019 program achievement. We will describe these in more detail below.

Residential Comparison with 2019 Programs

Table 7-1 summarizes Cascade's 2019 residential accomplishments and the 2021 UCT Achievable Economic potential estimates from LoadMAP. The LoadMAP estimate of 470 thousand therms is higher than Cascade's 2019 accomplishments at 376 thousand therms.

Table 7-1 Comparison of Cascade's 2019 Residential Accomplishments with 2021-2023 UCT Achievable Economic Potential (therms)

Measure Category	CNGC 2019 Achievement	LoadMAP UCT Incremental Savings (thousand therms)		
		2021	2022	2023
Furnace	170,680	143,352	154,417	169,721
Weatherization	83,726	216,180	218,140	233,605
Water Heaters	37,196	49,961	71,075	107,368
Thermostats	23,084	20,124	20,326	32,266
Built Green / ESTAR Homes	26,843	16,225	18,539	27,096
Combined Boiler + DHW	20,283	4,870	6,272	8,070
Fireplace	10,030	10,864	12,508	17,307
Showerheads and Aerators	3,836	0	0	0
Boiler	767	649	937	1,400
Other Measures	292	7,947	8,244	11,387
Total	**376,737**	**470,173**	**510,458**	**608,221**

The main reason that potential is higher is a large increase in modeled weatherization potential due to improved cost-effectiveness. Additional notes on differences for specific measures/program are below:

- Savings for furnaces use a market baseline, which assumes some customers purchase equipment above the minimum federal standard in the absence of efficiency programs. This results in approximately 20% of customers purchasing an AFUE 90% and 5% purchasing an AFUE 92% in the baseline, which reduces the average unit energy consumption upon which savings for furnaces are based, Despite this difference in the UES, modeled potential is within range of Cascade's accomplishments, representing a robust and mature program.
- Potential for Built Green and ENERGY STAR Homes is still ramping up but larger than in the 2017 CPA. However, changes to Washington building code that will take effect in 2021+ will likely reduce this potential. This change will be assessed and reflected in Phase 2.

- Weatherization measures are a retrofit measure and WSEC 2015 does not apply. We have found that Cascade's weatherization programs, especially in Climate Zone 3, are ramping up. As such, we are modeling higher potential for these measures in 2021 forward. The latest avoided costs, including the social cost of carbon, have made weatherization measures significantly more cost-effective, passing in some segments they were not in the 2017 CPA.
- Showerheads and Faucet aerators are an expected removal following Washington's HB-1444 requirements. Energy reduction from these applications is now part of code and not captured as measure potential.
- Combination unit potential is lower due to a difference in assumed unit energy savings. Once AEG characterized Cascade's market, we recalculated potential for this measure using the revised baseline, where consumption for boilers was lower than previously estimated. This reduces the savings substantially.

Commercial and Industrial Comparison with 2019 Programs

Table 7-2 summarizes Cascade's 2019 commercial and industrial accomplishments and the 2021-2023 UCT Achievable Economic potential estimates from LoadMAP. The LoadMAP estimate of 578 thousand therms is substantially higher than Cascade's 2019 accomplishments at 384 thousand therms, largely due to newly cost-effective LoadMAP measures not currently in Cascade's program activity that would likely be part of custom potential in the future.

Table 7-2 Comparison of Cascade's 2019 Commercial and Industrial Accomplishments with 2018 UCT Achievable Economic Potential (thousand therms)

C&I Measure Category	CNGC 2019 Achievement	LoadMAP UCT Savings (thousand therms) 2021	2022	2023
Boiler	80,438	157,942	107,492	117,162
Custom Boiler	115,580	-	-	-
Furnace	5,543	6,434	6,510	9,826
Unit and Radiant Heaters	3,139	7,112	5,169	8,918
Water Heaters	14,181	20,098	19,403	25,902
Food Equipment	29,453	29,979	27,652	37,630
Insulation	53,361	65,294	66,411	119,509
Faucets and Showerheads	38,401	5,263	5,296	5,327
Other and custom savings	44,080	286,360	271,708	270,016
Total	**384,176**	**578,483**	**509,641**	**594,290**

The following are key drivers in commercial potential:

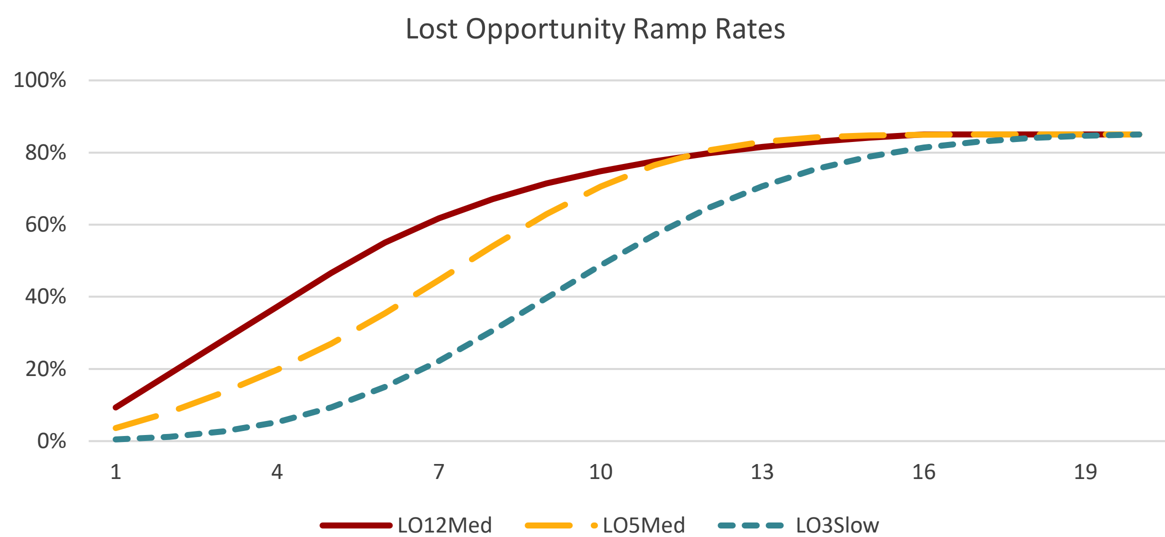
- In addition to new measures within the "Custom" bundle such as retrocommissioning and strategic energy management, we estimate that some measures may realize additional potential in 2021. These, along with additional custom opportunities, make up the majority of additional potential.
    - A substantial subset of this Custom potential (146 thousand therms in 2021) is in maintenance and retrofit measures for boiler and steam systems.
- HVAC equipment shows promising levels of potential. Efficient boiler and furnace installations are two of the top ten measures, even after reducing the applicable furnace market to exclude difficult-to-reach rooftop unit furnaces, which make up about 40-50% of the installed technology.

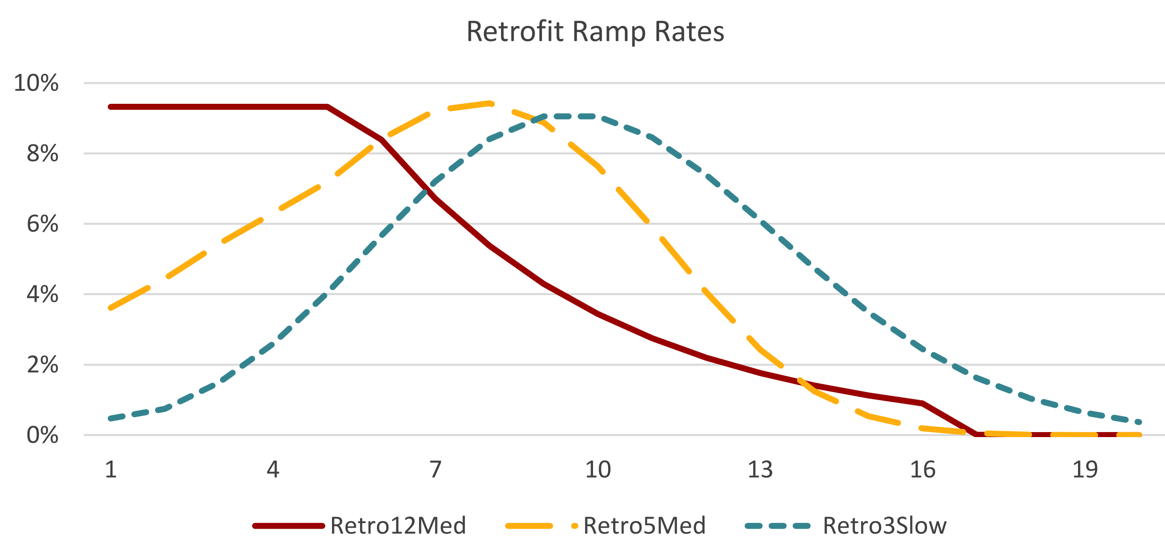
- Fryer and convection oven potential is substantial due to the high gas consumption of restaurants and Cascade's current success with this program.

Application of Electricity Ramp Rates to Natural Gas Measures

A key driver in estimation of potential are participation rates, also known as ramp rates. These identify the percentage of an applicable population that will adopt an efficiency measure as part of a utility energy efficiency program or other non-utility mechanism within the territory. For CPAs in the Northwest, and particularly the state of Washington, the 2021 Power Plan's electric ramp rates are a key source of information. While very thorough and straightforward to use, these were developed with electric utilities and electric programs in mind. This implies that they may not be appropriate to apply directly to natural gas energy efficiency programs or measures.

Figure 7-1 Example Power Council Ramp Rates





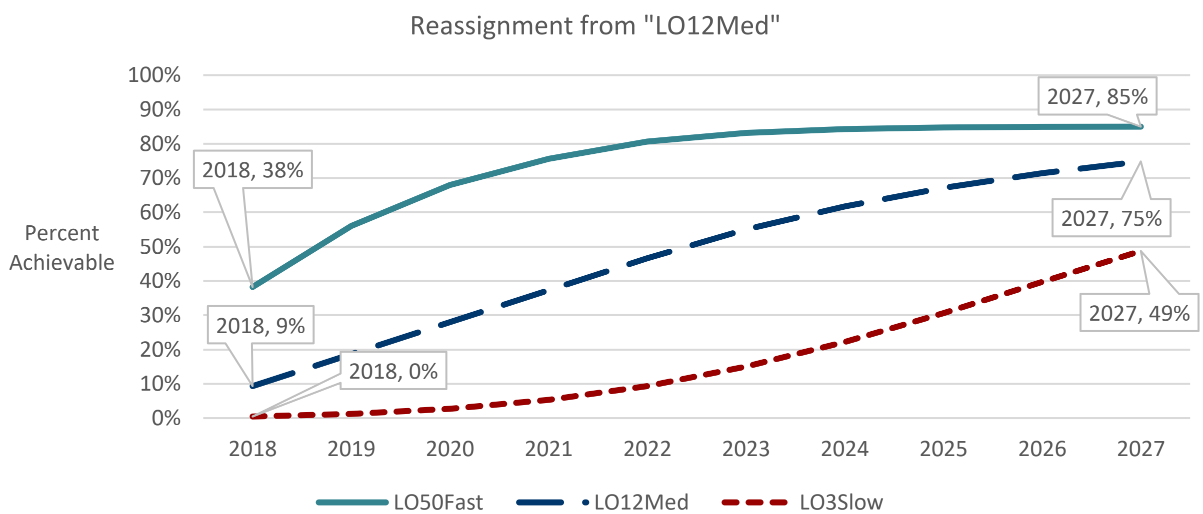
Beginning with the 2017 CPA, AEG adjusted the Power Council's ramp rates from the Seventh Power Plan using three of the four approaches illustrated below. Although ramp rates themselves have been updated to 2021 Power Plan guidance, the same adjustments made in 2017 continue to be appropriate for Cascade's territory.

Reassign an Individual Measure Ramp Rate

Each electric measure within the Seventh Plan was prescribed a ramp rate as part of the analysis. AEG began by mapping those to similar gas measures (e.g. using similar HVAC equipment or low-flow showerhead ramp rates) when estimating potential. In some cases, we found that these did not align with what we expected for natural gas programs or Cascade's accomplishments. For example, commercial boilers were originally on the "LO20Fast" ramp rate, which is a lost opportunity (turnover) ramp rate that starts at about 20% of applicable participants and approaches 85% quickly. When comparing with Cascade's current programs, AEG observed that Cascade was realizing higher potential, indicating that this is a more mature program. As a result, we reassigned this to the "LO50Fast" ramp rate, which begins around 50% and ramps up quickly as well.

We also investigated lowering a few ramp rates. The most notable is in residential weatherization. When discussing current Cascade programs with the team, we noticed that potential has been challenging to achieve in recent years. In this case, we remapped weatherization to a slower ramp rate, which begins at a lower percentage but increases year-over-year as the program gains traction. Figure 7-2 summarizes the process of reassigning "LO12Med" to both a faster and slower rate.

Figure 7-2 Example of Ramp Rate Reassignment

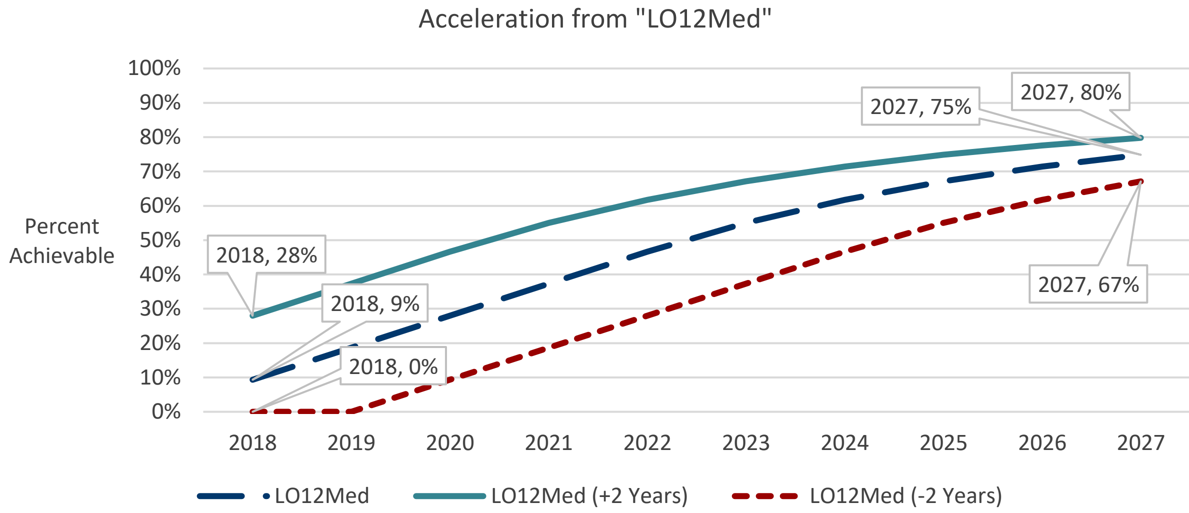


Accelerate or Decelerate an Existing Ramp Rate

While reassignment of rates was used to make changes to the achievability, AEG also configured the model to shift ramp rates forward or backward to start in a year other than the first. This allows us to state that a measure or program may be more mature than the rate originally implies but allows us to keep it on the same trajectory. We may employ this method when we observe a measure to be conserving more in practice than LoadMAP originally estimates, but not by enough to warrant complete reassignment.

Another use of this approach is to delay potential for specific measures by beginning the ramp rate in year 2 or beyond, which could simulate a delay between the identification of potential in the study and the time it takes to recruit contractors and organize a brand-new program that has no working momentum. Figure 7-3 illustrates the process of accelerating and decelerating the "LO12Med" ramp rate by two years.

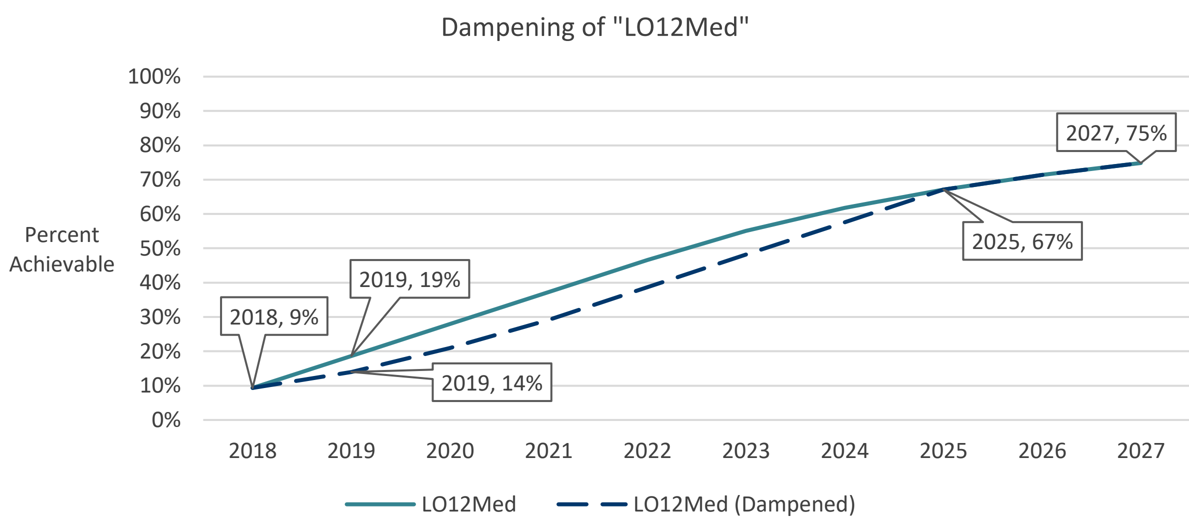
Figure 7-3 Example of Ramp Rate Acceleration/Deceleration



Dampen Early-Year Measure Ramping Effects

Many of the Council's ramp rates are designed to increase achievability rapidly over time. This can result in two-to-three times the incremental potential for a measure compared to the previous year. In our experience, this is not always a possibility as programs require time to mature and gain traction. As such, we applied an early-year adjustment to ramp rates within LoadMAP. To do this, we reduced the acceleration in years two and three by 50%, then accelerated in years four through eight to catch up with the unmodified ramp rate. We did this such that the Council's 85% long-term achievability target would still be met while reflecting the realities in working to increase program participation. Note that this does not affect many of the more mature "Retrofit" ramp rates since they achieve a constant percentage in each of the early years. Figure 7-4 illustrates the impact of this dampening and re-acceleration on the "LO12Med" ramp rate.

Figure 7-4 Example of Ramp Rate Dampening



Design a New Ramp Rate

The final approach which AEG developed for adjusting ramp rates is to design an entirely new rate. While we prefer to use prescribed rates consistent with the Council, there are measures and programs which may not be suitable for any existing rate. While completing Cascade's CPA, AEG did not apply this approach, however it is documented here for potential future use.

We recommend using this approach sparingly, and to reflect specific programs or measures where participation is dramatically different from a typical approach. In other CPAs, we have used this approach most frequently when assessing potential for home energy reports. Within this measure, the utility contracts with a third party to communicate energy-efficient behaviors directly to customers, using their bills as a reference. The difference between this measure and others is that it does not require the customer to participate. Participation is rather determined by the utility in coordination with their report vendor. Typical program participation may take the form of a small pilot (small achievability percentage in year-1) and a full-scale program in years 2 and 3 (high achievability percentage). This measure may also apply to more or less than the 85% maximum achievability based on the number of customers reserved in a control group for future evaluation efforts.

In the example above, none of the Council's electricity ramp rates accelerate over the course of two-to-three years to maximum achievability, which removes them as applicable options, necessitating development of this "Custom" ramp rate. The actual percentages in each year will be documentable based on the utility's deployment plan. AEG's LoadMAP model is configured to quickly incorporate additional ramp rates as necessary, which can be assigned to each individual measure permutation within the study.

8

CPA NEXT STEPS

This 2020 update to the CPA is the first phase of a two-part project, which updated the base year and market characterization, brought Cascade's models to the newest version of LoadMAP, and reviewed modeled potential against Cascade's program achievement to re-evaluate the appropriateness of the adoption ramp rates as assigned in the 2017 CPA, including a review of modeled incentives. A comprehensive list of updates during phase one is provided below.

Phase 1 Update Summary

- Updated sector and segment energy control totals using 2019 billing data from CNGC
- Revised saturations (presence of equipment) based on updated billing data
- Updated residential annual equipment consumption data based on most recent DOE data
- Updated Commercial end use intensities to align with CBSA 2019
- Reviewed and updated incentives for measures currently active in CNGC programs
- Updated measure achievability ramp rates to improve model alignment with achieved program results
- Updated avoided costs to be consistent with most current IRP and include social cost of carbon adder
- Updated model engine files to the most current AEG versions

Phase 2 Goals

A second phase of the CPA project will begin in 2021 and focus on potential for the 2022-2023 biennium period. Updates anticipated in that phase include:

- Calibration of the natural gas baseline projections to 2020 actual sales
- Comprehensive updates to measure characterizations, including new and emerging measures if data is available.
- Updating non-energy impacts and values
- Estimating RVT Economic Achievable Potential

Low Income Customers

As a separate task order added to Phase 2, Cascade has asked AEG to conduct a thorough analysis of available data to characterize low income customers separately in the residential model for Washington, as well as research into understanding energy burdens in different communities and the success of programs in reaching communities where they are needed.

The final CPA including the updates from both phases is intended to be filed with the commission at completion by June 15, 2021 in accordance with HB-1257 requirements.

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