AEG

AVISTA NATURAL GAS CONSERVATION POTENTIAL ASSESSMENT FOR 2023-2045

Prepared For: Avista Corporation
By: Applied Energy Group, Inc.
Date: December 21, 2022
AEG Key Contact: Eli Morris

This work was performed by

Applied Energy Group, Inc. (AEG)
2300 Clayton Road, Suite 1370
Concord, CA 94520

Project Director: E. Morris

Project Manager: A. Hudson

Project Team:

K. Marrin
K. Walter
F. Nguyen
T. Williams
K. Billeci
S. Chen
L. Khan
C. Struthers

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 | INTRODUCTION

In October 2021, Avista Corporation (Avista) engaged Applied Energy Group (AEG) to conduct a Conservation Potential Assessment (CPA) for its Washington and Idaho service areas. AEG first performed an electric CPA for Avista in 2013; since then, AEG has performed both electric and natural gas CPAs for Avista's planning cycles. This study represents the first assessment of the potential for natural gas demand response resources within Avista's service area, including Oregon. The CPA is a 20-year study of electric and natural gas conservation potential, performed in accordance with Washington Initiative 937 and associated Washington Administrative Code provisions. This study provides data on conservation resources to support the development of Avista's 2023 Integrated Resource Plan (IRP). For reporting purposes, the potential results are separated by fuel. This report documents the natural gas CPA.

Notable updates from prior CPAs include:

- The analysis base year was brought forward from 2019 to 2021.
- For the residential sector, the study still incorporates Avista's GenPOP residential saturation survey from 2012, which provides a more localized look at Avista's customers than regional surveys. The survey provided the foundation for the base year market characterization and energy market profiles. The Northwest Energy Efficiency Alliance's (NEEA's) 2016 Residential Building Stock Assessment II (RBSA) supplemented the GenPOP survey to account for trends in the intervening years.
- The residential segmentation was expanded to include household counts and energy characteristics of low-income customers by dwelling type.
- For the commercial sector, the analysis was performed for the major building types in the service territory. Results from NEEA's 2019 Commercial Building Stock Assessment (CBSA), including hospital and university data, provided useful information for this analysis.
- The list of energy conservation measures was updated with research from the Regional Technical Forum (RTF).
- Measure characterizations, which previously relied on data from the Northwest Power and Conservation Council's (NWPCC or Council) Seventh Power Plan, is now updated to the 2021 Power Plan, including measure data, adoption rates, and updated measure applicability.
- The study incorporates updated forecasting assumptions that align with the most recent Avista load forecast.

Summary of Report Contents

Volume 1, Final Report

The report is divided into seven chapters. Chapters 2 through 6 describe the analysis approach taken and the data sources used to develop the energy efficiency potential estimates and Chapter 7 discusses the demand response analysis.

- Chapter 2 – Energy Efficiency Analysis Approach and Data Development. A detailed description of AEG's approach to estimating the energy efficiency potential and documentation of data sources used.
- Chapter 3 – Energy Efficiency Market Characterization presents how Avista's customers use natural gas today and what equipment is currently being used.
- Chapter 4 – Energy Efficiency Baseline Projection presents the baseline end-use projections developed for each sector and state as well as a summary.
- Chapter 5 – Conservation Potential. Energy efficiency potential results for each state across all sectors and separately for each sector.

- **Chapter 6 - Sector-Level Energy Efficiency Potential.** Summary of energy efficiency potential for each market sector within Avista's service territory for both Washington and Idaho. This chapter includes a detailed breakdown of potential by measure type, vintage, market segment, end use, and state.
- **Chapter 7 – Demand Response Potential.** Demand response potential results for each state across all sectors and separately for each sector.

Volume 2, Appendices

The appendices for this report are provided in separate spreadsheets accompanying the delivery of this report and consist of the following:

- **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 electrical power conservation supply curve workbooks for the estimation of achievable natural gas potential.
- **Measure List.** List of measures, along with example baseline definitions and efficiency options by market sector analyzed.
- **Detailed Measure Assumptions.** This dataset provides input assumptions, measure characteristics, cost-effectiveness results, and potential estimates for each measure permutation analyzed within the study.

Abbreviations and Acronyms

Table 1-1 shows the abbreviations and acronyms used in this report, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	U.S. Census American Community Study
AEG	Applied Energy Group
AEO	EIA's Annual Energy Outlook
BEST	AEG's Building Energy Simulation Tool
C&I	Commercial and Industrial
CBSA	NEEA's Commercial Building Stock Assessment
COMMEND	EPRI's Commercial End-Use Planning System
CPA	Conservation Potential Assessment
DEEM	AEG's Database of Energy Efficiency Measures
DEER	California Database for Energy Efficient Resources
DR	Demand Response
DSM	Demand Side Management
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
EUI	Energy Use Index
HDD	Heating Degree Day
HVAC	Heating Ventilation and Air Conditioning
IFSA	NEEA's Industrial Facilities Site Assessment
IRP	Integrated Resource Plan
LoadMAP	AEG's Load Management Analysis and Planning™ tool
NEEA	Northwest Energy Efficiency Alliance
NWPCC	Northwest Power and Conservation Council
O&M	Operations and Maintenance
RBSA	NEEA's Residential Building Stock Assessment
REEPS	EPRI's Residential End-Use Energy Planning System
RTF	NWPCC's Regional Technical Forum
TRC	Total Resource Cost test
TRM	Technical Reference Manual
UCT	Utility Cost Test
UEC	Unit Energy Consumption
WSEC	2015 Washington State Energy Code

2 | ENERGY EFFICIENCY ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the analysis approach and the data sources used to develop the energy efficiency potential estimates. The demand response analysis discussion can be found in Chapter 6.

Overview of Analysis Approach

AEG used a bottom-up approach to perform the potential analysis. The major steps are listed below and detailed detail throughout this section.

1. Perform a market characterization to describe sector-level natural gas use for the residential, commercial, and industrial sectors for the base year, 2021. The market characterization included extensive use of Avista data and other secondary data sources from NEEA and the Energy Information Administration (EIA).
2. Develop a baseline projection of energy consumption by sector, segment, end use, and technology for 2023 through 2045.
3. Define and characterize several hundred energy efficiency measures to be applied to all sectors, segments, and end uses.
4. Estimate technical, achievable technical, and achievable economic energy savings at the measure level for 2023 through 2045. Achievable economic potential was assessed using the Utility Cost Test (UCT) test for Avista's Idaho territory and the Total Resource Cost (TRC) test for Avista's Washington territory.

Comparison with NWPCC Methodology

It is important to note that electricity is the primary focus of the regionwide potential assessed in the NWPCC's Plans. 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). Although Avista is a dual-fuel utility, this study focuses on natural gas measures and programs, which exhibit noticeable differences from electric programs, notably regarding avoided costs. To account for this, AEG sometimes adapted NWPCC methodologies rather than using them directly from the source. This adaptation is especially relevant in the development of ramp rates when achievability was determined not to be applicable to a specific natural gas measure or program.

A primary objective of the study was to estimate natural gas potential consistent with the NWPCC's analytical methodologies and procedures for electric utilities. While developing Avista's 2023- 2045 CPA, AEG relied on an approach vetted and adapted through the successful completion of CPAs referencing the NWPCC's Fifth, Sixth, Seventh, and now 2021 Power Plans. Among other aspects, this approach involves using consistent:

- Data sources: Avista surveys, regional surveys, market research, and assumptions
- Measures and assumptions: Avista TRM, 2021 Power Plan supply curves and RTF work products
- Potential factors: 2021 Power Plan ramp rates
- Levels of potential: technical, achievable technical, and achievable economic
- Cost-effectiveness approaches: assessed potential under the UCT for Idaho and TRC for Washington, including non-energy impacts (and non-gas energy impacts), which may be quantified and monetized, as well as operations and maintenance (O&M) impacts within the TRC.
- Conservation credit: applied NWPCC 10% conservation credit to avoided energy costs in Washington for energy benefits. This is incorporated into the TRC calculation.

LoadMAP Model

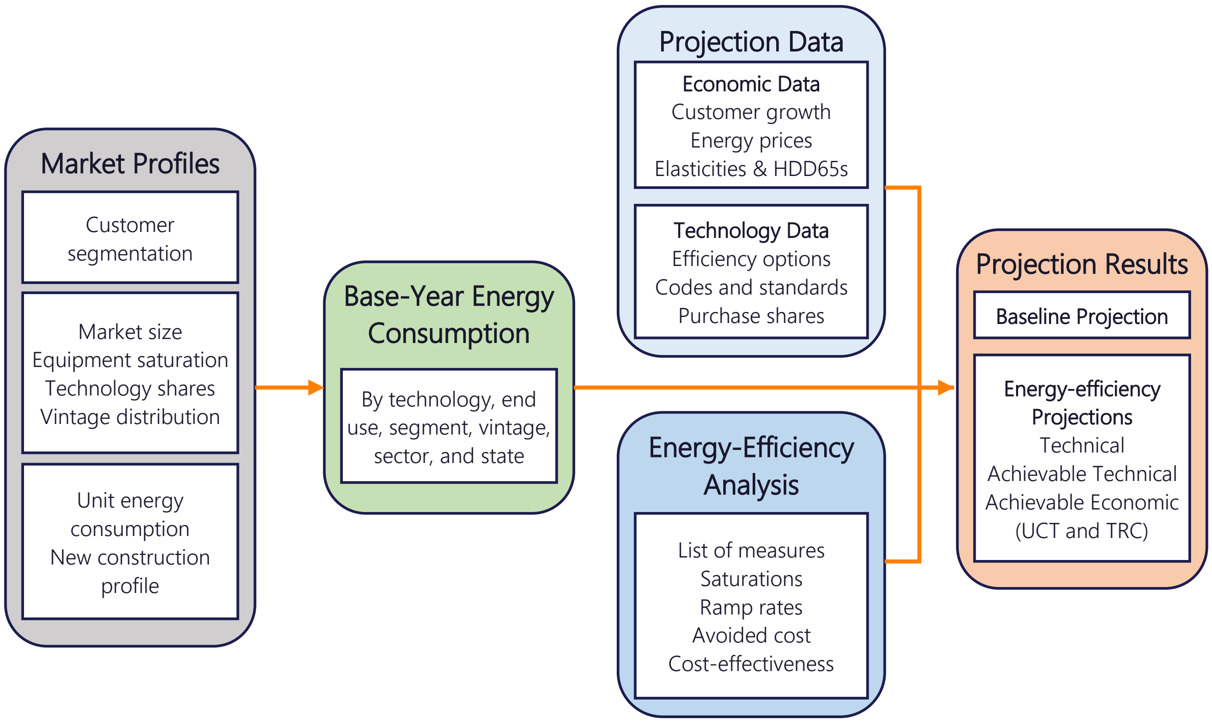
AEG used its Load Management Analysis and Planning tool (LoadMAP™) version 5.0 to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for the Electric Power Research Institute (EPRI) National Potential Study and numerous utility-specific forecasting and potential studies since. Built in Excel, the LoadMAP framework (see Figure 2-1) is 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 more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately. This is especially relevant in the state of Washington where the 2015 Washington State Energy Code (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. 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, state, 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 market profiles described below, LoadMAP provides projections of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It provides forecasts of total energy use and energy efficiency savings associated with the various types of potential.[1]

[1] 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).

Figure 2-1 LoadMAP Analysis Framework



Definitions of Potential

AEG's approach for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy Efficiency's Guide for Conducting Potential Studies[2] and is consistent with the methodology used by the Northwest Power and Conservation Council to develop its regional power plans. The guide represents the most credible and comprehensive industry practice for specifying conservation potential. Four types of potential were developed as part of this effort:

- Technical Potential is the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible efficient 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 choose the efficient equipment option relative to applicable codes and standards. Non-equipment measures, which may be realistically installed apart from equipment replacements, are implemented according to ramp rates informed by the NWPCC 2021 Power Plan, applied to 100% of the applicable market. This case is provided primarily for planning and informational purposes.
- Achievable Technical Potential refines Technical Potential by applying market adoption rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that may affect market penetration of energy efficiency measures. AEG used achievability assumptions from the NWPCC's 2021 Power Plan, adjusted for Avista's recent program accomplishments, as the customer adoption rates for this study. For the achievable technical case, ramp rates are applied to between 85% - 100% of the applicable market, per NWPCC methodology. This achievability factor represents potential that all available mechanisms, including utility programs, updated codes and standards, and market transformation, can reasonably acquire. Thus, the market applicability assumptions utilized in this study include savings outside of utility programs.[3] The market adoption factors can be found in Appendix B.

---

[2] 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.

[3] Council's 7th Power Plan applicability assumptions reference an "Achievable Savings" report published August 1, 2007. http://www.nwcouncil.org/reports/2007/2007-13/

  - Note that the previous CPA used ramp rates from the NWPCC's Seventh Power Plan, which assumed a fixed 85% achievability for all measures. In the 2021 Power Plan, some measures have this limit increased.

- UCT Achievable Economic Potential further refines achievable technical potential by applying a cost-effectiveness screen. The UCT test 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. The costs are the incentive, as a percent of the incremental cost of the given measure, relative to the relevant baseline (e.g., the 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 (that is, if the UCT ratio is greater than 1.0), a given measure is included in the economic potential.
- TRC Achievable Economic Potential also refines achievable technical potential through cost-effectiveness analysis. The TRC test assesses cost-effectiveness from a combined utility and participant perspective. As such, this test includes the full cost of the measure and non-energy impacts realized by the customer (if quantifiable and monetized). AEG also assessed the impacts of non-gas savings following the NWPCC methodology. For the assessment, AEG used 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.

Market Characterization

To estimate the savings potential from energy efficient measures, it is necessary to understand how much energy is used today and what equipment is currently being used. The characterization begins with a segmentation of Avista's natural gas footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies. To complete this step, AEG relied on information from Avista, NEEA, and secondary sources, as necessary.

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses, and other dimensions) relevant to Avista's service territory. The segmentation scheme is presented in Table 2-1.

Table 2-1 Overview of Avista Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
0	State	Washington and Idaho
1	Sector	Residential, Commercial, Industrial
2	Segment	Residential: Single Family, Multifamily, and Mobile Home, by income group Commercial: Office, Restaurant, Retail, Grocery, School, College, Health, Lodging, Warehouse, Miscellaneous Industrial: Total
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, 2021. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. The market profiles provide the foundation for the development of the baseline projection and the potential estimates. A market profile includes the following elements:

- Market size represents the number of customers in the segment. For the residential sector, it is the number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is the 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:
    - Conditioned space accounts for the fraction of each building that is conditioned by the end use, applying 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 served by the end use. Examples are commercial refrigeration, food service, and domestic water heating and appliances.
    - The 100% saturation approach applies to end uses generally present in every building or home and are set to 100% in the base year.
- UEC (unit energy consumption) or EUI (energy use index) describes the amount of energy consumed in 2021 by a specific technology in buildings with the technology. UECs are expressed in therms/household for the residential sector and EUIs are expressed in therms/square foot for the commercial sector or therms/employee for the industrial sector.
- Annual Energy Intensity for the residential sector represents the average energy use for the technology across all homes in 2021 and is the product of the saturation. The commercial and industrial sectors represent the average use for the technology across all floor space or employees in 2021 and is the product of the saturation and EUI.
- Annual Usage is the annual energy use by an end-use technology in the segment. It is the product of the market size and intensity and is quantified in therms or dekatherms.

The market characterization and market profiles are presented in Chapter 3.

Baseline Projection

The next step was to develop the baseline projection of annual natural gas use for 2023 through 2045 by customer segment and end use in the absence of new utility energy efficiency programs. The baseline projection is the foundation for the analysis of savings in future conservation cases as well as the metric against which potential savings are measured. The end-use projection includes the impacts of future codes and standards that were effective as of May 2022.

Naturally occurring efficiency is energy conservation that is realized within the service area independent of utility-sponsored programs. It was incorporated into the baseline projection consistent with the EIA's Annual Energy Outlook (AEO) for the Pacific region.

Inputs to the baseline projection include:

- Avista's official forecast (Heating Degree Days base 65°F (HDD65)), calibrated to actual sales
- Current economic growth forecasts (i.e., customer growth, changes in weather (HDD65 normalization))
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards

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

Washington HB 1444

Washington's HB 1444 established energy efficiency standards around equipment that exceed federal standards. These energy efficiency measures include but are not limited to showerheads, aerators, commercial food service equipment, and office equipment. This study's foundational setup included assumptions of HB-1444's impact on the available market for energy efficiency measures in Washington.

Conservation Measure Analysis

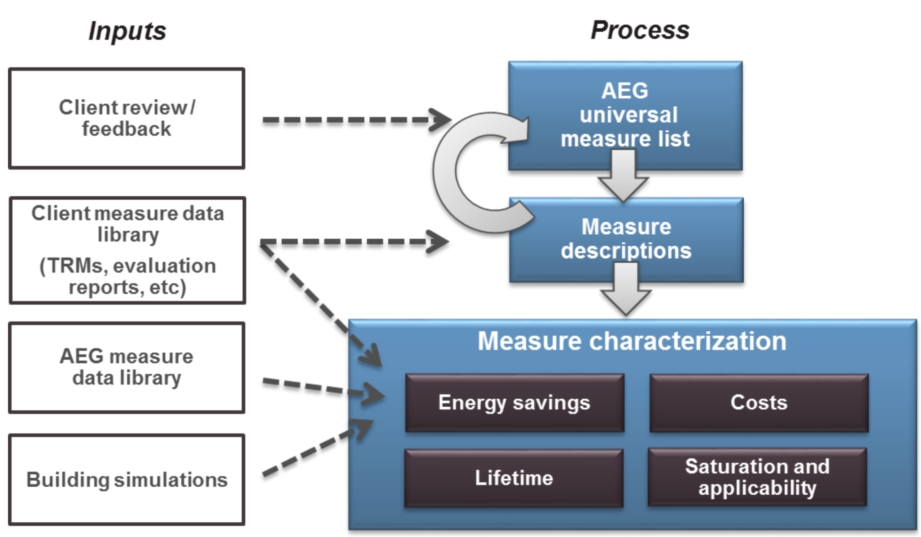
This section describes the framework used to assess conservation measures' savings, costs, and other attributes. These characteristics form the basis for measure-level cost-effectiveness analyses and determining measure-level savings. For all measures, AEG assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information combined with Avista's avoided cost data to inform the economic screens that determine economically feasible measures.

Conservation Measures

Figure 2-2 outlines the framework for conservation measure analysis. The framework involves identifying the list of measures to include in the analysis, determining their applicability to each sector and segment, and fully characterizing each measure. Finally, cost-effectiveness screening is performed. Avista provided feedback during each step to ensure measure assumptions and results lined up with programmatic experience.

AEG compiled a robust list of conservation measures for each customer sector, drawing upon Avista's Technical Reference Manual (TRM) and program experience, the RTF's Unit Energy Savings measure workbooks, and the 2021 Power Plan's electric power conservation supply curves, as well as a variety of secondary sources. This universal list of measures covers all major types of end use equipment, as well as devices and actions to reduce energy consumption.

Figure 2-2 Approach for Measure Development



The selected measures are categorized into the following two types according to the LoadMAP taxonomy:

- 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 are generally referred to as lost opportunity measures by the NWPCC because once a purchase decision is made, there will not be another opportunity to improve the efficiency of the equipment until its effective useful life is reached.

- 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). An example would be low-flow showerheads that modify a household's hot water consumption. The showerhead can be replaced without waiting for the existing showerhead to malfunction, and saves energy used by the water heating equipment. 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 (ENERGY STAR homes)
    - Retrocommissioning and strategic energy management

We developed a preliminary list of efficient measures, which was distributed to Avista's project team for review. Once the measure list was finalized, AEG characterized measure savings, incremental cost, service life, non-energy impacts, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential scenarios. Table 2-2 summarizes the number of measures evaluated within each sector.

Table 2-2 Number of Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ All Segments & States
Residential	61	122	1,464
Commercial	64	128	2,560
Industrial	34	68	136
Total Measures Evaluated	**159**	**318**	**4,160**

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied. Data sources included Avista, Northwest, and well-vetted national or other regional secondary sources. In general, data were adapted to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Avista Data

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

- *Customer Data:* Avista provided billing data for development of customer counts and energy use for each sector. We also used the results of the Avista GenPOP survey, a residential saturation survey.
- *Load Forecasts:* Avista provided forecasts, by sector and state, of energy consumption, customer counts, weather actuals for 2020 and 2021, as well as weather-normal HDD65.
- *Economic Information:* Avista provided a discount rate as well as avoided cost forecasts consistent with those utilized in the IRP.
- *Program Data:* Avista provided information about past and current programs, including program descriptions, goals, and achievements to date.
- *Avista TRM:* Avista provided energy conservation measure assumptions within current programs. We utilized this as a primary source of measure information, supplemented secondary data.

Northwest Energy Efficiency Alliance Data

The NEEA conducts research for the Northwest region. The NEEA surveys were used extensively to develop base saturation and applicability assumptions for many of the non-equipment measures within the study.

The following studies were particularly useful:

- Residential Building Stock Assessment II, Single-Family Homes Report 2016-2017.
- Residential Building Stock Assessment II, Manufactured Homes Report 2016-2017.
- Residential Building Stock Assessment II, Multifamily Buildings Report 2016-2017.
- 2019 Commercial Building Stock Assessment, May 21, 2020.
- 2014 Industrial Facilities Site Assessment, December 29, 2014.

Northwest Power and Conservation Council Data

Several sources of data were used to characterize the conservation measures. We used the following regional data sources and supplemented with AEG's data sources to fill in any gaps.

- RTF Deemed Measures. The NWPCC RTF maintains databases of deemed measure savings data.
- NWPCC 2021 Power Plan and Regional Technical Forum Workbooks. To develop its Power Plan, the NWPCC maintains workbooks with detailed information about measures.
- NWPCC, MC and Loadshape File, September 29, 2016. The Council's load shape library was utilized to convert CPA results into hourly conservation impacts for use in Avista's IRP process.

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: AEG maintains regional profiles of end-use consumption. The profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The EIA 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 HVAC-related measures.
- AEG's Database of Energy Efficiency Measures (DEEM): AEG maintains an extensive database of measure data, drawing upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data.
- Recent studies: AEG has conducted numerous studies of energy efficiency potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies 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 include:

- AEO: Conducted each year by the U.S. EIA, the AEO presents yearly projections and analysis of energy topics. For this study, we used data from the 2021 AEO.
- American Community Survey (ACS). The U.S. Census ACS is an ongoing survey that provides data every year on household characteristics.

- Local Weather Data: Weather from National Oceanic and Atmospheric Administration's National Climatic Data Center for Spokane, WA and Coure d'Alene in Idaho were used as the basis for building simulations.
- EPRI End-Use Models (REEPS and COMMEND): These models provide the elasticities we apply to prices, household income, home size and heating and cooling.
- DEER: The California Energy Commission and California Public Utilities Commission sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life for the state of California.
- Other relevant regional sources: These include reports from the Consortium for Energy Efficiency, the Environmental Protection Agency, and the American Council for an Energy-Efficient Economy. This also includes technical reference manuals from other states. When using data from outside the region, especially weather-sensitive data, AEG adapted assumptions for use within Avista's territory.

Data Application

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 Avista's billing data as well as secondary data from AEG's Energy Market Profiles database.

- Residential Segments. Avista estimated the numbers of customers and average energy use per customer for each of the three segments, based on its GenPOP survey matched to billing data for surveyed customers. AEG compared the resulting segmentation with data from the ACS regarding housing types and income and found that the Avista segmentation corresponded well with the ACS data.
- C&I Segments. We relied upon the allocation from the previous energy efficiency potential study. For the previous study, customers and sales were allocated to building type based on SIC codes, with some adjustments between the C&I sectors to better group energy use by facility type and predominate end uses.

Data Application for Market Profiles

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

1. Developed control totals for each segment. These include market size, segment-level annual natural gas use, and annual intensity. Control totals were based on Avista's actual sales and customer-level information found in Avista's customer billing database.
2. Developed existing appliance saturations and the energy characteristics of appliances, equipment, and buildings using equipment flags within Avista's billing data; NEEA's RBSA, CBSA, and IFSA; U.S. EIA's surveys and AEO; AEG's Energy Market Profile for the Pacific region; and the American Community Survey.
3. Ensured calibration to control totals for annual natural gas sales in each sector and segment.
4. Compare and cross-checked with other recent AEG studies.
5. Worked with Avista staff to vet the data against their knowledge and experience.

Table 2-3 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, and industrial employment	Avista 2020-2021 actual sales Avista customer account database
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee	Avista customer account database AEG's Energy Market Profiles NEEA RBSA and CBSA AEO 2021 Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Avista GenPOP Survey RBSA, CBSA, and IFSA ACS 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 Avista Engineering analysis AEG DEEM AEO 2021 Recent AEG studies
Appliance/equipment age distribution	Age distribution for each technology	RBSA, CBSA, and recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Avista current program offerings AEG DEEM AEO 2021 DEER RTF and NWPCC 2021 Plan data Recent AEG studies

Data Application for Baseline Projection

Table 2-4 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 2-4 Data Needs for the Baseline Projection and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential, commercial, and industrial sectors	Avista load forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipment data from AEO and ENERGY STAR AEO 2021 regional forecast assumptions[4] Appliance/efficiency standards analysis Avista program results and evaluation reports
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models

In addition, we implemented assumptions for known future equipment standards as of May 2022, 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.

[4] We developed baseline purchase decisions using the EIA's *AEO* report (2016), which utilizes the National Energy Modeling System 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 2-5 Residential Natural Gas Equipment Standards[5]

End-Use	Technology	2021	2022	2023	2024	2025
Space Heating	Furnace – Direct Fuel	AFUE 80%			AFUE 90%	
	Boiler – Direct Fuel	AFUE 80%				
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				

Table 2-6 Commercial and Industrial Natural Gas Equipment Standards

End-Use	Technology	2021	2022	2023	2024	2025
Space Heating	Furnace	AFUE 80% / TE 0.80			TE 0.90	
	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				
Food Preparation	Fryer	N/A	ENERGY STAR 3.0			
	Steamer	N/A	ENERGY STAR 1.2			
Miscellaneous	Pool Heater	TE 0.82				

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

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 Avista analysis.

Table 2-7 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	Avista TRM NWPCC workbooks, RTF AEG BEST AEG DEEM AEO 2021 DEER Other secondary sources
Costs	Equipment Measures: 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 - costs may be either the full cost of the measure or, as appropriate, the incremental cost of upgrading from a standard level to a higher efficiency level.	Avista TRM NWPCC workbooks, RTF AEG DEEM AEO 2021 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.	Avista TRM NWPCC workbooks, RTF AEG DEEM AEO 2021 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.	RBSA, CBSA WSEC for limitations on new construction AEG DEEM DEER Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the technology is available or no longer available in the market.	AEG appliance standards and building codes analysis

Data Application for Cost-effectiveness Screening

All cost and benefit values were analyzed as real dollars, converted from nominal provided by Avista. We applied Avista's long-term discount rate of 5.21% excluding inflation. LoadMAP is configured to vary this by market sector (e.g., residential and commercial) if Avista develops alternative values in the future.

Estimates of Customer Adoption

Two parameters are needed to estimate the timing and rate of customer adoption in the potential forecasts.

- 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 NWPCC's retrofit ramp rates, labeled "Retro".
- Adoption rates. Customer adoption rates or take rates are applied to technical potential to estimate Technical Achievable Potential. For equipment measures, the NWPCC's "Lost Opportunity" ramp rates were applied to technical potential with a maximum achievability of 85%-100% depending on the measure. For non-equipment measures, the NWPCC's "Retrofit" ramp rates have already been applied to calculate

technical diffusion. In this case, we multiply each of these by 85% (for most measures) to calculate Technical Achievable Potential.

3 | ENERGY EFFICIENCY MARKET CHARACTERIZATION

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

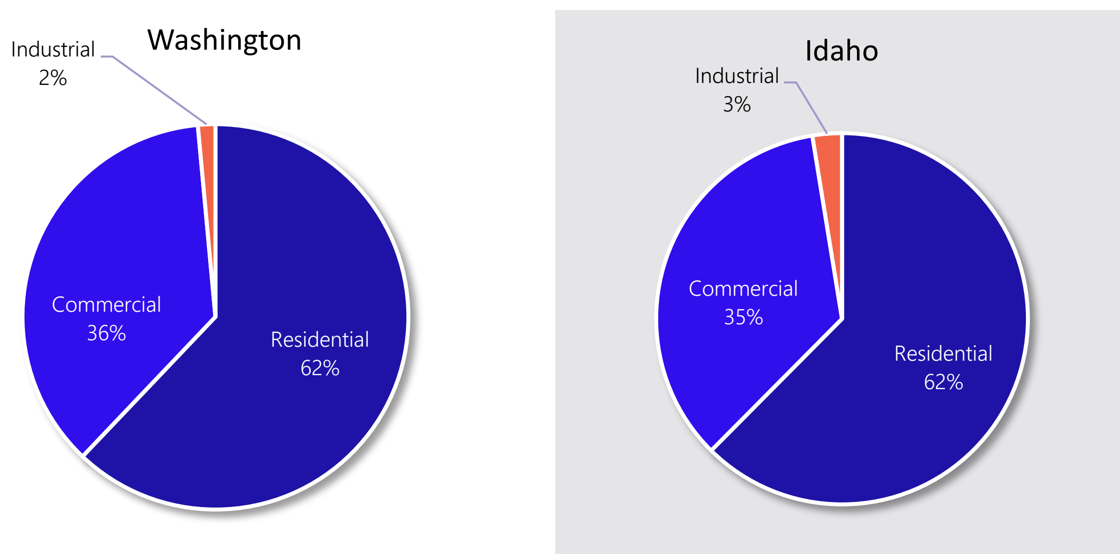
Energy Use Summary

Avista's total natural gas consumption for the residential, commercial, and industrial sectors in 2021 was 27,285,801 dekatherms (dtherms or dth); 18,288,700 dtherms in Washington and 8,997,101 dtherms in Idaho. As shown in Table 3-1 and Figure 3-1, the residential sector accounts for the largest share of annual energy use at 62%, followed by the commercial sector at approximately 35%.

Table 3-1 Residential Sector Control Totals, 2021

Sector	Washington		Idaho	
	Natural Gas Usage (Dth)	% of Annual Use	Natural Gas Usage (Dth)	% of Annual Use
Residential	11,356,811	62.1%	5,617,143	62.4%
Commercial	6,665,122	36.4%	3,149,752	35.0%
Industrial	266,766	1.5%	230,206	2.6%
Total	18,288,700	100%	8,997,101	100%

Figure 3-1 Avista Sector-Level Natural Gas Use (2021)



Residential Sector

Washington Characterization

The total number of households and natural gas sales for the service territory were obtained from Avista's actual sales. In 2021, there were 157,808 households in the state of Washington that used a total of 11,356,811 dtherms, resulting in an average use per household of 720 therms per year. Table 3-2 and Figure 3-2 shows the total number of households and natural gas sales in the six residential segments for each state. These values represent weather actuals for 2021 and were adjusted within LoadMAP to normal weather using heating degree day, base 65°F, using data provided by Avista.

Table 3-2 Residential Sector Control Totals, Washington, 2021

Segment	Households	Natural Gas Use (dtherms)	Annual Use/Customer (therms/HH)
Single Family	84,836	7,324,885	863
Multi-Family	8,705	431,675	496
Mobile Home	5,136	305,566	595
Low Income - Single Family	39,810	2,481,707	623
Low Income – Multi-Family	15,263	546,435	358
Low Income – Mobile Home	4,057	266,544	657
Total	**157,808**	**11,356,811**	**720**

Figure 3-2 Residential Natural Gas Use by Segment, Washington, 2021

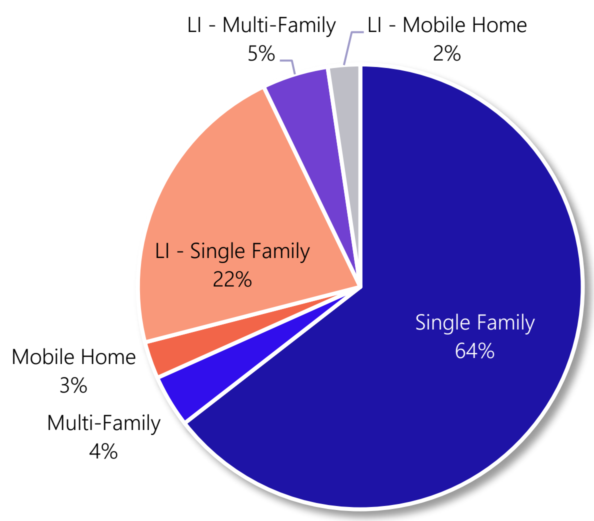


Figure 3-3 and Table 3-3 show the distribution of annual natural gas consumption by end use for an average residential household. Space heating comprises most of the load at 83%, followed by water heating at 12%. Appliances, secondary heating, and miscellaneous loads make up the remaining portion (5%) of the total load.

The market profiles provide the foundation for development of the baseline projection and the potential estimates. The average market profile for the residential sector is presented in Table 3-3.

Figure 3-3 Residential Natural Gas Use by End Use, Washington, 2021

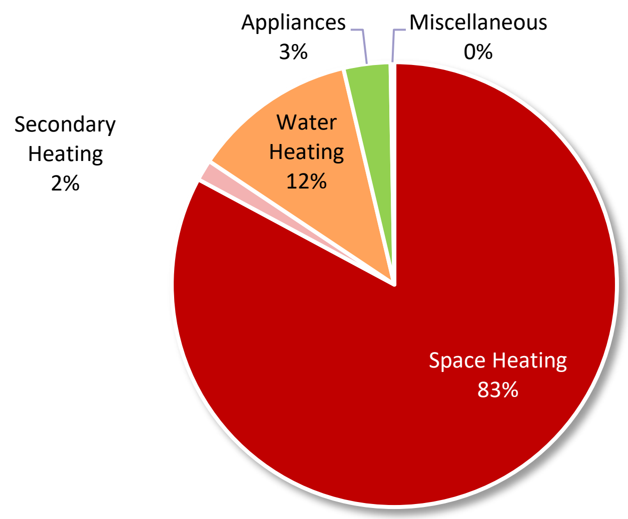
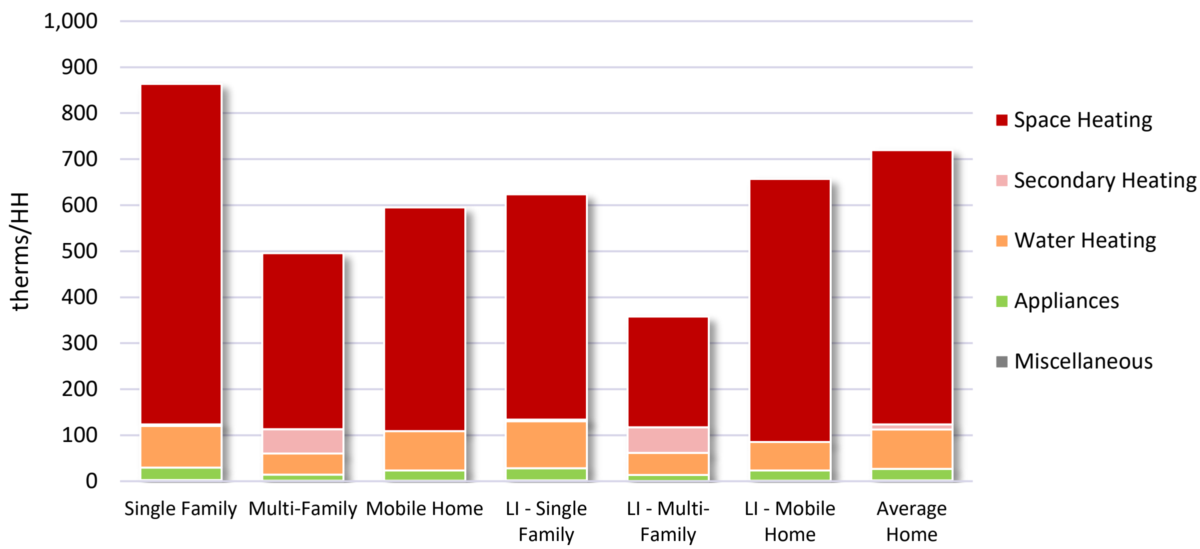


Table 3-3 Average Market Profile for the Residential Sector, Washington, 2021

End Use	Technology	Saturation	UEC (therms)	Intensity (therms/HH)	Usage (dtherms)
Space Heating	Furnace - Direct Fuel	84.8%	685	581	9,175,585
	Boiler - Direct Fuel	2.4%	628	15	233,076
Secondary Heating	Fireplace	5.1%	216	11	172,769
Water Heating	Water Heater (<= 55 Gal)	55.1%	156	86	1,356,503
	Water Heater (>55 Gal)	0.0%	148	0	457
Appliances	Clothes Dryer	28.4%	23	6	101,141
	Stove/Oven	58.6%	31	18	286,622
Miscellaneous	Pool Heater	0.9%	106	1	15,120
	Miscellaneous	100%	1	1	15,539
Total				**720**	**11,356,811**

Figure 3-4 presents average natural gas intensities by end use and housing type. Single family homes consume substantially more energy in space heating because single family homes are larger and more walls are exposed to the outside environment, compared to multifamily dwellings with many shared walls. Additional exposed walls increase heat transfer, resulting in greater heating loads. Water heating consumption is also higher in single family homes due to a greater number of occupants.

Figure 3-4 Residential Energy Intensity by End Use and Segment, Washington, 2021



Idaho Characterization

In 2021, there were 80,127 households in Avista's Idaho territory that used a total of 5,617,143 dtherms, resulting in an average use per household of 701 therms per year. Table 3-4 and Figure 3-5 shows the total number of households and natural gas sales in the six residential segments for each state.

Table 3-4 Residential Sector Control Totals, Idaho, 2021

Segment	Households	Natural Gas Use (dekatherms)	Annual Use/Customer (therms/HH)
Single Family	55,954	4,471,261	799
Multi-Family	8,690	379,050	436
Mobile Home	5,585	261,344	468
Low Income – Single Family	6,505	377,733	581
Low Income – Multi-Family	2,685	85,112	317
Low Income – Mobile Home	708	42,642	603
Total	**80,127**	**5,617,143**	**701**

Figure 3-5 Residential Natural Gas Use by Segment, Idaho, 2021

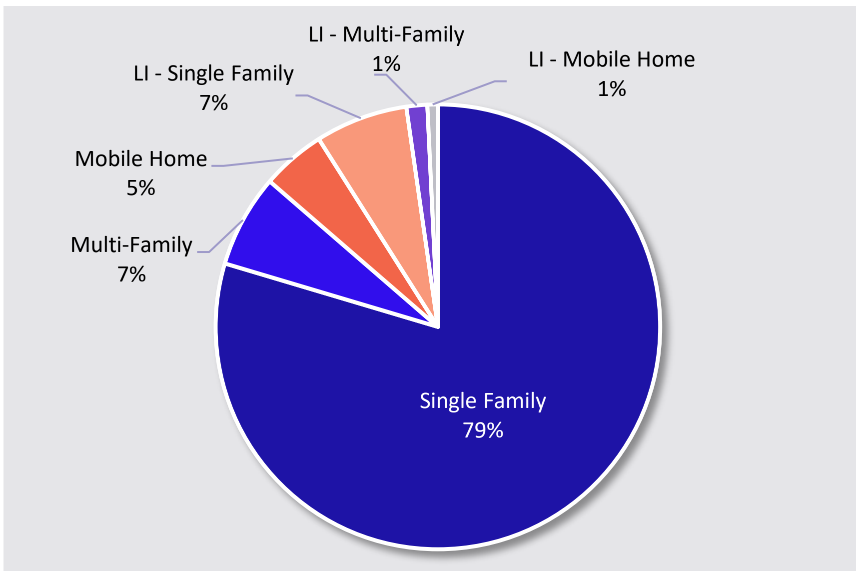


Figure 3-6 and Table 3-5 show the distribution of annual natural gas consumption by end use for an average residential household. Space heating comprises most of the load at 84%, followed by water heating at 12%. Appliances, secondary heating, and miscellaneous loads make up the remaining portion (4%) of the total load.

Figure 3-6 Residential Natural Gas Use by End Use, Idaho, 2021

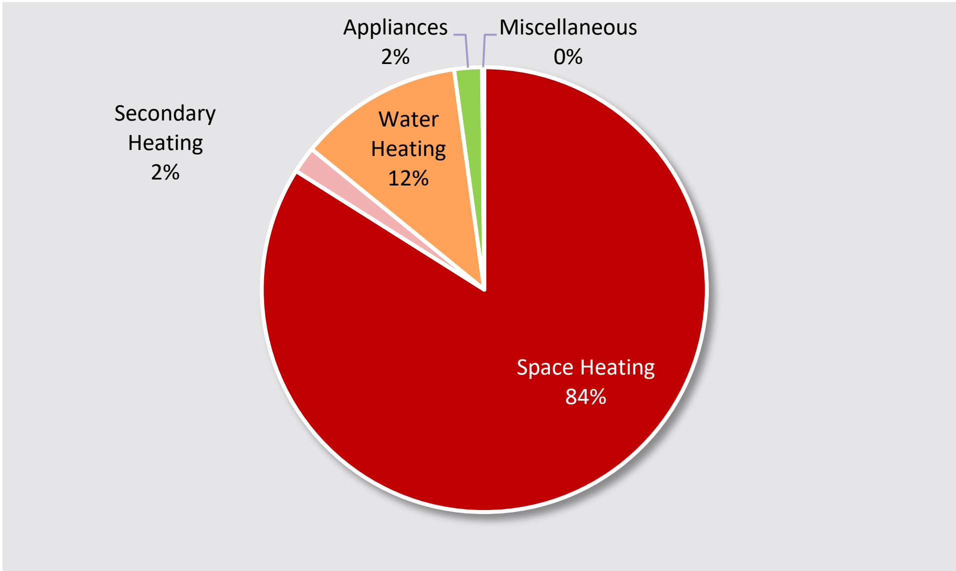
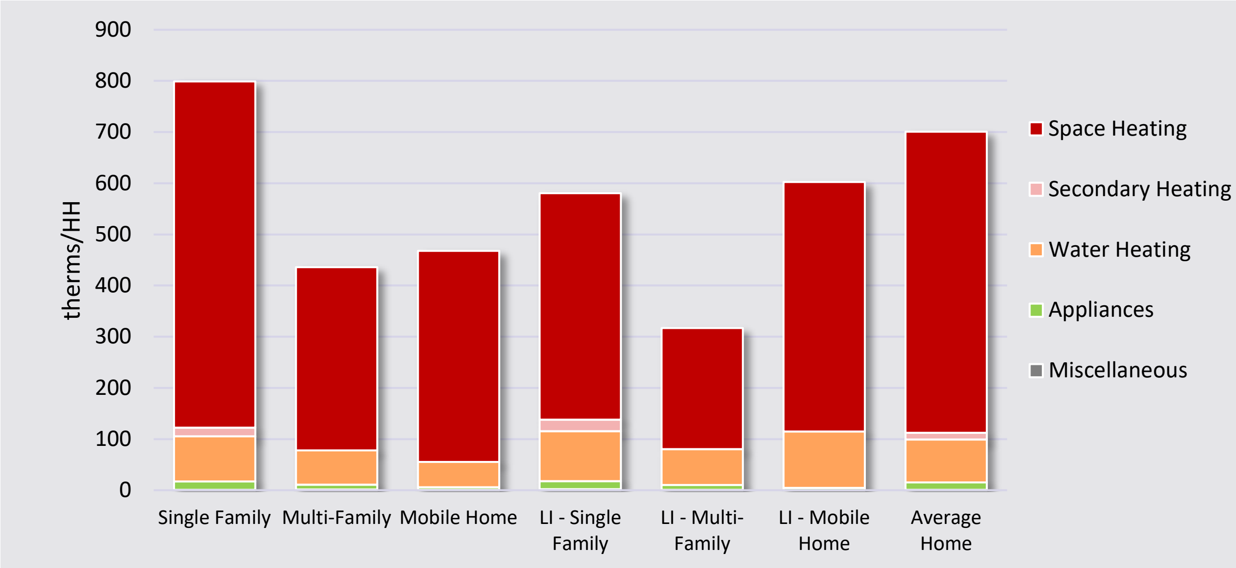


Table 3-5 Average Market Profile for the Residential Sector, Idaho 2021

End Use	Technology	Saturation	UEC (therms)	Intensity (therms/HH)	Usage (dtherms)
Space Heating	Furnace - Direct Fuel	88.0%	669	589	4,715,719
	Boiler - Direct Fuel	0.0%	-	-	-
Secondary Heating	Fireplace	6.0%	225	14	108,339
Water Heating	Water Heater (<= 55 Gal)	50.9%	152	77	618,978
	Water Heater (>55 Gal)	4.3%	151	7	52,229
Appliances	Clothes Dryer	16.2%	22	4	28,672
	Stove/Oven	34.7%	30	11	84,402
Miscellaneous	Pool Heater	0.3%	106	0	2,848
	Miscellaneous	100%	1	1	5,958
Total				**701**	**5,617,143**

Figure 3-7 presents average natural gas intensities by end use and housing type. Single family homes consume substantially more energy in space heating. Water heating consumption is higher in single family homes as well, due to a greater number of occupants, which increases the demand for hot water.

Figure 3-7 Residential Energy Intensity by End Use and Segment, Idaho, 2021 (Annual Therms/HH)



Commercial Sector

Washington Characterization

The total natural gas consumed by commercial customers in Avista's Washington service area in 2021 was 6,665,122 dtherm. The total number of non-residential accounts and natural gas sales for the Washington service territory were obtained from Avista's customer account database. AEG separated the commercial and industrial accounts by analyzing the SIC codes and rate codes assigned in the billing system. 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 2021 non-residential load to the sectors and segments according to the proportions in the billing data.

Table 3-6 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 2021 CBSA and equipment saturations extracted from Avista's database.

Table 3-6 Commercial Sector Control Totals, Washington, 2021

Segment	Description	Intensity (therms/Sq Ft)	Natural Gas Use (dekatherms)
Office	Traditional office-based businesses including finance, insurance, law, government buildings, etc.	0.53	536,771
Restaurant	Sit-down, fast food, coffee shop, food service, etc.	2.60	747,786
Retail	Department stores, services, boutiques, strip malls etc.	0.79	1,547,664
Grocery	Supermarkets, convenience stores, market, etc.	0.55	125,630
School	Day care, pre-school, elementary, secondary schools	0.28	187,678
College	College, university, trade schools, etc.	0.59	182,118
Health	Health practitioner office, hospital, urgent care centers, etc.	0.99	243,745
Lodging	Hotel, motel, bed and breakfast, etc.	0.67	370,063
Warehouse	Large storage facility, refrigerated/unrefrigerated warehouse	0.57	688,567
Miscellaneous	Catchall for buildings not included in other segments, includes churches, recreational facilities, public assembly, correctional facilities, etc.	0.95	2,035,100
Total		**0.78**	**6,665,1222T**

Figure 3-8 shows the distribution of annual natural gas consumption by segment across all commercial buildings. The three segments with the highest natural gas usage in 2021 are miscellaneous (30%), retail (23%), and restaurant (11%).

Figure 3-8 Commercial Natural Gas Use by Segment, Washington, 2021

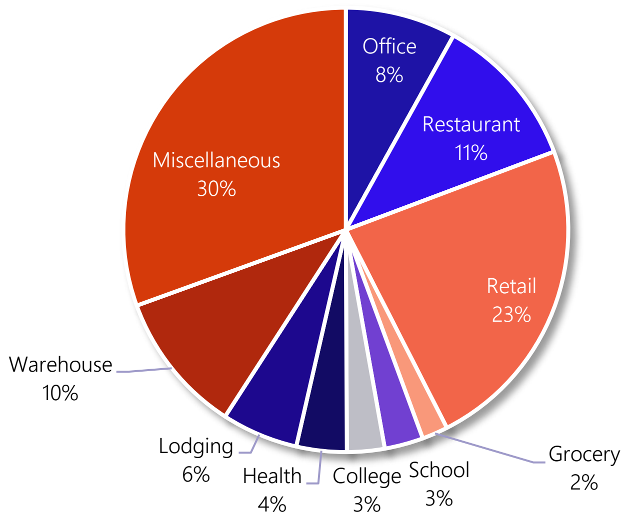


Figure 3-9 shows the distribution of natural gas consumption by end use for the entire commercial sector. Space heating is the largest end use, followed by water heating and food preparation. The miscellaneous end use is quite small, as expected.

Figure 3-9 Commercial Sector Natural Gas Use by End Use, Washington, 2021

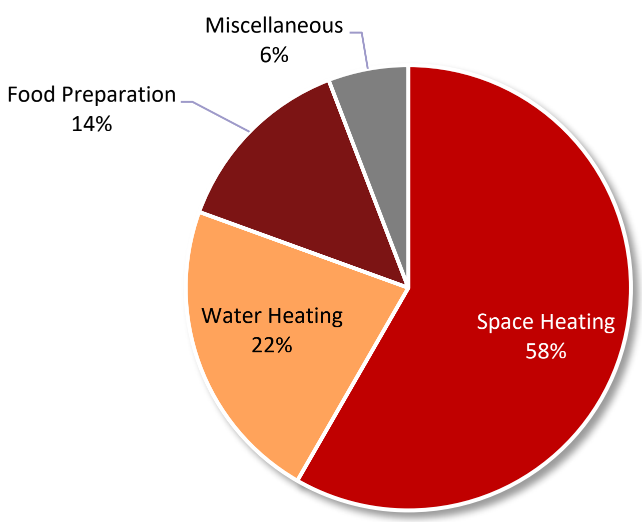


Figure 3-10 presents average natural gas intensities by end use and segment. In Washington, restaurants use the most natural gas in the service territory. Avista customer account data informed the market profile by providing information on saturation of key equipment types. Secondary data was used to develop estimates of energy intensity and square footage and fill in saturations for any equipment types not included in the database.

Figure 3-10 Commercial Energy Usage Intensity by End Use and Segment, Washington, 2021

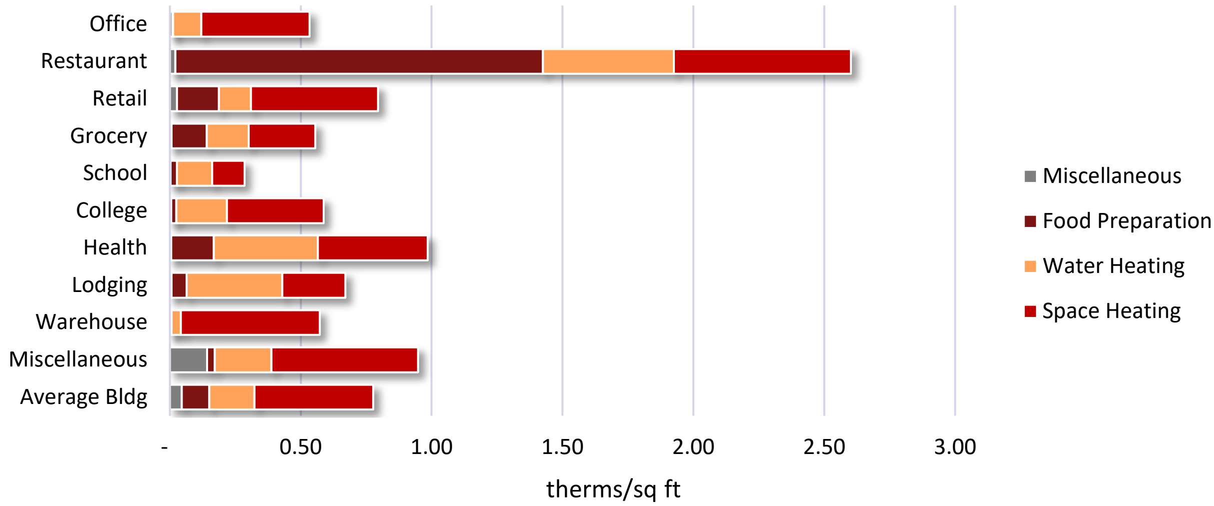


Table 3-7 shows the average market profile for the commercial sector as a whole, representing a composite of all segments and buildings.

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

End Use	Technology	Saturation	EUI (therms/ Sq Ft)	Intensity (therms/Sq Ft)	Usage (dtherms)
Space Heating	Furnace	52.4%	0.55	0.29	2,485,626
	Boiler	21.9%	0.66	0.15	1,247,409
	Unit Heater	5.9%	0.31	0.02	156,793
Water Heating	Water Heater	58.7%	0.29	0.17	1,481,152
Food Preparation	Oven	11.3%	0.08	0.01	73,181
	Conveyor Oven	5.6%	0.13	0.01	62,609
	Double Rack Oven	5.6%	0.20	0.01	95,114
	Fryer	8.0%	0.44	0.04	300,472
	Broiler	13.3%	0.12	0.02	133,574
	Griddle	17.5%	0.08	0.01	118,981
	Range	17.8%	0.07	0.01	113,457
	Steamer	1.9%	0.07	0.00	10,828
	Commercial Food Prep Other	0.2%	0.02	0.00	221
Miscellaneous	Pool Heater	1.0%	0.06	0.00	5,419
	Miscellaneous	100%	0.04	0.04	383,287
Total				**0.78**	**6,665,122**

Idaho Characterization

The total natural gas consumed by commercial customers in Avista's Idaho service area in 2021 was 3,149,752 dtherm. Table 3-8 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 2021 CBSA and equipment saturations extracted from Avista's database.

Table 3-8 Commercial Sector Control Totals, Idaho, 2021

Segment	Description	Intensity (therms/Sq Ft)	Natural Gas Use (dekatherms)
Office	Traditional office-based businesses including finance, insurance, law, government buildings, etc.	0.53	226,954
Restaurant	Sit-down, fast food, coffee shop, food service, etc.	2.60	139,154
Retail	Department stores, services, boutiques, strip malls etc.	0.79	959,894
Grocery	Supermarkets, convenience stores, market, etc.	0.55	58,138
School	Day care, pre-school, elementary, secondary schools	0.28	184,533
College	College, university, trade schools, etc.	0.59	179,370
Health	Health practitioner office, hospital, urgent care centers, etc.	1.01	102,436
Lodging	Hotel, motel, bed and breakfast, etc.	0.67	170,255
Warehouse	Large storage facility, refrigerated/unrefrigerated warehouse	0.57	334,864
Miscellaneous	Catchall for buildings not included in other segments, includes churches, recreational facilities, public assembly, correctional facilities, etc.	0.95	794,154
Total		0.70	3,149,752

Figure 3-11 shows the distribution of annual natural gas consumption by segment across all commercial buildings. The three segments with the highest natural gas usage in 2021 are retail (31%), miscellaneous (25%), and warehouse (11%).

Figure 3-11 Commercial Natural Gas Use by Segment, Idaho, 2021

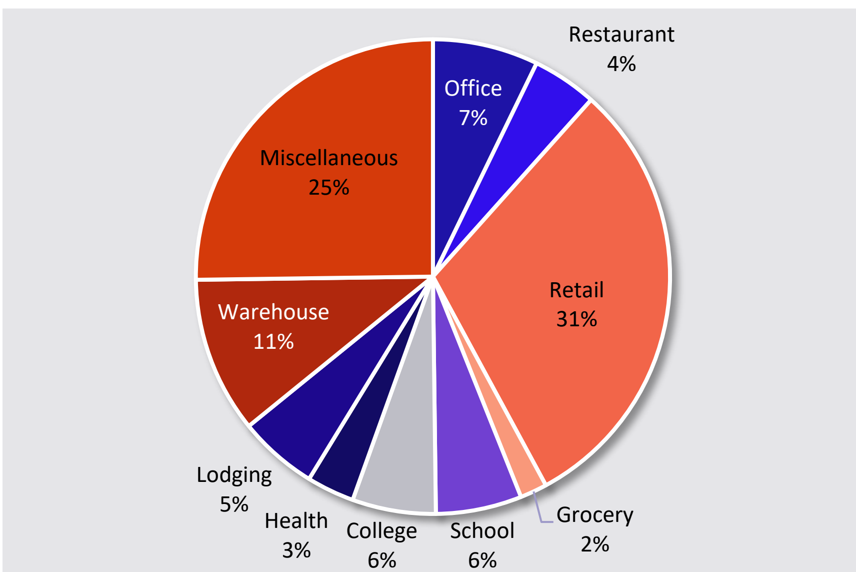


Figure 3-12 shows the distribution of natural gas consumption by end use for the entire commercial sector. Space heating is the largest end use, followed by water heating and food preparation. The miscellaneous end use is quite small, as expected.

Figure 3-12 Commercial Sector Natural Gas Use by End Use, Idaho, 2021

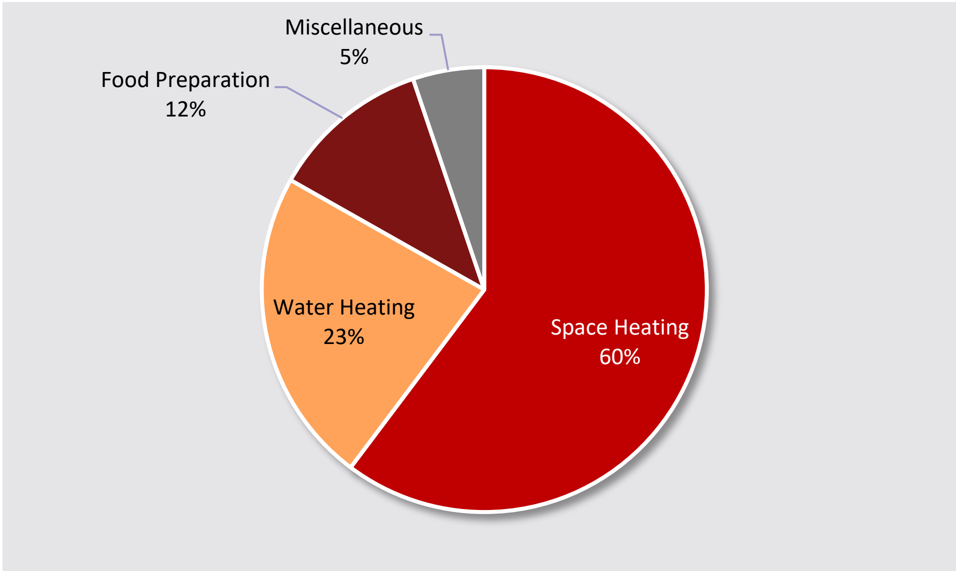


Figure 3-13 presents average natural gas intensities by end use and segment. In Idaho, restaurants use the most natural gas in the service territory. Avista customer account data informed the market profile by providing information on saturation of key equipment types. Secondary data was used to develop estimates of energy intensity and square footage and fill in saturations for any equipment types not included in the database.

Figure 3-13 Commercial Energy Usage Intensity by End Use and Segment, Idaho, 2021

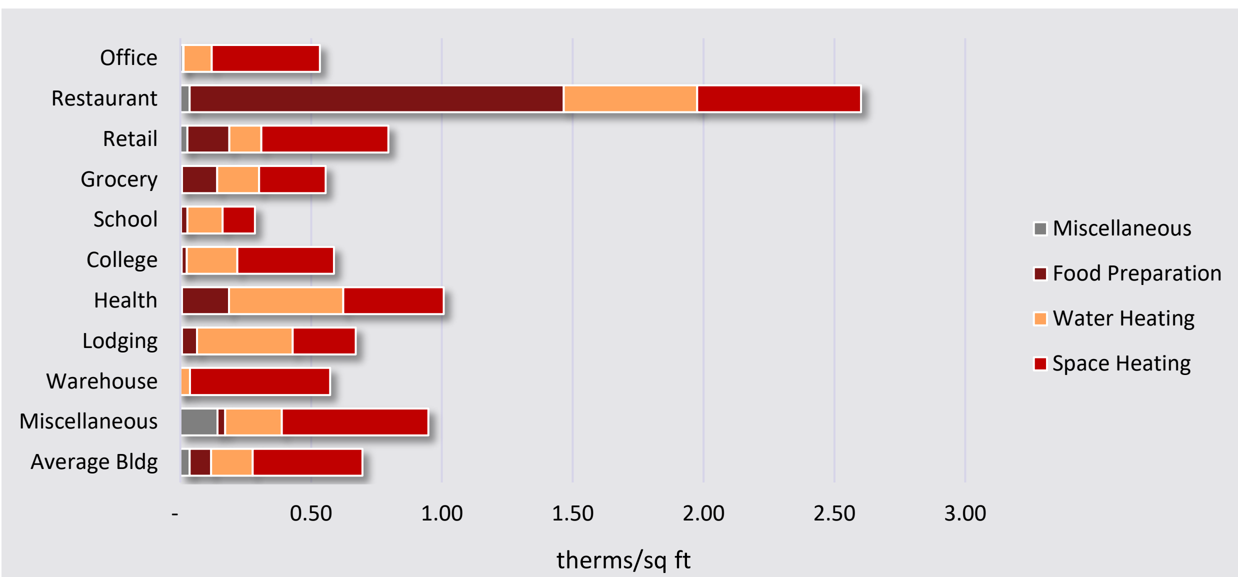


Table 3-9 shows the average market profile for the commercial sector as a whole, representing a composite of all segments and buildings.

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

End Use	Technology	Saturation	EUI (therms/ Sq Ft)	Intensity (therms/Sq Ft)	Usage (dtherms)
Space Heating	Furnace	50.1%	0.53	0.26	1,194,251
	Boiler	24.5%	0.56	0.14	621,861
	Unit Heater	6.2%	0.29	0.02	81,760
Water Heating	Water Heater	60.5%	0.26	0.16	722,590
Food Preparation	Oven	9.7%	0.09	0.01	40,281
	Conveyor Oven	4.8%	0.16	0.01	34,461
	Double Rack Oven	4.8%	0.24	0.01	52,353
	Fryer	6.8%	0.44	0.03	134,342
	Broiler	11.1%	0.07	0.01	33,837
	Griddle	15.2%	0.05	0.01	33,185
	Range	16.0%	0.05	0.01	32,941
	Steamer	2.6%	0.04	00.0	4,364
	Commercial Food Prep Other	0.3%	0.01	0.00	118
Miscellaneous	Pool Heater	0.9%	0.05	0.00	2,146
	Miscellaneous	100%	0.04	0.04	161,261
Total				**0.70**	**3,149,752**

Industrial Sector

Table 3-10 Industrial Sector Control Totals, 2021

Segment	Intensity (therms/employee)	Natural Gas Usage (dtherms)
Washington Industrial	1,699	266,766
Idaho Industrial	2,327	230,206

Washington Characterization

The total natural gas consumed by industrial customers in Avista's Washington service area in 2021 was 266,766 dtherms. Like in the commercial sector, customer account data was used to allocate usage among segments. Energy intensity was derived from AEG's Energy Market Profiles database. Most industrial measures are installed through custom programs, where the unit of measure is not as necessary to estimate potential.

Figure 3-14 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.

Figure 3-14 Industrial Natural Gas Use by End Use, Washington, 2021

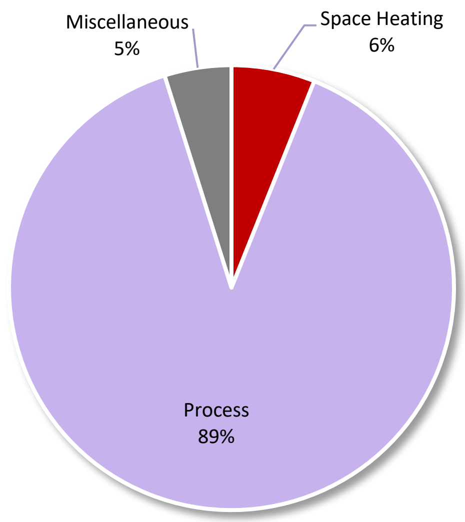


Table 3-11 shows the composite market profile for the Washington industrial sector. Process cooling is very small and represents niche technologies such as gas-driven absorption chillers.

Table 3-11 Average Natural Gas Market Profile for the Industrial Sector, Washington, 2021

End Use	Technology	Saturation	EUI (therms/ Sq Ft)	Intensity (therms/ Sq Ft)	Usage (dtherms)
Space Heating	Furnace	32.3%	103.12	33.3	5,230
	Boiler	51.5%	103.12	53.2	8,346
	Unit Heater	16.2%	103.12	16.7	2,615
Process	Process Boiler	100%	750.42	750.4	117,823
	Process Heating	100%	686.11	686.1	107,725
	Process Cooling	100%	6.65	6.7	1,045
	Other Process	100%	70.14	70.1	11,012
Miscellaneous	Miscellaneous	100%	82.61	82.6	12,971
Total				**1,699.1**	**266,766**

Idaho Characterization

The total natural gas consumed by industrial customers in Avista's Idaho service area in 2021 was 230,206 dtherms.

Figure 3-15 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.

Figure 3-15 Industrial Natural Gas Use by End Use, Idaho, 2021

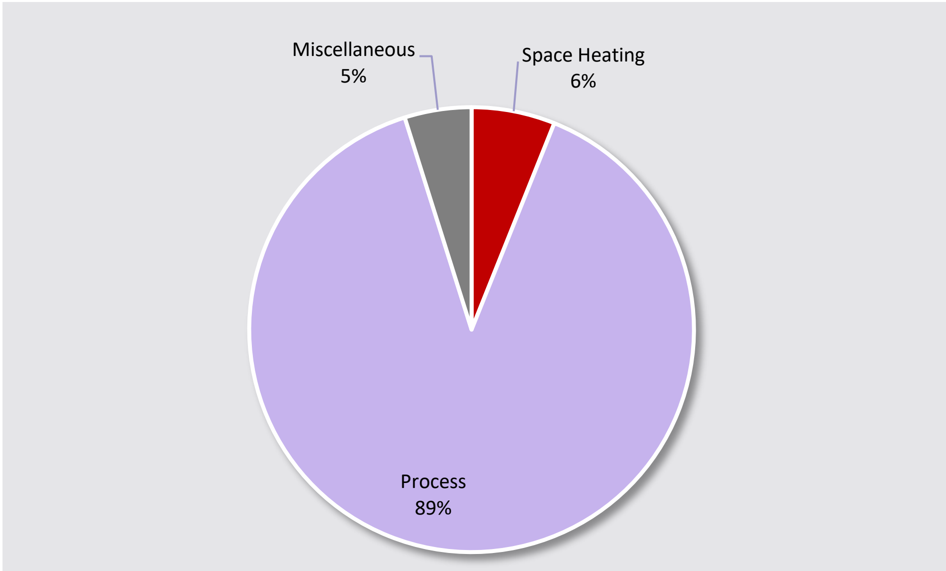


Table 3-13 shows the composite market profile for the industrial sector. Process cooling is very small and represents technologies such as gas-driven absorption chillers.

Table 3-12 Average Natural Gas Market Profile for the Industrial Sector, Idaho, 2021

End Use	Technology	Saturation	EUI (therms/ Sq Ft)	Intensity (therms/ Sq Ft)	Usage (dekatherms)
Space Heating	Furnace	32.3%	141.24	45.6	4,513
	Boiler	51.5%	141.24	72.8	7,203
	Unit Heater	16.2%	141.24	22.8	2,257
Process	Process Boiler	100.0%	1,027.79	1,027.8	101,675
	Process Heating	100.0%	939.70	939.7	92,961
	Process Cooling	100.0%	9.11	9.1	901
	Other Process	100.0%	96.06	96.1	9,503
Miscellaneous	Miscellaneous	100.0%	113.14	113.1	11,193
Total				**2,327.0**	**230,206**

4 | BASELINE PROJECTION

Prior to developing estimates of energy efficiency potential, we developed a baseline end-use projection to quantify the likely future consumption in absence of any future 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. Possible savings from future programs are captured by the potential estimates.

The baseline projection incorporates assumptions about:

- 2021 energy consumption based on the market profiles
- Customer forecast and population growth
- Appliance/equipment standards and building codes and purchase decisions
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous natural gas growth

This chapter presents the annual baseline natural gas projections developed for each sector and state. Although it aligns closely, the baseline projection is not Avista's official load forecast. It was developed to serve as the metric against which energy efficiency potentials are measured.

Overall Baseline Projection

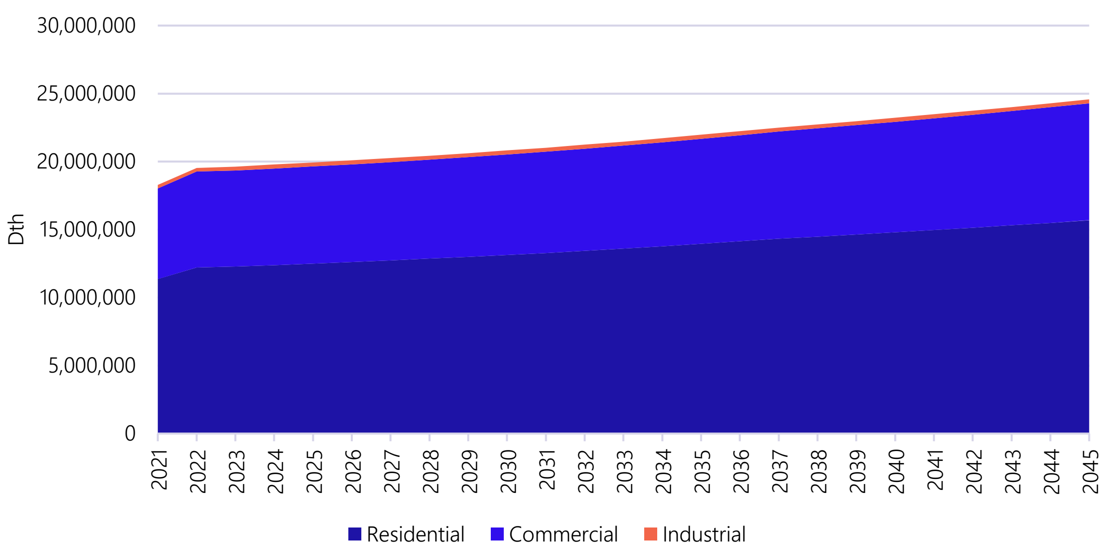
Washington

Table 4-1 and Figure 4-13 summarize the baseline projection for annual use by sector for Avista's Washington service territory. The forecast shows modest annual growth, driven by the residential and commercial sectors.

Table 4-1 Baseline Projection Summary by Sector, Washington (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Residential	11,356,811	12,274,400	12,387,892	12,501,697	13,948,186	15,683,198	38.10%
Commercial	6,665,122	7,069,971	7,101,191	7,136,906	7,720,617	8,594,749	28.95%
Industrial	266,766	287,959	293,150	296,345	298,131	298,267	11.81%
Total	**18,288,700**	**19,632,329**	**19,782,233**	**19,934,947**	**21,966,934**	**24,576,214**	**34.38%**

Figure 4-1 Baseline Projection Summary by Sector, Washington



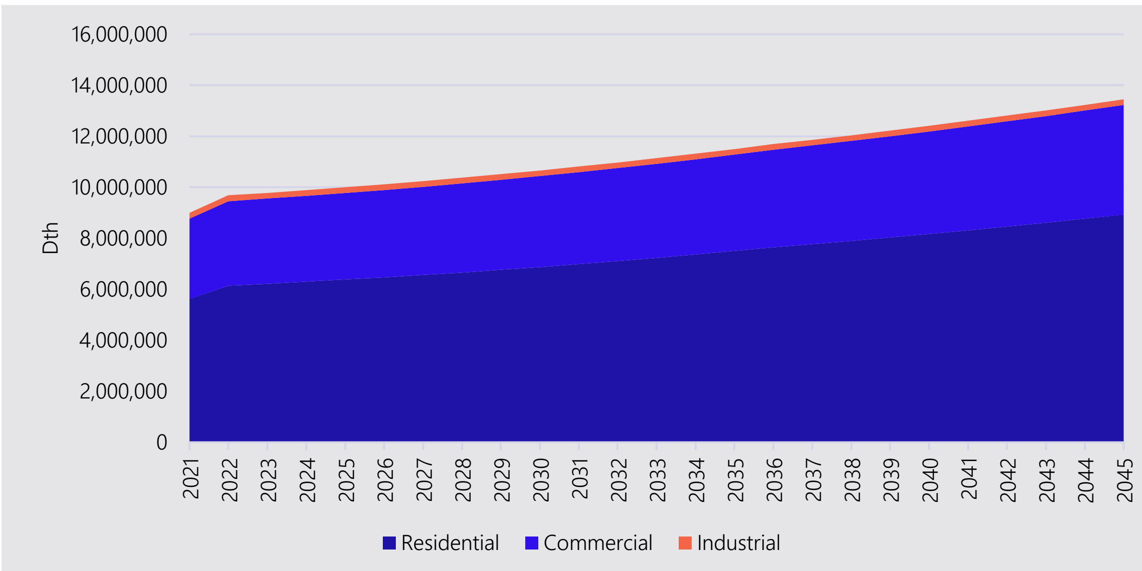
Idaho

Table 4-2 and Figure 4-2 summarize the baseline projection for annual use by sector for Avista's Idaho service territory. The forecast shows modest annual growth, driven by the residential and commercial sectors.

Table 4-2 Baseline Projection Summary by Sector, Idaho (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Residential	5,617,143	6,215,422	6,300,557	6,382,522	7,499,611	8,929,190	58.96%
Commercial	3,149,752	3,342,401	3,368,913	3,397,011	3,778,711	4,299,692	36.51%
Industrial	230,206	223,967	223,982	223,868	222,921	222,119	-3.51%
Total	**8,997,101**	**9,781,790**	**9,893,452**	**10,003,402**	**11,501,243**	**13,451,001**	**49.50%**

Figure 4-2 Baseline Projection Summary by Sector, Idaho



Residential Sector

Washington Projection

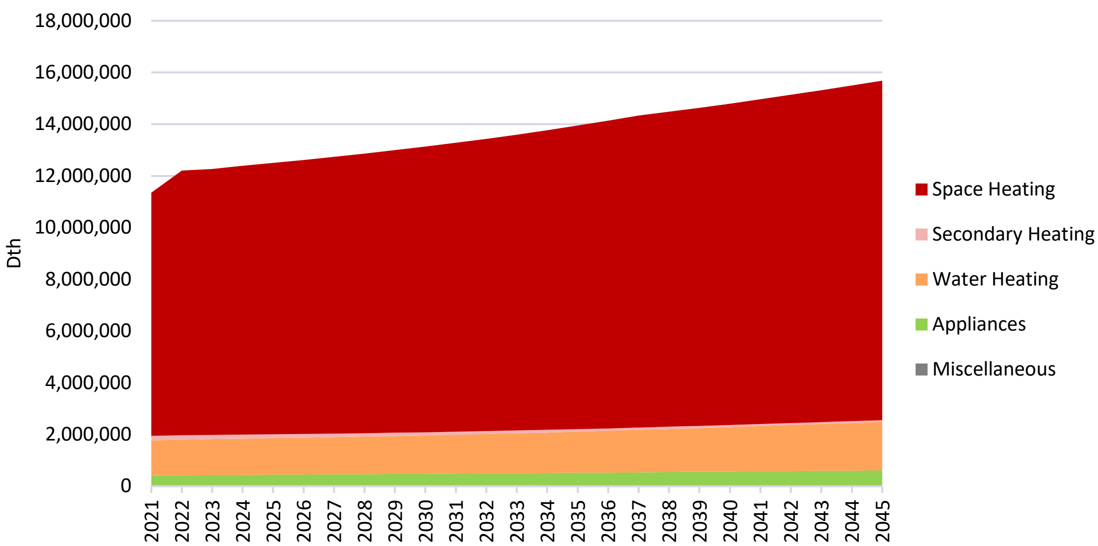
Table 4-3 and Figure 4-3 present the baseline projection for natural gas at the end-use level for the residential sector. Overall, residential use increases from 11,356,811 dtherms in 2021 to 15,683,198 dtherms in 2045 (38.1%). Factors affecting growth include a moderate increase in the number of households and customers as well as a decrease in equipment consumption due to standards and naturally occurring efficiency.

We model gas-fired fireplaces as secondary heating. These consume energy and may heat a space but are rarely used as the primary heating technology. As such, they are estimated to be more aesthetic and less weather-dependent. 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, including technologies with low penetration, such as gas barbeques.

Table 4-3 Residential Baseline Projection by End Use, Washington (dtherms)

End Use	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	9,408,661	10,290,384	10,391,860	10,493,546	11,739,189	13,126,445	39.5%
Secondary Heating	172,769	164,209	157,168	150,444	98,948	66,939	-61.3%
Water Heating	1,356,961	1,387,160	1,399,677	1,411,982	1,589,357	1,875,045	38.2%
Appliances	387,763	401,031	407,136	413,242	483,593	572,381	47.6%
Miscellaneous	30,658	31,616	32,051	32,482	37,100	42,388	38.3%
Total	**11,356,811**	**12,274,400**	**12,387,892**	**12,501,697**	**13,948,186**	**15,683,198**	**38.1%**

Figure 4-3 Residential Baseline Projection by End Use, Washington



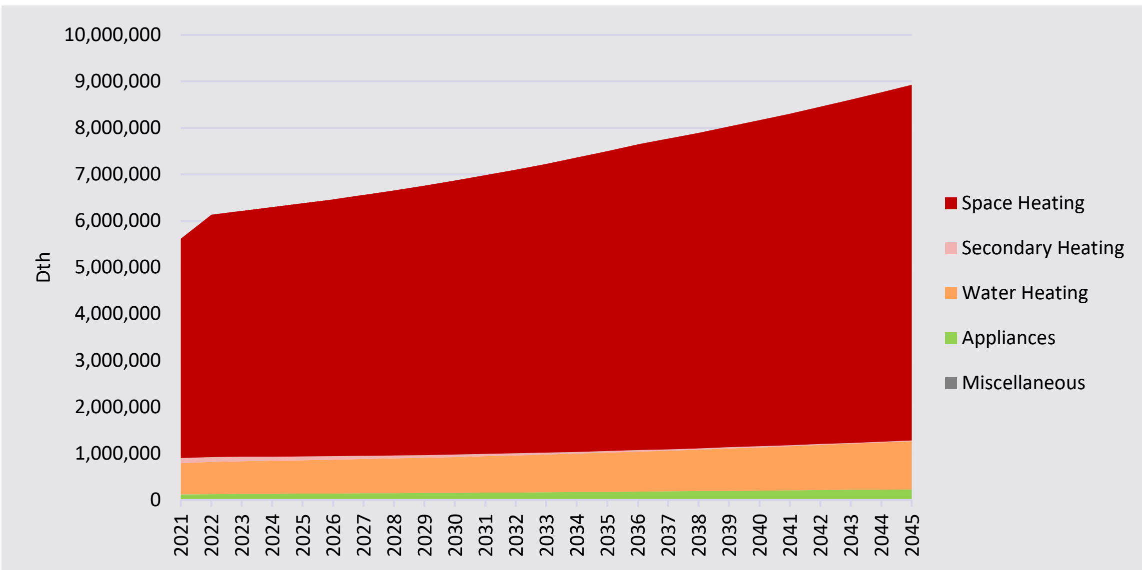
Idaho Projection

Table 4-4 and Figure 4-4 present the baseline projection for natural gas at the end-use level for the residential sector. Overall, residential use increases from 5,617,143 dtherms in 2021 to 8,929,190 dtherms in 2045, an increase of 59.0%.

Table 4-4 Residential Baseline Projection by End Use, Idaho (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	4,715,719	5,287,189	5,367,732	5,445,288	6,446,442	7,649,958	62.2%
Secondary Heating	108,339	96,535	88,722	81,446	34,921	15,001	-86.2%
Water Heating	671,206	701,265	710,412	718,910	841,874	1,033,899	54.0%
Appliances	113,073	121,097	124,167	127,175	164,577	215,963	91.0%
Miscellaneous	8,806	9,336	9,523	9,703	11,797	14,369	63.2%
Total	**5,617,143**	**6,215,422**	**6,300,557**	**6,382,522**	**7,499,611**	**8,929,190**	**59.0%**

Figure 4-4 Residential Baseline Projection by End Use, Idaho



Commercial Sector

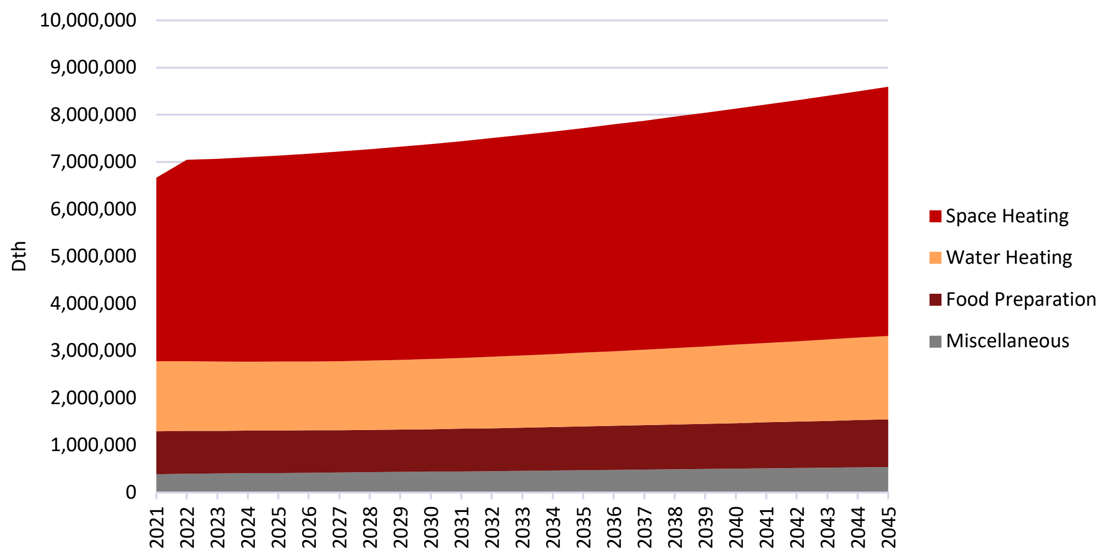
Washington Projection

Annual natural gas use in the commercial sector grows 29.0% during the overall forecast horizon, starting at 6,665,122 dtherms in 2021, and increasing to 8,594,749 dtherms in 2045. Table 4-5 and Figure 4-5 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 4-5 Commercial Baseline Projection by End Use, Washington (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	3,886,828	4,295,626	4,330,709	4,365,994	4,759,146	5,275,544	35.7%
Water Heating	1,481,152	1,467,668	1,461,346	1,458,458	1,563,969	1,770,182	19.5%
Appliances	908,437	903,690	900,737	898,613	925,243	1,009,887	11.2%
Miscellaneous	388,706	402,987	408,399	413,840	472,259	539,135	38.7%
Total	**6,665,122**	**7,069,971**	**7,101,191**	**7,136,906**	**7,720,617**	**8,594,749**	**29.0%**

Figure 4-5 Commercial Baseline Projection by End Use, Washington



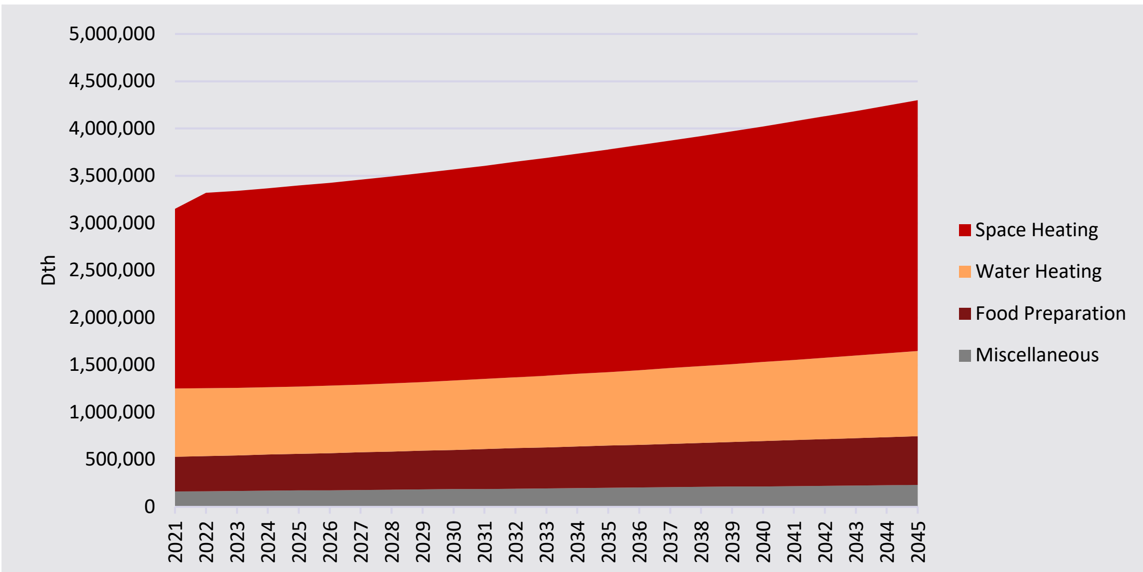
Idaho Projection

Annual natural gas use in the Idaho commercial sector grows 36.5% during the forecast horizon, starting at 3,149,752 dtherms in 2021, and increasing to 4,299,692 dtherms in 2045. Table 4-6 and Figure 4-6 present the baseline projection at the end-use level for the commercial sector. Similar to the residential sector, market size is increasing and usage per square foot is decreasing slightly.

Table 4-6 Commercial Baseline Projection by End Use, Idaho (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	1,897,872	2,083,872	2,104,055	2,124,262	2,352,655	2,653,169	39.8%
Water Heating	722,590	713,016	711,324	711,267	778,543	899,018	24.4%
Food Preparation	365,882	377,145	382,602	387,980	446,014	513,408	40.3%
Miscellaneous	163,408	168,369	170,932	173,502	201,500	234,097	43.3%
Total	**3,149,752**	**3,342,401**	**3,368,913**	**3,397,011**	**3,778,711**	**4,299,692**	**36.5%**

Figure 4-6 Commercial Baseline Projection by End Use, Idaho



Industrial Sector

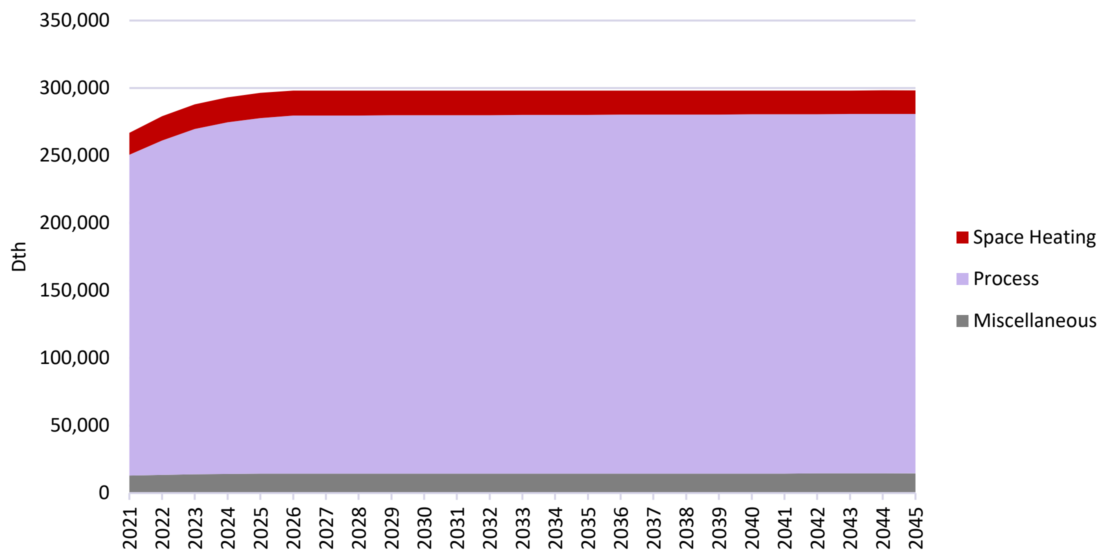
Washington Projection

Industrial sector usage increases throughout the planning horizon. Table 4-7 and Figure 4-7 present the projection at the end-use level. Overall, industrial annual natural gas use increases from 266,766 dtherms in 2021 to 298,267 dtherms in 2040, an increase of 11.8%.

Table 4-7 Industrial Baseline Projection by End Use, Washington (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	16,191	18,321	18,519	18,611	17,961	17,407	7.5%
Process	237,604	255,680	260,415	263,357	265,667	266,323	12.1%
Miscellaneous	12,971	13,957	14,216	14,376	14,502	14,538	12.1%
Total	**266,766**	**287,959**	**293,150**	**296,345**	**298,131**	**298,267**	**11.8%**

Figure 4-7 Industrial Baseline Projection by End Use, Washington



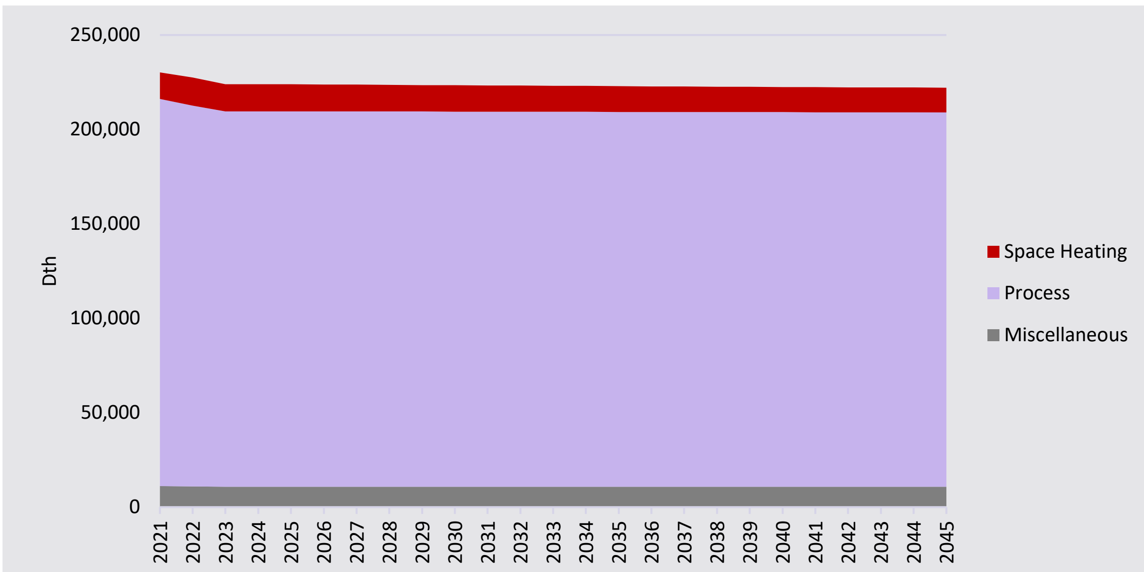
Idaho Projection

Industrial annual natural gas use decreases from 230,206 dtherms in 2021 to 222,119 dtherms in 2045, a decrease of 3.5%. Table 4-8 and Figure 4-8 present the projection at the end-use level.

Table 4-8 Industrial Baseline Projection by End Use, Idaho (dtherms)

Sector	2021	2023	2024	2025	2035	2045	% Change ('21-'45)
Space Heating	13,972	14,459	14,392	14,317	13,624	13,111	-6.2%
Process	205,041	198,663	198,741	198,704	198,463	198,190	-3.3%
Miscellaneous	11,193	10,845	10,849	10,847	10,834	10,819	-3.3%
Total	**230,206**	**223,967**	**223,982**	**223,868**	**222,921**	**222,119**	**-3.5%**

Figure 4-8 Industrial Baseline Projection by End Use, Idaho



5 | CONSERVATION POTENTIAL

This chapter presents the conservation potential across all sectors for Avista's Washington and Idaho territories. Conservation potential includes every measure considered in the measure list, regardless of delivery mechanism (program implementation, etc.). Year-by-year annual energy savings are available in the LoadMAP model and measure assumption summary, provided to Avista at the conclusion of the study. Please note that all savings are at the customer site.

Washington Overall Energy Efficiency Potential

Table 5-1 and Figure 5-1 summarize the 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 cumulative energy conservation forecasts, which reflect the effects of persistent savings in prior years and new savings.

- Technical Potential reflects the adoption of all conservation measures regardless of cost-effectiveness. Efficient equipment makes up all lost opportunity installations and all retrofit measures are installed, regardless of achievability. First-year savings are 429,564 dtherms, or 2.2% of the baseline projection. Cumulative savings in 2045 are 8,637,218 dtherms, or 35.1% of the baseline.
- Achievable Technical Potential refines Technical Potential by applying market adoption rates to each measure. The market adoption rates estimate the percentage of customers who would be likely to select each measure given market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of conservation measures. First-year savings are 191,654 dtherms, or 1.0% of the baseline projection. Cumulative savings in 2045 are 4,938,238 dtherms, or 20.1% of the baseline.
- TRC Achievable Economic Potential refines Achievable Technical Potential by applying the TRC economic cost-effectiveness screen, 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. For the TRC, AEG also applied (1) benefits for non-gas energy savings, such as electric HVAC savings for weatherization, (2) the NWPCC's calibration credit to space heating savings to reflect that additional fuels may be used as a supplemental heat source within an average home, and (3) a 10% conservation credit to avoided costs per the NWPCC methodologies. First-year savings are 111,992 dtherms, or 0.6% of the baseline projection. Cumulative savings in 2045 are 2,497,540 dtherms, or 10.2% of the baseline.

Table 5-1 Summary of Energy Efficiency Potential, Washington

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (Dth)	19,632,329	19,782,233	19,934,947	21,966,934	24,576,214
Cumulative Savings (Dth)					
TRC Achievable Economic Potential	111,992	225,734	361,485	1,833,863	2,497,540
Achievable Technical Potential	191,654	423,238	686,518	3,774,115	4,938,238
Technical Potential	429,564	884,194	1,375,956	6,455,295	8,637,218
Energy Savings (% of Baseline)					
TRC Achievable Economic Potential	0.6%	1.1%	1.8%	8.3%	10.2%
Achievable Technical Potential	1.0%	2.1%	3.4%	17.2%	20.1%
Technical Potential	2.2%	4.5%	6.9%	29.4%	35.1%

Figure 5-1 Cumulative Energy Efficiency Potential as % of Baseline Projection, Washington

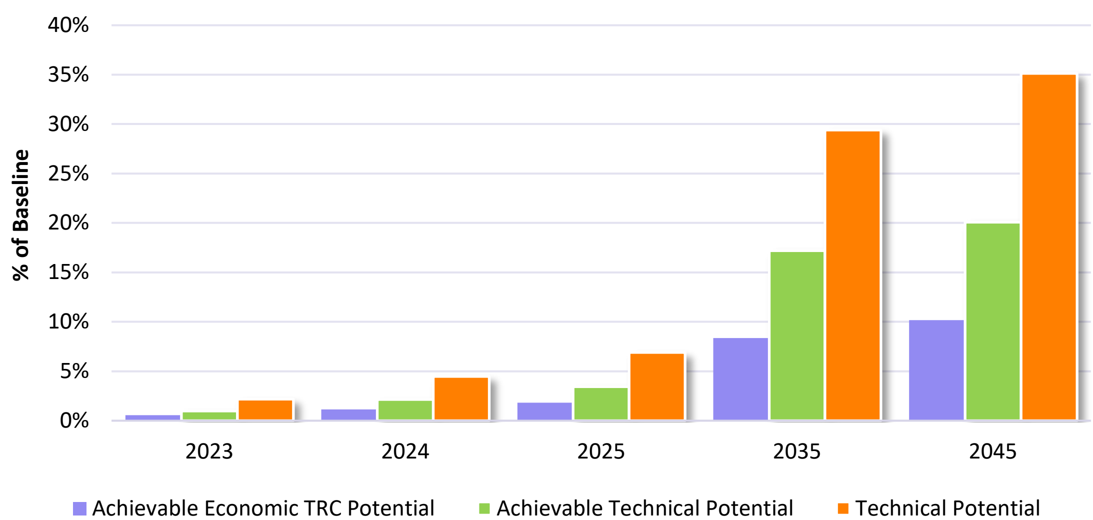
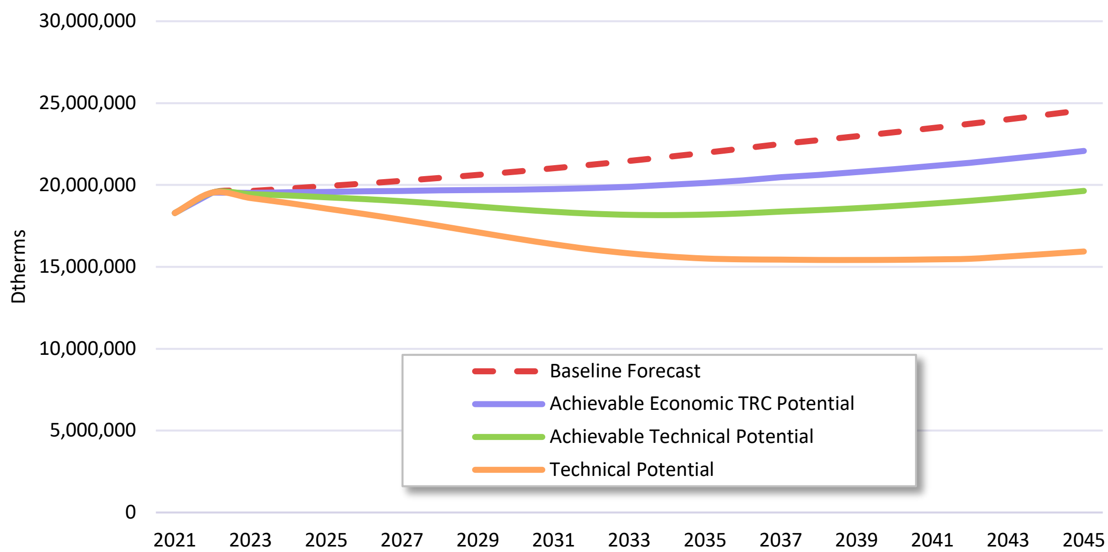


Figure 5-2 Baseline Projection and Energy Efficiency Forecasts, Washington



Idaho Overall Energy Efficiency Potential

Table 5-2 and Figure 5-3 summarize the conservation savings in terms of annual energy use for all measures for four levels of potential relative to the baseline projection. Figure 5-4 displays the cumulative energy conservation forecasts, which reflect the effects of persistent savings in prior years in addition to new savings.

- Technical Potential first-year savings in 2023 are 254,213 dtherms, or 2.6% of the baseline projection. Cumulative savings in 2045 are 5,060,646 dtherms, or 37.6% of the baseline.
- Achievable Technical Potential first-year savings are 105,612 dtherms, or 1.1% of the baseline projection. Cumulative savings in 2045 are 2,885,725 dtherms, or 21.5% of the baseline
- UCT Achievable Economic Potential first-year savings are 46,414 dtherms, or 0.5% of the baseline projection. Cumulative savings in 2045 are 1,278,511 dtherms, or 9.5% of the baseline

Table 5-2 Summary of Energy Efficiency Potential, Idaho

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (Dth)	9,781,790	9,893,452	10,003,402	11,501,243	13,451,001
Cumulative Savings (Dth)					
UCT Achievable Economic Potential	46,414	96,705	155,748	906,240	1,278,511
Achievable Technical Potential	105,612	228,853	371,295	2,144,539	2,885,725
Technical Potential	254,213	498,497	772,091	3,673,174	5,060,646
Energy Savings (% of Baseline)					
UCT Achievable Economic Potential	0.5%	1.0%	1.6%	7.9%	9.5%
Achievable Technical Potential	1.1%	2.3%	3.7%	18.6%	21.5%
Technical Potential	2.6%	5.0%	7.7%	31.9%	37.6%

Figure 5-3 Cumulative Energy Efficiency Potential as % of Baseline Projection, Idaho

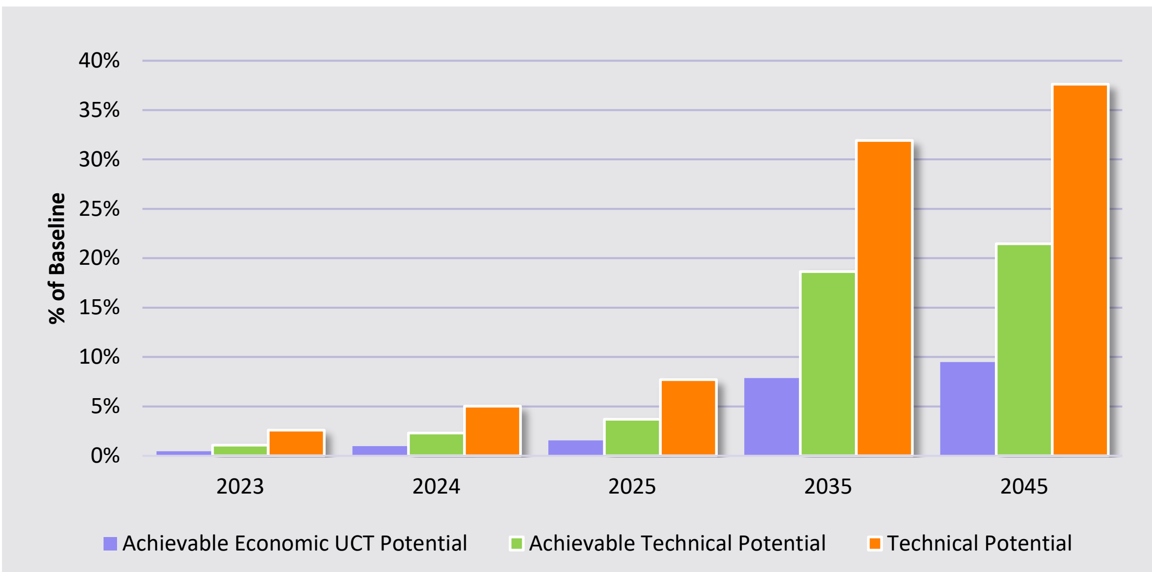
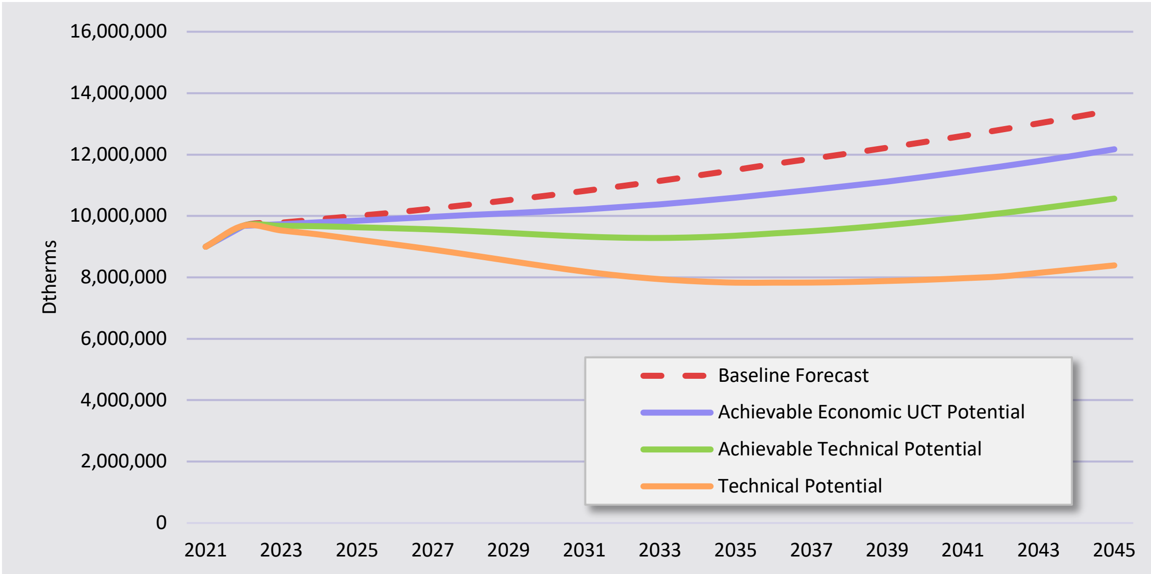


Figure 5-4 Baseline Projection and Energy Efficiency Forecasts, Idaho



6 | SECTOR-LEVEL ENERGY EFFICIENCY POTENTIAL

This chapter provides energy efficiency potential at the sector level.

Residential Sector

Washington Potential

Table 6-1 and Figure 6-1 summarize the energy efficiency potential for the residential sector. In 2023, TRC achievable economic potential is 54,479 dtherms, or 0.4% of the baseline projection. By 2040, cumulative savings are 1,187,145 dtherms, or 7.6% of the baseline.

Table 6-1 Residential Energy Conservation Potential Summary, Washington

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (Dth)	12,274,400	12,387,892	12,501,697	13,948,186	15,683,198
Cumulative Savings (Dth)					
TRC Achievable Economic Potential	54,479	103,469	169,578	866,240	1,187,145
Achievable Technical Potential	111,343	254,601	423,501	2,522,674	3,258,916
Technical Potential	264,105	573,696	906,085	4,569,190	6,154,164
Energy Savings (% of Baseline)					
TRC Achievable Economic Potential	0.4%	0.8%	1.4%	6.2%	7.6%
Achievable Technical Potential	0.9%	2.1%	3.4%	18.1%	20.8%
Technical Potential	2.2%	4.6%	7.2%	32.8%	39.2%

Figure 6-1 Cumulative Residential Potential as % of Baseline Projection, Washington

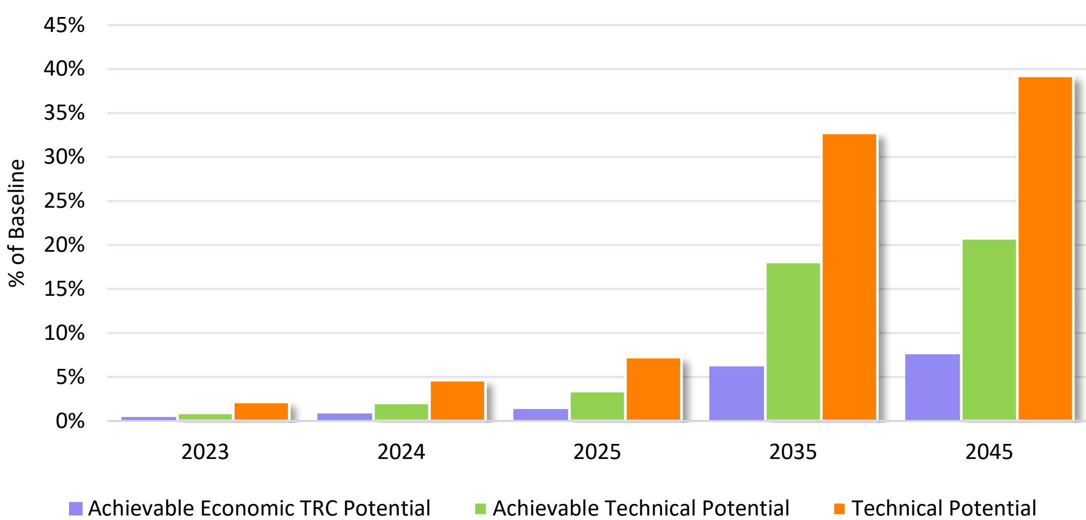


Figure 5-8 presents the forecast of cumulative energy savings by end. Space heating makes up a majority of potential followed by water heating.

Figure 6-2 Residential TRC Achievable Economic Potential – Cumulative Savings by End Use, Washington

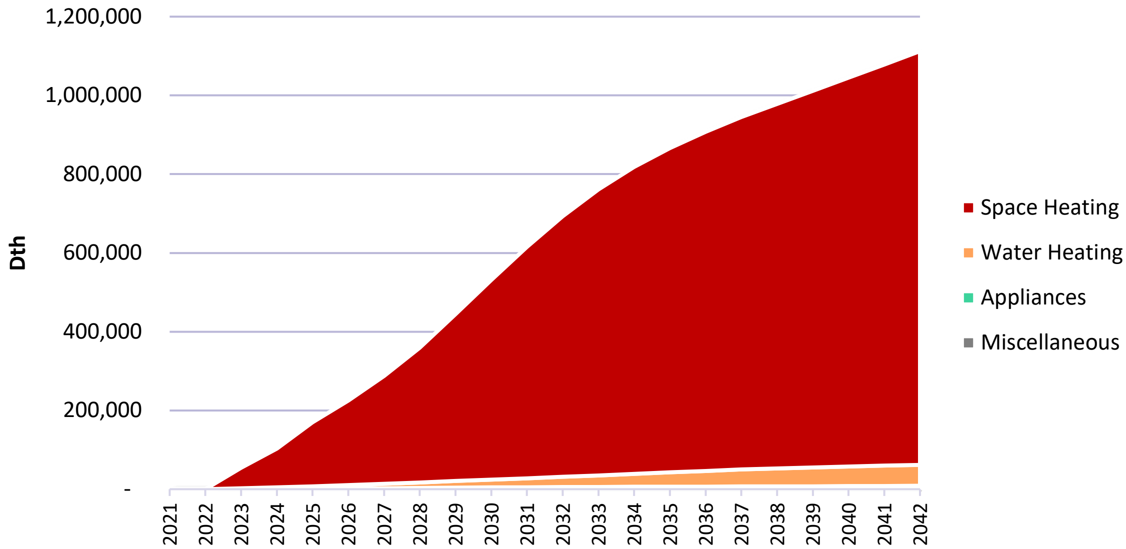


Table 6-2 identifies the top 20 residential measures by cumulative 2023 and 2035 savings. Furnaces, learning thermostats, insulation and water heating are the top measures.

Table 6-2 Residential Top Measures in 2023 and 2035, TRC Achievable Economic Potential, Washington

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Gas Furnace - Maintenance	19,639	36.0%	53,786	6.2%
2	Furnace	13,294	24.4%	248,091	28.6%
3	Connected Thermostat - ENERGY STAR (1.0)	7,426	13.6%	236,408	27.3%
4	Building Shell - Whole-Home Aerosol Sealing	6,216	11.4%	127,435	14.7%
5	Insulation - Ceiling Installation	3,478	6.4%	72,298	8.3%
6	Clothes Washer - ENERGY STAR (8.0)	2,161	4.0%	20,175	2.3%
7	Gas Boiler - Steam Trap Maintenance	637	1.2%	3,474	0.4%
8	Boiler	408	0.7%	11,449	1.3%
9	Behavioral Programs	298	0.5%	9,308	1.1%
10	Insulation - Wall Sheathing	271	0.5%	5,770	0.7%
11	ENERGY STAR Home Design	212	0.4%	25,408	2.9%
12	Building Shell - Liquid-Applied Weather-Resistive Barrier	130	0.2%	15,425	1.8%
13	Gas Boiler - Pipe Insulation	79	0.1%	646	0.1%
14	Gas Boiler - Thermostatic Radiator Valves	67	0.1%	1,374	0.2%
15	Ducting - Repair and Sealing - Aerosol	52	0.1%	2,314	0.3%
16	Water Heater - Drain Water Heat Recovery	38	0.1%	10,190	1.2%
17	Windows - Low-e Storm Addition	24	0.0%	5,184	0.6%
18	Circulation Pump - Timer	11	0.0%	2,719	0.3%
19	Windows - High Efficiency (Class 22)	11	0.0%	2,195	0.3%
20	Windows - High Efficiency (Class 30)	9	0.0%	1,798	0.2%
	Subtotal	54,462	100.0%	855,447	98.8%
	Total Savings in Year	**54,479**	**100.0%**	**866,240**	**100.0%**

Idaho Potential

Table 6-3 and Figure 6-3 summarize the energy efficiency potential for the residential sector. In 3, UCT achievable economic potential is 27,232 dtherms, or 0.4% of the baseline projection. By 2045, cumulative savings are 658,730 dtherms, or 7.4% of the baseline.

Table 6-3 Residential Energy Conservation Potential Summary, Idaho

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (Dth)	6,215,422	6,300,557	6,382,522	7,499,611	8,929,190
Cumulative Savings (Dth)					
Achievable Economic UCT Potential	27,232	55,524	90,790	455,114	658,730
Achievable Technical Potential	65,493	144,748	240,091	1,466,014	1,972,483
Technical Potential	165,889	331,905	520,749	2,640,710	3,686,728
Energy Savings (% of Baseline)					
Achievable Economic UCT Potential	0.4%	0.9%	1.4%	6.1%	7.4%
Achievable Technical Potential	1.1%	2.3%	3.8%	19.5%	22.1%
Technical Potential	2.7%	5.3%	8.2%	35.2%	41.3%

Figure 6-3 Cumulative Residential Potential as % of Baseline Projection, Idaho

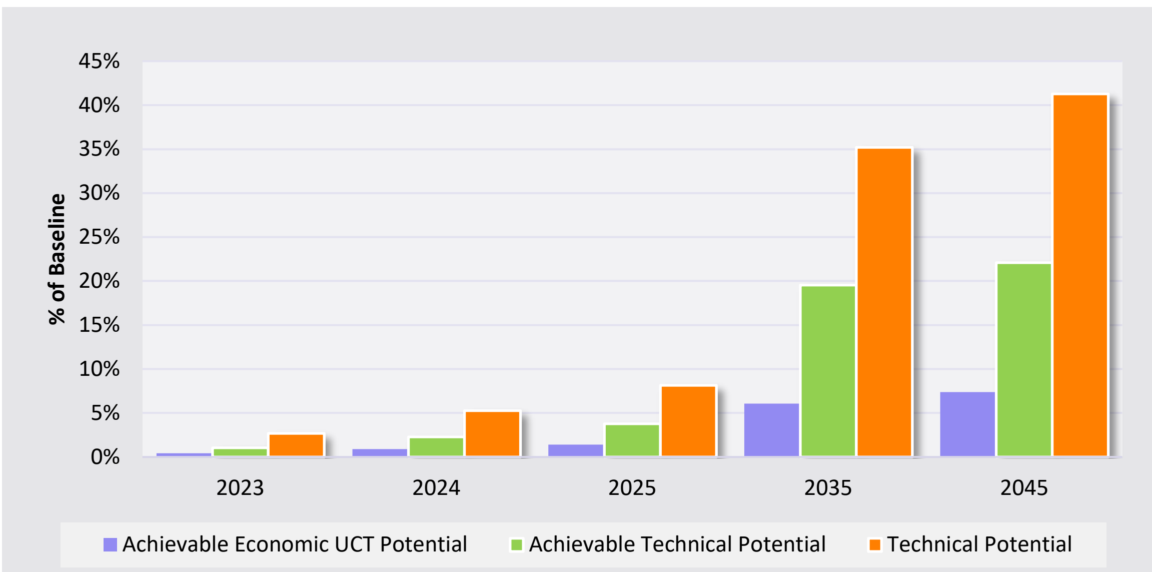


Figure 6-4 presents the forecast of cumulative energy savings by end use. Space heating makes up a majority of potential followed by water heating.

Figure 6-4 Residential UCT Achievable Economic Potential – Cumulative Savings by End Use, Idaho

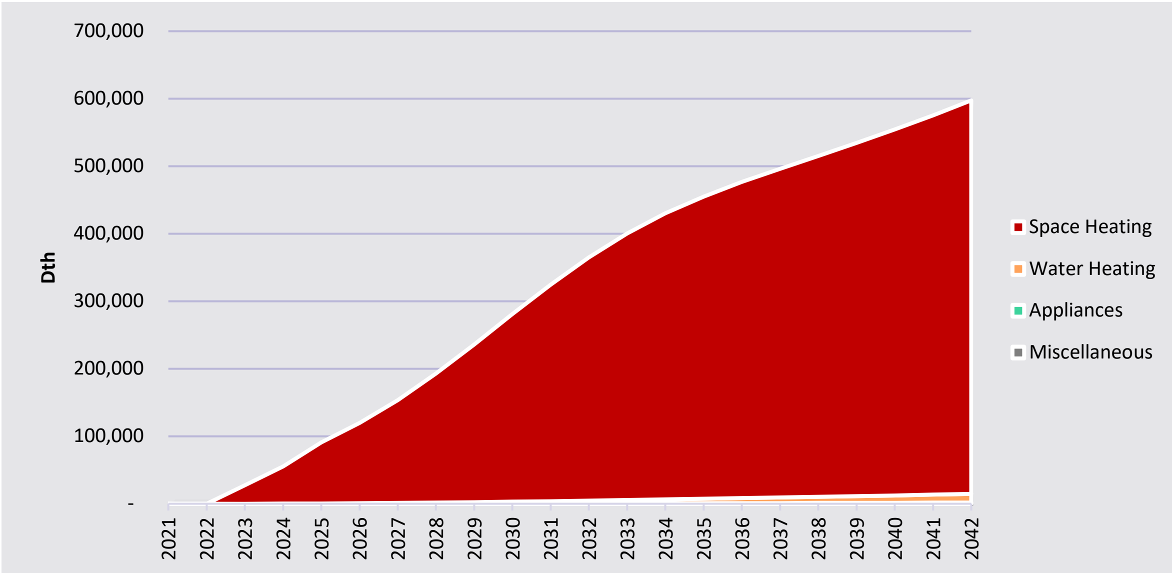


Table 6-4 identifies the top 20 residential measures by cumulative 2023 and 2035 savings. Furnaces, tankless water heaters, windows, and insulation are the top measures.

Table 6-4 Residential Top Measures in 2023 and 2035, TRC Achievable Economic Potential, Idaho

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Gas Furnace - Maintenance	11,234	41.3%	11,234	41.3%
2	Connected Thermostat - ENERGY STAR (1.0)	6,439	23.6%	6,439	23.6%
3	Furnace	3,261	12.0%	3,261	12.0%
4	Building Shell - Whole-Home Aerosol Sealing	2,962	10.9%	2,962	10.9%
5	Insulation - Ceiling Installation	1,906	7.0%	1,906	7.0%
6	Windows - Low-e Storm Addition	791	2.9%	791	2.9%
7	ENERGY STAR Home Design	263	1.0%	263	1.0%
8	Behavioral Programs	150	0.6%	150	0.6%
9	Insulation - Wall Sheathing	117	0.4%	117	0.4%
10	Insulation - Wall Cavity Installation	57	0.2%	57	0.2%
11	Windows - High Efficiency (Class 22)	15	0.1%	15	0.1%
12	Windows - High Efficiency (Class 30)	12	0.0%	12	0.0%
13	Building Shell - Liquid-Applied Weather-Resistive Barrier	11	0.0%	11	0.0%
14	Circulation Pump - Timer	8	0.0%	8	0.0%
15	Water Heater - Pipe Insulation	5	0.0%	5	0.0%
	Subtotal	27,232	100.0%	27,232	100.0%
	Total Savings in Year	**27,232**	**100.0%**	**27,232**	**100.0%**

Commercial Sector

Washington Potential

Table 6-5 and Figure 6-5 summarize the energy conservation potential for the commercial sector. In 2023, TRC achievable economic potential is 55,557 dtherms, or 0.8% of the baseline projection. By 2045, cumulative savings are 1,273,615 dtherms, or 14.8% of the baseline.

Table 6-5 Commercial Energy Conservation Potential Summary, Washington

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (dtherms)	7,069,971	7,101,191	7,136,906	7,720,617	8,594,749
Cumulative Savings (dtherms)					
Achievable Economic TRC Potential	55,557	118,321	185,945	941,943	1,273,615
Achievable Technical	78,348	164,679	257,030	1,225,667	1,642,279
Technical Potential	162,823	305,303	462,087	1,853,896	2,436,763
Energy Savings (% of Baseline)					
Achievable Economic TRC Potential	0.8%	1.7%	2.6%	12.2%	14.8%
Achievable Technical	1.1%	2.3%	3.6%	15.9%	19.1%
Technical Potential	2.3%	4.3%	6.5%	24.0%	28.4%

Figure 6-5 Cumulative Commercial Potential as % of Baseline Projection, Washington

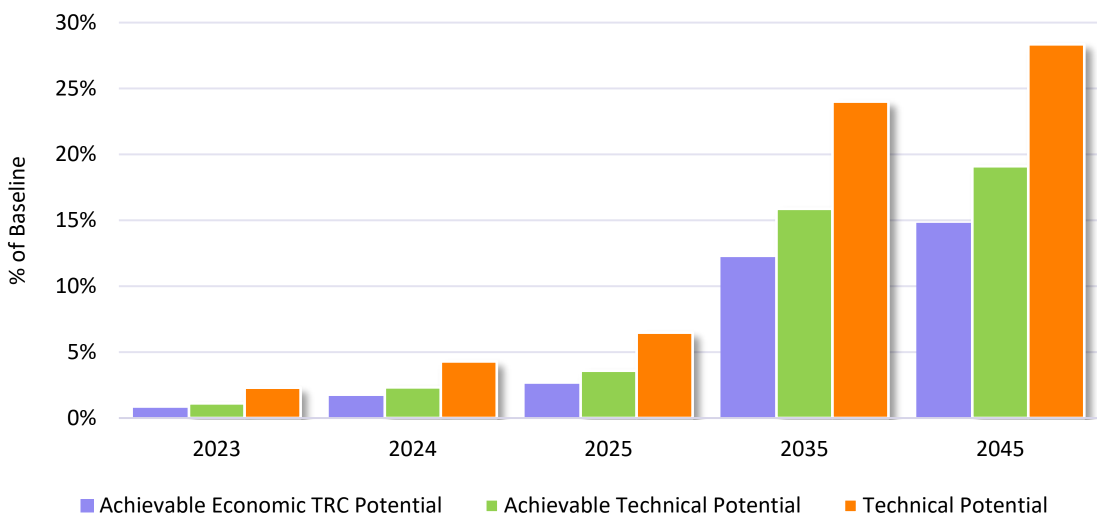


Figure 6-6 presents the cumulative forecast of energy savings by end. Space heating makes up a majority of the potential early, but water heating and food preparation equipment upgrades provide increased savings opportunities in the later years.

Figure 6-6 Commercial TRC Achievable Economic Potential – Cumulative Savings by End Use, Washington

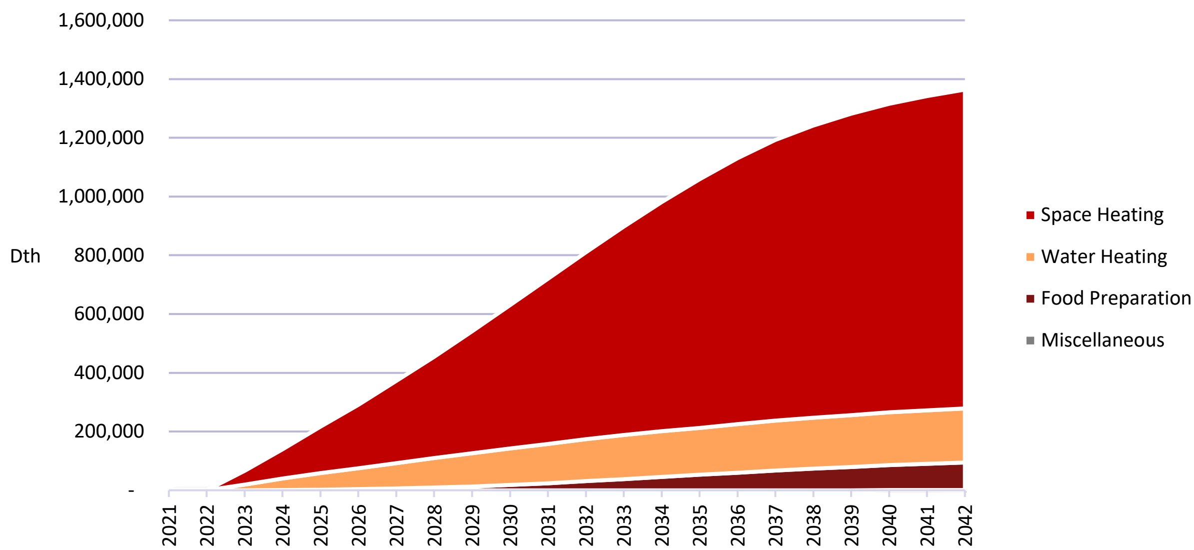


Table 6-6 identifies the top 20 commercial measures by cumulative savings in 2023 and 2035. Strategic Energy Management is the top measure, followed by Retrocommissioning and several HVAC and space heating measures, along with water heater controls.

Table 6-6 Commercial Top Measures in 2023 and 2035, TRC Achievable Economic Potential, Washington

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Strategic Energy Management	6,581	11.8%	44,626	4.7%
2	Retrocommissioning	5,777	10.4%	30,609	3.2%
3	Ventilation - Demand Controlled	5,364	9.7%	32,722	3.5%
4	HVAC - Energy Recovery Ventilator	4,613	8.3%	44,592	4.7%
5	Water Heater - Circulation Pump Controls	4,137	7.4%	32,785	3.5%
6	Boiler	3,630	6.5%	89,444	9.5%
7	Water Heater - Solar System	3,524	6.3%	23,836	2.5%
8	Water Heater - Temperature Setback	3,510	6.3%	6,799	0.7%
9	Thermostat - Connected	3,161	5.7%	13,233	1.4%
10	Water Heater - Tank Blanket/Insulation	1,875	3.4%	13,377	1.4%
11	Insulation - Wall Cavity	1,804	3.2%	127,530	13.5%
12	Water Heater - Efficient Dishwasher	1,793	3.2%	10,455	1.1%
13	Gas Boiler - Thermostatic Radiator Valves	1,750	3.1%	31,775	3.4%
14	Water Heater	1,743	3.1%	55,529	5.9%
15	Insulation - Ceiling	1,192	2.1%	76,887	8.2%
16	Water Heater - Pipe Insulation	896	1.6%	7,333	0.8%
17	Gas Boiler - High Turndown Burner	763	1.4%	5,194	0.6%
18	Gas Boiler - Hot Water Reset	747	1.3%	14,411	1.5%
19	Gas Boiler - Insulate Steam Lines/Condensate Tank	651	1.2%	6,552	0.7%
20	Advanced Kitchen Ventilation Controls	402	0.7%	8,883	0.9%
	Subtotal	53,913	97.0%	676,571	71.8%
	Total Savings in Year	**55,557**	**100.0%**	**941,943**	**100.0%**

Idaho Potential

Table 6-7 and Figure 6-7 summarize the energy conservation potential for the commercial sector. In 2023, UCT achievable economic potential is 17,641 dtherms, or 0.5% of the baseline projection. By 2045, cumulative savings are 591,777dtherms, or 13.8% of the baseline.

Table 6-7 Commercial Energy Conservation Potential Summary, Idaho

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (dtherms)	3,342,401	3,368,913	3,397,011	3,778,711	4,299,692
Cumulative Savings (dtherms)					
Achievable Economic UCT Potential	17,641	38,098	60,322	431,420	591,777
Achievable Technical	38,577	81,016	126,554	658,739	885,023
Technical Potential	86,399	162,707	245,484	1,007,830	1,338,703
Energy Savings (% of Baseline)					
Achievable Economic UCT Potential	0.5%	1.1%	1.8%	11.4%	13.8%
Achievable Technical	1.2%	2.4%	3.7%	17.4%	20.6%
Technical Potential	2.6%	4.8%	7.2%	26.7%	31.1%

Figure 6-7 Cumulative Commercial Potential as % of Baseline Projection, Idaho

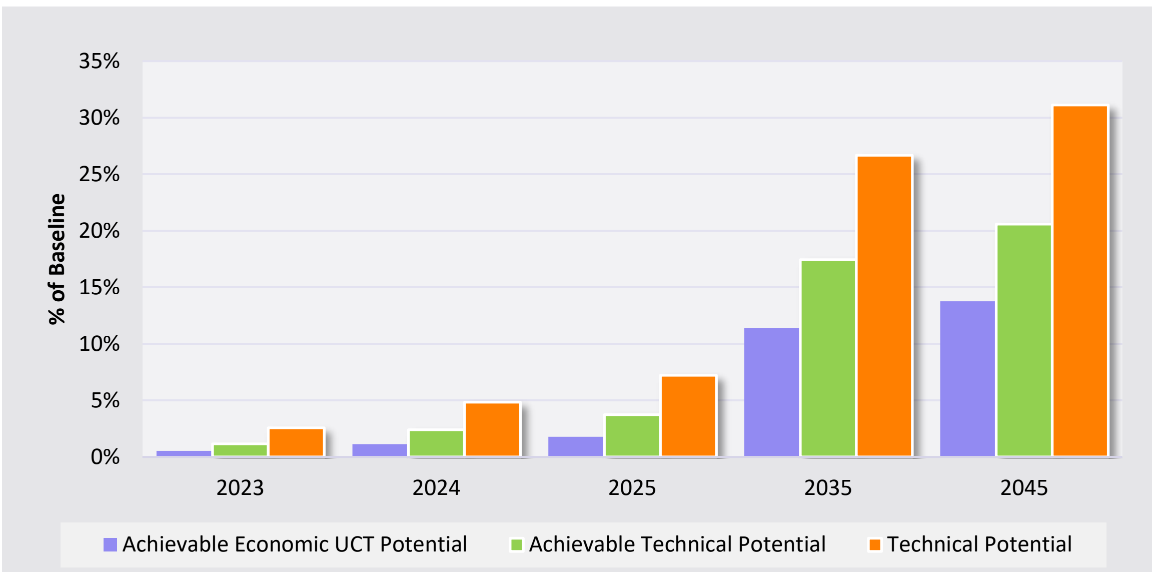


Figure 6-8 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings. Space heating makes up a majority of the potential early, but food preparation equipment upgrades provide substantial savings opportunities in the later years.

Figure 6-8 Commercial UCT Achievable Economic Potential – Cumulative Savings by End Use, Idaho

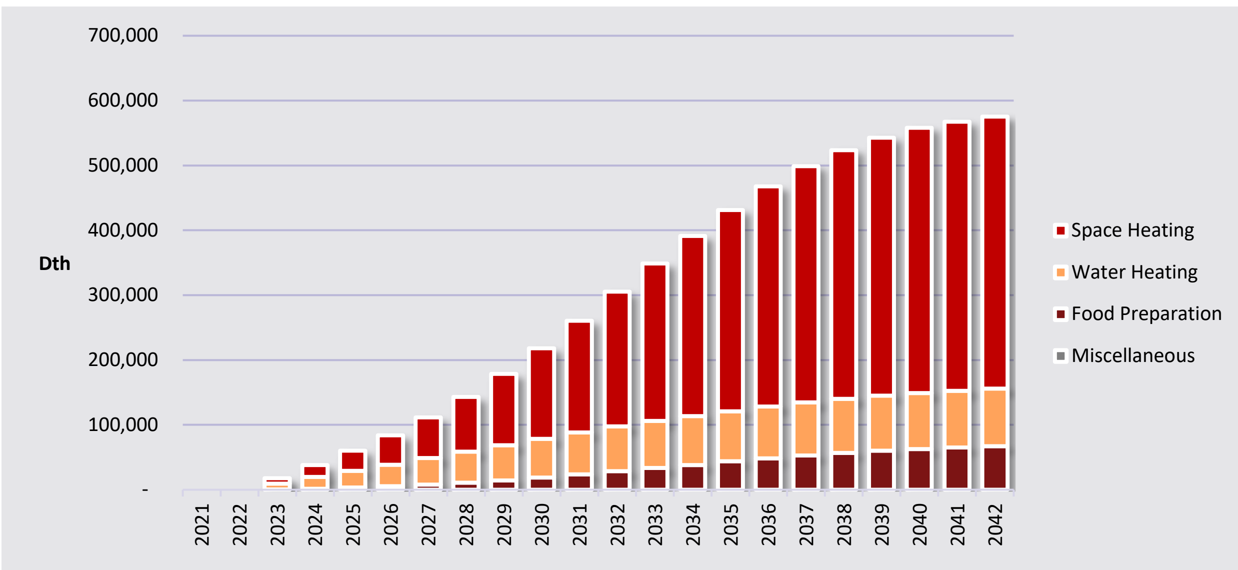


Table 6-8 identifies the top 20 commercial measures by cumulative savings in 2023 and 2035. Water Heaters are the top measure, followed by custom HVAC measures and insulation.

Table 6-8 Commercial Top Measures in 2023 and 2035, TRC Achievable Economic Potential, Idaho

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Water Heater - Circulation Pump Controls	2,030	11.5%	16,022	3.7%
2	Water Heater - Temperature Setback	1,703	9.7%	3,301	0.8%
3	Strategic Energy Management	1,492	8.5%	10,327	2.4%
4	HVAC - Energy Recovery Ventilator	1,426	8.1%	14,038	3.3%
5	Retrocommissioning	1,084	6.1%	5,705	1.3%
6	Water Heater - Low-Flow Showerheads	1,071	6.1%	7,967	1.8%
7	Ventilation - Demand Controlled	1,028	5.8%	6,326	1.5%
8	Water Heater - Tank Blanket/Insulation	915	5.2%	6,526	1.5%
9	Insulation - Wall Cavity	907	5.1%	94,182	21.8%
10	Water Heater	868	4.9%	27,735	6.4%
11	Gas Boiler - Thermostatic Radiator Valves	866	4.9%	16,123	3.7%
12	Insulation - Ceiling	536	3.0%	50,921	11.8%
13	Fryer	501	2.8%	30,335	7.0%
14	Water Heater - Faucet Aerators	413	2.3%	3,132	0.7%
15	Water Heater - Pipe Insulation	383	2.2%	3,120	0.7%
16	Gas Boiler - Hot Water Reset	370	2.1%	7,266	1.7%
17	Water Heater - Thermostatic Shower Restriction Valve	314	1.8%	2,262	0.5%
18	Gas Boiler - Insulate Steam Lines/Condensate Tank	294	1.7%	3,020	0.7%
19	Gas Boiler - High Turndown Burner	290	1.6%	2,041	0.5%
20	Water Heater - Drainwater Heat Recovery	254	1.4%	1,707	0.4%
	Subtotal	16,745	94.9%	312,056	72.3%
	Total Savings in Year	**17,641**	**100.0%**	**431,420**	**100.0%**

Industrial Sector

Washington Potential

Table 6-9 and Figure 6-9 summarize the energy conservation potential for the industrial sector. In 2023, TRC achievable economic potential is 1,956 dtherms, or 0.7% of the baseline projection. By 2045, cumulative savings reach 36,780 dtherms, or 12.3% 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 processes 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.

Table 6-9 Industrial Energy Conservation Potential Summary, Washington

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (dtherms)	287,959	293,150	296,345	298,131	298,267
Cumulative Savings (dtherms)					
Achievable Economic TRC Potential	1,956	3,943	5,963	25,680	36,780
Achievable Technical	1,963	3,957	5,988	25,774	37,043
Technical Potential	2,637	5,195	7,784	32,209	46,291
Energy Savings (% of Baseline)					
Achievable Economic TRC Potential	0.7%	1.3%	2.0%	8.6%	12.3%
Achievable Technical	0.7%	1.3%	2.0%	8.6%	12.4%
Technical Potential	0.9%	1.8%	2.6%	10.8%	15.5%

Figure 6-9 Cumulative Industrial Potential as % of Baseline Projection, Washington

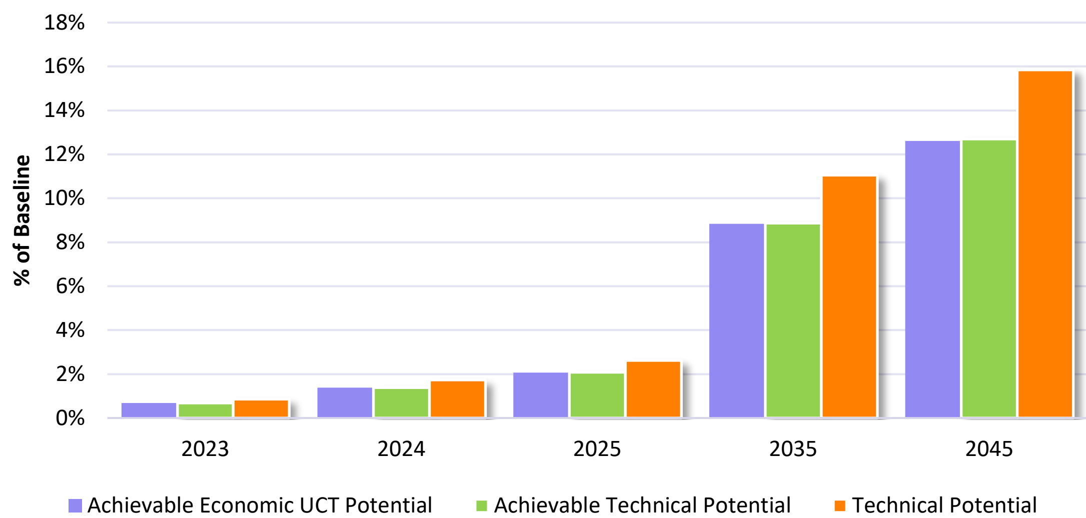


Figure 6-10 presents the forecast of cumulative energy savings by end use.

Figure 6-10 Industrial TRC Achievable Economic Potential – Cumulative Savings by End Use, Washington

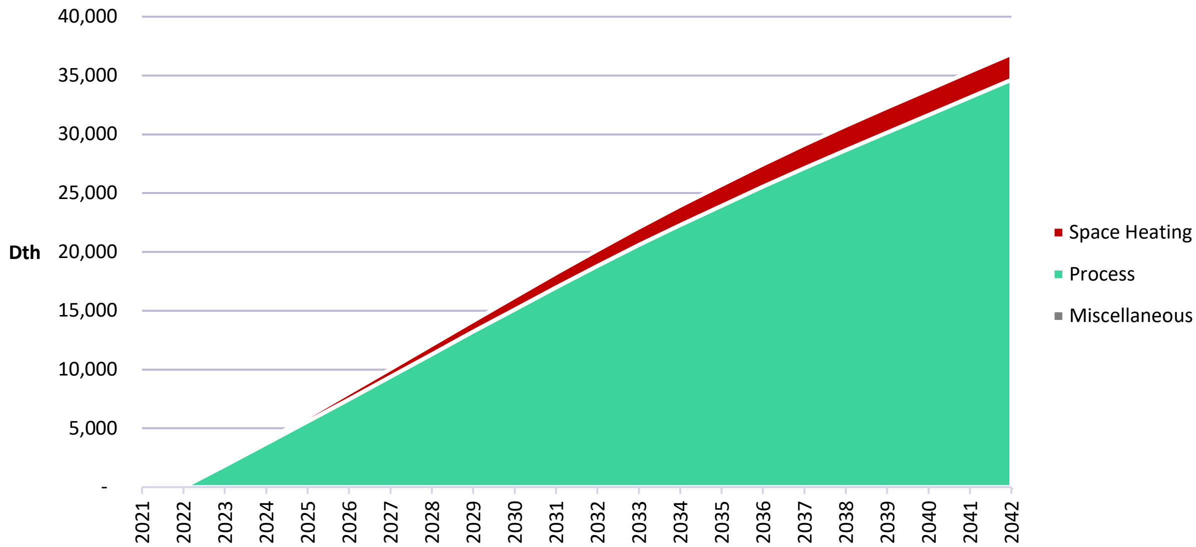


Table 6-10 identifies the top 20 industrial measures by cumulative 2023 and 2035 savings. Process Heat Recovery and Process Boiler control measures have the largest potential savings.

Table 6-10 Industrial Top Measures in 2023 and 2035, TRC Achievable Economic Potential, Washington

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Process - Heat Recovery	1,464.9	74.9%	19,327.6	75.3%
2	Process Boiler - Stack Economizer	135.7	6.9%	1,205.7	4.7%
3	Process Boiler - Insulate Steam Lines/Condensate Tank	69.6	3.6%	810.6	3.2%
4	Process Boiler - Hot Water Reset	66.5	3.4%	1,372.5	5.3%
5	Process Boiler - Insulate Hot Water Lines	46.6	2.4%	463.7	1.8%
6	Process Boiler - Maintenance	40.7	2.1%	87.6	0.3%
7	Destratification Fans (HVLS)	29.8	1.5%	375.3	1.5%
8	Thermostat - Connected	28.9	1.5%	146.6	0.6%
9	HVAC - Energy Recovery Ventilator	10.6	0.5%	111.2	0.4%
10	Gas Boiler - Stack Economizer	9.2	0.5%	64.7	0.3%
11	Ventilation - Demand Controlled	7.4	0.4%	47.6	0.2%
12	Retrocommissioning	7.3	0.4%	42.4	0.2%
13	Gas Boiler - High Turndown Burner	6.0	0.3%	45.0	0.2%
14	Gas Boiler - Insulate Steam Lines/Condensate Tank	5.2	0.3%	57.3	0.2%
15	Gas Boiler - Hot Water Reset	5.0	0.3%	97.1	0.4%
16	Process Boiler - Steam Trap Replacement	4.3	0.2%	26.9	0.1%
17	Process Boiler - Burner Control Optimization	4.1	0.2%	637.9	2.5%
18	Gas Boiler - Insulate Hot Water Lines	3.5	0.2%	31.8	0.1%
19	Gas Boiler - Maintenance	3.0	0.2%	5.7	0.0%
20	Unit Heater	2.3	0.1%	110.7	0.4%
	Subtotal	1,950.4	99.7%	25,067.8	97.6%
	Total Savings in Year	1,955.9	100.0%	25,679.6	100.0%

Idaho Potential

Table 6-11 and Figure 6-11 summarize the energy conservation potential for the industrial sector. In 2023, UCT achievable economic potential is 1,540 dtherms, or 0.7% of the baseline projection. By 2045, cumulative savings reach 28,004 dtherms, or 12.6% 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 processes 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.

Table 6-11 Industrial Energy Conservation Potential Summary, Idaho

Scenario	2023	2024	2025	2035	2045
Baseline Forecast (dekatherms)	223,967	223,982	223,868	222,921	222,119
Cumulative Savings (dekatherms)					
Achievable Economic UCT Potential	1,540	3,083	4,636	19,707	28,004
Achievable Technical	1,543	3,089	4,649	19,786	28,219
Technical Potential	1,925	3,886	5,857	24,634	35,215
Energy Savings (% of Baseline)					
Achievable Economic UCT Potential	0.7%	1.4%	2.1%	8.8%	12.6%
Achievable Technical	0.7%	1.4%	2.1%	8.9%	12.7%
Technical Potential	0.9%	1.7%	2.6%	11.1%	15.9%

Figure 6-11 Cumulative Industrial Potential as % of Baseline Projection, Idaho

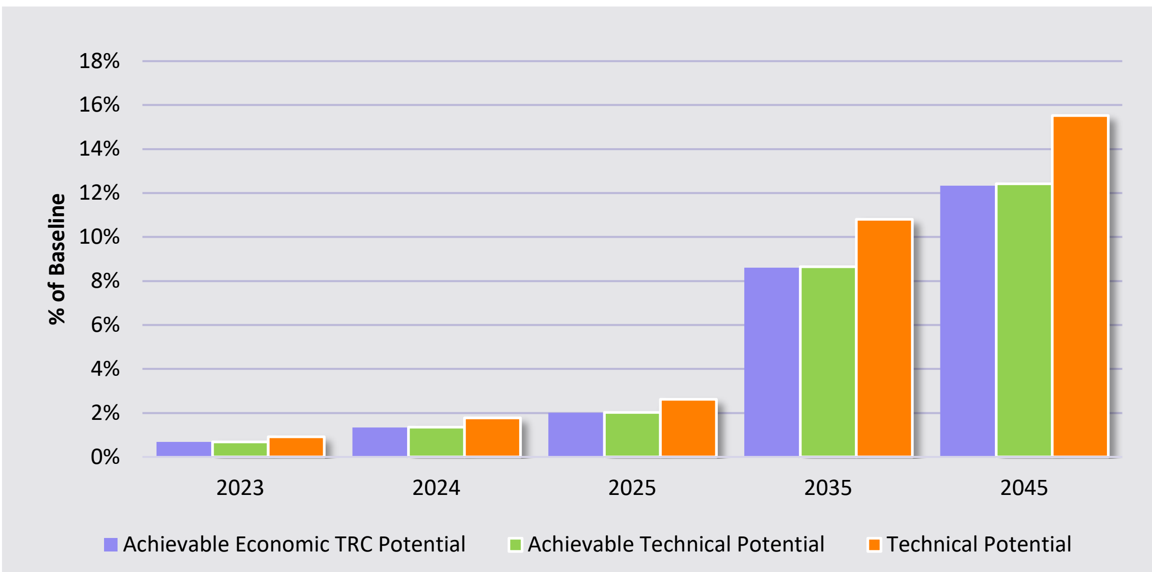


Figure 6-12 presents forecasts of energy savings by end use as a percent of total annual savings and cumulative savings.

Figure 6-12 Industrial UCT Achievable Economic Potential – Cumulative Savings by End Use, Idaho

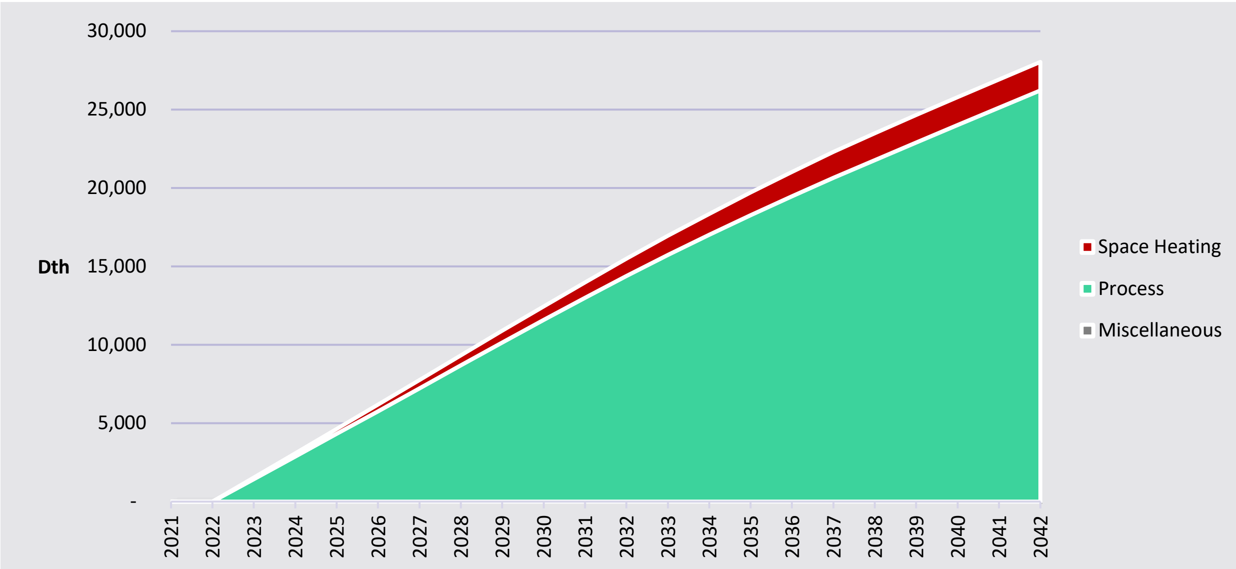


Table 6-12 identifies the top 20 industrial measures by cumulative 2023 and 2035 savings.

Table 6-12 Industrial Top Measures in 2023 and 2035, UCT Achievable Economic Potential, Idaho

Rank	Measure / Technology	2023 Cumulative dtherms	% of Total	2035 Cumulative dtherms	% of Total
1	Process - Heat Recovery	1,138.1	73.9%	14,508.6	73.6%
2	Process Boiler - Stack Economizer	105.4	6.8%	907.7	4.6%
3	Process Boiler - Insulate Steam Lines/Condensate Tank	59.4	3.9%	692.5	3.5%
4	Process Boiler - Hot Water Reset	57.4	3.7%	1,184.4	6.0%
5	Process Boiler - Insulate Hot Water Lines	39.8	2.6%	396.2	2.0%
6	Process Boiler - Maintenance	33.3	2.2%	71.7	0.4%
7	Destratification Fans (HVLS)	23.4	1.5%	285.5	1.4%
8	Thermostat - Connected	22.4	1.5%	111.9	0.6%
9	HVAC - Energy Recovery Ventilator	9.2	0.6%	96.0	0.5%
10	Gas Boiler - Stack Economizer	7.9	0.5%	55.8	0.3%
11	Ventilation - Demand Controlled	6.4	0.4%	41.1	0.2%
12	Retrocommissioning	6.3	0.4%	36.6	0.2%
13	Gas Boiler - High Turndown Burner	5.2	0.3%	38.9	0.2%
14	Gas Boiler - Insulate Steam Lines/Condensate Tank	4.5	0.3%	49.0	0.2%
15	Gas Boiler - Hot Water Reset	4.3	0.3%	83.8	0.4%
16	Process Boiler - Steam Trap Replacement	3.5	0.2%	21.7	0.1%
17	Process Boiler - Burner Control Optimization	3.2	0.2%	476.9	2.4%
18	Gas Boiler - Insulate Hot Water Lines	3.0	0.2%	27.2	0.1%
19	Gas Boiler - Maintenance	2.5	0.2%	4.7	0.0%
20	Gas Furnace - Maintenance	1.6	0.1%	2.9	0.0%
	Subtotal	1,536.7	99.8%	19,093.1	96.9%
	Total Savings in Year	**1,540.4**	**100%**	**19,702.8**	**100%**

7 | DEMAND RESPONSE POTENTIAL

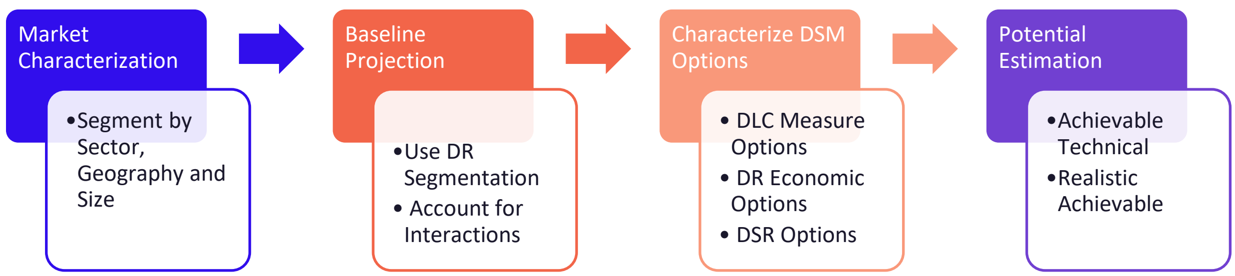
This study is the first time AEG estimated demand response (DR) potential for natural gas in the Avista territory. Natural gas DR is an emerging market with only a few programs offered in the US. To estimate potential, AEG referenced current natural gas DR program data and addressed gaps utilizing information from the electric DR study.

This study provides demand response potential and cost estimates for the 23-year planning horizon (2023-2045) across three states in the Avista territory (Washington, Idaho, and Oregon) to inform the development of Avista's 2023 IRP. Through this assessment, AEG sought to develop reliable estimates of the magnitude, timing, and costs of DR resources likely available to Avista over the planning horizon. The analysis focuses on resources assumed achievable during the planning horizon, recognizing known market dynamics that may hinder resource acquisition. The DR potential will be incorporated into subsequent DR planning and program development efforts.

Study Approach

Figure 7-1 outlines the analysis approach used to develop potential and cost estimates, with each step described in more detail in the following subsections.

Figure 7-1 Demand Response Analysis Approach



AEG estimated demand response potential across the following scenarios:

- Achievable Technical Potential or Stand Alone. Program options are treated as the only programs running in the Avista territory and are viewed in a vacuum. Potential savings cannot be added since it does not account for program overlap.
- Achievable Potential or Integrated. Program options are treated as if they are run simultaneously, and a program hierarchy is applied to account for participation overlap across programs that use the same end-use. For programs that affect the same end use, the model selects the most likely program a customer would participate in, and eligible participants were chosen for that program first. The remaining pool of eligible participants will then be available to participate in the secondary program. This scenario allows for potential to be added as it removes any double counting of savings.

Market Characterization

The first step was to segment customers by service class and develop characteristics for each segment. The two relevant characteristics for the DR potential analysis are end-use saturations of the controllable equipment types in each market segment and coincident peak demand in the base year. The market characteristics are consistent with the natural gas energy efficiency analysis (see Chapter 2 for more information on market profiles).

AEG used Avista's rate schedules as the basis for customer segmentation by state and customer class. Table 7-1 summarizes the market segmentation developed for this study.

Table 7-1 Market Segmentation

Market Dimensions	Segmentation Variable	Description
1	State	Idaho Oregon Washington
2	Customer Class	Residential Commercial Industrial

Baseline Forecast

Once the customer segments were defined and characterized, AEG developed the baseline projection. Load and consumption characteristics, including customer counts and peak-hour demand values, were provided by Avista and aligned with the natural gas energy efficiency analysis.

Customer Counts

Avista provided actual customer counts by rate schedule for each state over the 2017-2021 timeframe and forecasted customer counts over the 2022-2026 period. AEG used this data to calculate the growth rates by customer class across the final two forecasted years and projected customer counts through 2045. The average annual customer growth rate for all sectors is 1.3% in Washington, 1.5% in Idaho, and 0.9% in Oregon. Table 7-2, Table 7-3, and Table 7-4 show the number of customers by state and customer class for selected years.

Table 7-2 Baseline Customer Forecast by Customer Class, Washington

Customer Class	2023	2024	2025	2035	2045
Residential	162,739	164,977	167,198	190,988	218,240
Commercial	15,277	15,349	15,421	16,154	16,922
Industrial	93	93	93	93	93

Table 7-3 Baseline Customer Forecast by Customer Class, Idaho

Customer Class	2023	2024	2025	2035	2045
Residential	84,954	86,656	88,289	106,441	128,443
Commercial	9,623	9,739	9,845	10,879	12,050
Industrial	68	68	68	68	68

Table 7-4 Baseline Customer Forecast by Customer Class, Oregon

Customer Class	2023	2024	2025	2035	2045
Residential	94,779	95,803	96,875	108,034	120,487
Commercial	12,110	12,197	12,289	13,226	14,234
Industrial	26	26	26	26	26

Winter Peak Load Forecasts by State

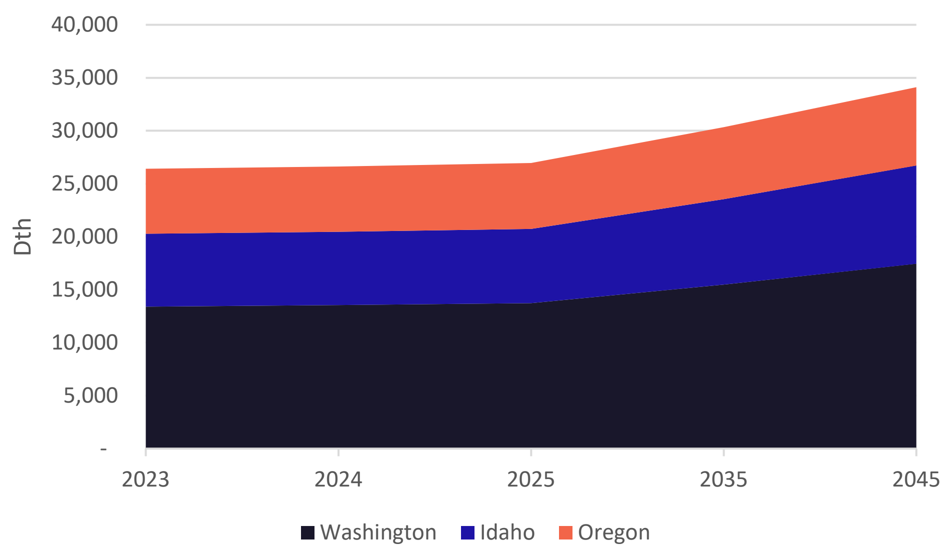
Winter peak load forecasts were developed by state and customer class by multiplying the per customer peak-hour demand values by class by the forecasted customer counts. Table 7-5 shows the winter system peak for selected future years. The system peaks are expected to increase by 33% between 2023-2045.

Table 7-5 Baseline February Winter System Peak Forecast (Dth @Generation) by State

State	2023	2024	2025	2035	2045
Washington	13,399	13,553	13,721	15,474	17,454
Idaho	6,877	6,909	7,026	8,077	9,273
Oregon	6,123	6,162	6,219	6,781	7,384
Grand Total	26,399	26,624	26,966	30,331	34,111

Figure 7-2 shows the contribution to the estimated system coincident winter peak by state. In 2023, system peak load for the winter is 26,399 dekatherms at generation. Washington contributes 51% to the winter system peak, while Idaho and Oregon contribute 26% and 23%, respectively. Winter coincident peak load is expected to grow by an average of 1.3% annually from 2023-2045.

Figure 7-2 Coincident Peak Load Forecast by State (Winter)



Characterize Demand Response Program Options

Next, AEG identified and described the viable DR programs for inclusion in the analysis and developed assumptions for key program parameters, including per customer impacts, participation rates, program eligibility, and program costs. AEG considered the characteristics and applicability of a comprehensive list of options available that could be feasibly run in Avista's territory. Once a list of DR options was determined, AEG characterized each option.

Each selected option is described briefly below.

Program Descriptions

DLC Smart Thermostats - Heating

These programs use the two-way communicating ability of smart thermostats to cycle heating end uses on and off during events. The program targets Avista's Residential and Commercial customers with qualifying equipment in Washington, Idaho, and Oregon. This was assumed to be a Bring Your Own Thermostat (BYOT) program; therefore, no equipment or installation costs were estimated.

Third Party Contracts

Third Party Contracts are assumed to be available for large commercial and industrial customers. This program is based on a firm curtailment strategy targeting large process and heating loads. It is also assumed that participating customers will agree to reduce demand by a specific amount or curtail consumption to a predefined level at the time of an event. In return, they receive a fixed incentive payment in the form of capacity credits or reservation payments (typically expressed as $/therm-month or $/therm-year). Customers are paid to be on call even though actual load curtailments may not occur. The amount of the capacity payment typically varies with the load commitment level. In addition to the fixed capacity payment, participants typically receive a payment for gas reduction during events. Because it is a firm, contractual arrangement for a specific level of load reduction, enrolled loads represent a firm resource and can be counted toward installed capacity requirements. Penalties may be assessed for under-performance or non-performance. Events may be called on a day-of or day-ahead basis as conditions warrant.

This option is typically delivered by load aggregators and is most attractive for customers with high natural gas demand and flexibility in their operations. Industry experience indicates that aggregation of customers with smaller-sized loads is less attractive financially due to lower economies of scale. In addition, customers with 24x7 operations, continuous processes, or with obligations to continue providing service (such as schools and hospitals) are not often good candidates for this option.

Time-of-Use Pricing

The TOU pricing rate is a standard rate structure where rates are lower during off-peak hours and higher during peak hours during the day, incentivizing participants to shift energy use to periods of lower grid stress. For the TOU rate, there are no events called, and the structure does not change during the year. Therefore, it is a good default rate for customers that still offers some load-shifting potential. This rate is assumed to be available to all service classes.

Variable Peak Pricing

The Variable Peak Pricing (VPP) rate is composed of significantly higher prices during relatively short critical peak periods on event days to encourage customers to reduce their usage. VPP is usually offered in conjunction with a time-of-use rate, which implies at least three time periods: critical peak, on-peak and off-peak. The customer incentive is a more heavily discounted rate during off-peak hours throughout the year (relative a standard TOU rate). Event days are dispatched on relatively short notice (day ahead or day of), typically for a limited number of days during the year. Over time, event-trigger criteria become well-established so that customers can expect events based on hot weather or other factors. Events can also be called during times of system contingencies or emergencies. This rate has been assumed to be offered to all service classes.

Behavioral DR

Behavioral DR is structured like traditional demand response interventions, but it does not rely on enabling technologies, nor does it offer financial incentives to participants. Participants are notified of an event and simply asked to reduce their consumption during the event window. Generally, notification occurs the day prior to the event and are deployed utilizing a phone call, email, or text message. The next day, customers may receive post-event feedback that includes personalized results and encouragement. This program is assumed to be offered to residential and commercial customers.

Program Assumptions and Characteristics

The key parameters required to estimate the potential for a DR program are participation rate, per-participant load reduction, and eligibility or end use saturations.[6] The development of these parameters is based on research findings and a review of available information on the topic, including national program survey

[6] End Use Saturations used in this study are provided in Appendix D.

databases, evaluation studies, program reports, and regulatory filings. AEG's assumptions of these parameters are described below.

Participation Rate Assumptions

Table 7-6 below shows the steady-state participation rate assumptions for each demand side management (DSM) option as well as the basis for the assumptions.

Table 7-6 Steady-State Participation Rate Assumptions (% of eligible customers)

DSM Option	Residential Service	Commercial Service	Industrial Service	Basis for Assumption
Behavioral	12%	12%	-	PG&E rollout with six waves (2017) - 60% of Electric Behavioral Program Participation
DLC Smart Thermostats - BYOT	9%	9%	-	NWPC Smart Thermostat cooling assumption - 60% of Electric Smart Thermostat Program Participation
Time-of-Use	8%	8%	8%	Industry experience - 60% of Electric TOU Program Participation
Variable Peak Pricing	15%	15%	15%	OG&E 2019 Smart Hours Study - 60% of Electric VPP Program Participation
Third Party Contracts	-	5%	13%	Industry Experience - 60% of Electric Third Party Contracts Program Participation. Commercial adjusted to reflect challenge of reducing heating loads

Load Reduction Assumptions

Table 7-7 presents the per participant load reductions for each DSM option and explains the basis for these assumptions.

Table 7-7 DSM Per Participant Impact Assumptions

DSM Option	Residential Service	Commercial Service	Industrial Service	Basis for Assumption
Behavioral	2%	2%	-	PG&E rollout with six waves (2017)
DLC Smart Thermostats - BYOT	15%	15%	-	SoCalGas 2019 Impact Evaluation
Time-of-Use	3%	1%	2%	Electric TOU Winter Program Impacts
Variable Peak Pricing	8%	4%	3%	OG&E 2019 Smart Hours Impact Evaluation
Third Party Contracts	-	8%	8%	De-rated BYOT Residential impact for Third Party accounting for less discretionary load

Other Cross-cutting Assumptions

In addition to the above program-specific assumptions, there are three that affect all programs:

- Discount rate. A nominal discount rate of 5.21% was used to calculate the net present value of costs over the useful life of each DR program. All cost results are shown in nominal dollars.
- Line losses. Avista provided a line loss factor of 6.16% to convert estimated demand savings at the customer meter level to the generator level. Results in the next section are reported at the generator level.
- Shifting and Saving. Each program varies in the way energy is shifted or saved throughout the day. For example, customers on the DLC Smart Thermostat program are likely to pre-heat their homes prior to the event and turn their heaters back on after the event (snapback effect). The results in this report only show

the savings during the event window and not before and after the event. However, shifting and savings assumptions were provided to Avista for each program to inform the IRP results.

Integrated DR Potential Results

This section presents analysis results for demand savings and levelized costs for all considered DR programs. In the interest of succinctness, AEG only presents the Integrated scenario results in this chapter. The integrated approach represents Realistic Achievable Potential and is the most realistic scenario allowing for multiple DR programs to be run at the same time employing a hierarchy that eliminates double counting of impacts. The stand-alone scenario (Achievable Technical Potential) results can be found in Appendix D. All potential results represent savings at the generator.[7]

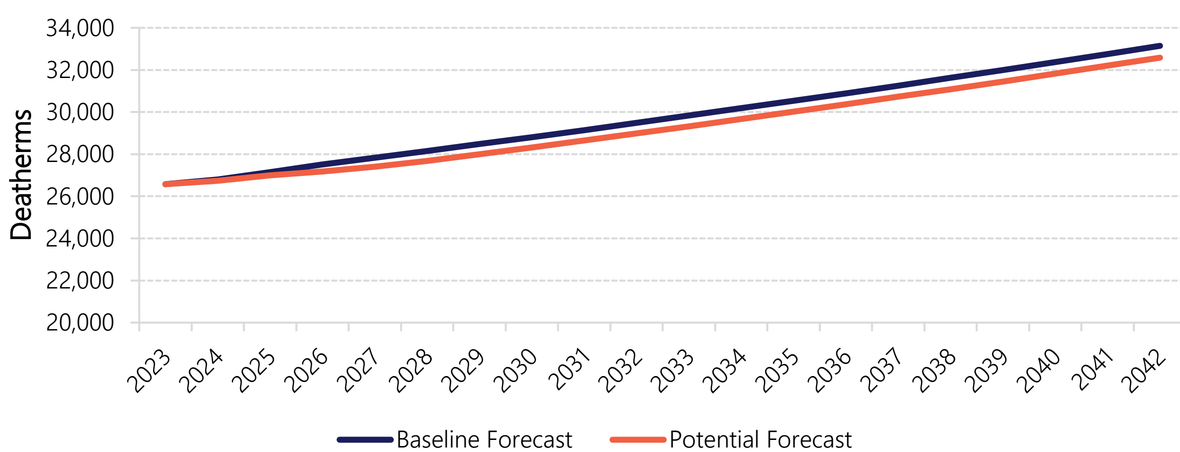
Integrated Results Summary

Table 7-8, and Figure 7-3 show the total winter demand savings for selected years. These savings represent total integrated savings from all available DR options in Avista's Washington, Idaho, and Oregon service territories. All programs are assumed to start in 2024 so there is zero potential across all programs in 2023. The total potential savings are expected to increase from 0 in 2023 to 614 dekatherms by 2045. The percentage of system peak goes from 0% in 2023 to 1.8% by 2045.

Table 7-8 Summary of Integrated Potential (Dekatherms @ Generator)

	2023	2024	2025	2035	2045
Baseline Forecast	26,574	26,801	27,145	30,533	34,338
Achievable Potential	-	72	176	545	614
Achievable Potential (% of baseline)	0%	0%	1%	2%	2%
Potential Forecast	26,574	26,729	26,969	29,988	33,724

Figure 7-3 Summary of Integrated Potential (Dekatherms @ Generator)



Integrated Results

Key findings from the integrated scenario include:

- The largest potential option is DLC Smart Thermostats - BYOT, contributing 403 dekatherms by 2045.
- The next largest projected savings comes from the Variable Peak Pricing Rate, contributing 120 dekatherms by 2045.

[7] Line losses were applied to all savings potential as well as demand forecasts to present the results in terms of generation as opposed to meter.

- The three remaining options contribute 92 dekatherms by 2045

Potential by DSM Option

Figure 7-4 and Table 7-9 show the total winter demand savings from individual DR options for selected years. These savings represent integrated savings from all available DR options in Avista's Washington, Idaho, and Oregon service territories. Several DR programs require Advanced Metering Infrastructure (AMI) such as rates (TOU and VPP) and behavioral options. Currently Washington is the only state in the Avista territory with AMI[8]. Therefore, DLC Smart Thermostats – BYOT and Third Party Contracts are the only two programs available to all three states. Across Avista's entire territory, The DLC Smart Thermostats – BYOT program is projected to save the most of all programs at 403 dekatherms by 2045 followed by Variable Peak Pricing at 120 dekatherms by 2045.

Figure 7-4 Summary of Potential by Option – (Dekatherms @ Generator)

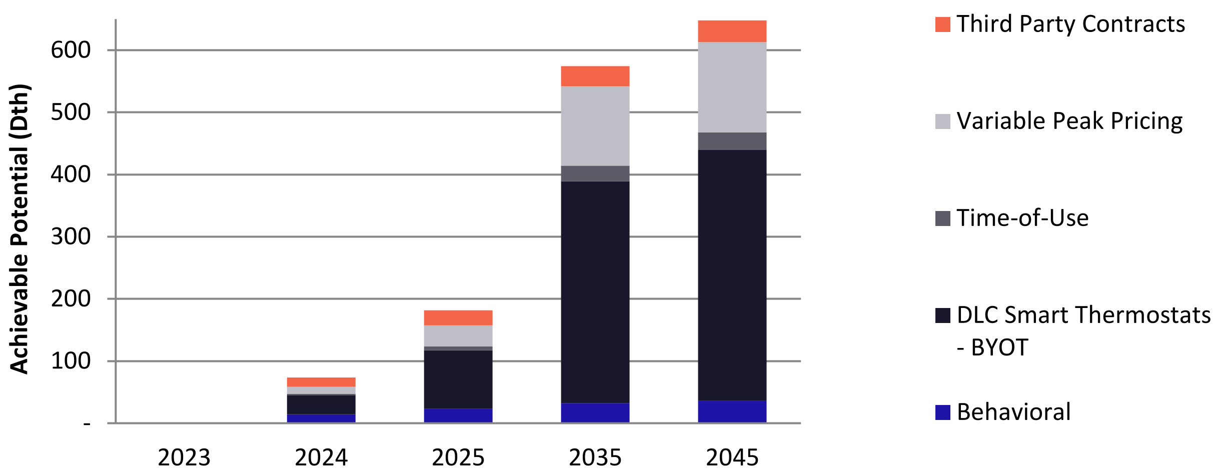


Table 7-9 Summary of Potential by Option – (Dekatherms @ Generator)

	2023	2024	2025	2035	2045
Behavioral	-	14	22	30	33
DLC Smart Thermostats - BYOT	-	31	94	357	403
Time-of-Use	-	2	6	21	23
Variable Peak Pricing	-	10	30	105	119
Third Party Contracts	-	15	24	32	35

Potential by Class

Table 7-10, Table 7-11, and Table 7-12 show the total winter demand savings by class for Washington, Idaho, and Oregon respectively. Washington is projected to save 407 dekatherms (2.3% of winter system peak demand) by 2045, Idaho is projected to save 126 dekatherms (1.4% of winter system peak demand) by 2045, and Oregon is projected to save 80 dekatherms (1.1% of winter system peak demand) by 2045.

The residential sector contributes 69% of the total load across all three states while commercial and industrial contribute 44% and 2% respectively. This is due primarily to the low number of industrial natural gas customers in Avista's territory.

[8] See Appendix Section A | for end use saturation details

Table 7-10 Potential by Class – Dekatherms @Generator, Washington

	2023	2024	2025	2035	2045
Baseline Forecast	13,399	13,553	13,721	15,474	17,454
Achievable Potential	-	51	120	361	407
Residential	-	30	76	249	284
Commercial	-	20	43	110	121
Industrial	-	1	1	2	2

Table 7-11 Potential by Class – Dekatherms @Generator, Idaho

	2023	2024	2025	2035	2045
Baseline Forecast	6,877	6,909	7,026	8,077	9,273
Achievable Potential	-	12	32	110	126
Residential	-	6	19	76	91
General Service	-	6	13	33	35
Large General Service	-	0	1	1	1

Table 7-12 Potential by Class – Dekatherms @Generator, Oregon

	2023	2024	2025	2035	2045
Baseline Forecast	6,123	6,162	6,219	6,781	7,384
Achievable Potential	-	9	24	74	80
Residential	-	4	12	43	48
General Service	-	5	11	30	32
Large General Service	-	0	0	0	0

Figure 7-5 Potential by Class –Dekatherms @Generator, Washington

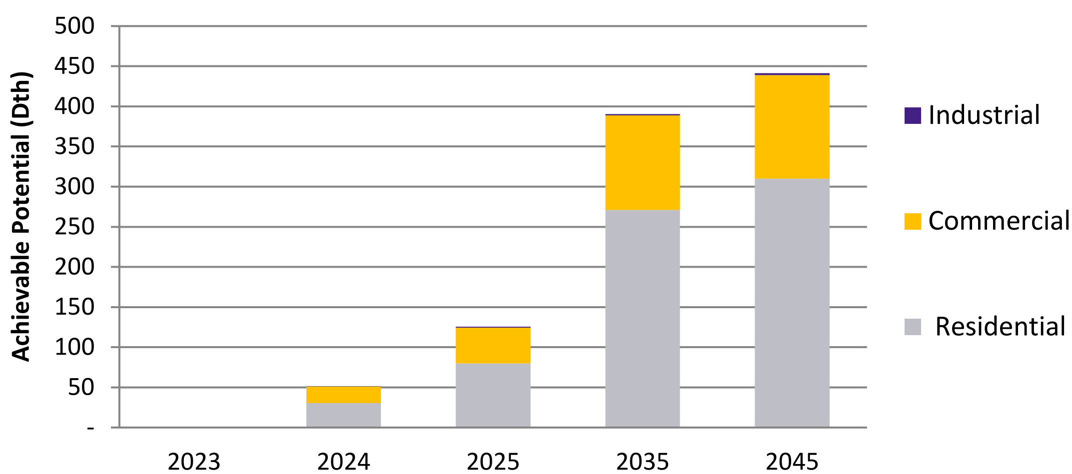


Figure 7-6 Potential by Class – Dekatherms @Generator, Idaho

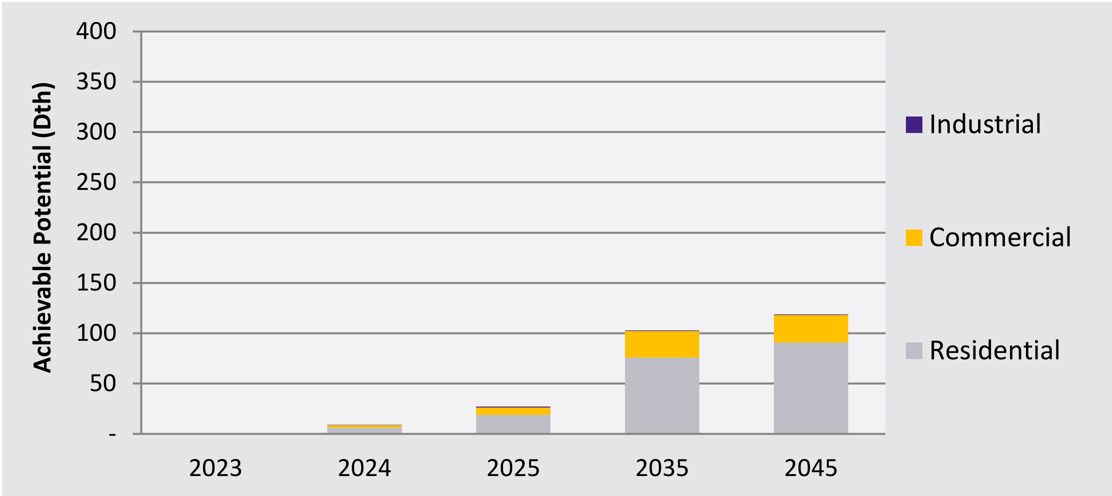
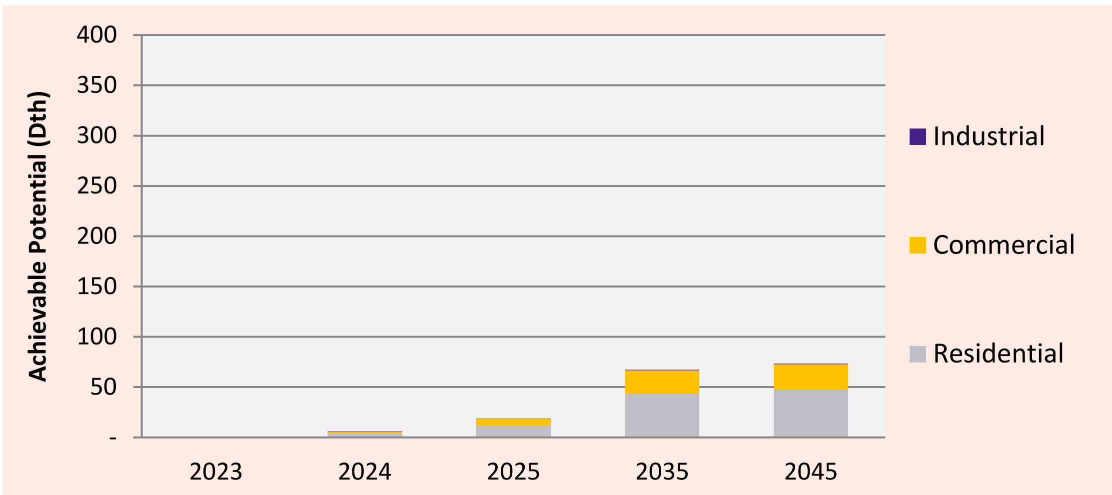


Figure 7-7 Potential by Class – Dekatherms @Generator, Oregon



Levelized Costs

Table 7-13 presents the levelized costs per dekatherm of equivalent generation capacity over 2023-2032 for Washington, Idaho, and Oregon. The ten-year NPV dekatherm potential by program is shown for reference in the first column.

Key findings include:

- The Third Party Contracts option is expected to be the cheapest program to run per dekatherm savings at approximately $2,568/Dth-year. Capacity-based and energy-based payments to the third-party constitutes the major cost component for this option. All development, O&M, and administrative costs are expected to be incurred by the representative third-party contractor.
- The Time-of-Use option has the highest levelized cost among all the DR options over ten years at $16,815/dekatherm-year system-wide. The main contributors to the high cost compared to low savings are marketing and recruitment and administrative costs.

Table 7-13 Levelized Program Costs and Potential (TOU Opt-In Winter)

Program	NPV Dth Potential	Levelized Costs ($/Dth)
Behavioral	168.48	$11,170.36
DLC Smart Thermostats - BYOT	1633.65	$4,924.69
Time-of-Use	94.94	$16,814.75
Variable Peak Pricing	487.42	$4,338.36
Third Party Contracts	186.21	$2,567.59

A | DEMAND RESPONSE POTENTIAL APPENDIX

Equipment End Use Saturation

The end use saturation data is required to further segment the market and identify eligible customers for direct control of different equipment options. Table A-1 below shows saturation estimates by state and customer class for Washington, Idaho, and Oregon. For Washington and Idaho, AEG used the end use saturation data from the energy efficiency study. In absence of saturation data, Oregon saturations use Washington saturations as a proxy. For AMI, Avista provided gas AMI saturation data for Washington, but AMI has yet to be rolled out in Idaho and Oregon.

Table A-1 End Use Saturations by Customer Class and State[9]

State	Customer Class	End Use Saturation	2023	2024	2025	2035	2045	Source
WA	Res	Gas Space Heat	87%	87%	87%	89%	89%	Baseline Survey
WA	Res	Gas Water Heat	55%	55%	55%	56%	56%	Baseline Survey
WA	Res	Behavioral	100%	100%	100%	100%	100%	Default
WA	Res	AMI	85%	85%	85%	85%	85%	AMI data from Avista
WA	Com	Gas Space Heat	77%	77%	77%	77%	77%	Baseline Survey
WA	Com	Gas Water Heat	58%	58%	58%	58%	58%	Baseline Survey
WA	Com	Behavioral	100%	100%	100%	100%	100%	Default
WA	Com	AMI	86%	86%	86%	86%	86%	AMI data from Avista
WA	Ind	Gas Space Heat	84%	84%	84%	84%	84%	Baseline Survey
WA	Ind	Gas Process Heat	100%	100%	100%	100%	100%	Baseline Survey
WA	Ind	AMI	97%	97%	97%	97%	97%	AMI data from Avista
ID	Res	Gas Space Heat	94%	94%	94%	94%	94%	Baseline Survey
ID	Res	Gas Water Heat	56%	56%	56%	56%	56%	Baseline Survey
ID	Res	Behavioral	100%	100%	100%	100%	100%	Default
ID	Res	AMI	0%	0%	0%	0%	0%	AMI data from Avista
ID	Com	Gas Space Heat	77%	77%	77%	77%	77%	Baseline Survey
ID	Com	Gas Water Heat	58%	58%	58%	58%	58%	Baseline Survey
ID	Com	Behavioral	100%	100%	100%	100%	100%	Default
ID	Com	AMI	0%	0%	0%	0%	0%	AMI data from Avista
ID	Ind	Gas Space Heat	84%	84%	84%	84%	84%	Baseline Survey
ID	Ind	Gas Process Heat	100%	100%	100%	100%	100%	Baseline Survey
ID	Ind	AMI	0%	0%	0%	0%	0%	AMI data from Avista
OR	Res	Gas Space Heat	87%	87%	87%	89%	89%	WA Proxy
OR	Res	Gas Water Heat	55%	55%	55%	56%	56%	WA Proxy
OR	Res	Behavioral	100%	100%	100%	100%	100%	WA Proxy
OR	Res	AMI	0%	0%	0%	0%	0%	AMI data from Avista
OR	Com	Gas Space Heat	77%	77%	77%	77%	77%	WA Proxy
OR	Com	Gas Water Heat	58%	58%	58%	58%	58%	WA Proxy
OR	Com	Behavioral	100%	100%	100%	100%	100%	Default
OR	Com	AMI	0%	0%	0%	0%	0%	AMI data from Avista
OR	Ind	Gas Space Heat	84%	84%	84%	84%	84%	WA Proxy
OR	Ind	Gas Process Heat	100%	100%	100%	100%	100%	WA Proxy
OR	Ind	AMI	0%	0%	0%	0%	0%	AMI data from Avista

Mechanism and Event Hours

Table A-2 lists the DSM options considered in the study, including the eligible sectors, the mechanism for deployment, and the expected annual event hours.

[9] Res = Residential, Com = Commercial, Ind = Industrial

Table A-2 DSM Program Event Hours

DSM Option	Eligible Sectors	Annual Seasonal Hours	Average Event Duration (hours)	Estimated Number of Events per Year
Behavioral	Res and Com	40	6	7
Third Party Contracts	C&I	30	4	8
Time-of-Use	All	528	6	88
Variable Peak Pricing Rates	All	80	4	20
DLC Smart Thermostats - BYOT	Res and Com	36	3	12

Stand Alone Results

Figure A-1 and Table A-3 show the winter demand savings from individual DR options. These savings represent stand-alone savings from all available DR options in Washington, Idaho, and Oregon service territories. The Smart Thermostats and Third Party Contracts programs are projected to save the same amount as in the integrated scenario due to the expectation that there won't be participation overlap across other programs for these offerings.

- Like in the integrated scenario, the largest potential option is DLC Smart Thermostats - BYOT, contributing 403 dekatherms by 2045.
- The next largest projected savings comes from the Variable Peak Pricing Rate, contributing 145 dekatherms by 2045.

Figure A-1 Summary of Potential by Option – Stand Alone (Dekatherms @Generator)

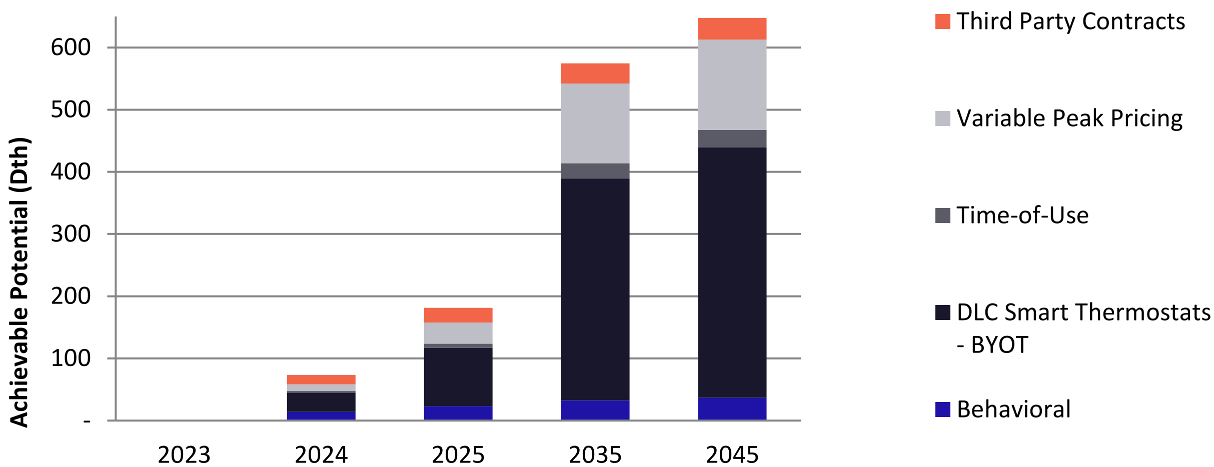


Table A-3 Summary of Potential by Option – Stand Alone (Dekatherms @ Generator)

	2023	2024	2025	2035	2045
Behavioral	-	14	23	33	37
DLC Smart Thermostats - BYOT	-	31	94	357	403
Time-of-Use	-	2	7	25	28
Variable Peak Pricing	-	11	34	128	145
Third Party Contracts	-	15	24	32	35

Applied Energy Group, Inc.
2300 Clayton Road, Suite 1370
Concord, CA 94520