AEG

Idaho Power Company - Energy Efficiency Potential Study

Prepared for: Idaho Power Company
By: Applied Energy Group, Inc.
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AEG Key Contact: Eli Morris

This work was performed by

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

Project Director: Eli Morris
Project Manager: Neil Grigsby
Project Team: Kenneth Walter
Fuong Nguyen

EXECUTIVE SUMMARY

In 2021, Idaho Power Company (IPC) contracted with Applied Energy Group (AEG) to provide an Energy Efficiency Potential Study (Potential Study) to support its 2023 Integrated Resource Plan (IRP) process. This study provides reliable estimates of the magnitude, timing, and costs of DSM resources that are likely available to IPC over a 20-year planning horizon. The study focuses on resources assumed achievable during the planning horizon, recognizing that known market dynamics may hinder resource acquisition. Study results will be incorporated into IPC's 2023 IRP and subsequent DSM planning and program development efforts. This study serves as an update to similar studies completed previously for IPC.

AEG used the analysis framework and data developed for the 2020 Potential Study as a starting point, implementing targeted updates to address IPC's evolving energy efficiency program requirements and stakeholder feedback. The key updates relative to the 2020 study include:

- Measure characterization based on changes in measure assumptions used in the Northwest Power and Conservation Council's 2021 Power Plan.
- Recent IPC energy efficiency program experience.
- Base-year (2021) customer usage.
- Results of IPC's 2022 Residential End-Use Survey, a residential saturation survey.
- Expected impacts of future known codes and standards throughout the forecast period.
- Current technology saturations and assumptions about future adoption of energy-efficient options from the Energy Information Administration's 2021 Annual Energy Outlook (AEO).

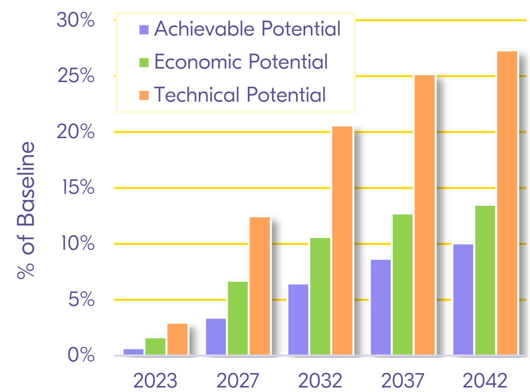
The study uses the updated data to:

- Provide credible and transparent estimation of the technical, economic, and achievable energy efficiency potential annually over the next 20 years within IPC's service area,
- Develop a final report including summary data tables and graphs reporting annual incremental and cumulative potential from 2023 through 2042, and
- Provide inputs into IPC's 2023 IRP to test the need for, and value of, energy efficiency potential.

The results presented in this report are estimates based on the best available information available at the time of the analysis. Variation in outcomes is expected in the real world, giving energy-efficiency administrators the opportunity to use the results as guidance (instead of gospel) as they design programs and commit to annual program targets. In addition, we recommend that IPC strive to incorporate any additional territory-specific information about baselines, saturations, and demand for program offerings that may become available in the future.

Summary of Potential Savings

Potential estimates presented in this report represent gross savings for three types of potential: technical, economic, and achievable. Table ES-1 summarizes the cumulative energy efficiency savings in terms of annual energy use for all measures for these levels of potential relative to the baseline projection. All savings in this report are provided at the customer meter level.



- Technical potential reflects the adoption of all energy-efficiency measures regardless of cost-effectiveness or customer willingness to adopt. First-year savings in 2023 are 468 GWh or 2.9% of the baseline projection. Cumulative technical savings in 2042 are 5,555 GWh, or 27.3% of the baseline.
- Economic potential reflects the savings for measures deemed cost-effective using the Utility Cost Test. The first-year savings in 2023 are 261 GW, or 1.6% of the baseline projection. By 2042, cumulative economic savings reach 2,746 GWh, or 13.5% of the baseline projection.
- Achievable potential represents a subset of economic potential accounting for likely customer measure adoption. The achievable potential is 107 GWh savings in the 2023, or 0.7% of the baseline projection, and reaches 2,043 GWh cumulative achievable savings by 2042, or 10% of the baseline projection. This equates to an average annual savings of 0.5% of the baseline projection each year. Achievable potential represents 74% of economic potential by the end of the forecast horizon.

Table ES-1 Summary of Energy Efficiency Potential (Cumulative and Incremental Energy Savings, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	15,882	16,697	17,793	18,997	20,344
Cumulative Savings (GWh)					
Achievable Potential	107	565	1,149	1,646	2,043
Economic Potential	261	1,120	1,890	2,417	2,746
Technical Potential	468	2,081	3,663	4,785	5,555
Cumulative Savings as a % of Baseline					
Achievable Potential	0.7%	3.4%	6.5%	8.7%	10.0%
Economic Potential	1.6%	6.7%	10.6%	12.7%	13.5%
Technical Potential	2.9%	12.5%	20.6%	25.2%	27.3%
Incremental Savings (GWh)					
Achievable Potential	107	119	116	94	78
Economic Potential	261	189	141	97	74
Technical Potential	468	395	308	199	148

Table ES-2 summarizes the summer peak demand savings from all energy efficiency measures for the three levels of potential relative to the baseline projection.

- Technical potential for summer peak demand savings is 99 MW in 2023 or 2.7% of the baseline projection. This increases to 1,191 MW by 2042, or 26.2% of the summer peak demand baseline projection.

- Economic potential is estimated at 44 MW of 2023, or 1.2% of the baseline projection. In 2042, savings are 501 MW, or 11.0% of the summer peak baseline projection.
- Achievable potential is 17 MW by 2023 or 0.5% of the baseline projection. By 2042, cumulative savings reach 360 MW, or 7.9% of the baseline projection.

Table ES-2 Summary of Energy Efficiency Potential (Summer Peak, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	3,610	3,802	4,023	4,269	4,554
Cumulative Savings (MW)					
Achievable Potential	17	94	197	287	360
Economic Potential	44	197	340	440	501
Technical Potential	99	458	804	1,044	1,191
Cumulative Savings as a % of Baseline					
Achievable Potential	0.5%	2.5%	4.9%	6.7%	7.9%
Economic Potential	1.2%	5.2%	8.4%	10.3%	11.0%
Technical Potential	2.7%	12.0%	20.0%	24.4%	26.2%

Summary of Energy Efficiency Potential by Sector

Residential Sector

Table ES-3 shows the cumulative energy efficiency potential for the residential sector. Achievable potential in the first year (2023) is 20 GWh, or 0.3% of the baseline projection. By 2042, cumulative achievable savings are 445 GWh, or 5.8% of the baseline projection.

Table ES-3 Residential Energy Efficiency Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	6,005	6,300	6,682	7,149	7,687
Cumulative Savings (GWh)					
Achievable Potential	20	91	202	323	445
Economic Potential	66	297	475	571	603
Technical Potential	166	831	1,557	2,078	2,443
Cumulative Savings as a % of Baseline					
Achievable Potential	0.3%	1.4%	3.0%	4.5%	5.8%
Economic Potential	1.1%	4.7%	7.1%	8.0%	7.8%
Technical Potential	2.8%	13.2%	23.3%	29.1%	31.8%

The top measures contributing to cumulative energy savings over the next 20 years are high-efficiency Central AC, high-efficiency water heaters (less than 55 gallons), TVs, Clothes Washers, and Set-top Boxes. Together these measures account for over 55% of total cumulative savings. Efficiency lighting, which has played a big role in the past accounts for minimal savings in the future due to successful programs and the EISA standards.

Commercial Sector

Table ES-4 shows the cumulative energy efficiency potential for the commercial sector. In 2023, the achievable potential is 39 GWh, or 1.1% of the baseline projection. By 2042, savings are 946 GWh, or 18.8% of the baseline projection. The top two measures in the commercial sector are interior LED replacements for High-Bay and Linear Lighting, contributing 62% of the cumulative energy savings by 2042 and 49.7% of the savings during the summer Peak.

Table ES-4 Commercial Energy Efficiency Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	3,731	3,916	4,246	4,620	5,039
Cumulative Savings (GWh)					
Achievable Potential	39	240	516	755	946
Economic Potential	89	425	773	1,056	1,279
Technical Potential	154	732	1,295	1,721	2,027
Cumulative Savings as a % of Baseline					
Achievable Potential	1.1%	6.1%	12.2%	16.3%	18.8%
Economic Potential	2.4%	10.9%	18.2%	22.9%	25.4%
Technical Potential	4.1%	18.7%	30.5%	37.2%	40.2%

Industrial Sector

Table ES-5 presents cumulative energy efficiency potential for the Industrial sector. Achievable savings in the first year, 2023, are 38 GWh, or 0.9% of the baseline projection. In 2042, savings reach 543 GWh, or 10.4% of the baseline projection. Long-term potential is lower than in the previous study, due to the maturation of IPC's industrial programs when compared to similar utilities. The top measures from the perspective of cumulative energy savings over the next 20 years are Linear and High Bay Lighting, followed by Refrigeration Floating Head Pressure Controls, High-efficiency Ventilation, and High-Efficiency Refrigeration Compressors. Together, these measures account for over 50% of the savings potential.

Table ES-5 Industrial Energy Efficiency Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	4,168	4,438	4,723	4,973	5,242
Cumulative Savings (GWh)					
Achievable Potential	38	187	351	468	543
Economic Potential	95	339	533	653	722
Technical Potential	134	445	676	821	912
Cumulative Savings as a % of Baseline					
Achievable Potential	0.9%	4.2%	7.4%	9.4%	10.4%
Economic Potential	2.3%	7.6%	11.3%	13.1%	13.8%
Technical Potential	3.2%	10.0%	14.3%	16.5%	17.4%

Irrigation Sector Potential Savings

Table ES-6 shows the cumulative energy efficiency potential for the Irrigation sector. Achievable savings in the first year, 2023, are 9 GWh, or 0.5% of the baseline projection. In 2042, savings reach 109 GWh, or 4.6% of the baseline projection. Incorporating updated Regional Technical Forum (RTF) methodologies and draft updates to the Irrigation measures from The Council's 2021 Power Plan reduces savings and potentially cost-effective potential compared to the previous study. Key findings include:

- The top measure is Variable Frequency Drives for motors, which accounts for 39.9% of cumulative savings by 2042.
- The next two measures in ranking are Pump Replacements and Lower Energy Spray Application Center Pivot Systems, contributing 40.5% of the cumulative energy savings by 2042.

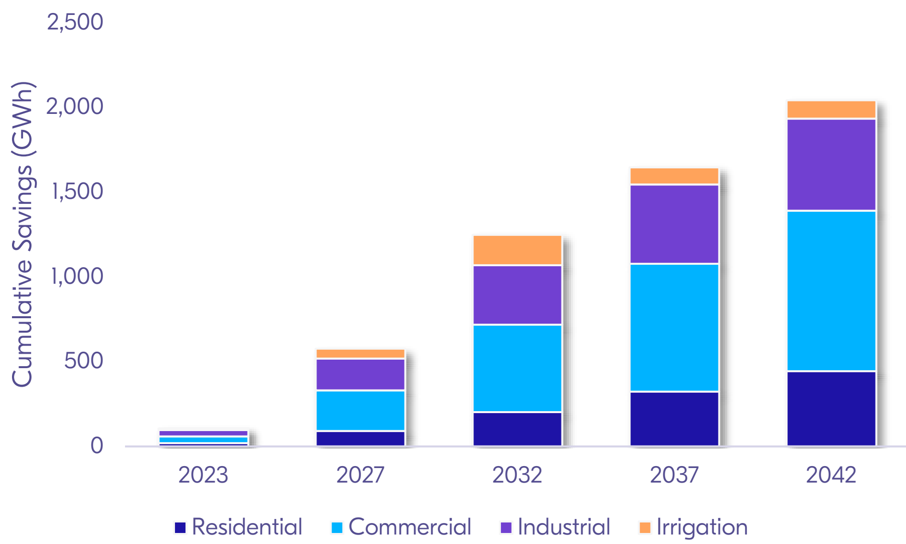
Table ES-6 Irrigation Energy Efficiency Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	1,978	2,042	2,142	2,255	2,376
Cumulative Savings (GWh)					
Achievable Potential	9	47	79	101	109
Economic Potential	11	59	108	137	142
Technical Potential	14	73	135	166	173
Cumulative Savings as a % of Baseline					
Achievable Potential	0.5%	2.3%	3.7%	4.5%	4.6%
Economic Potential	0.6%	2.9%	5.0%	6.1%	6.0%
Technical Potential	0.7%	3.6%	6.3%	7.4%	7.3%

Summary of Achievable Potential by Sector

Figure ES-1 summarizes cumulative achievable potential by sector. The commercial sector contributes the highest savings throughout the forecast horizon, followed by the industrial and residential sectors. Although not illustrated here, the sector contributions to summer peak demand savings follow the same pattern.

Figure ES-1 Achievable Cumulative EE Potential by Sector (Energy, GWh)



Summary of Technical Achievable Potential

While the potential assessment focuses primary on technical, economic, and achievable potential, AEG also estimated potential for a fourth type of potential, referred to as technical achievable potential. Technical achievable applies adoption rates to technical potential as if every measure were cost effective. While this level of potential is not reflective of what IPC may be able to achieve cost-effectively at this time, it does provide useful information for integrated resource planning and comparison to results of the Northwest Power and Conservation Council's 2021 Power Plan. It also provides useful information for measure bundling for program design.

A high-level summary of the technical achievable potential results is presented in Table ES-7. Detail is provided in Appendix A of this report.

Table ES-7 Summary of Technical and Technical Achievable Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	15,882	16,697	17,793	18,997	20,344
Cumulative Savings (GWh)					
Technical Achievable Potential	309	1,365	2,457	3,249	3,856
Technical Potential	468	2,081	3,663	4,785	5,555
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.9%	8.2%	13.8%	17.1%	19.0%
Technical Potential	2.9%	12.5%	20.6%	25.2%	27.3%

Comparison with the Previous Study

Table ES-8 summarizes cumulative achievable potential savings by sector for the current and previous studies. Key findings from this comparison include:

- Residential potential aligns in the first year, but the current study is lower than the previous in the forecast years. The biggest reduction comes from water heating savings. Heat pump water heaters are no longer cost-effective throughout the forecast and the recent adoption of this measure is much lower than projected in the previous study. Changes in measure assumptions reflect RTF changes.
- Commercial sector continues to contribute the most savings, but they are about 20% lower than the previous study. Lighting potential is lower than the previous study and reflects changes to calculations to align with the Council's 2021 Power Plan. Ventilation measure savings also decreased as a result of a shift toward naturally occurring savings based on EIA's most recent Annual Energy Outlook assumptions. Finally, savings from Strategic Energy Management decreased based on program maturation and lower future savings anticipated.
- Industrial sector potential is lower than the previous study, due to the maturity and success of IPC's industrial programs. Similar to commercial, Strategic Energy Management is maturing, which decreased motor savings. However, process refrigeration continues to be a strong measure for IPC so we anticipate additional potential savings from these measures.
- Irrigation sector potential is lower than the previous study. A few irrigation measures were deactivated by the RTF so they were removed from the study. Most importantly, IPC's irrigation programs are quite mature so there is little room for future growth in savings.

Table ES-8 Comparison of Achievable Potential Savings by Sector (Energy, Cumulative GWh)

	Current Study (2022)			Previous Study (2020)		
	2023	2032	2042	2021	2030	2040
Residential	20	202	445	21	331	737
Commercial	39	516	946	53	647	1,153
Industrial	38	351	543	50	431	572
Irrigation	9	79	109	10	123	164
Total	**106**	**1,148**	**2,043**	**135**	**1,532**	**2,626**

Report Organization

The details on how the potential estimates were developed and the results by sector are included in more detail through the rest of this report. The body of the report is organized as follows:

1. Introduction
2. Analysis Approach and Data Development
3. Market Characterization and Market Profiles
4. Baseline Projection
5. Energy Efficiency Potential

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INTRODUCTION

In 2021, Idaho Power Company (IPC) contracted with Applied Energy Group (AEG) to provide an Energy Efficiency Potential Assessment to support its 2023 Integrated Resource Plan (IRP) process. This study provides reliable estimates of the magnitude, timing, and costs of DSM resources that are likely available to IPC over a 20-year planning horizon. The study focuses on resources assumed achievable during the planning horizon, recognizing that known market dynamics may hinder resource acquisition. Study results will be incorporated into IPC's 2023 IRP and subsequent DSM planning and program development efforts. This study serves as an update to similar studies completed previously for IPC.

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Abbreviations and Acronyms

Throughout the report, several abbreviations and acronyms are used. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	American Community Survey
AEO	Annual Energy Outlook forecast developed by EIA
B/C Ratio	Benefit to Cost Ratio
BEST	AEG's Building Energy Simulation Tool
C&I	Commercial and Industrial
CAC	Central Air Conditioning
CFL	Compact fluorescent lamp
CHP	Combined heat and power
C&I	Commercial and Industrial
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Energy Information Administration
EUL	Estimated Useful Life
EUI	Energy Usage Intensity
RTF	Regional Technical Forum
HH	Household
HVAC	Heating Ventilation and Air Conditioning
IRP	Integrated Resource Plan
kWh	Kilowatt hour
LED	Light emitting diode lamp
LoadMAP	AEG's Load Management Analysis and Planning™ tool
MW	Megawatt
O&M	Operations and Maintenance
RTF	Regional Technical Forum
RTU	Roof top unit
TRC	Total Resource Cost test
UCT	Utility Cost Test
UEC	Unit Energy Consumption
WH	Water heater

2

ANALYSIS APPROACH AND DATA DEVELOPMENT

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

Overview of Analysis Approach

To perform the potential analysis, AEG used a bottom-up approach following steps listed below. These analysis steps are defined in more detail throughout the remainder of this chapter.

1. Perform a market characterization to describe sector-level electricity use for the residential, commercial, industrial, and irrigation sectors for the base year, 2021. This included using IPC data and other secondary data sources such as the Energy Information Administration (EIA).
2. Develop a baseline projection of energy consumption and peak demand by sector, segment, and end use for 2022 through 2042.
3. Define and characterize several hundred EE measures to be applied to all sectors, segments, and end uses.
4. Estimate technical, economic, and achievable potential at the measure level in terms of energy and peak demand impacts from EE measures for 2023 through 2042.
5. Develop measure bundles for dynamic optimization within Idaho Power's IRP utilizing technical achievable potential, estimated at the measure level in terms of energy and peak demand impacts from EE measures for 2023 through 2042.

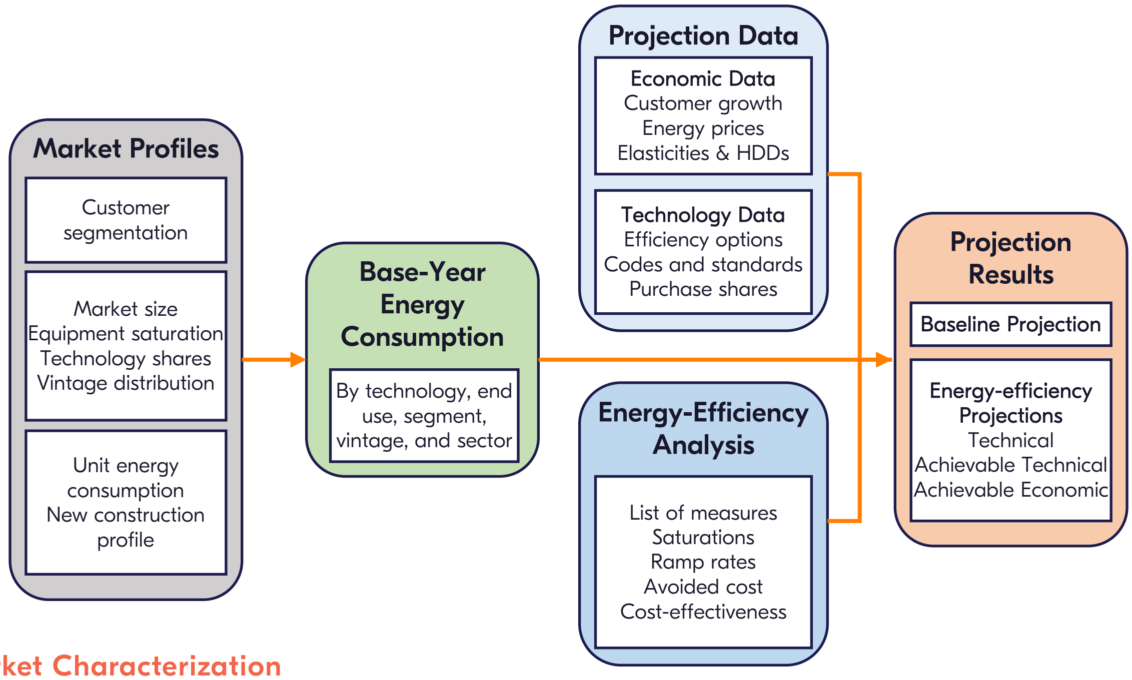
LoadMAP Model

AEG performed the energy efficiency potential analysis using its Load Management Analysis and Planning tool (LoadMAP™) to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for more than 80 utility-specific forecasting and potential studies. Built-in Microsoft Excel, the LoadMAP framework has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a simplified and more accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- Uses a simple logic for appliance and equipment decisions, rather than complex decision choice algorithms or diffusion assumptions which tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or manual adjustment.
- Accommodates various levels of segmentation. Analysis can be performed at the sector-level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

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

Figure 2-1 LoadMAP Analysis Framework



Market Characterization

The first step in the analysis approach is 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. This characterization begins with a segmentation of Idaho Power's electricity footprint to quantify energy use by sector, segment, vintage, end-use application, and the current set of technologies used. For this we rely primarily on information provided by Idaho Power and input from secondary sources, as necessary.

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses, and other dimensions) that are relevant in the Idaho Power service area. The segmentation scheme for this project is presented in.

Table 2-1.

Table 2-1 Overview of Idaho Power Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
1	Sector	Residential, Commercial, Industrial, Irrigation
2	Segment	**Residential:** single family, multi-family, manufactured home **Commercial:** small office, large office, restaurant, retail, grocery, college, school, hospital, lodging, warehouse, and miscellaneous **Industrial:** Food manufacturing, agriculture, general manufacturing, water and wastewater, electronics, and other industrial **Irrigation:** as a whole
3	Vintage	Existing and new construction
4	End uses	Cooling, heating, lighting, water heating, motors, etc. (as appropriate by sector)
5	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors, etc.
6	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

With the segmentation scheme defined, a high-level market characterization of electricity sales in the base year is performed to allocate sales to each customer segment. Idaho Power data and secondary sources were used to allocate energy use and customers to the various sectors and segments such that the total customer count, energy consumption, and peak demand matched the Idaho Power system totals from 2021 billing data. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- Market Size is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees, and for the irrigation sector, it is number of service points.
- Saturations define the fraction of the market size that is served by a particular end-use technology (e.g., homes with electric space heating).
- UEC (unit energy consumption) or EUI (energy-use index) describes the amount of energy consumed in 2021 by a specific technology in buildings that have the technology. The UECs are expressed in kWh/household for the residential sector, and EUIs are expressed in kWh/square foot, kWh/employee, or kWh/service point for the commercial, industrial and irrigation sectors, respectively.
- Annual Energy Intensity for the residential sector represents the average energy use for the technology across all homes in 2021. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial, industrial, and irrigation sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space, all employees, or all service points in 2021.
- 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 GWh.
- Peak Demand for each technology, summer peak and winter peak are calculated using peak fractions of annual energy use from AEG's EnergyShape library and Idaho Power system peak data. For this study, May through September are considered Summer months, while October through April are considered Winter months.

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

Baseline Projection

The next step in the analysis is to develop the baseline projection of annual electricity use and summer peak demand for 2023 through 2042 by customer segment and end use in the absence of new utility programs. The end-use projection includes the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of January 2022 are included in the baseline. The baseline projection is the foundation for the analysis of savings from future EE efforts as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards.
- Idaho Power's internally developed sector-level projections for electricity sales

A baseline projection was developed for summer and winter peak by applying the peak fractions from the energy market profiles to the annual energy forecast in each year.

The baseline projection results are presented for the system as a whole and for each sector in Chapter 4.

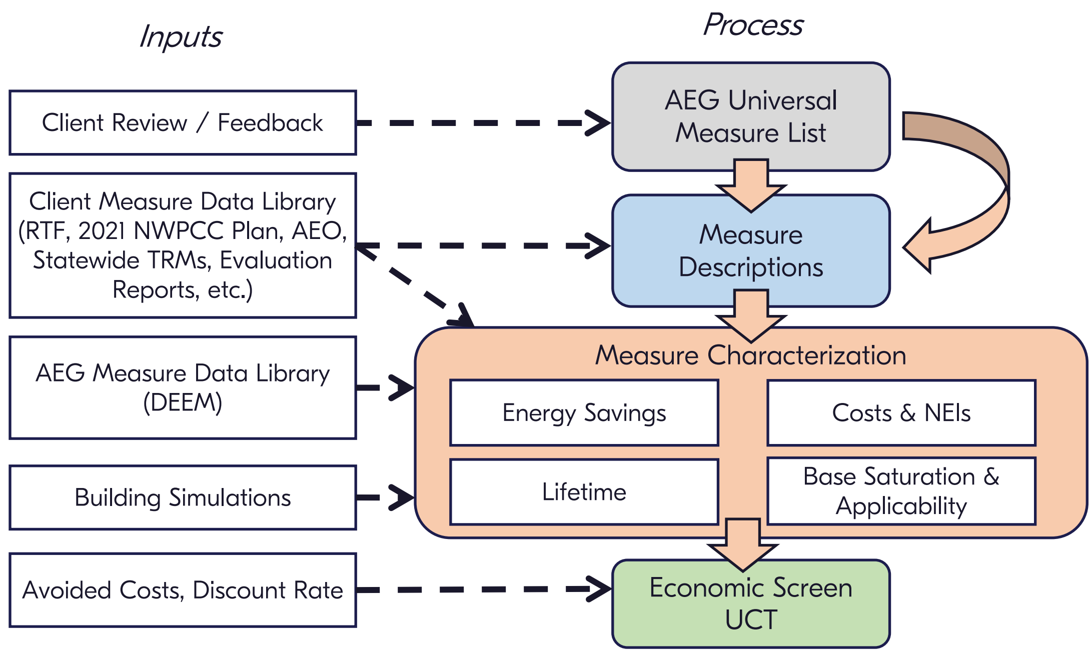
Energy Efficiency Measure Analysis

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

Figure 2-2 outlines the framework for energy efficiency measure analysis. The framework for assessing savings, costs, and other attributes of energy efficiency measures involves identifying the list of energy efficiency measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit or early replacement of equipment, improvements to the building envelope, the application of controls to optimize energy use, and other actions resulting in improved energy efficiency.

A robust list of energy efficiency measures was compiled for each customer sector, drawing upon Idaho Power's measure database, and the Regional Technical Forum's (RTF) deemed measures databases, as well as a variety of secondary sources, compiled from AEG's work across the country. This universal list of energy efficiency measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially but may pass in future years as a result of lower projected equipment costs or higher avoided costs.

Figure 2-2 Approach for Energy Efficiency Measure Characterization and Assessment



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

- Equipment measures are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard, SEER 13 unit, and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit.
- Non-equipment measures save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, addition of wall insulation will affect the energy use of both space heating and cooling. Non-equipment measures typically fall into one of the following categories:
    - Building shell (windows, insulation, roofing material)
    - Equipment controls (thermostat, energy management system)
    - Equipment maintenance (cleaning filters, changing set points)
    - Whole-building design (building orientation, passive solar lighting)
    - Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)
    - Displacement measures (ceiling fan to reduce use of central air conditioners)
    - Commissioning and retro commissioning (initial or ongoing monitoring of building energy systems to optimize energy use)
    - Behavioral Programs (home energy reports)

AEG developed a preliminary list of EE measures, which was distributed to the Idaho Power project team for review. The list was finalized after incorporating comments.

Once the list of EE measures was assembled, the project team assessed their energy-saving characteristics. For each measure, AEG also characterized incremental cost, service life, and other performance factors, drawing upon data from the Idaho Power measure database, the RTF deemed measure workbooks, and simulation modeling. Following the measure characterization, AEG performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential.

Table 2-2 Example of Equipment Measures — Single-Family Home, Existing

Efficiency Level	Useful Life	Equipment Cost	Base Year Energy Usage (kWh/yr.)	On Market	Off Market
SEER 13.0	18	2,055	1,924	2019	2040
SEER 14.0	18	2,454	1,765	2019	2040
SEER 15.0	18	2,854	1,706	2019	2040
SEER 16.0	18	3,253	1,656	2019	2040
SEER 18.0	18	4,056	1,578	2019	2040
SEER 21.0	18	5,104	1,494	2019	2040

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Table 2-3 lists some of the non-equipment measures applicable to CAC in an existing single-family home. All measures are evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings and costs are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[1] of the measure, and the savings as a percentage of the relevant energy end uses.

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

End Use	Measure	Saturation in 2021	Applicability[2]	Lifetime (yrs.)	Measure Installed Cost	Energy Savings (%)
Cooling	Insulation - Ceiling installation	26%	30%	45	$1,153	11%
Cooling	Ducting - Repair and Sealing	38%	46%	20	$793	3%
Cooling	Windows - High Eff/ENERGY STAR	34%	54%	45	$3,139	5%

Screening Energy Efficiency Measures for Cost-Effectiveness

Only measures that are cost-effective are included in economic and achievable potential. Therefore, for each individual measure, LoadMAP performs an economic screen. This study uses the utility cost test (UCT) that compares the lifetime energy and peak demand benefits of each applicable measure with its cost from the utility perspective. The lifetime benefits are calculated by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year and discounting the dollar savings to the present value equivalent. Lifetime costs represent annual Operation and Maintenance

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

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

(O&M) costs and program administrator costs. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above.

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

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

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus, if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen.
- If multiple equipment measures have Benefit/Cost (B/C) ratios greater than or equal to 1.0, the most efficient technology is selected by the economic screen.

Table 2-4 Measures Evaluated For Each Segment Within Each Sector

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ Segments
Residential	104	208	624
Commercial	133	266	2,926
Industrial	88	176	2,640
Irrigation	25	50	50
Total Measures Evaluated	351	**700**	**6,240**

Calculating Energy Efficiency Potential

This study developed into four types of potential: technical potential, economic potential, and achievable potential. Technical achievable potential was also estimated to develop measure bundles for IPC's IRP modeling.

- **Technical Potential** – The calculation of technical potential is a straightforward algorithm, aggregating the full, energy-saving effects of all the individual DSM measures included in the study at their maximum theoretical deployment levels, adjusting only for technical applicability.

  While all discretionary resources could theoretically be acquired in the study's first year, this would skew the potential for equipment measures and provide an inaccurate picture of measure-level potential. Therefore, the study assumes the realization of these opportunities over the 20-year planning horizon according to the shape of corresponding ramp rates adapted from the Northwest Power and Conservation Council's 2021 Power Plan, applied to 100% of applicable market units. By applying this assumption, natural equipment turnover rates, and other adjustments described above, the annual incremental and cumulative potential was estimated by sector, segment, construction vintage, end use, and measure. This allows the technical potential to be more closely compared with the technical achievable potential as defined below since a similar "phased-in" approach is used for both.
- **Economic Potential** – Economic potential constrains technical potential to EE measures that are cost-effective based upon the UCT. The LoadMAP model calculates the tests for each year in the forecast horizon. Thus, the model allows for a measure that does not pass in the early years of the forecast but passes in later years to be included in the analysis. LoadMAP applies measures one-by-one,

stacking their effects successively and interactively in descending order of their B/C ratios, thereby avoiding double counting of savings.

- **Achievable Potential** – To develop estimates for achievable potential, we constrain the economic potential by applying market adoption rates for each measure that estimate the percentage of customers who would be likely to select each measure, given consumer preferences (partially a function of incentive levels), retail energy rates, imperfect information, and real market barriers and conditions. These barriers tend to vary, depending on the customer sector, local energy market conditions, and other, hard-to-quantify factors. In addition to utility-sponsored programs, alternative acquisition methods, such as improved codes and standards and market transformation, can be used to capture portions of these resources, and are included within the achievable potential, per The Council's 2021 Power Plan methodology. This proves particularly relevant in the context of long-term DSM resource acquisition plans, where incentives might be necessary in earlier years to motivate acceptance and installations. As acceptance increases, so would demand for energy efficient products and services, likely leading to lower costs, and thereby obviating the need for incentives and (ultimately) preparing for transitions to codes and standards.
- **Technical Achievable Potential** –Technical Achievable Potential represents the potential savings if every measure were cost effective. This is useful in developing measure bundles for IPC's IRP modeling. It is calculated by applying market adoption rates to technical potential estimates.

Market adoption rates are based on ramp rates from The Council's Seventh Power Plan. As discussed below, two types of ramp rates (lost opportunity and retrofit) have been incorporated for all measures and market regions.

Measure Ramp Rates

The study applied measure ramp rates to determine the annual availability of the identified potential for lost opportunity and discretionary resources, interpreting and applying these rates differently for each class (as described below). Measure ramp rates generally matched those used in The Council's Seventh Power Plan, although the study incorporated additional considerations for DSM measure acquisition:

Lost Opportunity Resources

Lost opportunity energy efficiency measures correspond to equipment measures, which follow a natural equipment turnover cycle, as well as non-equipment measures in new construction instances that are fundamentally different and typically easier to implement during the construction process as opposed to after construction has been completed. For general measures, annual turnover is modeled as equipment stock divided by a measure's effective useful life (EUL). When information on existing equipment vintage was available, particularly due to IPC's 2022 End-Use survey, turnover is instead customized to the actual vintage distribution and varies by study year as units reach their EUL. In the Council's Seventh Power Plan, lighting fixture control measures are also modeled as lost opportunity measures, assumed that these advanced controls must be installed alongside new linear LED panels.

In addition to natural timing constraints imposed by equipment turnover and new construction rates, the AEG team applied measure ramp rates to reflect other resource acquisition limitations over the study horizon, such as market availability. These measure ramp rates had a maximum value of 85%, reflecting The Council's assumption that, on average, up to 85% of technical potential could be achieved by the end of a 20-year planning horizon. Measures on The Council's Seventh Power Plan's emerging technology ramp rate are constrained to 65% of economic potential.

To calculate the annual achievable potential for each lost-opportunity measure, the study multiplied the number of units turning over or available in any given year by the adoption factor provided by the ramp rate, consistent with The Council's methodology. Because of the interactions between equipment turnover and new construction, the lost opportunities of measure availability until the next life cycle, and the time frame limits at 20 years, The Council methodology for these measures produces potential less than 85% of economic potential.

Retrofit (Discretionary) Resources

Retrofit resources differ from lost opportunity resources due to their acquisition availability at any point within the study horizon. From a theoretical perspective, all achievable potential for discretionary resources could be acquired in the study's first year, but from a practical perspective, this outcome is realistically impossible to achieve due to infrastructure and cost constraints as well as customer preferences and considerations.

As a result, the study addresses the achievable potential for retrofit opportunities by spacing the acquisition according to the ramp rates specified for a given measure, thus creating annual, incremental values. To assess achievable potential, we then apply the 85% market achievability limit defined by The Council. Consistent with lost opportunity, discretionary measures on The Council's Seventh Power Plan's emerging technology ramp rate are constrained to 65% of economic potential. Since the opportunity is not limited by equipment turnover, achievable potential for these measures reaches 85% of the economic potential by the end of the 20-year period. Details regarding the ramp rates appear in Appendix C.

Data Development

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

Data Sources

The data sources are organized into the following categories:

- Idaho Power data
- Energy efficiency measure data
- AEG's databases and analysis tools
- Other secondary data and reports

Idaho Power Data

The highest priority data sources for this study were those that were specific to Idaho Power.

- Idaho Power customer data: Idaho Power provided billing data for development of customer counts and energy use for each sector. AEG used the results of the Idaho Power 2022 Residential End-Use Survey, a residential saturation survey. The lighting results from the 2019 survey were also supplemented with 2022 Residential End-Use Survey results.
- Load forecasts: Idaho Power provided an economic growth forecast by sector; electric load forecast; peak-demand forecasts at the sector level; and retail electricity price history and forecasts.
- Economic information: Idaho Power provided avoided cost forecasts, a discount rate, and line loss factor.
- Idaho Power program data: Idaho Power provided the C&I Technical Reference Manual and information about past and current programs, including program descriptions, goals, and achievements to date.

Northwest Region Data

The Northwest conducts collaborative research and the study used data from the following sources

- Regional Technical Forum (RTF) Unit Energy Savings Measure Workbooks: The RTF maintains workbooks that characterize selected measures and provide data on unit energy savings (UES), measure cost, measure life, and non-energy benefits. These workbooks provide Pacific Northwest-specific measure assumptions, drawing upon primary research, energy modeling (using the RTF's Simple Energy Enthalpy Model (SEEM), regional third-party research, and well-vetted national data. Workbooks are available at https://rtf.nwcouncil.org/measures

- RTF Standard Protocols: The RTF also maintains standard workbooks containing useful information for characterizing more complex measures for which UES values have not been developed, such as commercial sector lighting. https://rtf.nwcouncil.org/standard-protocols
- Northwest Power and Conservation Council's 2021 Power Plan Conservation Supply Curve Workbooks, 2020. To develop its Power Plan, The Council created workbooks with detailed information about measures, available at https://www.nwcouncil.org/2021-power-plan-technical-information-and-data
- Residential Building Stock Assessment: NEEA's 2016 Residential Building Stock Assessment (RBSA) provides results of a survey of thousands of homes in the Pacific Northwest. https://neea.org/data/residential-building-stock-assessment
- Commercial Building Stock Assessment: NEEA's 2019 Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. https://neea.org/data/commercial-building-stock-assessments
- Industrial Facilities Site Assessment: NEEA's 2014 Industrial Facilities Site Assessment (IFSA) provides data on regional industrial customers by major classification types. https://neea.org/data/industrial-facilties-site-assessment

AEG Data

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

- AEG Energy Market Profiles: For more than 10 years, AEG staff has maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- Building Energy Simulation Tool (BEST). AEG's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- AEG's EnergyShape™: This database of load shapes includes the following:
    - Residential – electric load shapes for ten regions, three housing types, 13 end uses
    - Commercial – electric load shapes for nine regions, 54 building types, ten end uses
    - Industrial – electric load shapes, whole facility only, 19 2-digit SIC codes, as well as various 3-digit and 4-digit SIC codes
- AEG's Database of Energy Efficiency Measures (DEEM): AEG maintains an extensive database of measure data for our studies. The database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data.
- Recent studies. AEG has conducted over sixty planning studies of EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include studies in nearby jurisdictions for Avista Energy, PacifiCorp, NV Energy, Tacoma Power, Black Hills Colorado Electric, and Chelan PUD. In addition, AEG used the information about impacts

of building codes and appliance standards from recent reports for the Edison Electric Institute[3].

Other Secondary Data and Reports

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

- Annual Energy Outlook. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, data from the 2021 AEO was used.
- Local Weather Data: Weather from NOAA's National Climatic Data Center for Boise, Idaho was used as the basis for building simulations.
- EPRI End-Use Models (REEPS and COMMEND). These models provide the elasticities applied to electricity prices, household income, home size and heating and cooling.
- Database for Energy Efficient Resources (DEER). The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California. AEG used the DEER database to cross check the measure savings developed using BEST and DEEM.
- Other relevant regional sources: These include reports from the Consortium for Energy Efficiency, the Environmental Protection Agency (EPA), and the American Council for an Energy Efficient Economy.

Application of Data to the Analysis

This section describes how each of the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity, use and households/floor space/service point for the residential, commercial, industrial, and irrigation sectors, AEG used Idaho Power billing data and customer surveys to estimate energy use.

- For the residential sector, Idaho Power estimated the numbers of customers and the average energy use per customer for each of the three segments, based on its 2016 Home Energy Survey, matched to billing data for surveyed customers. Growth in technology saturations since 2016 is based on the growth from EIA's Annual Energy Outlook (AEO). AEG compared the resulting segmentation with data from the American Community Survey (ACS) regarding housing types and income and found that the Idaho Power segmentation corresponded well with the ACS data; See Chapter 3 for additional details.
- To segment the commercial and industrial segments, AEG 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 Standard Industrial Classification (SIC) codes, with some adjustments between the commercial and industrial sectors to better group energy use by facility type and predominate end uses. For this study, the SIC codes were mapped differently, in order to line up customers with the same segmentation used for the Idaho Power load forecasting department; see Chapter 3 for additional details.
- For the irrigation sector, AEG treated the market as a single segment.

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

Data Application for Market Profiles

The specific data elements for the market profiles, together with key data sources, are shown in Table 2-5. To develop the market profiles for each segment, AEG used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity.
2. Used the Idaho Power 2022 Residential End-Use Survey, Idaho Power 2019 Lighting Study, NEEA's RBSA, NEEA's CBSA, and AEG's Energy Market Profiles database to develop existing appliance saturations, appliance, and equipment characteristics, and building characteristics.
3. Ensured calibration to control totals for annual electricity sales in each sector and segment.
4. Compared and cross-checked with other recent AEG studies.
5. Worked with Idaho Power staff to vet the data against their knowledge and experience.

Table 2-5 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings and commercial floor space, industrial employment	Idaho Power Billing Data Idaho Power 2022 Home Energy Survey NEEA RBSA and CBSA AEO 2019
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee Irrigation: Annual use per service point	Idaho Power billing data 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 commercial floor space/employment with technology	Idaho Power Home Energy Survey Idaho Power Lighting Study NEEA RBSA and CBSA AEG's Energy Market Profiles Idaho Power Load Forecasting
UEC/EUI for each end-use technology	UEC: Annual electricity use in homes and buildings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	NWPCC 2021 Plan and RTF data HVAC uses: BEST simulations using prototypes developed for Idaho Engineering Analysis AEG's DEEM Recent AEG studies AEO 2021
Appliance/equipment age distribution	Age distribution for each technology	NWPCC 2021 Plan and RTF Data NEEA Regional Survey Data Idaho Power 2016 Home Energy Survey AEG's DEEM Recent AEG Studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	AEG's DEEM AEO 2021 DEER NWPCC Workbooks, RTF Recent AEG Studies
Peak factors	Share of technology energy use that occurs during the system peak hour	RTF's Generalized Load Shape (GLS) Database AEG's EnergyShape Database

Data Application for Baseline Projection

Table 2-6 summarizes the LoadMAP model inputs required for the baseline projection. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-6 Data 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	Idaho Power Load Forecast AEO 2021 Economic Growth Forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments Data from AEO AEO 2021 Regional Forecast Assumptions[4] Appliance/Efficiency Standards Analysis Idaho Power Program Results and Evaluation Reports
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	Idaho Power Forecast
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND Models AEO 2021

In addition, AEG implemented assumptions for known future equipment standards as of January 2022, as shown in Table 2-7, and

[4] We developed baseline purchase decisions using the Energy Information Agency's Annual Energy Outlook report (2017), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and then held values constant for the study period. This removes any effects of naturally occurring conservation or effects of future DSM programs that may be embedded in the AEO forecasts.

Table 2-8. The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

Table 2-7 Residential Electric Equipment Standards[5]

<table>
<tr><th>End Use</th><th>Technology</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="2">Cooling</td><td>Central AC</td><td colspan="3">SEER 13.0</td><td colspan="3">SEER 14.0</td></tr>
<tr><td>Room AC</td><td colspan="6">EER 10.8</td></tr>
<tr><td>Cool/Heating</td><td>Air-Source Heat Pump</td><td colspan="3">SEER 14.0 / HSPF 8.2</td><td colspan="3">SEER 15.0 / HSPF 8.8</td></tr>
<tr><td rowspan="2">Water Heating</td><td>Water Heater (<=55 gallons)</td><td colspan="6">EF 0.95</td></tr>
<tr><td>Water Heater (>55 gallons)</td><td colspan="6">EF 2.0 (Heat Pump Water Heater)</td></tr>
<tr><td rowspan="2">Lighting</td><td>General Service</td><td colspan="6">Federal Backstop (45 lm/w lamp)</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="6">T8 (92.5 lm/W lamp)</td></tr>
<tr><td rowspan="3">Appliances</td><td>Refrigerator & Freezer</td><td colspan="6">25% more efficient than the 1997 Final Rule (62 FR 23102)</td></tr>
<tr><td>Clothes Washer</td><td colspan="6">IMEF 1.84 / WF 4.7</td></tr>
<tr><td>Clothes Dryer</td><td colspan="6">3.73 Combined EF</td></tr>
<tr><td>Miscellaneous</td><td>Furnace Fans</td><td colspan="6">ECM</td></tr>
</table>

Table 2-8 Commercial and Industrial Electric Equipment Standards

End Use	Technology	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1					
	RTUs	2007 ASHRAE 90.1					
	PTAC	EER 11.9					
Cool/Heating	Heat Pump	EER 11.3/COP 3.3					
	PTHP	EER 11.9/COP 3.3					
Ventilation	All	Constant Air Volume/Variable Air Volume					
Lighting	General Service	Federal Backstop (45 lm/w lamp)					
	Linear Lighting	T8 (92.5 lm/W lamp)					
	High Bay	High-Efficiency Ballast					
Refrigeration	Walk-In	24% more efficient than 2017					
	Reach-In	40% more efficient					
	Glass Door	12-28% more efficient					
	Open Display	10-20% more efficient					
	Icemaker	15% more efficient					
Food Service	Pre-Rinse	1.0 GPM					
Motors	All	Expanded EISA 2007					

Energy Efficiency 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 Idaho Power analysis.

Table 2-9 Data Needs for the Measure Characteristics in LoadMAP

Model Input	Description	Key Source
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.	Idaho Power Measure Data NWPCC 2021 Plan Conservation Workbooks BEST AEG's DEEM AEO 2021 DEER NWPCC Workbooks, RTF Other Secondary Sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	Idaho Power Measure Data NWPCC Seventh Plan Conservation Workbooks BEST AEG's DEEM AEG EnergyShape
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-unit basis. Non-equipment measures: Existing buildings — full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	Idaho Power Measure Data NWPCC 2021 Plan Conservation Workbooks RTF Deemed Measure Database AEG's DEEM AEO 2021 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.	Idaho Power Measure Data NWPCC 2021 Plan Conservation Workbooks RTF Deemed Measure Database AEG's DEEM DEER AEO 2021 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.	Idaho Power Measure Data NWPCC 2021 Plan Conservation Workbooks RTF Deemed Measure Database AEG's DEEM DEER Other Secondary Sources
On / Off Market Availability	Identifies when the equipment technology is available or no longer available in the market.	AEG Appliance Standards and Building Codes Analysis

3

MARKET CHARACTERIZATION AND MARKET PROFILES

This section describes how customers use electricity in the Idaho Power service area 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

Total electricity use for the residential, commercial, industrial and irrigation sectors for Idaho Power in 2021 was 15,188 GWh. Special-contract customers are included in this total, accounting for about 912 GWh.

As shown in Figure 3-1 and Table 3-1, the residential sector accounts for more than one-third (37%) of annual energy use, followed by industrial with 26%, commercial with 24%, and irrigation with 13%. In terms of summer peak demand, the total system peak in 2021 was 3,431 MW. The residential sector contributes the most to peak with 42%. This is due to the saturation of air conditioning equipment. The winter peak in 2021 was 1,964 MW, with the residential sector contributing over half of the impact (52%) at peak.

Figure 3-1 Sector-Level Electricity Use, 2021

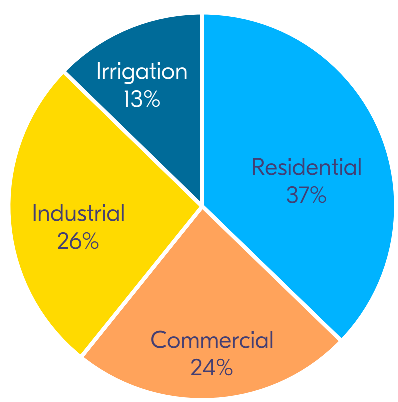


Table 3-1 Idaho Power Sector Control Totals, 2021

Sector	Annual Electricity Use (GWh)	% of Annual Use	Summer Peak Demand (MW)	% of Summer Peak	Winter Peak Demand (MW)	% of Winter Peak
Residential	5,656	37%	1,448	42%	1,013	52%
Commercial	3,576	24%	694	20%	592	30%
Industrial	4,024	26%	496	14%	354	18%
Irrigation	1,933	13%	792	23%	5	0.24%
Total	**15,188**	**100%**	**3,431**	**100%**	**1,964**	**100%**

Residential Sector

The total number of households and electricity sales for the service area were obtained from Idaho Power's customer database. In 2021, there were 499,216 households in the Idaho Power service area that used a total of 5,656 GWh with summer peak demand of 1,448 MW. Average use per customer (or household) at 11,330 kWh is about average compared to other regions of the country. AEG allocated these totals into three residential segments and the values are shown in Table 3-2. This table shows that Mobile homes have the highest use per customer at 14,559 kWh/year, which reflects a higher saturation of electric space heating and less efficient building shell.

Table 3-2 Residential Sector Control Totals, 2021

Segment	Number of Customers	Electricity Use (GWh)	% of Annual Use	Annual Use/Customer (kWh/HH)	Summer Peak (MW)	Winter Peak (MW)
Single Family	393,002	4,447	79%	11,316	1,273	796
Multifamily	58,333	512	9%	8,776	72	83
Manufactured Home	47,882	6,97	12%	14,559	104	134
Total	**499,216**	**5,656**	**100%**	**11,330**	**1,448**	**1,013**

Energy Market Profile

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

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

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Summer Peak (MW)
Cooling	Central AC	80.3%	2,267	1,820	908	814
	Room AC	7.8%	917	72	36	3
	Air-Source Heat Pump	8.3%	2,223	184	92	82
	Geothermal Heat Pump	0.1%	2,241	2	1	1
	Evaporative AC	1.0%	577	6	3	3
Space Heating	Electric Furnace	14.7%	9,168	1,346	672	0
	Electric Room Heat	8.1%	5,748	468	234	0
	Air-Source Heat Pump	8.3%	5,986	495	247	0
	Geothermal Heat Pump	0.1%	3,723	3	1	0
	Secondary Heating	19.6%	450	88	44	0
Water Heating	Water Heater (<= 55 Gal)	40.2%	2,607	1,049	524	68
	Water Heater (> 55 Gal)	4.4%	2,422	107	53	7
Interior Lighting	General Service Lighting	100.0%	651	651	325	20
	Linear Lighting	100.0%	67	67	33	2
	Exempted Lighting	100.0%	314	314	157	9
Exterior Lighting	General Service Lighting	100.0%	276	276	138	8
Appliances	Refrigerator	100.0%	542	542	270	16
	Second Refrigerator	36.4%	812	295	147	295
	Freezer	57.5%	477	274	137	12
	Clothes Washer	96.6%	106	102	51	5
	Clothes Dryer	96.2%	753	724	362	25
	Dishwasher	88.2%	83	74	37	3
	Stove/Oven	76.3%	162	124	62	6
	Microwave	100.9%	113	114	57	6
Electronics	Personal Computers	72.4%	133	96	48	3
	Monitor	122.8%	55	68	34	2
	Laptops	131.9%	34	45	22	1
	Printer/Fax/Copier	72.4%	39	28	14	1
	TVs	219.7%	126	276	138	8
	Set-top Boxes/DVRs	213.5%	91	194	97	6
	Devices and Gadgets	100.0%	416	416	208	12
Miscellaneous	Electric Vehicles	2.8%	2,538	72	36	2
	Pool Heater	0.5%	3,517	18	9	1
	Pool Pump	2.0%	3,508	71	36	2
	Furnace Fan	73.7%	347	255	127	7
	Well Pump	5.4%	532	29	14	1
	Miscellaneous	100.0%	570	570	284	16
Total	**Total**			**11,330**	**5,656**	**1,448**

Figure 3-2 shows the distribution of annual electricity use by end use for all customers. Two main electricity end uses —appliances and space heating— account for 41% of total electricity use. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the water heating, lighting, cooling, electronics, and the miscellaneous category — which is comprised of furnace fans, pool pumps, and other "plug" loads (all other usage not covered by those listed in Table 3-3 such as hair dryers, power tools, coffee makers, etc.).

Figure 3-2 also shows estimates of summer peak demand by end use. As expected, cooling is the largest contributor to summer peak demand, followed by appliances. Lighting has low coincidence and makes a small contribution at the time of the system peak.

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

Figure 3-2 Residential Electricity Use and Summer Peak Demand by End Use, 2021

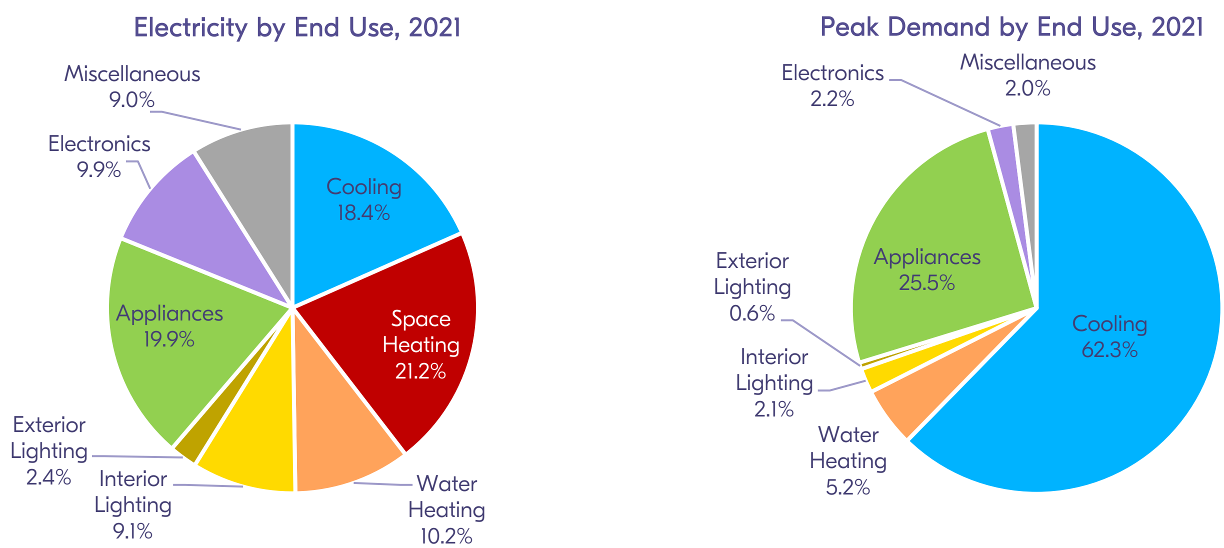
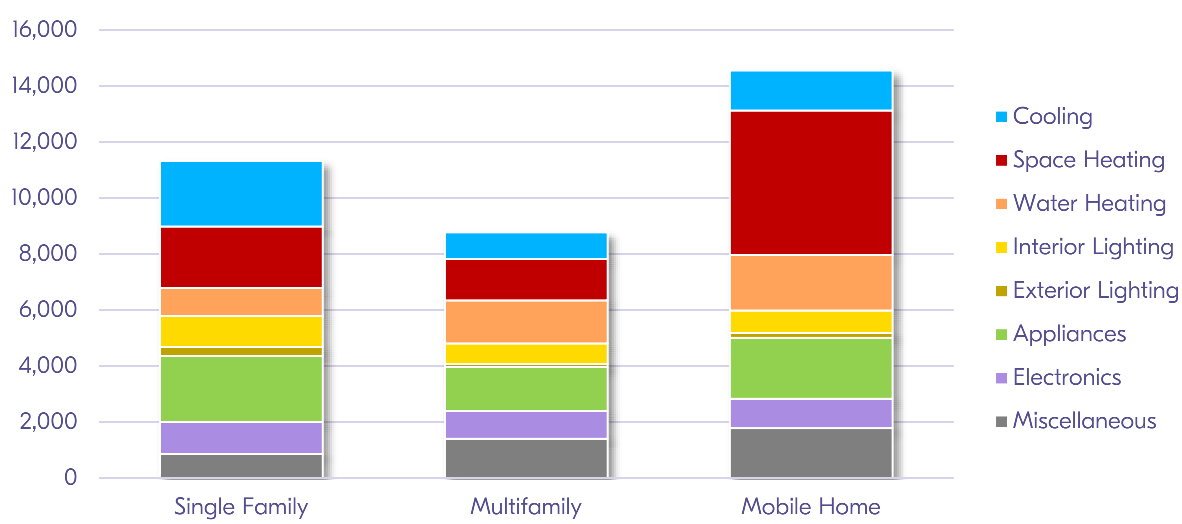


Figure 3-3 Residential Intensity by End Use and Segment (kWh/HH), 2021



Commercial Sector

The total electric energy consumed by commercial customers in Idaho Power's service area in 2021 was 3,576 GWh. As described in Chapter 2, Idaho Power billing data, CBSA and secondary data were used to allocate this energy usage to building type segments and to develop estimates of energy intensity (annual kWh/square foot). Using the electricity use and intensity estimates, floor space is inferred which is the unit of analysis in LoadMAP for the commercial sector. In addition, each segment's contribution to the summer and winter peak demand is estimated so that the weighted average aligns with the commercial sector contribution to the system peaks. The values are shown in Table 3-4.

Table 3-4 Commercial Sector Control Totals, 2021

Segment	Electricity Sales (GWh)	% of Total Usage	Intensity (Annual kWh/SqFt)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Small Office	598	17%	15.4	152	148
Large Office	208	6%	19.0	25	34
Restaurant	261	7%	36.1	40	32
Retail	431	12%	14.5	83	45
Grocery	242	7%	39.8	28	27
College	134	4%	10.8	28	22
School	248	7%	6.4	50	72
Hospital	311	9%	26.0	43	40
Lodging	167	5%	9.4	21	30
Warehouse	377	11%	4.7	86	68
Miscellaneous	598	17%	7.5	138	75
Total	**3,576**	**100%**	**10.7**	**694**	**592**

Energy Market Profile

Figure 3-4 shows the distribution of annual electricity consumption and summer peak demand by end use across all commercial buildings. Electric usage is dominated by lighting and cooling, which comprise 47% of annual electricity usage. Summer peak demand is dominated by cooling.

Figure 3-5 presents the electricity usage in annual GWh per square foot by end use and segment. Small offices, retail, and miscellaneous buildings use the most electricity in the service area whereas grocery and restaurants use the most electricity on a square footage basis. As far as end uses, cooling and lighting are the major end uses across all segments.

Figure 3-4 Commercial Sector Electricity Consumption and Summer Peak Demand by End Use, 2021

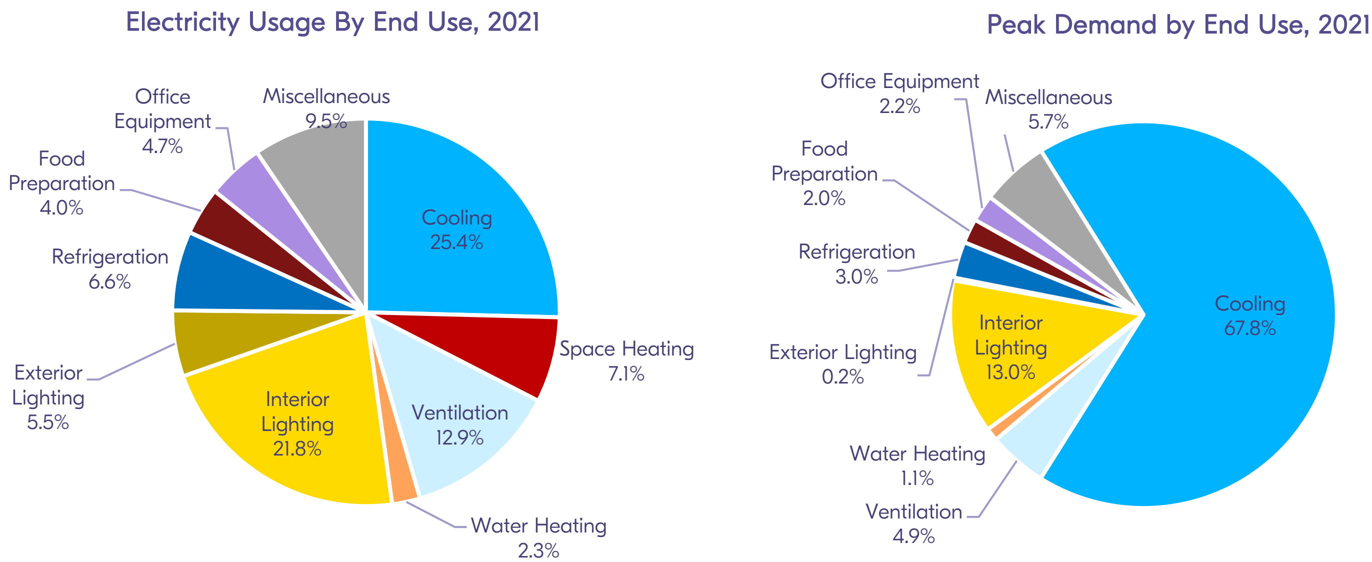


Figure 3-5 Commercial Electricity Intensity by End Use and Segment (kWh/sq.ft.), 2021

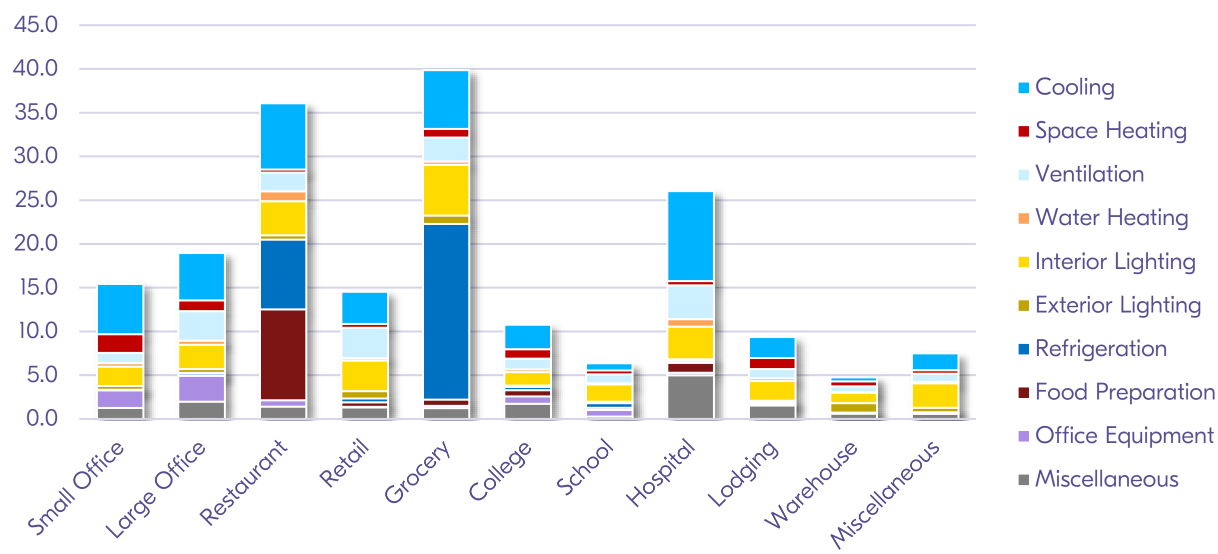


Table 3-5 shows the average market profile for electricity for the commercial sector, across all building types. Market profiles for each segment are presented in Appendix B.

Table 3-5 Average Electric Market Profile for the Commercial Sector, 2021

End Use	Technology	Saturation	UEC (kWh/SqFt)	Intensity (kWh/SqFt)	Usage (GWh)	Summer Peak Demand (MW)
Cooling	Air-Cooled Chiller	7.1%	3.19	0.23	75.3	45
	Water-Cooled Chiller	4.6%	7.23	0.33	110.5	35
	RTU	38.9%	4.09	1.59	530.4	290
	Evaporative Central AC	0.1%	2.71	0.00	1.2	0
	Packaged Terminal AC	4.2%	3.40	0.14	47.6	24
	Packaged Terminal HP	1.8%	2.91	0.05	17.7	9
	Air-Source Heat Pump	8.1%	3.86	0.31	104.7	57
	Geothermal Heat Pump	2.6%	2.40	0.06	21.1	11
Heating	Electric Furnace	2.6%	3.30	0.09	28.4	0
	Electric Room Heat	11.0%	3.51	0.38	128.3	0
	Packaged Terminal HP	1.8%	1.51	0.03	9.2	0
	Air-Source Heat Pump	8.1%	2.36	0.19	63.9	0
	Geothermal Heat Pump	2.6%	2.92	0.08	25.7	0
Ventilation	Ventilation	100.0%	1.39	1.39	462.9	34
Water Heat	Water Heater	26.6%	0.94	0.25	83.7	8
Interior Lighting	General Service Lighting	100.0%	0.38	0.38	127.4	14
	Exempted Lighting	100.0%	0.11	0.11	37.8	4
	High-Bay Lighting	100.0%	0.28	0.28	94.7	11
	Linear Lighting	100.0%	1.56	1.56	520.1	61
Exterior Lighting	General Service Lighting	100.0%	0.25	0.25	82.7	1
	Area Lighting	100.0%	0.03	0.03	11.0	0
	Linear Lighting	100.0%	0.31	0.31	103.4	1
Refrigeration	Walk-in Refrig/Freezer	7.9%	1.58	0.12	41.4	4
	Reach-in Refrig/Freezer	16.1%	0.31	0.05	16.5	1
	Glass Door Display	29.6%	0.33	0.10	32.6	3
	Open Display Case	29.6%	1.05	0.31	103.9	9
	Icemaker	33.3%	0.27	0.09	30.4	3
	Vending Machine	33.3%	0.11	0.04	11.9	1
Food Prep	Oven	41.1%	0.16	0.06	21.4	2
	Fryer	38.2%	0.45	0.17	57.5	6
	Dishwasher	22.2%	0.42	0.09	30.7	3
	Hot Food Container	23.2%	0.12	0.03	9.5	1
	Steamer	20.8%	0.33	0.07	23.1	2
Office Equip.	Desktop Computer	100.0%	0.19	0.19	64.6	6
	Laptop	99.3%	0.06	0.06	19.3	2
	Server	86.5%	0.22	0.19	64.0	6
	Monitor	100.0%	0.03	0.03	11.4	1
	Printer/Copier/Fax	100.0%	0.02	0.02	5.9	1
	POS Terminal	56.2%	0.02	0.01	3.5	0
Miscellaneous	Non-HVAC Motors	52.4%	0.17	0.09	28.9	4
	Pool Pump	9.1%	0.01	0.00	0.4	0
	Pool Heater	3.2%	0.02	0.00	0.2	0
	Clothes Washer	12.4%	0.00	0.00	0.1	0
	Clothes Dryer	7.9%	0.01	0.00	0.3	0
	Other Miscellaneous	100.0%	0.93	0.93	310.8	36
Total				**10.73**	**3,575.6**	**694**

Industrial Sector

The total electricity used in 2021 by Idaho Power's industrial customers was 4,024 GWh, while summer peak demand was 496 MW and winter peak demand was 354 MW. As described in Chapter 2, Idaho Power billing data, load forecast and secondary sources were used to allocate usage to industrial segments and to develop estimates of energy intensity (annual kWh/employee). Using the electricity use and intensity estimates, the number of employees is inferred, which is the unit of analysis in LoadMAP for the industrial sector. These are shown in Table 3-6.

Table 3-6 Industrial Sector Control Totals, 2021

Segment	Electricity Sales (GWh)	% of Total Usage	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Base Manufacturing	231	6%	30	26
Construction	246	6%	23	26
Dairy	524	13%	62	57
Electronics	693	17%	101	21
Food Base	459	11%	54	34
Food Packaging	619	15%	71	69
Gas pipeline	22	1%	2	3
Mining	16	0%	2	2
Snow Maker	15	0%	2	2
Sugar Base	152	4%	18	17
Water Treatment	139	3%	17	16
Other Agriculture	305	8%	37	34
Other Food Manufacturing	114	3%	14	13
Other Industrial	347	9%	50	20
Other Wastewater	140	3%	15	16
Total	**4,024**	**100%**	**496**	**354**

Figure 3-6 shows the distribution of annual electricity consumption and summer peak demand by end use for all industrial customers, not including the special contracts. Motors are the largest overall end use for the industrial sector, accounting for 40% of annual energy use. Note that this end use includes a wide range of industrial equipment, such as air compressors and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 34% of annual energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by space heating, miscellaneous, cooling and ventilation.

Figure 3-6 Industrial Sector Electricity Consumption by End Use (2021), All Industries

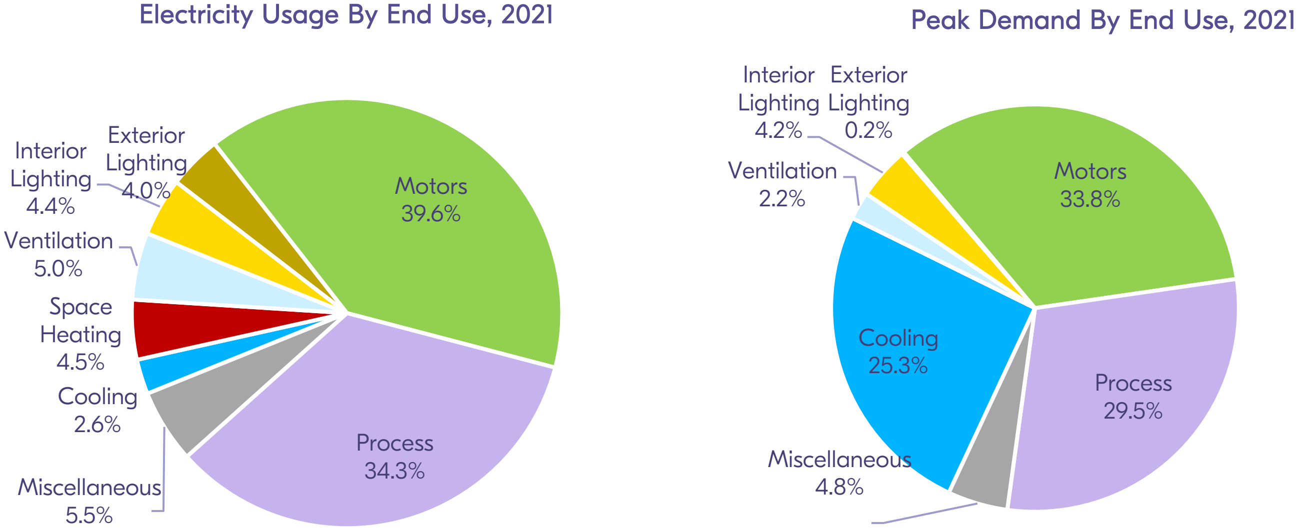


Table 3-7 shows the composite market profile for the industrial sector. The individual segment market profiles are shown in the Appendix B.

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

End Use	Technology	Saturation	UEC (kWh/ employee)	Intensity (kWh/ employee)	Usage (GWh)	Summer Peak Demand (MW)
Cooling	Air-Cooled Chiller	2.4%	4,842.4	115.1	10.7	13
	Water-Cooled Chiller	1.8%	5,748.8	101.0	9.4	11
	RTU	7.9%	4,990.6	393.5	36.6	43
	Air-Source Heat Pump	1.6%	5,131.6	82.5	7.7	9
	Geothermal Heat Pump	0.0%	0.0	0.0	0.0	0
Space Heating	Electric Furnace	1.9%	9,256.2	177.5	16.5	0
	Electric Room Heat	10.4%	8,815.4	914.2	85.0	0
	Air-Source Heat Pump	1.6%	5,057.6	81.3	7.6	0
	Geothermal Heat Pump	0.0%	0.0	0.0	0.0	0
Ventilation	Ventilation	95.1%	1,383.1	1,315.2	122.4	7
Interior Lighting	Gen. Service Lighting	99.8%	138.5	138.3	12.9	2
	High-Bay Lighting	99.8%	603.6	602.7	56.1	7
	Linear Lighting	99.8%	669.5	668.5	62.2	7
Exterior Lighting	Gen. Service Lighting	99.8%	409.9	409.3	38.1	0
	Area Lighting	99.8%	11.3	11.2	1.0	0
	Linear Lighting	99.8%	869.6	868.3	80.8	0
Motors	Pumps	93.6%	3,422.5	3,202.7	297.9	32
	Fans & Blowers	91.4%	1,401.2	1,280.4	119.1	13
	Compressed Air	88.8%	2,877.0	2,555.3	237.7	25
	Material Handling	93.0%	7,287.9	6,781.2	630.9	65
	Other Motors	49.0%	1,496.6	733.0	68.2	7
Process	Process Heating	90.1%	2,371.3	2,136.3	198.7	20
	Process Cooling	70.3%	7,654.2	5,378.7	500.4	53
	Process Refrigeration	85.6%	3,905.5	3,343.7	311.1	33
	Process Electrochemical	53.5%	372.3	199.3	18.5	2
	Process Other	53.5%	748.4	400.5	37.3	4
Miscellaneous	Other Miscellaneous	100.0%	1,563.7	1,563.7	145.5	15
	Total			**33,453.1**	**3,112.2**	**369**

Irrigation Sector

The total electricity used in 2021 by Idaho Power's irrigation customers was 6,309,431 MWh, while summer peak demand was 1,933 MW and winter peak demand was 792 MW. Idaho Power billing data were used to develop estimates of energy intensity (annual kWh/service point). For the irrigation sector, all the energy use is for the motors end use. Table 3-8 shows the composite market profile for the irrigation sector.

Table 3-8 Average Electric Market Profile for the Irrigation Sector, 2021

End Use	Size	Service Points	Electric Use (MWh)	Intensity (kWh/Service Point)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Motors	5 HP	10.5%	6,262	655	14	6
Motors	10 HP	15.4%	12,524	1,926	40	16
Motors	15 HP	8.0%	18,786	1,498	31	13
Motors	20 HP	7.7%	24,893	1,920	40	16
Motors	25 HP	7.3%	35,302	2,570	53	22
Motors	30 HP	6.4%	42,616	2,722	56	23
Motors	40 HP	8.1%	56,138	4,569	95	39
Motors	50 HP	6.4%	69,551	4,463	93	38
Motors	60 HP	4.0%	77,107	3,085	64	26
Motors	75 HP	4.8%	96,245	4,586	95	39
Motors	100 HP	4.7%	127,964	6,044	125	51
Motors	125 HP	3.0%	142,124	4,251	88	36
Motors	150 HP	2.7%	170,113	4,583	95	39
Motors	200 HP	3.4%	226,813	7,662	159	65
Motors	250 HP	1.8%	355,220	6,235	129	53
Motors	300 HP	1.6%	422,377	6,855	142	58
Motors	350 HP	1.1%	491,126	5,561	115	47
Motors	400 HP	1.0%	560,976	5,770	120	49
Motors	450 HP	0.6%	628,965	3,561	74	30
Motors	500 HP	0.6%	699,390	3,861	80	33
Motors	600 HP	0.5%	769,914	3,633	75	31
Motors	600+ HP	0.6%	1,275,025	7,219	150	61
	Total		**6,309,431**	**93,229**	**1,933**	**792**

4

BASELINE PROJECTION

Prior to developing estimates of energy efficiency potential, a baseline end-use projection is developed to quantify what the consumption would likely be in the future in absence of any efficiency programs. The savings from past programs are embedded in the forecast, but the baseline projection assumes that programs cease to exist in the future. Possible savings from future programs are captured by the potential estimates.

The baseline projection incorporates assumptions about:

- Customer population and economic growth
- Appliance/equipment standards and building codes already mandated
- Forecasts of future electricity prices and other drivers of consumption
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous electricity growth

Although it aligns closely, the baseline projection is not IPC's official load forecast. Rather, it was developed to serve as the metric against which EE potential estimates are measured. This chapter presents the baseline projections developed for this study. Below, the baseline projections for each sector are presented, which include projections of annual use in GWh and summer peak demand in MW. A summary across all sectors is also presented.

Summary of Baseline Projections Across Sectors

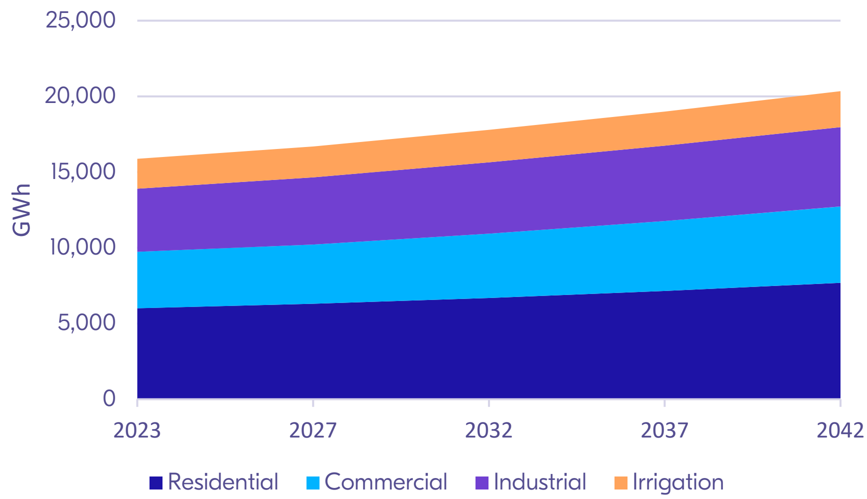
Annual Use

Table 4-1 and Figure 4-1 provide a summary of the baseline projection of annual use by sector for the entire Idaho Power service area, excluding special contracts. Overall, the projection shows strong growth in electricity use, driven by customer growth forecasts.

Table 4-1 Baseline Projection Summary (GWh)

Sector	2023	2027	2032	2037	2042	% Change ('21-'40)
Residential	6,005	6,300	6,682	7,149	7,687	28%
Commercial	3,731	3,916	4,246	4,620	5,039	35%
Industrial	4,168	4,438	4,723	4,973	5,242	26%
Irrigation	1,978	2,042	2,142	2,255	2,376	20%
Total	**15,882**	**16,697**	**17,793**	**18,997**	**20,344**	**28%**

Figure 4-1 Baseline Projection Summary (GWh)



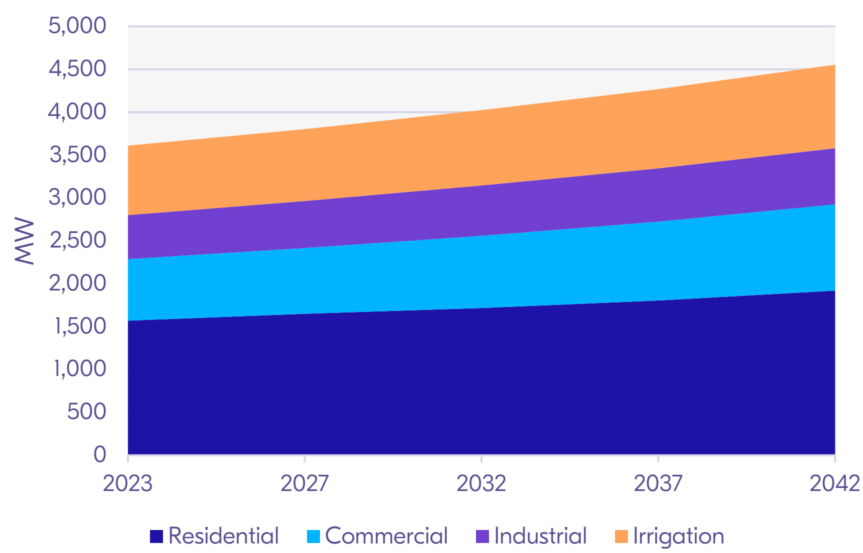
Summer Peak Demand Projection

Table 4-2 and Figure 4-2 provide a summary of the baseline projection for summer peak demand. Overall, the projection shows steady growth, again driven by the growth in customers.

Table 4-2 Summer Peak Baseline Projection Summary (MW)

Sector	2023	2027	2032	2037	2042	% Change ('23-'42)
Residential	1,569	1,650	1,717	1,805	1,919	22%
Commercial	718	766	840	919	1,006	40%
Industrial	513	550	588	620	654	28%
Irrigation	811	837	878	925	974	20%
Total	**3,610**	**3,802**	**4,023**	**4,269**	**4,554**	**26%**

Figure 4-2 Summer Peak Baseline Projection Summary (MW)



Residential Sector Baseline Projection

Table 4-3 and

Figure 4-3 present the baseline projection for electricity at the end-use level for the residential sector as a whole. Overall, residential use increases from 6,005 GWh in 2023 to 7,687 GWh in 2042, an increase of 28%. This reflects a modest customer growth forecast. Figure 4-4 presents the baseline projection of annual electricity use per household. Most noticeable is that lighting use decreases throughout the time period with the continued adoption of more efficient lighting options.

This projection is in general alignment with Idaho Power's residential load forecast. Specific observations include:

1. Lighting use declines as a result of the market transformation, which is expected to lead to the development of more efficient LED lamps becoming available in 2024. The more efficient lamp types are expected based on the assumptions from the Department of Energy's Forecast of Solid-State Lighting.[6]
2. Growth in the water heating end use is lower than average, reflecting the efficiency standards and impacts of RTF's market baseline on the projection.
3. Growth in electronics and appliances is substantial and reflects the trend toward higher-powered computers and smart appliances. Growth in other miscellaneous use[7] is also substantial. This category includes electric vehicles and many other small uses that are expected to grow in the forecast period. This end use has grown consistently in the past and future growth assumptions are incorporated that are consistent with the EIA's Annual Energy Outlook.

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

End Use	2023	2027	2032	2037	2042	% Change ('23-'42)
Cooling	1,164	1,253	1,319	1,394	1,488	28%
Heating	1,265	1,330	1,414	1,502	1,599	26%
Water Heating	608	648	695	740	788	30%
Interior Lighting	501	399	312	290	293	-42%
Exterior Lighting	131	97	75	67	65	-50%
Appliances	1,185	1,274	1,376	1,478	1,588	34%
Electronics	590	639	711	790	877	49%
Miscellaneous	561	660	779	888	990	77%
Total	**6,005**	**6,300**	**6,682**	**7,149**	**7,687**	**28%**

[6] *"Energy Savings Forecast of Solid-State Lighting in General Illumination Applications,"* Navigant Consulting for U.S. DOE, August 2014, January 2012 https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/energysavingsforecast14.pdf

[7] Miscellaneous is comprised of electric vehicles, furnace fans, pool pumps and heaters, well pumps, and other "plug" loads (such as hair dryers, power tools, coffee makers, etc.).

Figure 4-3 Residential Baseline Projection by End Use (GWh)

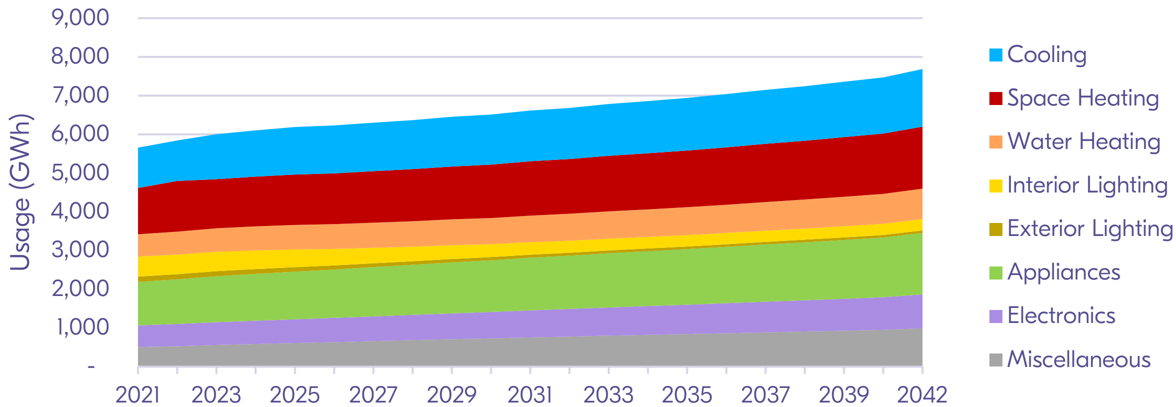
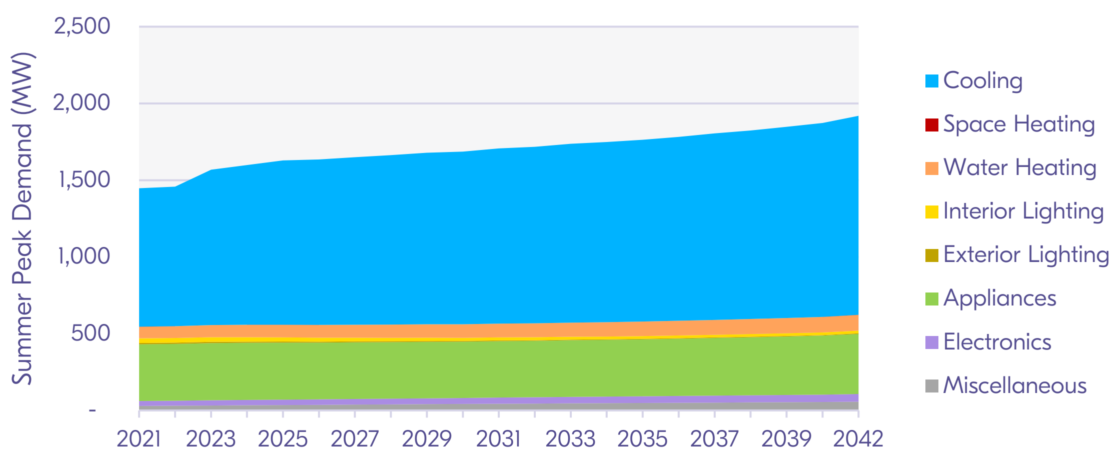


Table 4-4 Residential Summer Peak Baseline Projection by End Use (MW)and Figure 4-4 present the residential baseline projection for summer peak demand at the end-use level. Overall, residential summer peak increases from 1,569 MW in 2023 to 1,919 MW in 2042, an increase of 22%. All end uses except lighting show increases in the baseline peak projections. Electronics, appliances, and miscellaneous uses increases substantially, in correspondence with growth in annual energy use.

Table 4-4 Residential Summer Peak Baseline Projection by End Use (MW)

End Use	2023	2027	2032	2037	2042	% Change ('23-'42)
Cooling	1,012	1,092	1,150	1,215	1,296	28%
Water Heating	80	85	91	97	103	30%
Interior Lighting	30	24	19	17	18	-41%
Exterior Lighting	8	6	5	4	4	-50%
Appliances	373	369	367	375	391	5%
Electronics	34	37	41	45	50	49%
Miscellaneous	32	38	45	51	57	77%
Total	**1,569**	**1,650**	**1,717**	**1,805**	**1,919**	**22%**

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



Commercial Sector Baseline Projection

Annual electricity use in the commercial sector grows during the overall forecast horizon, starting at 3,731 GWh in 2023 and increasing by 35% to 5,039 GWh in 2042.

Table 4-5 and Figure 4-5 present the baseline projection at the end-use level for the commercial sector. Two main electricity end uses — Cooling and Lighting — account for 47% of the total annual electricity use.

Table 4-5 Commercial Baseline Projection by End Use (GWh)

End Use	2023	2027	2032	2037	2042	% Change ('23-'42)
Cooling	938	1,012	1,122	1,238	1,364	45%
Heating	290	313	346	379	414	43%
Ventilation	468	468	474	492	521	11%
Water Heating	88	96	106	116	126	43%
Interior Lighting	812	825	882	952	1,032	27%
Exterior Lighting	204	196	202	216	232	14%
Refrigeration	244	254	273	296	321	32%
Food Preparation	149	162	179	195	212	42%
Office Equipment	177	192	212	232	252	42%
Miscellaneous	361	399	451	506	566	57%
Total	**3,731**	**3,916**	**4,246**	**4,620**	**5,039**	**35%**

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

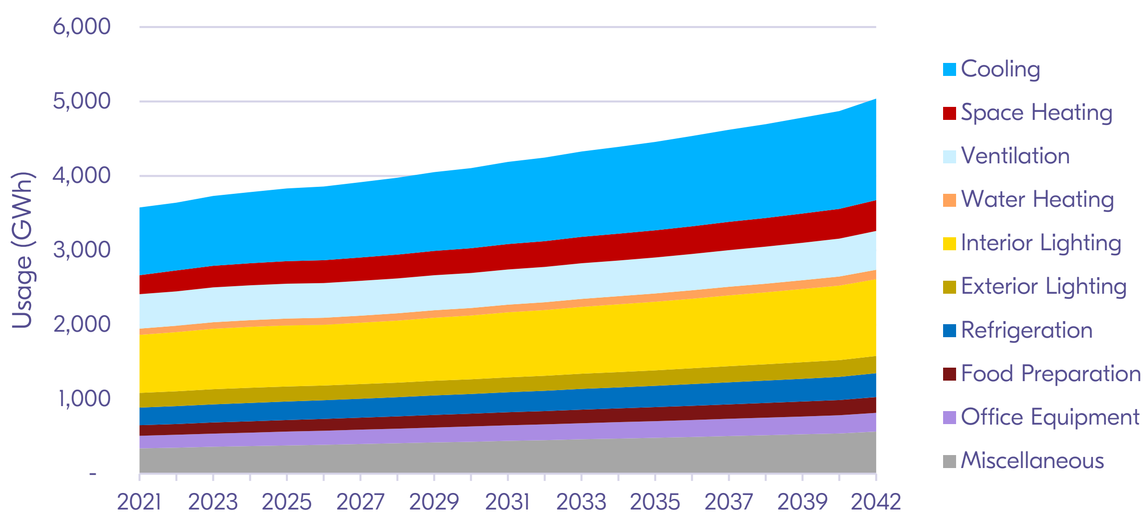
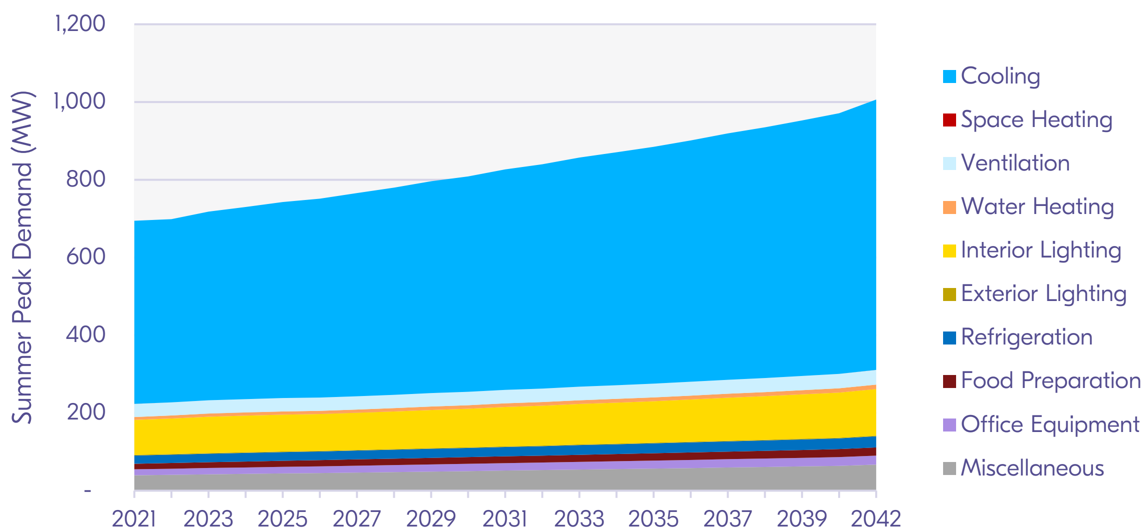


Table 4-6 and Figure 4-6 present the summer peak baseline projection at the end-use level for the commercial sector. Summer peak demand increases during the overall forecast horizon, starting at 718 MW in 2023 and increasing by 40% to 1,006 in 2042.

Table 4-6 Commercial Summer Peak Baseline Projection by End Use (MW)

End Use	2023	2027	2032	2037	2042	% Change ('23-'42)
Cooling	486	523	577	634	695	43%
Heating	0	0	0	0	0	43%
Ventilation	34	34	35	36	38	11%
Water Heating	8	9	9	10	11	43%
Interior Lighting	94	96	102	110	120	28%
Exterior Lighting	2	2	2	2	2	14%
Refrigeration	22	23	24	26	29	32%
Food Preparation	15	16	18	19	21	42%
Office Equipment	16	18	19	21	23	42%
Miscellaneous	42	47	53	60	67	59%
Total	**718**	**766**	**840**	**919**	**1,006**	**40%**

Figure 4-6 Commercial Summer Peak Baseline Projection by End Use (MW)



Industrial Sector Baseline Projection

Table 4-7 and

Figure 4-7 present the projection of electricity use in the industrial sector at the end-use level. Overall, industrial annual electricity use increases from 4,168 GWh in 2023 to 5,242 GWh in 2042. This comprises an overall increase of 26% over the 20-year period. Two main electricity end uses —Motors and Process — account for 74% of the total annual electricity use.

Table 4-7 Industrial Baseline Projection by End Use (GWh)

End Use	2023	2027	2032	2037	2042	Change ('23-'42)
Cooling	108	116	124	131	136	27%
Heating	201	211	222	232	241	20%
Ventilation	202	199	195	194	196	-3%
Interior Lighting	179	183	191	196	202	13%
Exterior Lighting	152	146	146	148	153	0%
Motors	1,658	1,780	1,900	1,998	2,099	27%
Process	1,429	1,526	1,619	1,696	1,774	24%
Miscellaneous	239	277	326	379	440	84%
Total	**4,168**	**4,438**	**4,723**	**4,973**	**5,242**	**26%**

Figure 4-7 Industrial Baseline Projection by End Use (GWh)

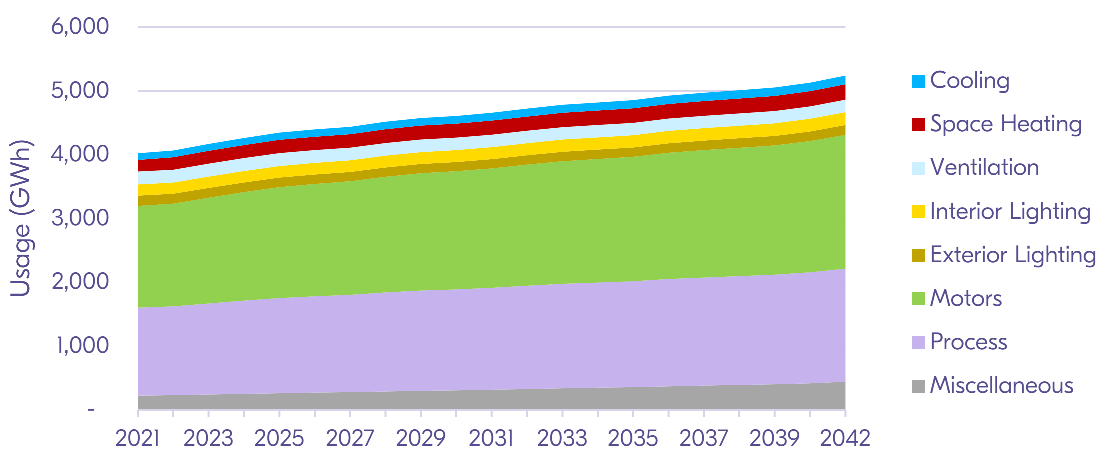
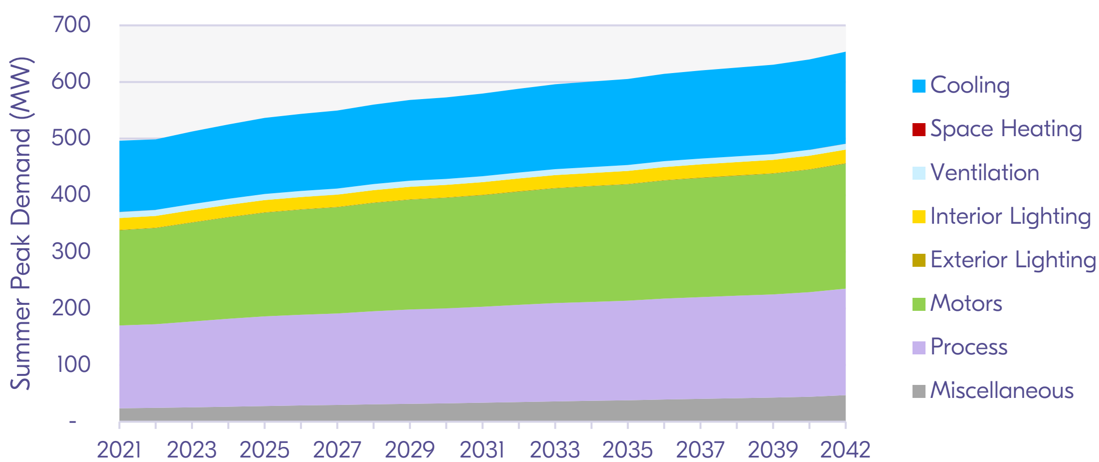


Table 4-8 and Figure 4-8 present the projection of summer peak demand for the industrial sector. Summer peak usage is 513 MW in the 2023, increasing by 28% to 654 MW in 2042.

Table 4-8 Industrial Summer Peak Baseline Projection by End Use (MW)

End Use	2023	2027	2032	2037	2042	Change ('23-'42)
Cooling	128	138	148	156	162	27%
Heating	-	-	-	-	-	-
Ventilation	11	11	10	10	11	-3%
Interior Lighting	21	22	22	23	24	13%
Exterior Lighting	1	1	1	1	1	0%
Motors	175	187	200	210	221	27%
Process	151	162	172	180	188	24%
Miscellaneous	25	29	35	40	47	84%
Total	**513**	**550**	**588**	**620**	**654**	**28%**

Figure 4-8 Industrial Summer Peak Baseline Projection by End Use (MW)



Irrigation Sector Baseline Projection

Annual irrigation uses increases throughout the forecast horizon by approximately 20.1%. However, use per service point decreases by 1.5% by 2042. The summer peak demand forecast is very similar because the irrigation sector has a high load factor. Table 4-9 presents the projections. It is not broken out by end use since all usage is due to motors.

Table 4-9 Irrigation Baseline Projection (GWh and MW)

End Use	2023	2027	2032	2037	2042	% Change ('23-'42)
Annual Energy Use:						
Total Energy Use (GWh)	1,978	2,042	2,142	2,255	2,376	20.1%
Use per service point (kWh/service point)	93,268	92,060	91,523	91,563	91,902	-1.5%
Summer Peak Demand (MW):						
Total Summer Peak Demand (MW)	811	837	878	925	974	20%
Use per service point (kW/service point)	38.2	37.7	37.5	37.5	37.7	-1.5%

5

ENERGY EFFICIENCY POTENTIAL

This chapter presents the measure-level energy efficiency potential for Idaho Power. The cumulative energy savings in GWh and the summer peak demand savings are presented in MW for selected years of the study. Year-by-year savings for energy and peak demand (summer and winter) are available in the LoadMAP model, which was provided to Idaho Power at the conclusion of the study.

A summary of energy and summer peak demand savings across all four sectors is provided first, followed by sector level results. Please note that all savings are provided at the customer meter.

AEG also used the results of the energy efficiency potential to create bundles of non-cost-effective technical achievable potential to have additional opportunities to be included as a future resource in IPC's resource planning efforts. In developing these bundles of extra energy efficiency potential, AEG made minor updates to certain assumptions relating to measure costs and incentives. These changes resulted in a 0.9% decrease in the Achievable Potential by the end of the 20-year forecast period. Since the difference in potential was minimal, and IPC had already proceeded forward with the results of the achievable economic energy efficiency, which was used by IPC to reduce the load forecast for the 2022 resource plan, this report does not reflect those minor updates.

Overall Summary of Energy Efficiency Potential

Table 5-1 and Figure 5-1 summarize the EE savings in terms of cumulative energy use for all measures for three levels of potential relative to the baseline projection. Figure 5-2 displays the EE projections as well as the baseline projection.

- **Technical potential** reflects the adoption of all EE measures regardless of cost-effectiveness. First-year savings are 468 GWh, or 2.9% of the baseline projection. Cumulative technical savings in 2042 are 5,555 GWh, or 27.3% of the baseline.
- **Economic potential** reflects the savings when the most efficient cost-effective measures, using the utility cost test, are taken by all customers. The first-year savings in 2023 are 261 GWh, or 1.6% of the baseline projection. By 2042, cumulative economic savings reach 2,746 GWh, or 13.5% of the baseline projection.
- **Achievable potential** represents savings that are possible when considering the availability, knowledge, and acceptance of the measure. Achievable potential is 107 GWh savings in the first year, or 0.7% of the baseline, and reaches 2,043 GWh cumulative achievable savings by 2042, or 10% of the baseline projection. This results in average annual savings of 0.5% of the baseline each year. Achievable potential reflects 74% of economic potential by the end of the forecast horizon. By 2024, cumulative achievable savings offset almost half the growth in the baseline projection.

Table 5-1 Summary of EE Potential (Cumulative Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Forecast	15,882	16,697	17,793	18,997	20,344
Cumulative Savings					
Achievable Potential	107	565	1,149	1,646	2,043
Economic Potential	261	1,120	1,890	2,417	2,746
Technical Potential	468	2,081	3,663	4,785	5,555
Savings (as % of Baseline)					
Achievable Potential	0.7%	3.4%	6.5%	8.7%	10.0%
Economic Potential	1.6%	6.7%	10.6%	12.7%	13.5%
Technical Potential	2.9%	12.5%	20.6%	25.2%	27.3%
Incremental Savings					
Achievable Potential	107	119	116	94	78
Economic Potential	261	189	141	97	74
Technical Potential	468	395	308	199	148

Figure 5-1 Summary of EE Potential as % of Baseline Projection (Cumulative Energy)

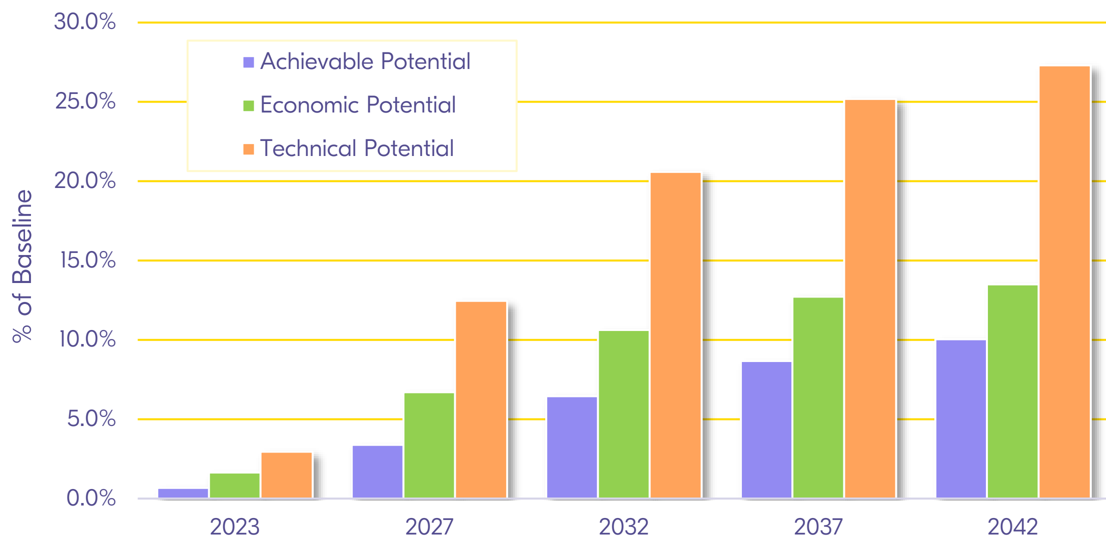


Figure 5-2 Baseline Projection and EE Forecast Summary (Energy, GWh)

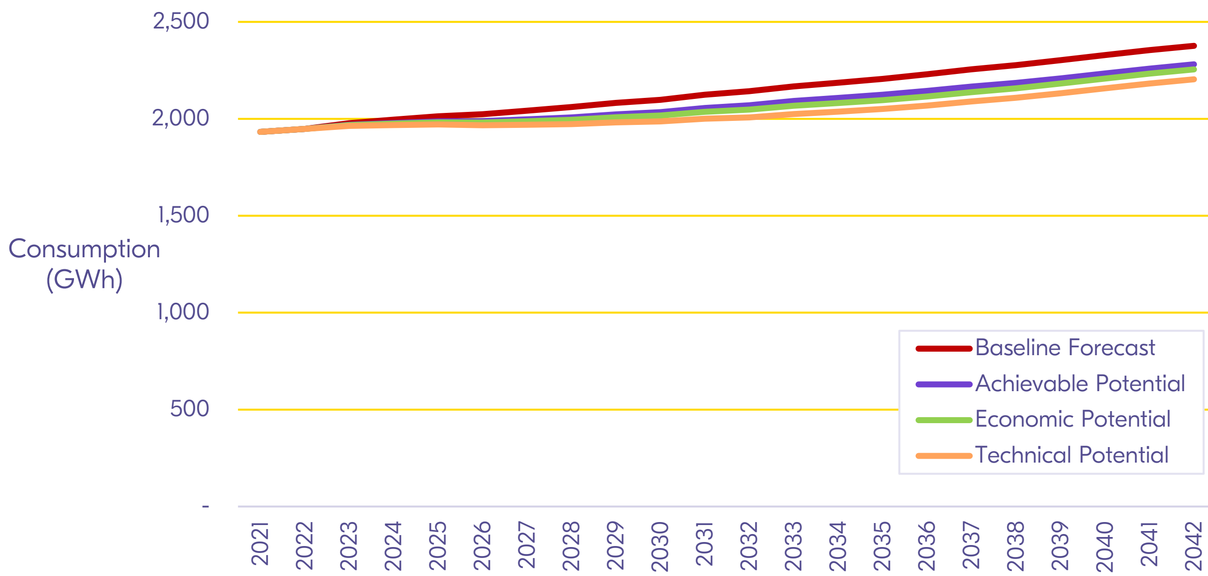


Table 5-2 and Figure 5-3 summarize the summer peak demand savings from all EE measures for three levels of potential relative to the baseline projection. Figure 5-4 displays the EE forecasts of summer peak demand.

- **Technical potential** for summer peak demand savings is 99 MW in 2023, or 2.7% of the baseline projection. This increases to 1,191 MW by 2042 or 26.2% of the summer peak demand baseline.
- **Economic potential** is estimated at 44 MW in the 2023, or 1.2% of the baseline projection. In 2042, savings are 501 MW, or 11.0% of the baseline projection.
- **Achievable potential** is 17 MW by 2023, or 0.5% of the baseline projection. By 2042, cumulative savings reach 360 MW, or 7.9% of the baseline projection.

Table 5-2 Summary of EE Potential (Summer Peak, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	3,610	3,802	4,023	4,269	4,554
Cumulative Savings (MW)					
Achievable Potential	17	94	197	287	360
Economic Potential	44	197	340	440	501
Technical Potential	99	458	804	1,044	1,191
Cumulative Savings as a % of Baseline					
Achievable Potential	0.5%	2.5%	4.9%	6.7%	7.9%
Economic Potential	1.2%	5.2%	8.4%	10.3%	11.0%
Technical Potential	2.7%	12.0%	20.0%	24.4%	26.2%

Figure 5-3 Summary of EE Potential as % of Summer Peak Baseline Projection

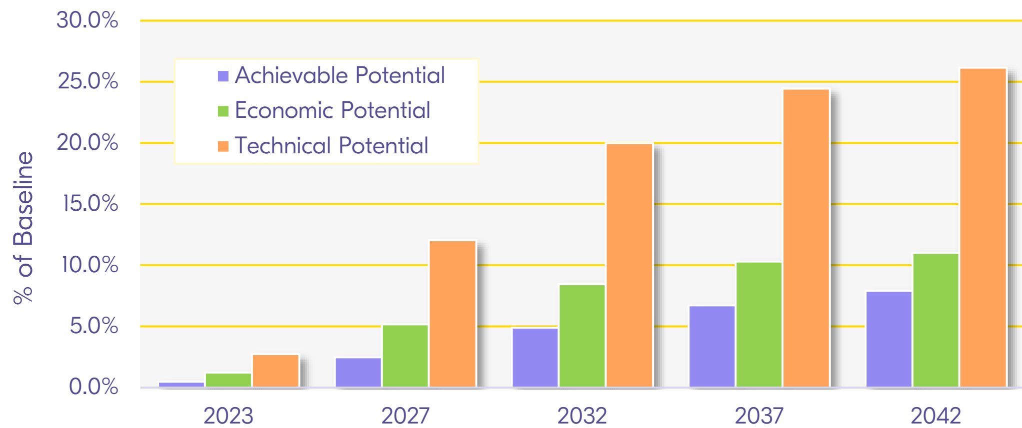
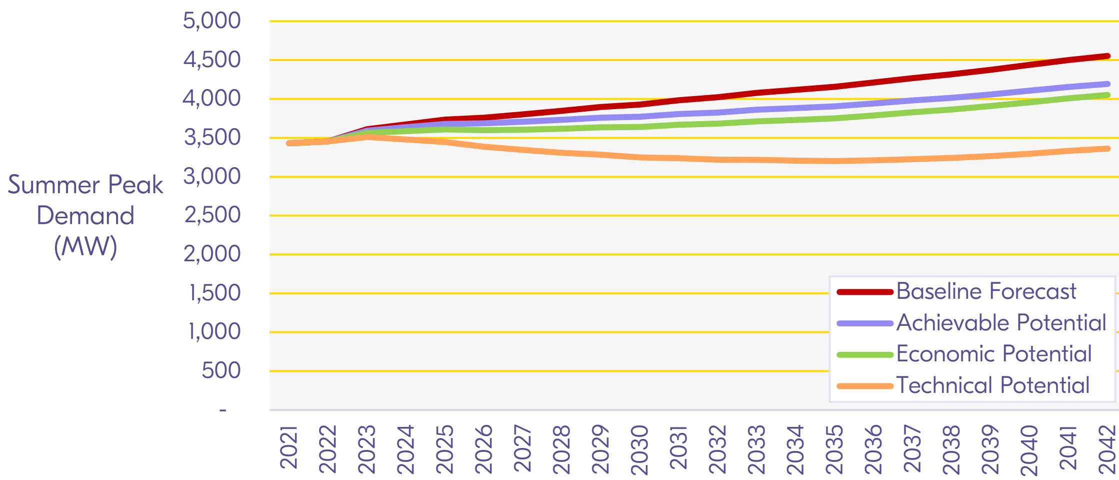


Figure 5-4 Summary Peak Baseline Projection and EE Forecast Summary (MW)



Energy Efficiency by Sector

Table 5-3, Figure 5-5, and Figure 5-6 summarize the range of potential cumulative energy and summer peak savings by sector. The commercial sector contributes the most savings throughout the forecast, followed by the residential sector.

Table 5-3 Achievable EE Potential by Sector (Energy and Summer Peak Demand)

	2023	2027	2033	2037	2042
Cumulative Energy Savings (GWh)					
Residential	20	91	202	323	445
Commercial	39	240	516	755	946
Industrial	38	187	351	468	543
Irrigation	9	47	79	101	109
Total	**106**	**565**	**1,148**	**1,647**	**2,043**
Cumulative Summer Peak Demand Savings (MW)					
Residential	4	18	41	69	96
Commercial	5	34	78	113	143
Industrial	4	22	44	62	76
Irrigation	4	20	33	42	46
Total	**17**	**94**	**196**	**286**	**361**

Figure 5-5 Achievable Cumulative EE Potential by Sector (Energy, GWh)

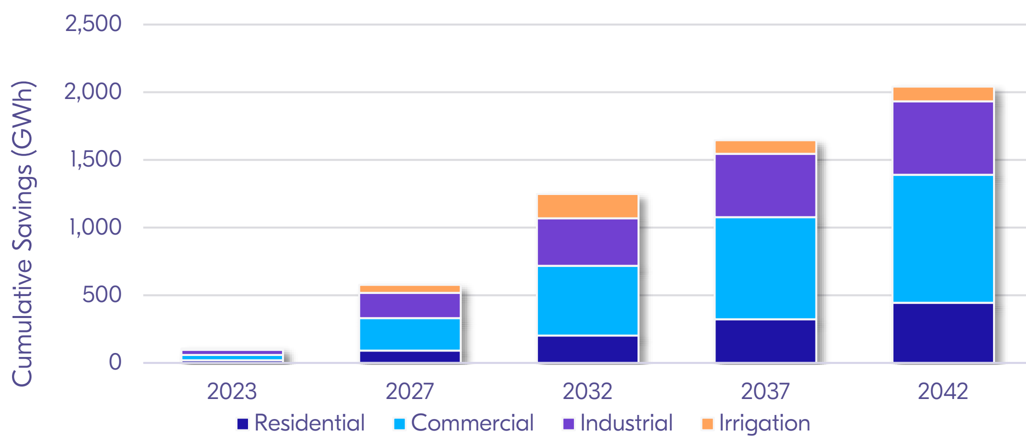
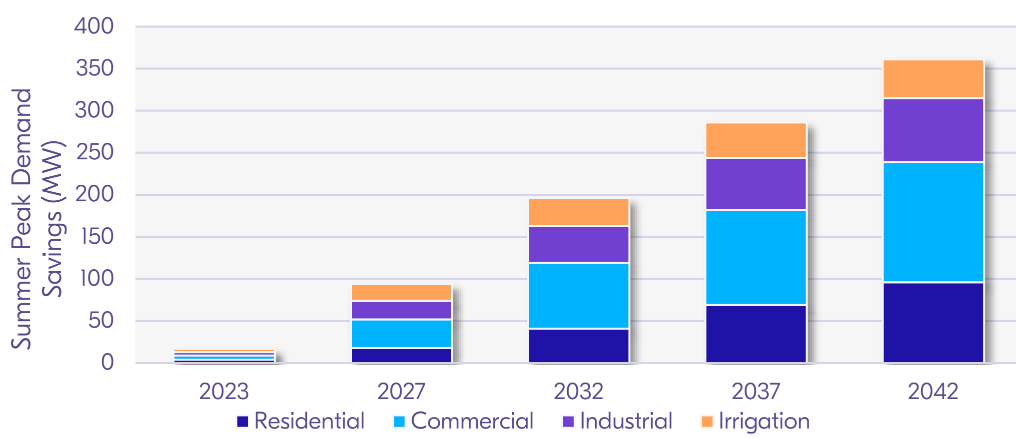


Figure 5-6 Achievable Cumulative EE Potential by Sector (Summer Peak Demand, MW)



Residential EE Potential

Table 5-4 and

Figure 5-7 present estimates for measure-level EE potential for the residential sector in terms of cumulative energy savings. Achievable potential in the first year, 2023 is 20 GWh, or 0.3% of the baseline projection. By 2042, cumulative achievable savings are 445 GWh, or 5.8% of the baseline projection. At this level, it represents just over half of economic potential.

Table 5-4 Residential EE Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	6,005	6,300	6,682	7,149	7,687
Cumulative Savings (GWh)					
Achievable Potential	20	91	202	323	445
Economic Potential	66	297	475	571	603
Technical Potential	166	831	1,557	2,078	2,443
Cumulative Savings as a % of Baseline					
Achievable Potential	0.3%	1.4%	3.0%	4.5%	5.8%
Economic Potential	1.1%	4.7%	7.1%	8.0%	7.8%
Technical Potential	2.8%	13.2%	23.3%	29.1%	31.8%

Figure 5-7 Residential Cumulative EE Savings as a % of the Energy Baseline Projection

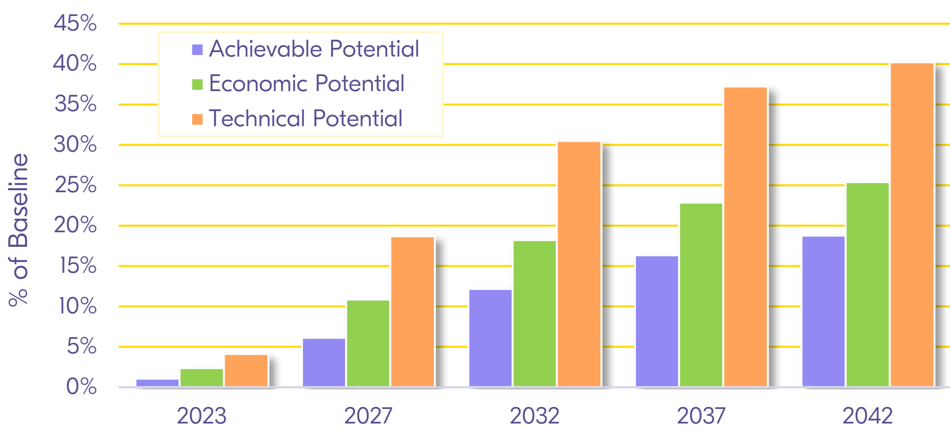
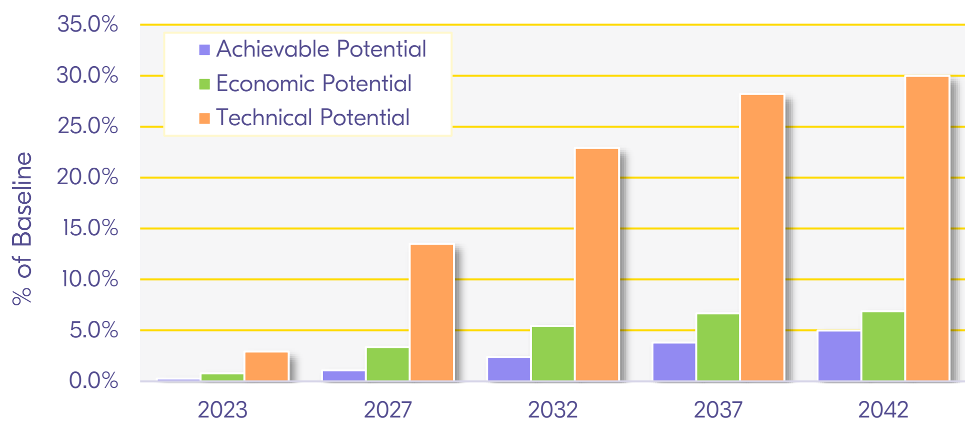


Table 5-5 and Figure 5-8 show residential EE potential in terms of summer peak savings. In the first year, 2023, achievable summer peak savings are 4 MW of the baseline summer peak projection. By 2042, cumulative achievable savings are 96 MW of the baseline summer peak projection.

Table 5-5 Residential EE Potential (Summer Peak Demand, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	1,569	1,650	1,717	1,805	1,919
Cumulative Savings (MW)					
Achievable Potential	4	18	41	69	96
Economic Potential	12	56	93	120	132
Technical Potential	46	223	393	509	575
Cumulative Savings as a % of Baseline					
Achievable Potential	0.3%	1.1%	2.4%	3.8%	5.0%
Economic Potential	0.8%	3.4%	5.4%	6.7%	6.9%
Technical Potential	2.9%	13.5%	22.9%	28.2%	30.0%

Figure 5-8 Residential EE Savings as a % of the Summer Peak Demand Baseline Projection



Residential Top Measures

Below, the top residential measures from the perspective of energy use and summer peak demand are presented. Table 5-6 identifies the top 20 residential measures from the perspective of cumulative energy savings in 2032 and 2042, ranked by savings in 2042. The top measures are Central AC, followed by Water Heaters, TVs and Clothes Washers.

Table 5-6 Residential Top Measures in 2032 and 2042 (Energy, MWh)

Rank	Measure	Cumulative Achievable Potential in 2032	Cumulative Achievable Potential in 2042	% of Total in 2042
1	Central AC	29,698	60,226	13.5%
2	Water Heater (<= 55 Gal)	6,995	56,371	12.7%
3	TVs	26,155	50,404	11.3%
4	Clothes Washer - ENERGY STAR (8.0)	8,244	45,003	10.1%
5	Set-top Boxes/DVRs	21,461	43,486	9.8%
6	Behavioral Programs	41,025	39,776	8.9%
7	Clothes Dryer	2,513	23,126	5.2%
8	Linear Lighting	8,076	18,595	4.2%
9	Air-Source Heat Pump	4,853	18,174	4.1%
10	Connected Thermostat - ENERGY STAR (1.0)	14,310	16,592	3.7%
11	Insulation - Ceiling Installation	4,901	6,158	1.4%
12	Pool Heater	2,236	6,136	1.4%
13	Freezer	690	6,039	1.4%
14	Building Shell - Liquid-Applied Weather-Resistive Barrier	667	5,665	1.3%
15	HVAC - Plant Shade Trees	1,788	5,393	1.2%
16	Room AC - Recycling	920	4,265	1.0%
17	Insulation - Basement Sidewall	3,298	4,130	0.9%
18	Well pump	1,245	3,723	0.8%
19	Mobile Home Low Income - HVAC and Weatherization	1,717	3,378	0.8%
20	Ducting - Repair and Sealing	2,528	3,221	0.7%
	Total of Top 20 Measures	**183,317**	**419,861**	**94.4%**

Figure 5-9 presents forecasts of energy savings by end use in cumulative savings and as a percent of total savings per year. Lighting savings account for a substantial portion of the savings throughout the forecast horizon, but the share declines over time as the market is transformed. The same is true for exterior lighting. Behavioral Program savings contribute a large portion of the savings to all end uses in the early years of the forecast but taper off later in the study due to degrading savings from sunsetting of the program. Water heater savings contribute a large portion, as a result of heat pump water heaters being cost effective from the start of the forecast. Savings from cooling measures and appliances are steadily increasing throughout the forecast horizon.

Figure 5-9 Residential Achievable EE Savings Forecast by End Use (Cumulative Energy)

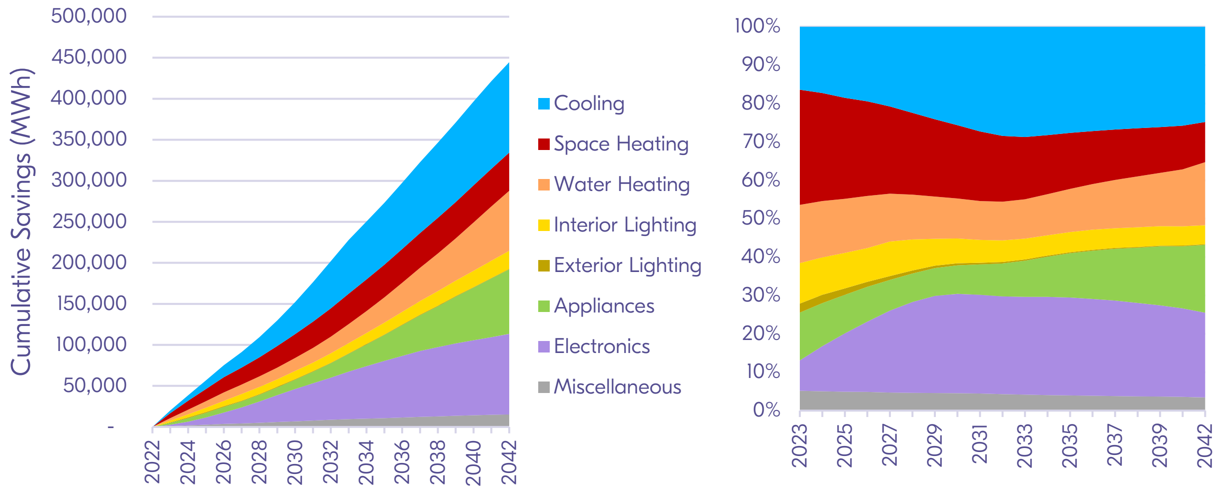
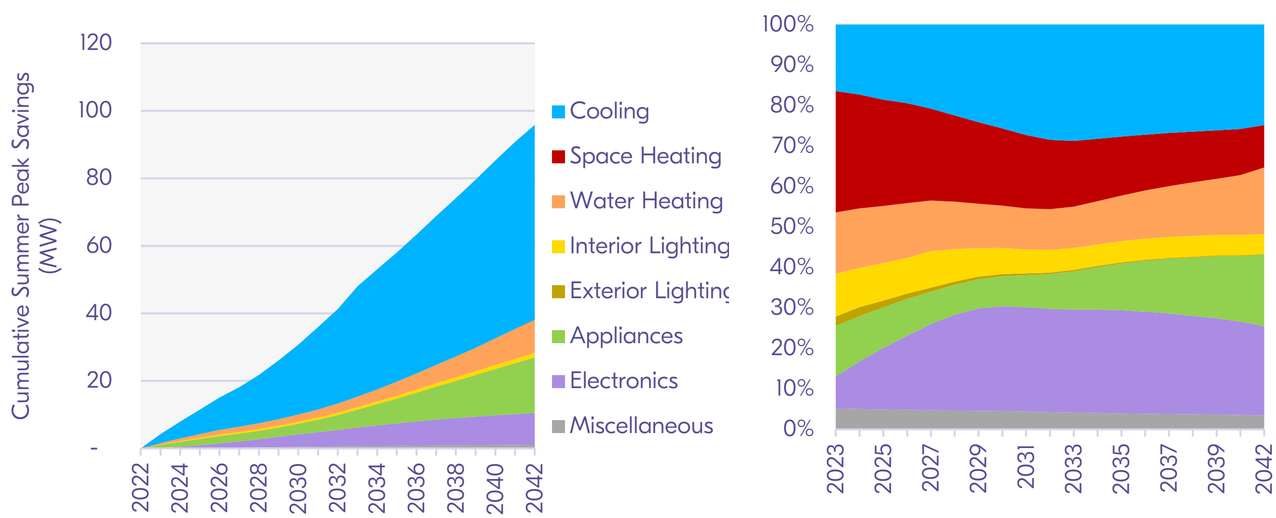


Table 5-7 identifies the top 20 residential measures from the perspective of summer peak savings in 2032 and 2042. The top measure is Central ACs, accounting for 23.4% of cumulative peak achievable savings. Clothes Washers account for approximately 11.3% of the achievable savings, followed by Behavioral Program savings at 8.5%. Figure 5-10 presents forecasts of summer peak savings by end use as cumulative savings and as a percent of total savings per year. Savings from appliances, cooling, and water heating-related measures are expected to increase throughout the forecast horizon as lighting usage decreases with more efficient lightbulbs.

Table 5-7 Residential Top Measures in 2032 and 2042 (Summer Peak Demand, MW)

Rank	Measure	Achievable Potential in 2032	Achievable Potential in 2042	% of Total in 2042
1	Central AC	5.7	22.5	23.4%
2	Clothes Washer - ENERGY STAR (8.0)	2.1	10.8	11.3%
3	Behavioral Programs	8.7	8.1	8.5%
4	Water Heater (<= 55 Gal)	0.9	7.6	8.0%
5	Connected Thermostat - ENERGY STAR (1.0)	6.5	7.4	7.7%
6	Air-Source Heat Pump	1.7	6.2	6.5%
7	TVs	2.6	5.0	5.2%
8	HVAC - Plant Shade Trees	1.6	4.9	5.1%
9	Set-top Boxes/DVRs	2.0	4.1	4.3%
10	Clothes Dryer	0.3	3.1	3.3%
11	Building Shell - Liquid-Applied Weather-Resistive Barrier	0.3	2.5	2.6%
12	Insulation - Radiant Barrier	1.5	1.7	1.8%
13	Insulation - Ceiling Installation	1.2	1.5	1.5%
14	Windows - High Efficiency (U-0.22)	1.1	1.3	1.4%
15	Linear Lighting	0.5	1.1	1.2%
16	Insulation - Basement Sidewall	0.9	1.1	1.2%
17	Freezer	0.1	1.0	1.1%
18	Ducting - Repair and Sealing	0.7	0.8	0.9%
19	Mobile Home Low Income - HVAC and Weatherization	0.4	0.7	0.8%
20	Insulation - Ducting	0.6	0.7	0.7%
	Total of Top 20 Measures	**39.4**	**92.4**	**96.4%**

Figure 5-10 Residential Achievable Savings Forecast (Summer Peak, MW)



Commercial EE Potential

Table 5-8 and Figure 5-11 present estimates for the three levels of EE potential for the commercial sector from the perspective of cumulative energy savings. In 2023, achievable potential is 39 GWh, or 1.1% of the baseline projection. By 2042, savings are 946 GWh, or 18.8% of the baseline projection. By the end of the forecast horizon, achievable potential represents about 74% of economic potential.

Table 5-8 Commercial EE Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	3,731	3,916	4,246	4,620	5,039
Cumulative Savings (GWh)					
Achievable Potential	39	240	516	755	946
Economic Potential	89	425	773	1,056	1,279
Technical Potential	154	732	1,295	1,721	2,027
Cumulative Savings as a % of Baseline					
Achievable Potential	1.1%	6.1%	12.2%	16.3%	18.8%
Economic Potential	2.4%	10.9%	18.2%	22.9%	25.4%
Technical Potential	4.1%	18.7%	30.5%	37.2%	40.2%

Figure 5-11 Commercial Cumulative EE Savings as a % of the Energy Baseline Projection

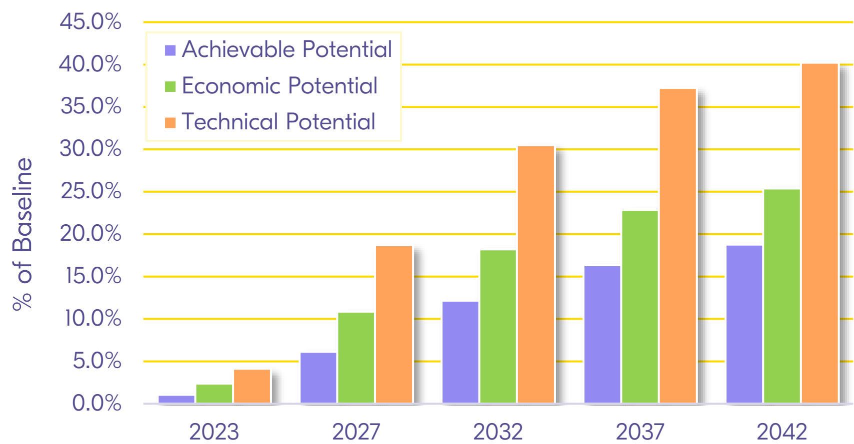


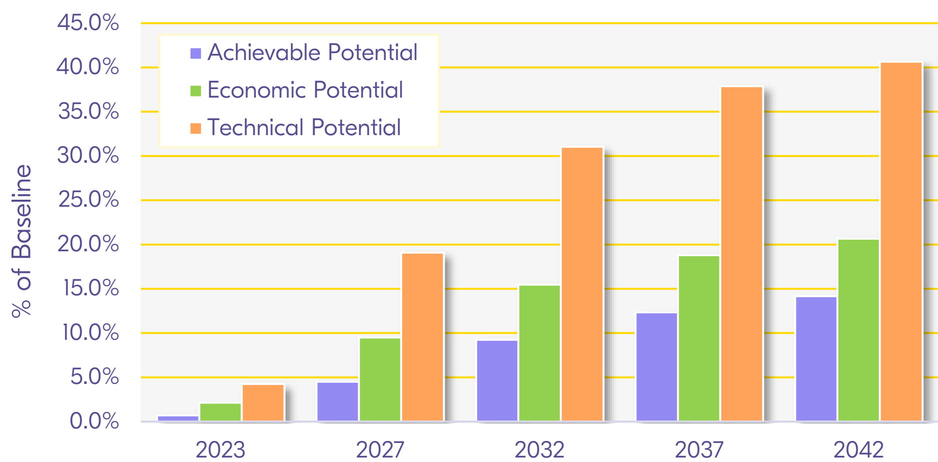
Table 5-9 and

Figure 5-12 present savings estimates from the perspective of summer peak demand. In 2023, achievable potential is 5 MW of the baseline summer peak projection or 0.7% of the baseline projection. By 2042, savings are 143 MW or 14.2% of the baseline projection.

Table 5-9 Commercial EE Potential (Summer Peak Demand, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	718	766	840	919	1,006
Cumulative Savings (MW)					
Achievable Potential	5	34	78	113	143
Economic Potential	15	73	130	173	208
Technical Potential	31	146	261	348	409
Cumulative Savings as a % of Baseline					
Achievable Potential	0.7%	4.5%	9.3%	12.3%	14.2%
Economic Potential	2.1%	9.5%	15.5%	18.8%	20.7%
Technical Potential	4.3%	19.1%	31.1%	37.9%	40.7%

Figure 5-12 Commercial EE Savings as a % of the Summer Peak Baseline Projection



Commercial Sector Top Measures

Table 5-10 identifies the top 20 commercial-sector measures from the perspective of energy savings in 2032 and 2042. The top two measures are interior LED replacements for High-Bay, Area, and Linear-Fluorescent-style lighting applications. Lighting dominates the top measures, followed by Water-Cooled Chillers, Duct Repair and Sealing and Server.

Table 5-10 Commercial Top Measures in 2032 and 2042 (Energy, MWh)

Rank	Measure	Cumulative Achievable Potential in 2032	Cumulative Achievable Potential in 2042	% of Total
1	Linear Lighting	242,679	506,778	53.6%
2	High-Bay Lighting	45,204	77,845	8.2%
3	Water-Cooled Chiller	16,817	52,805	5.6%
4	Ducting - Repair and Sealing	15,715	19,060	2.0%
5	Server	15,891	18,526	2.0%
6	Retrocommissioning	16,815	14,682	1.6%
7	RTU	5,803	14,503	1.5%
8	Engine Block Heater Controls	9,527	12,620	1.3%
9	Ventilation - Variable Speed Control	1,539	11,743	1.2%
10	Air-Source Heat Pump	4,361	11,639	1.2%
11	Refrigeration - Heat Recovery	8,054	11,076	1.2%
12	Refrigeration - Variable Speed Compressor	8,986	10,602	1.1%
13	Grocery - Display Case - Door Retrofit	8,523	10,318	1.1%
14	Air-Cooled Chiller	3,447	9,402	1.0%
15	Area Lighting	5,420	9,302	1.0%
16	General Service Lighting	6,027	8,279	0.9%
17	Ventilation	3,149	8,078	0.9%
18	HVAC - Maintenance	7,497	7,674	0.8%
19	Oven	4,699	7,530	0.8%
20	Advanced New Construction Designs	323.9	7,374	0.8%
	Total of Top 20 Measures	**430,475**	**829,837**	**87.7%**

Figure 5-13 presents forecasts of energy savings by end use as cumulative savings and a percent of total savings per year. Lighting savings from interior and exterior applications account for a substantial portion of the savings throughout the forecast horizon.

Figure 5-13 Commercial Achievable EE Savings Forecast by End Use (Energy, MWh

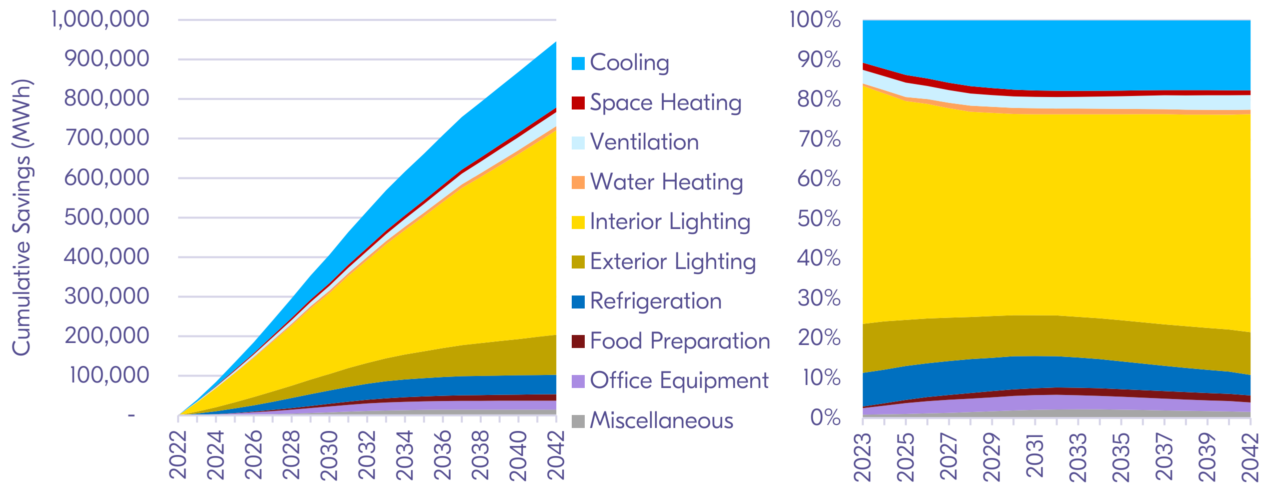


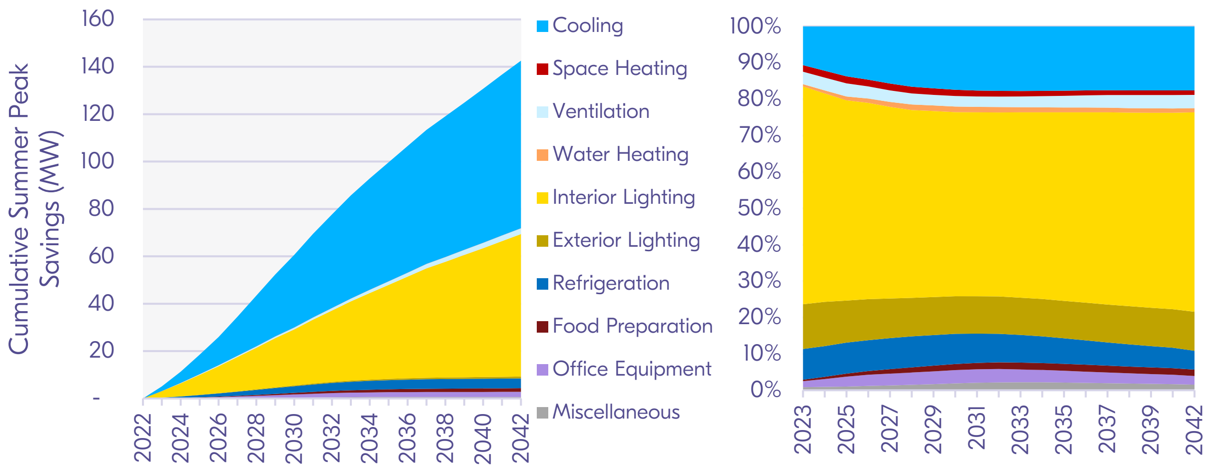
Table 5-11 identifies the top 20 commercial-sector measures from the perspective of summer peak savings in 2032 and 2042. The top two measures are Linear Lighting and Water-Cooled Chiller, with nearly half of the cumulative peak savings 2042. This is because commercial lighting use is coincident with the system peak hour. The top 20 measures account for nearly all of total summer peak savings in 2042.

Table 5-11 Commercial Top Measures in 2032 and 2042 (Summer Peak Demand, MW)

Rank	Measure	Cumulative Achievable Potential in 2032	Cumulative Achievable Potential in 2042	% of Total
1	Linear Lighting	23.9	50.0	35.4%
2	Water-Cooled Chiller	7.3	23.3	16.5%
3	High-Bay Lighting	5.4	9.2	6.5%
4	Ducting - Repair and Sealing	7.2	8.8	6.2%
5	Air-Cooled Chiller	2.6	7.0	4.9%
6	Air-Source Heat Pump	1.5	3.9	2.8%
7	Building Shell - High Reflectivity Roofs	2.7	3.4	2.4%
8	Ventilation - Nighttime Air Purge	2.5	3.3	2.3%
9	Retrocommissioning	3.4	3.2	2.3%
10	HVAC — Maintenance	3.1	3.2	2.3%
11	RTU	1.1	2.8	2.0%
12	Water-Cooled Chiller - Condenser Water Temp Reset	2.0	2.1	1.5%
13	Server	1.5	1.8	1.2%
14	Water-Cooled Chiller - Var Flow Condenser Water Pump	1.4	1.7	1.2%
15	HVAC - Economizer Controls	0.2	1.5	1.1%
16	Chiller - Variable Flow Chilled Water Pump	1.2	1.3	0.9%
17	Chiller - Variable Speed Fans	1.1	1.3	0.9%
18	Windows - Secondary Glazing Systems	0.8	1.0	0.7%
19	Refrigeration - Heat Recovery	0.7	0.9	0.6%
20	Refrigeration - Variable Speed Compressor	0.7	0.9	0.6%
	Total of Top 20 Measures	**70.2**	**130.8**	**91.7%**

Figure 5-14 presents forecasts of summer peak savings by end use as a percent of total summer peak savings and cumulative savings. Savings from cooling and lighting-related measures dominate throughout the forecast horizon.

Figure 5-14 Commercial Achievable EE Savings Forecast by End Use (Summer Peak Demand)



Industrial EE Potential

Table 5-12 and

Figure 5-15 present potential estimates at the measure level for the Industrial sector, from the perspective of cumulative energy savings. Achievable savings in the first year, 2023, are 38 GWh, or 0.9% of the baseline projection. In 2042, savings reach 543 GWh, or 10.4% of the baseline projection.

Table 5-12 Industrial EE Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	4,168	4,438	4,723	4,973	5,242
Cumulative Savings (GWh)					
Achievable Potential	38	187	351	468	543
Economic Potential	95	339	533	653	722
Technical Potential	134	445	676	821	912
Cumulative Savings as a % of Baseline					
Achievable Potential	0.9%	4.2%	7.4%	9.4%	10.4%
Economic Potential	2.3%	7.6%	11.3%	13.1%	13.8%
Technical Potential	3.2%	10.0%	14.3%	16.5%	17.4%

Figure 5-15 Industrial Cumulative EE Savings as a % of the Energy Baseline Projection

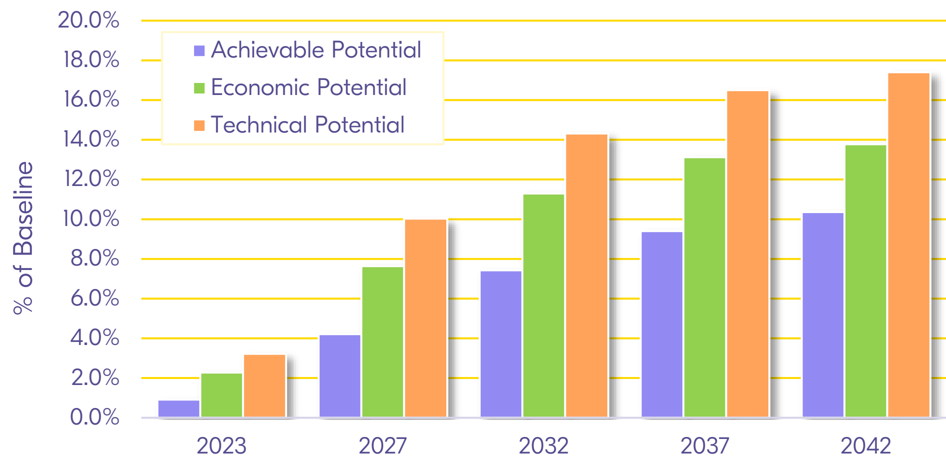


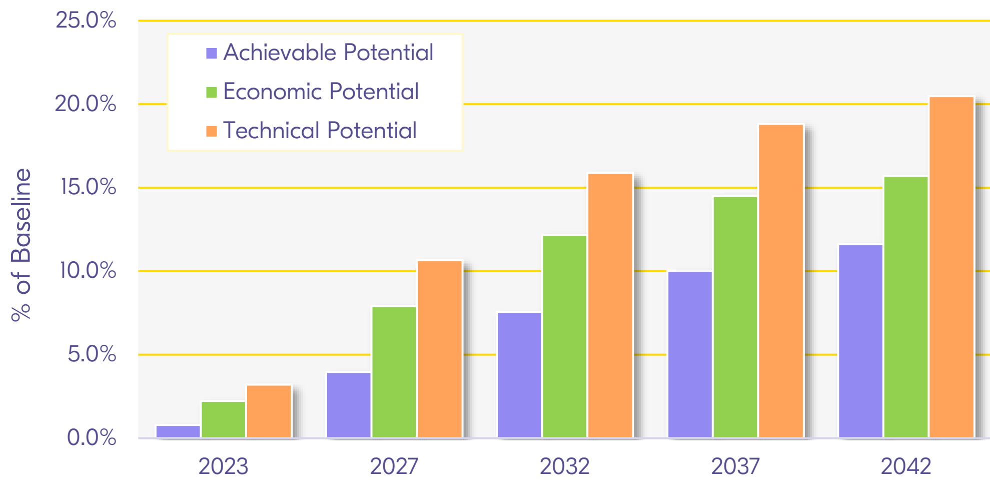
Table 5-13 and

Figure 5-16 present potential estimates from the perspective of summer peak savings. In 2023, the first year of the potential forecast, achievable savings are 4 MW of the baseline projection or 0.8% of the baseline projection. By 2042, savings have increased to 76 MW of the baseline summer peak projection or 11.6% of the baseline projection.

Table 5-13 Industrial EE Potential (Summer Peak Demand, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	513	550	588	620	654
Cumulative Savings (MW)					
Achievable Potential	4	22	44	62	76
Economic Potential	11	44	72	90	103
Technical Potential	16	59	93	117	134
Cumulative Savings as a % of Baseline					
Achievable Potential	0.8%	4.0%	7.6%	10.0%	11.6%
Economic Potential	2.2%	7.9%	12.2%	14.5%	15.7%
Technical Potential	3.2%	10.7%	15.9%	18.8%	20.5%

Figure 5-16 Industrial EE Savings as a % of the Summer Peak Demand Baseline Projection



Industrial Sector Top Measures

Table 5-14 identifies the top 20 industrial measures from the perspective of energy savings in 2032 and 2042. The top measures are Linear and High Bay Lighting, followed by Refrigeration Floating Head Pressure Controls, High-efficiency Ventilation, and High-Efficiency Refrigeration Compressors.

Table 5-14 Industrial Top Measures in 2032 and 2042 (Energy, MWh)

Rank	Measure	Cumulative Achievable Potential in 2032	Cumulative Achievable Potential in 2042	% of Total
1	Linear Lighting	57,567	128,642	23.7%
2	High-Bay Lighting	39,623	72,925	13.4%
3	Refrigeration - Floating Head Pressure	33,186	39,771	7.3%
4	Ventilation	12,120	35,158	6.5%
5	Refrigeration - High Efficiency Compressor	23,714	28,114	5.2%
6	Pumping System - Controls	17,628	22,738	4.2%
7	Refrigeration - System Optimization	19,095	22,345	4.1%
8	Strategic Energy Management	10,663	20,684	3.8%
9	Compressed Air - End Use Optimization	14,955	15,420	2.8%
10	Switch from Belt Drive to Direct Drive	11,477	13,733	2.5%
11	Material Handling - Variable Speed Drive	10,644	13,297	2.4%
12	Process - Tank Insulation	12,329	13,088	2.4%
13	Water-Cooled Chiller	4,180	12,663	2.3%
14	Advanced Industrial Motors	7,677	10,021	1.8%
15	Fan System - Equipment Upgrade	6,946	9,135	1.7%
16	Municipal Sewage Treatment - Optimization	8,426	8,442	1.6%
17	Pumping System - System Optimization	6,509	7,156	1.3%
18	High Frequency Battery Chargers	5,462	7,078	1.3%
19	Fan System - Controls	5,425	7,009	1.3%
20	Air-Cooled Chiller	2,026	5,907	1.1%
	Total of Top 20 Measures	**309,654**	**493,328**	**90.8%**

Figure 5-17 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Motor-related measures account for a substantial portion of the savings throughout the forecast horizon. The share of savings by end use remains fairly similar throughout the forecast period.

Figure 5-17 Industrial Achievable EE Savings Forecast by End Use (Cumulative Energy, MWh)

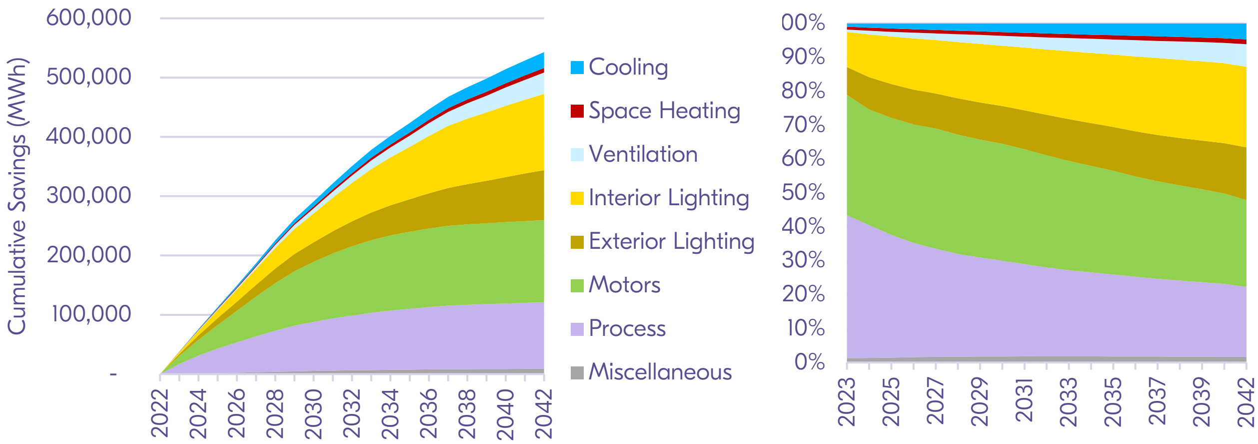


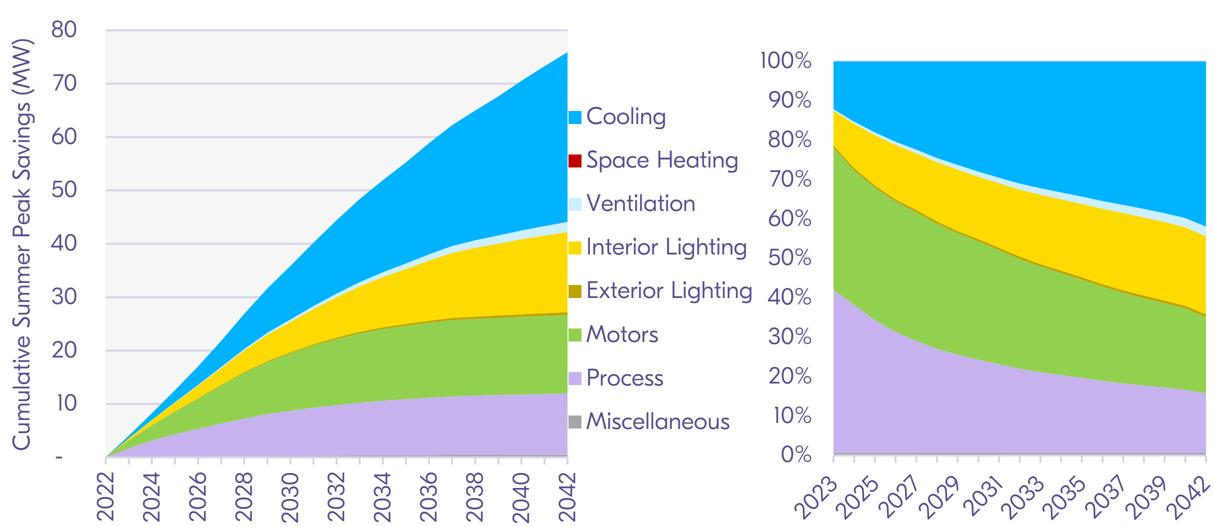
Table 5-15 Identifies the top 20 Industrial measures from the perspective of summer peak savings in 2032 and 2042. The top measure, Water-Cooled Chillers, accounts for 20.2% of the cumulative peak savings in 2042. Linear and High-Bay Lighting, and Refrigeration control measures also provide significant summer peak savings.

Table 5-15 Industrial Top Measure in 2032 and 2042 (Summer Peak Demand, MW)

Rank	Measure	Cumulative Achievable Potential in 2032	Cumulative Achievable Potential in 2042	% of Total
1	Water-Cooled Chiller	5.1	15.3	20.2%
2	High-Bay Lighting	4.7	8.6	11.3%
3	Air-Cooled Chiller	2.4	7.0	9.3%
4	Linear Lighting	2.9	6.4	8.5%
5	Refrigeration - Floating Head Pressure	3.3	4.0	5.2%
6	Refrigeration - High Efficiency Compressor	2.4	2.8	3.7%
7	Strategic Energy Management	1.3	2.6	3.4%
8	Chiller - Chilled Water Reset	2.5	2.6	3.4%
9	Pumping System - Controls	1.9	2.4	3.2%
10	Refrigeration - System Optimization	2.0	2.4	3.2%
11	Ducting - Repair and Sealing	0.7	2.0	2.6%
12	Ventilation	0.6	1.9	2.5%
13	Industrial Air Curtains	0.9	1.7	2.2%
14	Compressed Air - End Use Optimization	1.6	1.6	2.2%
15	Switch from Belt Drive to Direct Drive	1.2	1.4	1.9%
16	Material Handling - Variable Speed Drive	1.1	1.4	1.8%
17	Process - Tank Insulation	1.3	1.4	1.8%
18	Advanced Industrial Motors	0.8	1.1	1.4%
19	Fan System - Equipment Upgrade	0.7	1.0	1.3%
20	Municipal Sewage Treatment - Optimization	0.9	0.9	1.2%
	Total of Top 20 Measures	**38.3**	**68.5**	**90.2%**

Figure 5-18 presents forecasts of summer peak savings by end use as a percent of total summer peak savings and cumulative savings. Lighting, motors, and process all contribute to the savings throughout the forecast horizon.

Figure 5-18 Industrial Achievable EE Savings Forecast by End Use (Summer Peak Demand, MW)



Irrigation EE Potential

Table 5-16 and Figure 5-19 present potential estimates at the measure level for the Irrigation sector, from the perspective of cumulative energy savings. Achievable savings in the first year, 2023, are 9 GWh, or 0.5 % of the baseline projection. In 2042, savings reach 109 GWh, or 4.6% of the baseline projection.

Table 5-16 Irrigation EE Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	1,978	2,042	2,142	2,255	2,376
Cumulative Savings (GWh)					
Achievable Potential	9	47	79	101	109
Economic Potential	11	59	108	137	142
Technical Potential	14	73	135	166	173
Cumulative Savings as a % of Baseline					
Achievable Potential	0.5%	2.3%	3.7%	4.5%	4.6%
Economic Potential	0.6%	2.9%	5.0%	6.1%	6.0%
Technical Potential	0.7%	3.6%	6.3%	7.4%	7.3%

Figure 5-19 Irrigation Cumulative EE Savings as a % of the Energy Baseline Projection

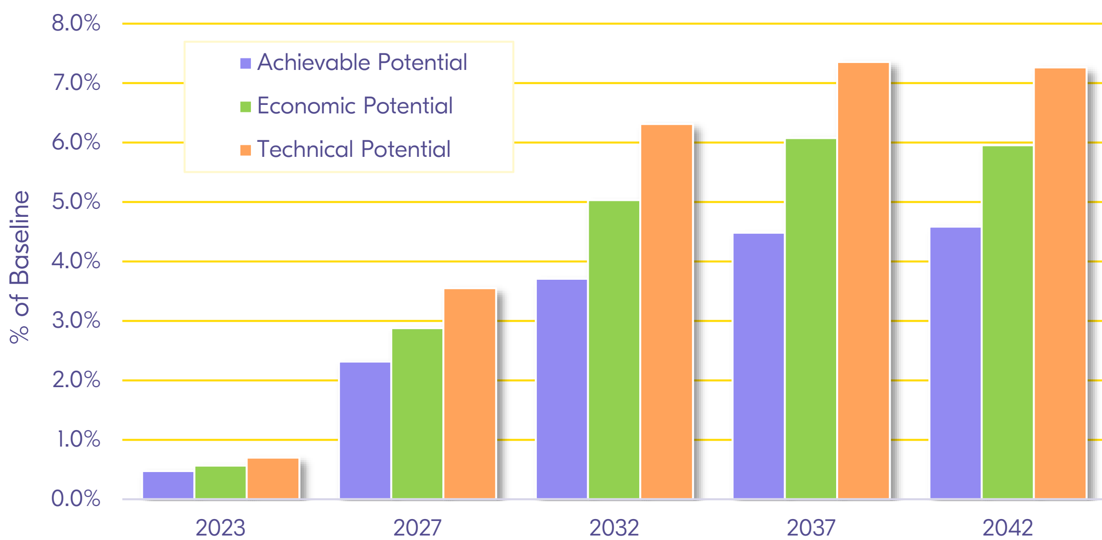


Table 5-17 and Figure 5-20 present potential estimates from the perspective of summer peak savings. In 2023, the first year of the potential forecast, achievable savings are 4 MW or 0.5% of the baseline projection. By 2042, cumulative peak savings have increased to 46 MW or 4.7% of the baseline summer peak projection.

Table 5-17 Irrigation EE Potential (Summer Peak Demand, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	811	837	878	925	974
Cumulative Savings (MW)					
Achievable Potential	4	20	33	42	46
Economic Potential	5	25	45	57	59
Technical Potential	6	30	57	70	72
Cumulative Savings as a % of Baseline					
Achievable Potential	0.5%	2.4%	3.8%	4.6%	4.7%
Economic Potential	0.6%	2.9%	5.1%	6.2%	6.1%
Technical Potential	0.7%	3.6%	6.5%	7.5%	7.4%

Figure 5-20 Irrigation EE Savings as a % of the Summer Peak Demand Baseline Projection

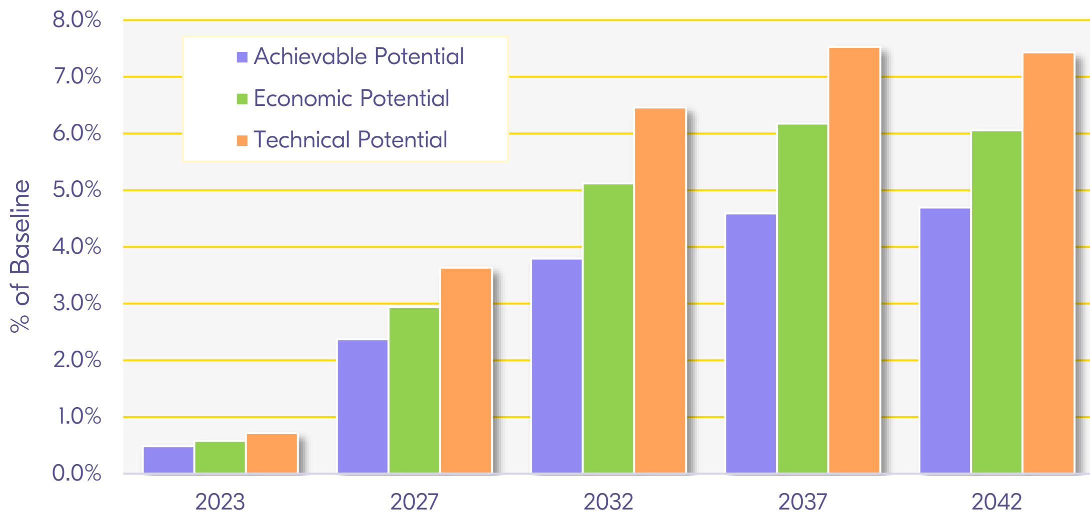


Table 5-18 identifies the top Irrigation measures from the perspective of energy savings in 2032 and 2042. The top measure is Variable Frequency Drives for motors, which accounts for 26.0% cumulative savings in 2042. The next two measures in ranking are a pump replacements and Center pivot/Linear – MESA sprinkler replacements.

Table 5-18 Irrigation Top Measures in 2023 (Energy, MWh)

Rank	Measure	Achievable Potential in 2032	Achievable Potential in 2042	% of Total
1	Motors - Variable Frequency Drive	28,549	28,327	26.0%
2	CS to CS Pump Replacement	23,845	27,478	25.2%
3	Center Pivot/Linear - Medium P to Low P	3,360	21,297	19.5%
4	Center Pivot/Linear - MESA Sprinkler Replacement	5,558	6,270	5.8%
5	Center Pivot/Linear - Upgrade High P to MESA	5,414	5,715	5.2%
6	Center Pivot/Linear - Upgrade MESA to LESA	710	4,461	4.1%
7	Center Pivot/Linear - High P Sprinkler Replacement	2,674	3,024	2.8%
8	VS to VS Pump Replacement	2,324	2,679	2.5%
9	Center Pivot/Linear - High P to Medium P	931	2,174	2.0%
10	Green Motor Rewind - Surface and Tailwater Pump	1,297	1,480	1.4%
	Total of Top 10 Measures	**74,663**	**102,905**	**94.4%**

Table 5-19 identifies the top Irrigation measures from the perspective of summer peak savings in 2032 and 2042. The list of top measures is very similar to the top measures for energy savings. Over half the peak savings come from a Variable Frequency Drives and Pump Replacements.

Table 5-19 Irrigation Top Measures in 2023 (Summer Peak Demand, MW)

Rank	Measure	Achievable Potential in 2032	Achievable Potential in 2042	% of Total
1	Motors - Variable Frequency Drive	12.0	11.9	26.0%
2	CS to CS Pump Replacement	10.0	11.5	25.2%
3	Center Pivot/Linear - Medium P to Low P	1.4	8.9	19.5%
4	Center Pivot/Linear - MESA Sprinkler Replacement	2.3	2.6	5.7%
5	Center Pivot/Linear - Upgrade High P to MESA	2.3	2.4	5.2%
6	Center Pivot/Linear - Upgrade MESA to LESA	0.3	1.9	4.1%
7	Center Pivot/Linear - High P Sprinkler Replacement	1.1	1.3	2.8%
8	VS to VS Pump Replacement	1.0	1.1	2.5%
9	Center Pivot/Linear - High P to Medium P	0.4	0.9	2.0%
10	Green Motor Rewind - Surface and Tailwater Pump	0.5	0.6	1.4%
	Total of Top 10 Measures	**31.3**	**43.2**	**94.4%**

A

TECHNICAL ACHIEVABLE POTENTIAL

This Appendix presents the Technical and Technical Achievable energy efficiency potential for Idaho Power. This includes every possible measure that is considered in the measure list, regardless of program implementation concerns or cost-effectiveness. The energy savings in GWh and the summer peak demand savings are presented in MW from energy efficiency measures. Year-by-year savings for energy and peak demand (summer and winter) are available in the LoadMAP model, which was provided to Idaho Power at the conclusion of the study.

A summary of cumulative energy and summer peak demand savings across all four sectors is provided, then details for each sector are shown. Please note that all savings are provided at the customer meter.

Technical Achievable Potential

To develop estimates for technical achievable potential, we constrain the technical potential by applying market adoption rates for each measure that estimate the percentage of customers who would be likely to select each measure, given consumer preferences (partially a function of incentive levels), retail energy rates, imperfect information, and real market barriers and conditions. These barriers tend to vary, depending on the customer sector, local energy market conditions, and other, hard-to-quantify factors. In addition to utility-sponsored programs, alternative acquisition methods, such as improved codes and standards and market transformation, can be used to capture portions of these resources, and are included within the technical achievable potential, per The Council's Seventh Power Plan methodology. This proves particularly relevant in the context of long-term DSM resource acquisition plans, where incentives might be necessary in earlier years to motivate acceptance and installations. As acceptance increases, so would demand for energy efficient products and services, likely leading to lower costs, and thereby obviating the need for incentives and (ultimately) preparing for transitions to codes and standards.

These market adoption rates are based on ramp rates from The Council's Seventh Power Plan. As discussed below, two types of ramp rates (lost opportunity and retrofit) have been incorporated for all measures and market regions.

Estimated technical achievable potential principally serves as a planning guideline since the measures have not yet been screened for cost-effectiveness, which is assessed within IPC's IRP modeling.

Levelized Cost of Measures

Although Technical Achievable Potential was not screened for cost-effectiveness, a levelized cost of energy ($/MWh) was calculated for each measure following the supply curve development process for The Council's Seventh Power Plan. This metric serves as an indicator for cost-effectiveness where all costs and non-energy impacts for a measure have been levelized over its lifetime. This calculation is guided by principles of the Utility Cost Test (UCT) and is intended to pass the inputs necessary to conduct cost-effectiveness testing within the IRP. Since the benefits of energy conservation are not monetized as part of this process, the denominator in this case is the first-year MWh saved.

Summary of Technical Achievable EE Potential

Table A-1 summarizes the EE savings in terms of cumulative energy use for all measures for two levels of potential relative to the baseline projection.

- **Technical potential** reflects the adoption of all EE measures regardless of cost-effectiveness. First-year savings are 468 GWh, or 3% of the baseline projection. Cumulative technical savings in 2042 are 5,555 GWh, or 27.3% of the baseline.

- **Technical achievable potential** represents savings that are possible when considering the availability, knowledge, and acceptance of the measure regardless of cost. The first-year savings in 2023 are 309 GWh, or 1.9% of the baseline projection. By 2042, cumulative technical achievable savings reach 3,856 GWh, or 19% of the baseline projection.

Table A-1 Summary of Technical Achievable Potential (Energy, GWh)

	2023	2027	2032	2037	2042
Baseline Projection (GWh)	15,882	16,697	17,793	18,997	20,344
Cumulative Savings (GWh)					
Technical Achievable Potential	309	1,365	2,457	3,249	3,856
Technical Potential	468	2,081	3,663	4,785	5,555
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.9%	8.2%	13.8%	17.1%	19.0%
Technical Potential	2.9%	12.5%	20.6%	25.2%	27.3%

Table A-2 summarize the summer peak demand savings from all EE measures for three levels of potential relative to the baseline projection.

- **Technical potential** for summer peak demand savings is 99 MW in 2023 of the baseline projection. This increases to 1,191 MW by 2042 of the summer peak demand baseline projection.
- **Technical achievable potential** is estimated at 62 MW in the 2023 summer peak demand baseline projection. In 2042, savings are 761 MW of the summer peak baseline projection.

Table A-2 Summary of EE Potential (Summer Peak, MW)

	2023	2027	2032	2037	2042
Baseline Projection (MW)	3,610	3,802	4,023	4,269	4,554
Cumulative Savings (MW)					
Technical Achievable Potential	62	289	512	660	761
Technical Potential	99	458	804	1,044	1,191
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.7%	7.6%	12.7%	15.5%	16.7%
Technical Potential	2.7%	12.0%	20.0%	24.4%	26.2%

Technical Achievable Potential by Sector

Table A-3,

Figure A-1 and Figure A-2 summarize the range of electric achievable potential summer peak savings by sector. The commercial sector contributes the most savings throughout the forecast, followed by the residential sector.

Table A-3 Technical Achievable Potential by Sector (Annual Energy and Summer Peak Demand)

	2023	2027	2032	2037	2042
Cumulative Energy Savings (GWh)					
Residential	85	414	801	1,106	1,397
Commercial	106	528	981	1,316	1,542
Industrial	106	361	559	686	768
Irrigation	12	62	115	142	147
Total	**309**	**1,365**	**2,456**	**3,250**	**3,854**
Cumulative Summer Peak Demand Savings (MW)					
Residential	24	119	206	260	305
Commercial	20	101	188	253	293
Industrial	12	43	70	88	101
Irrigation	5	26	48	59	62
Total	**61**	**289**	**512**	**660**	**761**

Figure A-1 Technical Achievable Cumulative EE Potential by Sector (Energy, GWh)

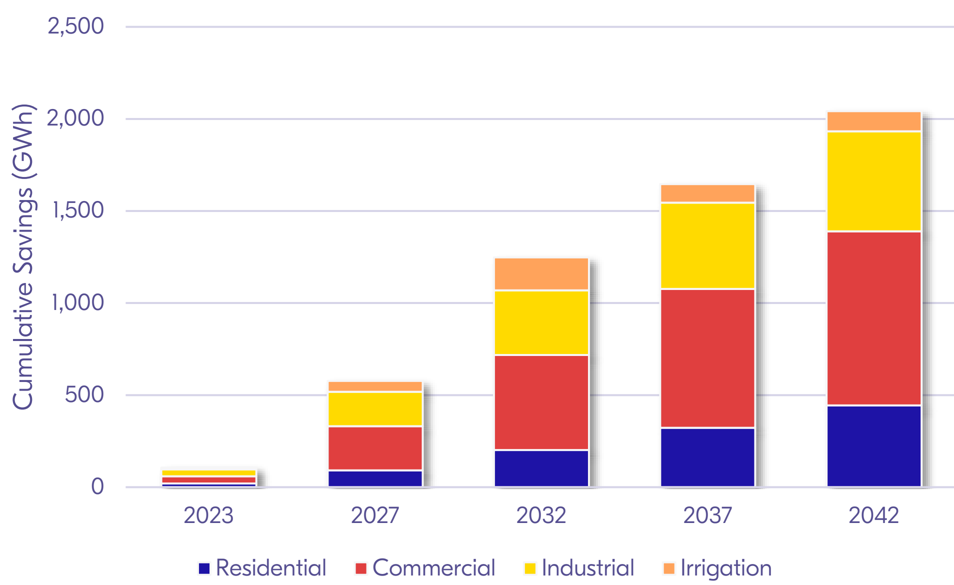


Figure A-2 Technical Achievable EE Potential by Sector (Summer Peak Demand, MW)

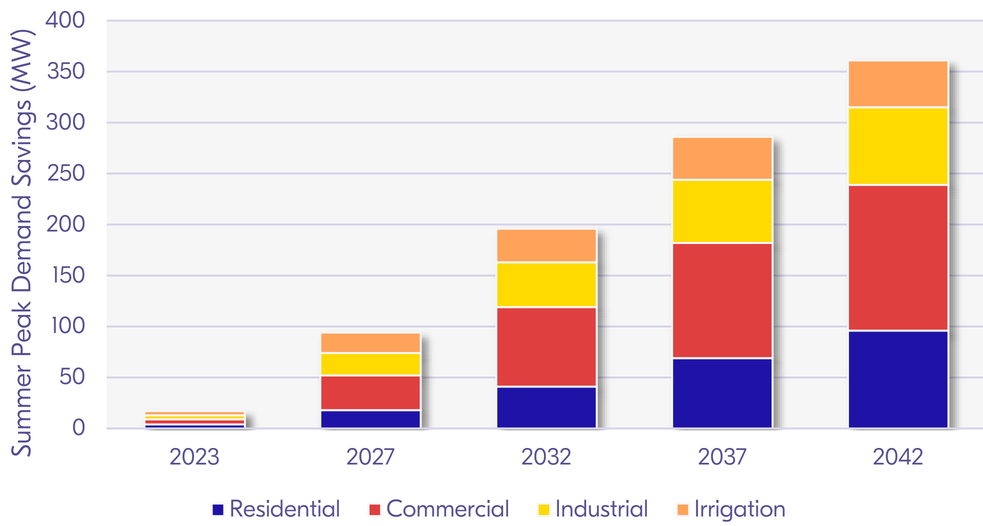


Figure A-3 presents forecasts of technical achievable energy savings by end use as a percent of total savings per year and cumulative savings. Lighting savings account for a substantial portion of the savings throughout the forecast horizon, but the share declines over time as the market is transformed. The same is true for exterior lighting. Water heater savings contribute a large portion of savings as a result of increased adoption throughout the forecast horizon. Savings from cooling measures and appliances are steadily increasing throughout the forecast horizon.

Figure A-3 Residential Technical Achievable Savings Forecast (Energy, GWh)

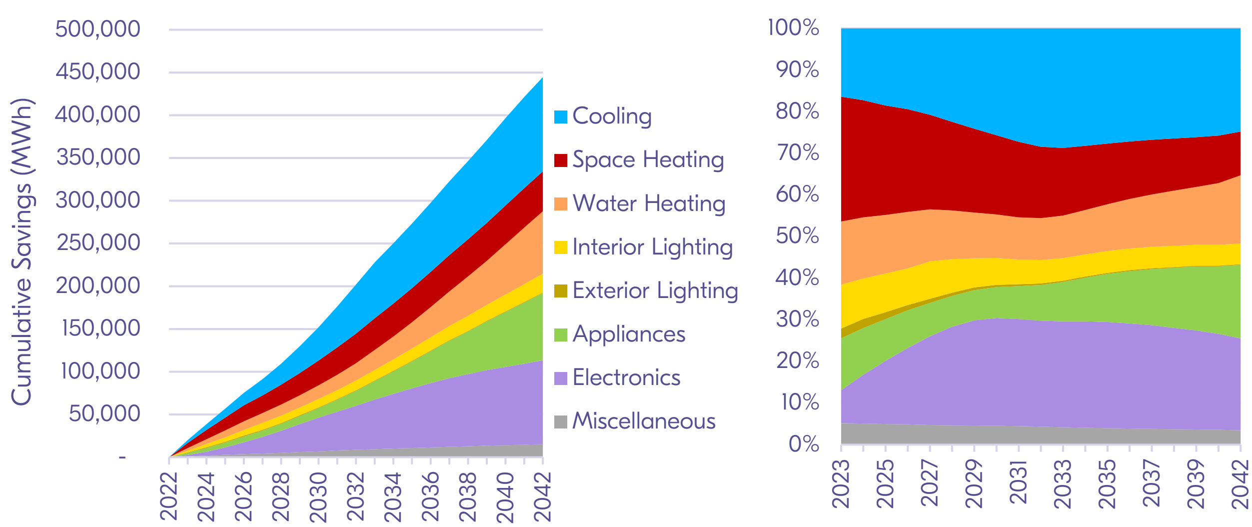
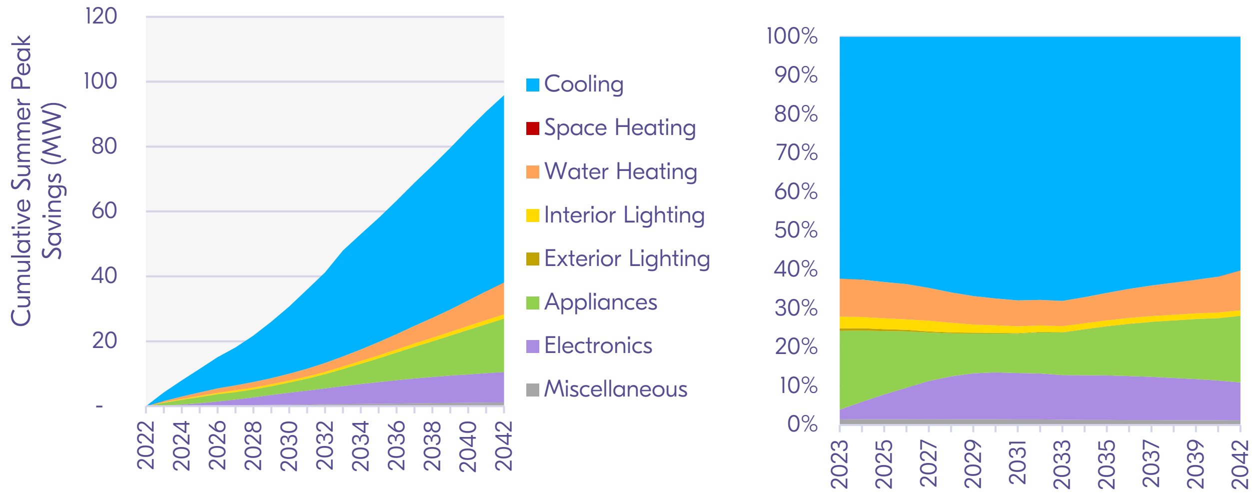


Figure A-4 presents technical achievable savings for summer peak demand by end use. Savings are dominated by cooling, as expected.

Figure A-4 Residential Technical Achievable Savings Forecast (Summer Peak, MW)



Commercial Technical Achievable Potential by End Use

Figure A-5 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Lighting savings from interior and exterior applications account for a substantial portion of the savings throughout the forecast horizon.

Figure A-5 Commercial Technical Achievable Savings Forecast (Energy, GWh)

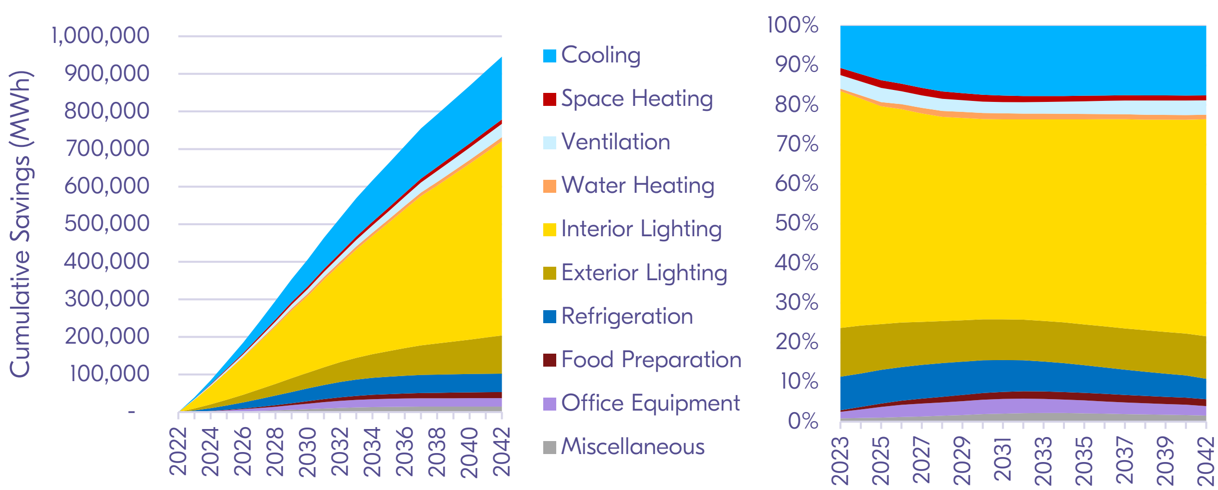
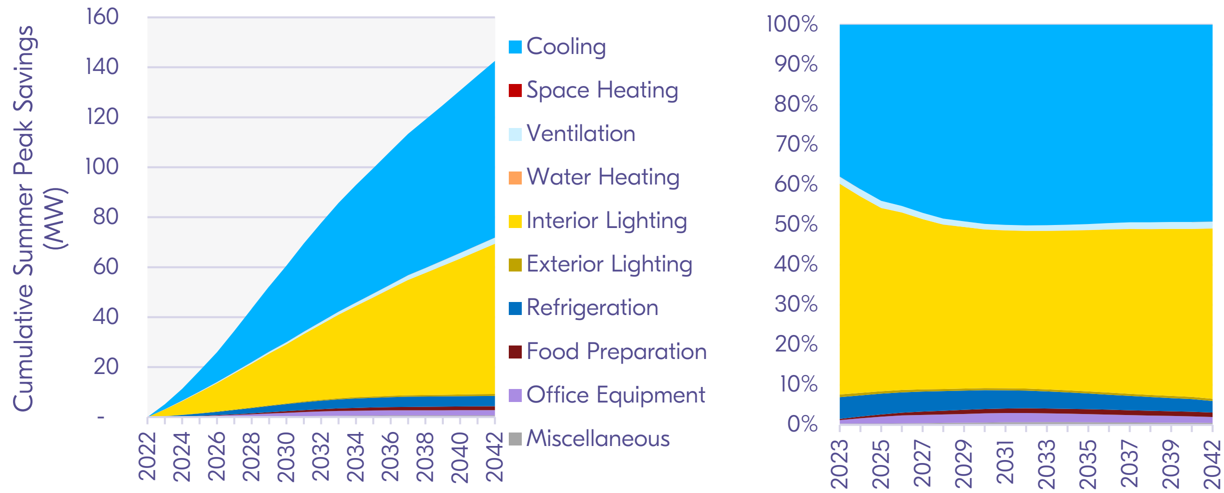


Figure A-6 presents forecasts of summer peak savings by end use as a percent of total summer peak savings and cumulative savings. Savings from cooling and lighting-related measures dominate throughout the forecast horizon.

Figure A-6 Commercial Technical Achievable Savings Forecast (Summer Peak, MW)



Industrial Technical Achievable Potential by End Use

Figure A-7 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Motor-related measures account for a substantial portion of the savings throughout the forecast horizon. The share of savings by end use remains fairly similar throughout the forecast period.

Figure A-7 Industrial Technical Achievable Savings Forecast (Energy, GWh)

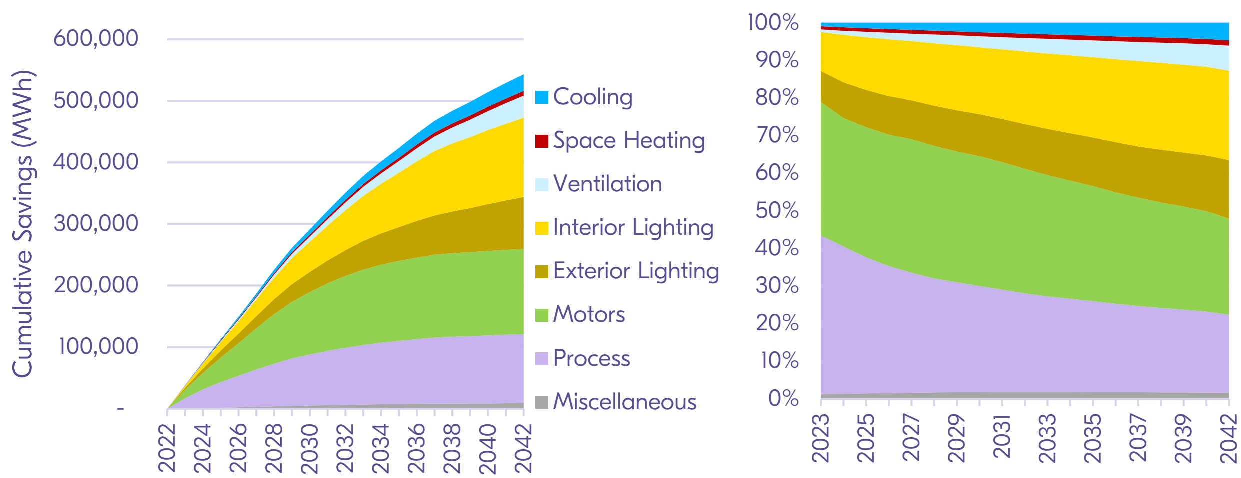
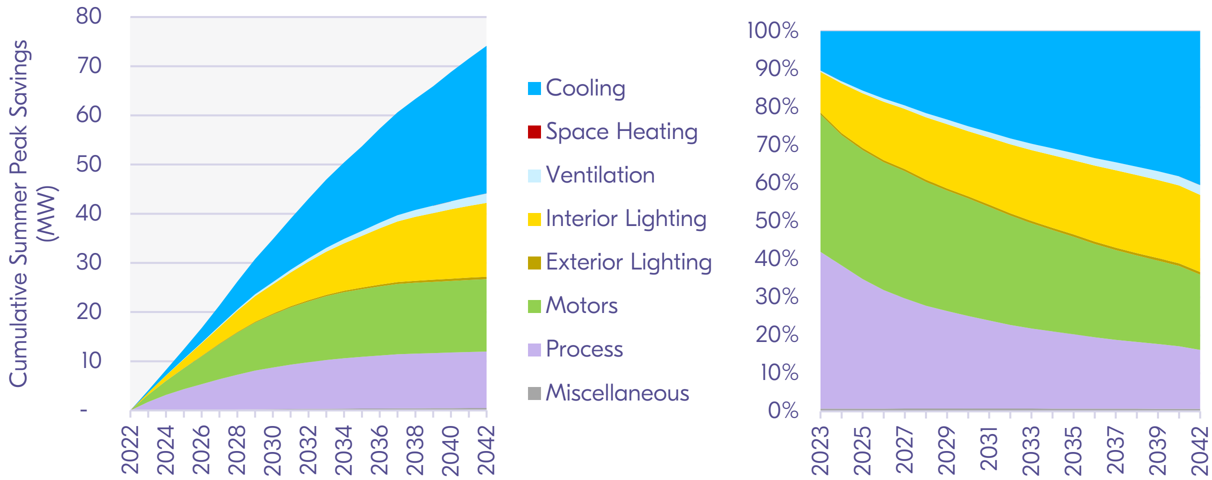


Figure A-8 Industrial Technical Achievable Savings Forecast (Summer Peak, MW) presents forecasts of summer peak savings by end use as a percent of total summer peak savings and cumulative savings. Cooling, lighting, motors, and process all contribute to the savings throughout the forecast horizon.

Figure A-8 Industrial Technical Achievable Savings Forecast (Summer Peak, MW)



B

MARKET PROFILES

The market profiles can be found in the file called *"Appendix B – Idaho Power Market Profiles.xlsx."*

Appendix B - Idaho
Power Market Profil

C

MARKET ADOPTION RATES

The market adoption rates can be found in the file called *"Appendix C – Idaho Power Market Adoption Rates.xlsx."*

Appendix C - Idaho
Power Market Adop

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

P: 510.982.3525