Applied Energy Group

IDAHO POWER COMPANY ENERGY EFFICIENCY POTENTIAL STUDY

Final Report – FINAL DRAFT FOR IDAHO POWER REVIEW

January 25, 2021

Report prepared for:
IDAHO POWER COMPANY

Energy Solutions. Delivered.

This work was performed by

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EXECUTIVE SUMMARY

In 2019, Idaho Power (IPC) contracted with Applied Energy Group (AEG), to perform a comprehensive energy efficiency market potential study. This report documents the study and provides estimates of the potential reductions in annual energy usage and peak demand for the time horizon 2021 to 2040 for the IPC service area.

The results of the study will aid Idaho Power in their development of their program portfolio and support their integrated resource planning (IRP) process.

Study Objectives

Key objectives for the study include:

- Provide credible and transparent estimation of the technical, economic, and achievable energy efficiency potential by year over the next 20 years within the Idaho Power service area
- Assess potential energy savings associated with each potential area by energy efficiency measure and sector
- Provide an executable dynamic model that will support the potential assessment and allow for testing of sensitivity of all model inputs and assumptions
- Review and update market profiles by sector, segment, and end use
- Develop a final report including summary data tables and graphs reporting incremental and cumulative potential by year from 2021 through 2040.

Definitions of Potential

In this study, the energy efficiency potential estimates represent gross savings developed into three types of potential: technical potential, economic potential, and achievable potential.

- 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 The Council's Seventh Power Plan ramp rates, 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 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.
- Technical Achievable Potential. This study also estimated "technical achievable potential" (TAP) which constrains 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. This level of potential can be useful for developing IRP inputs. It is described further in Appendix A, which also presents estimates for technical achievable potential.

Cumulative and Incremental Savings

Throughout this report, we present estimates of cumulative savings, defined as savings resulting from measures adopted by new participants in each year in addition to savings from measures installed in previous years that persist through the end of the measure life. Incremental savings represent the first-year savings of measures installed in each year.

We present annual energy savings – the amount of savings over the course of one full year. We also present peak demand savings that occur coincident with the system peak.

Overview of Analysis Approach

AEG utilizes its custom market simulation tool, Load Management, Analysis, and Planning (LoadMAP™), to forecast energy usage and savings potential. Originally developed in 2007, it has been updated annually to accommodate the expanded scope of potential studies and the individual needs of our clients. The model can be used to develop a baseline forecast and alternative forecasts characterizing technical potential, economic potential, and achievable potential. LoadMAP is built in the Microsoft Excel spreadsheet framework so it is accessible and transparent.

To perform the potential analysis, AEG used an approach following the major steps listed below. These analysis steps are described 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, 2019. 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 2019 through 2040.
3. Define and characterize several hundred EE measures to be applied to all sectors, segments, and end uses.
4. Estimate technical and technical achievable potential at the measure level in terms of energy and peak demand impacts from EE measures for 2021 through 2040.
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 2021 through 2040.

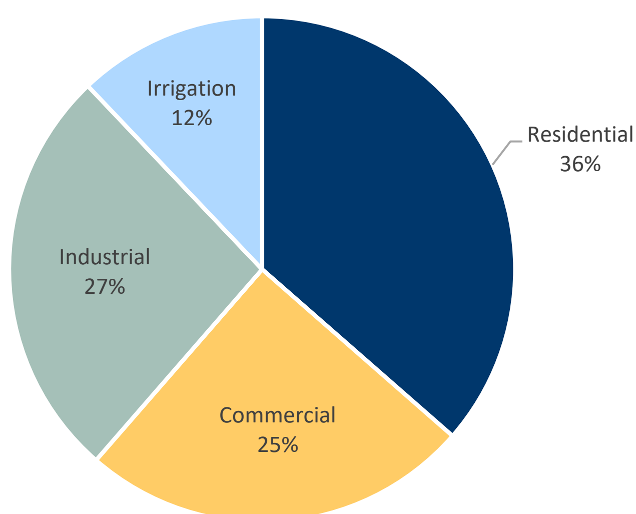
Market Characterization

Idaho Power, established in 1916, is an investor-owned electric utility that serves more than 490,000 customers within a 24,000-square-mile area in southern Idaho and eastern Oregon. To meet its customers' electricity demands, Idaho Power maintains a diverse generation portfolio which includes 17 hydroelectric projects. The company also actively seeks cost-effective ways to encourage wise use of electricity by providing energy efficiency programs for all customers.

Total electricity use for the residential, commercial, industrial and irrigation sectors for Idaho Power in 2019 was 14,542 GWh. Special-contract customers are included in this total accounting for about 895 GWh.

As shown in Figure ES-1, the residential sector accounts for more than one-third (36%) of annual energy use, followed by commercial with 25%, industrial with 27%, and irrigation with 12%.

Figure ES-1 Sector-Level Electricity Use, 2019



In terms of summer peak demand, the total system peak in 2019 was 3,088 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 2019 was 2,138 MW, with the residential sector contributing over half of the impact (56%) at peak.

Table ES-1 Idaho Power Sector Control Totals, 2019

Sector	Annual Electricity Use (GWh)	% of Annual Use	Summer Peak Demand (MW)	% of Summer Peak	Winter Peak Demand (MW)	% of Winter Peak
Residential	5,299	36%	1,292	42%	1,192	56%
Commercial	3,629	25%	722	23%	644	30%
Industrial	3,854	27%	335	11%	297	14%
Irrigation	1,759	12%	739	24%	5	0.2%
Total	**14,542**	**100%**	**3,088**	**100%**	**2,138**	**100%**

Figure ES-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 47% 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 ES-3 shows the intensity by end use for each residential segment.

Figure ES-2 Residential Electricity Use and Summer Peak Demand by End Use, 2019

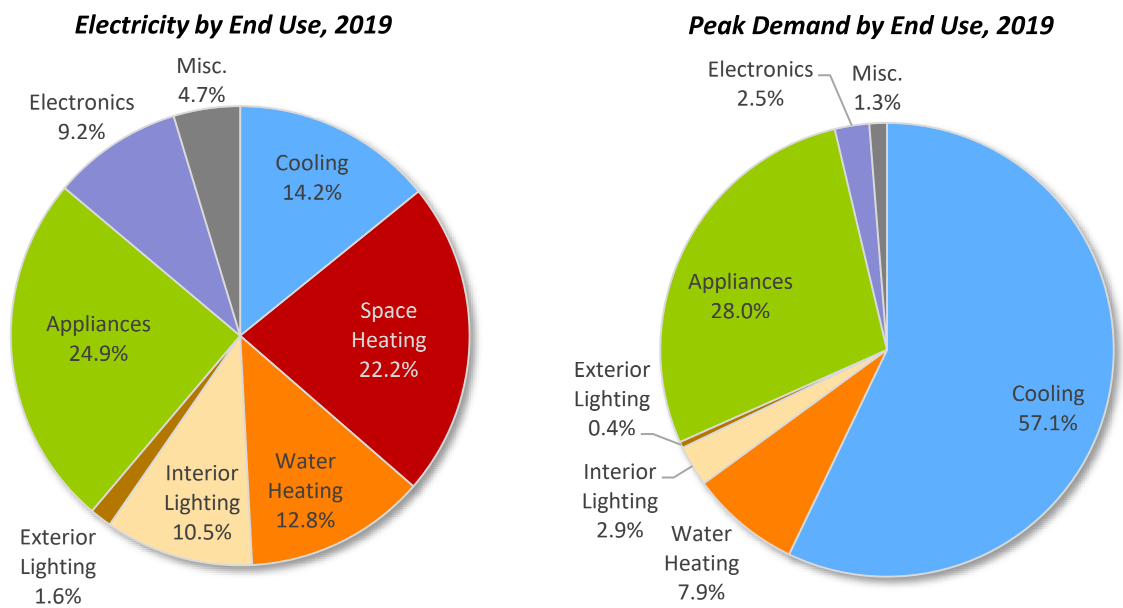


Figure ES-3 Residential Intensity by End Use and Segment (Annual kWh/HH, 2019)

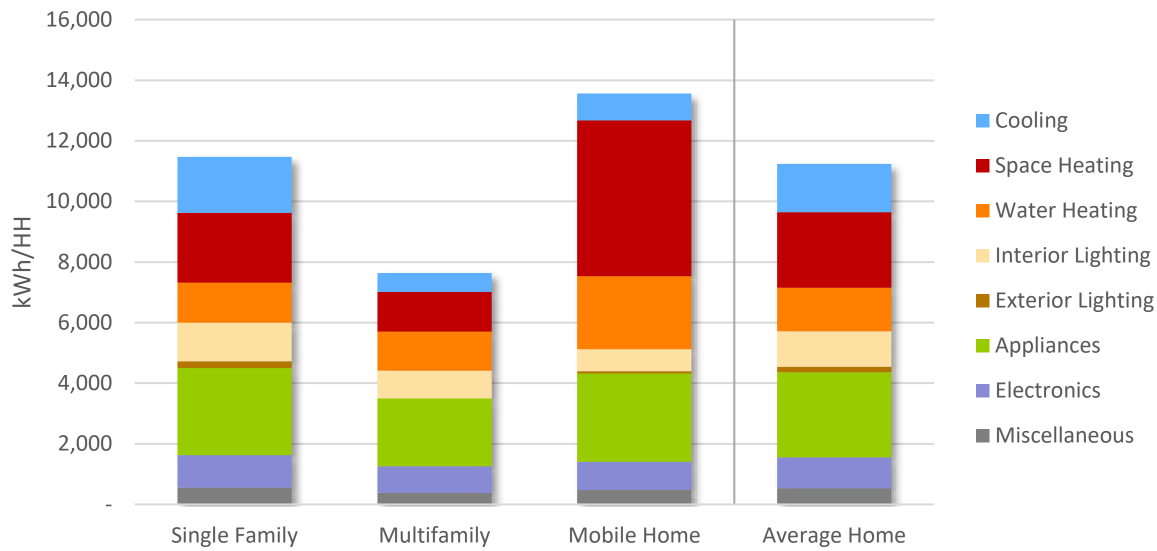


Figure ES-4 shows the distribution of annual electricity consumption and summer peak demand by end use across all commercial buildings. Electric usage is dominated by lighting and cooling, which comprise 50% of annual electricity usage. Summer peak demand is dominated by cooling.

Figure ES-5 presents the electricity usage in annual kWh 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 ES-4 Commercial Sector Electricity Consumption and Summer Peak Demand by End Use, 2019

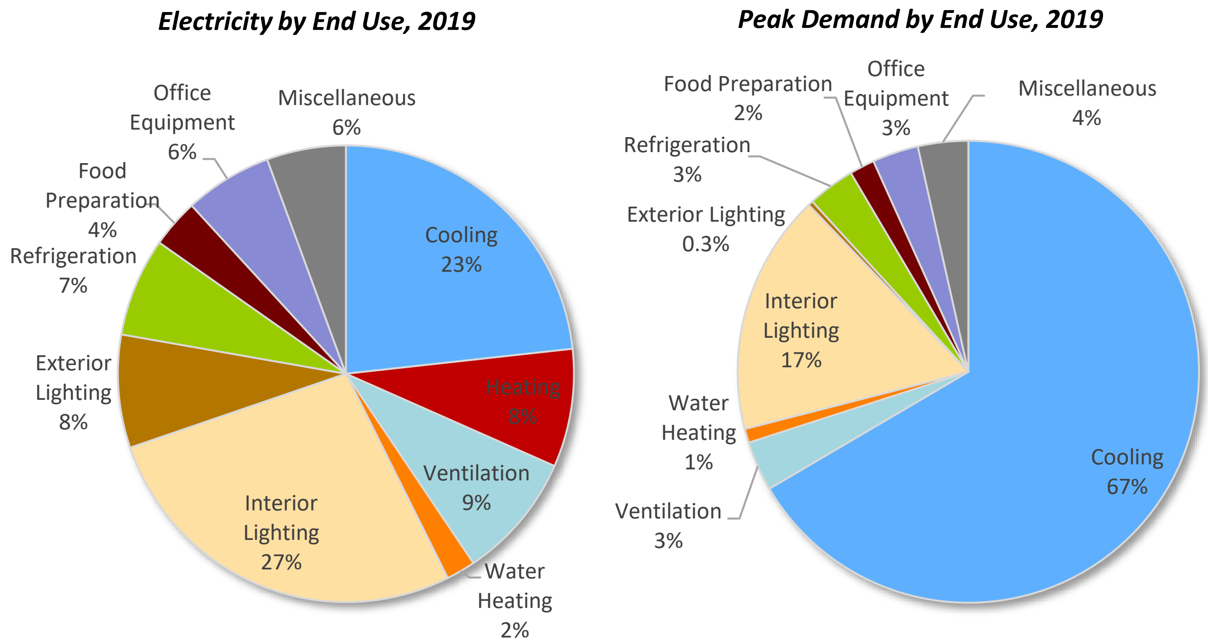


Figure ES-5 Commercial Electricity Usage by End Use and Segment (kWh/sq ft, 2019)

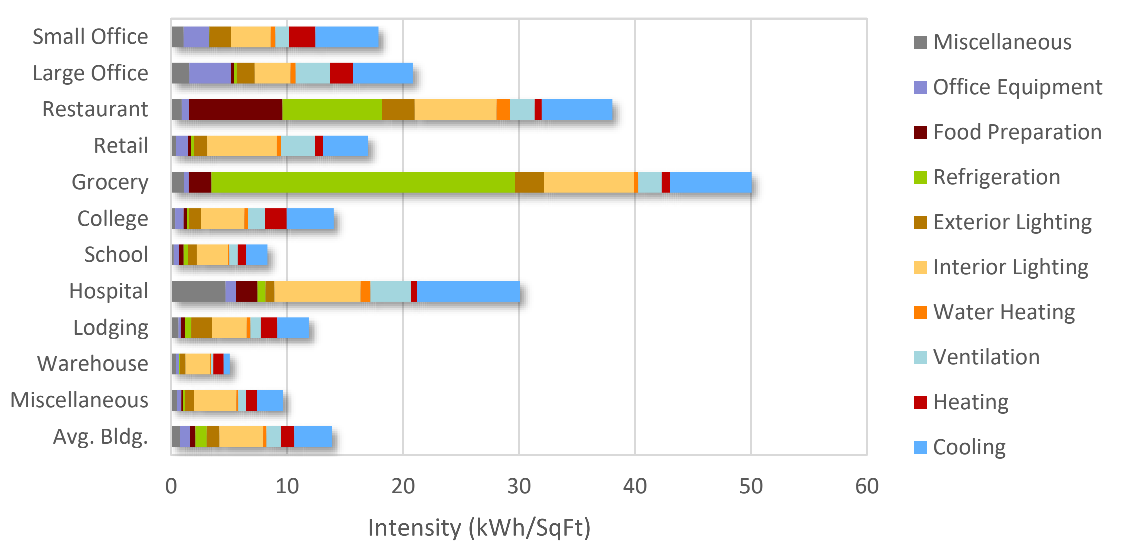
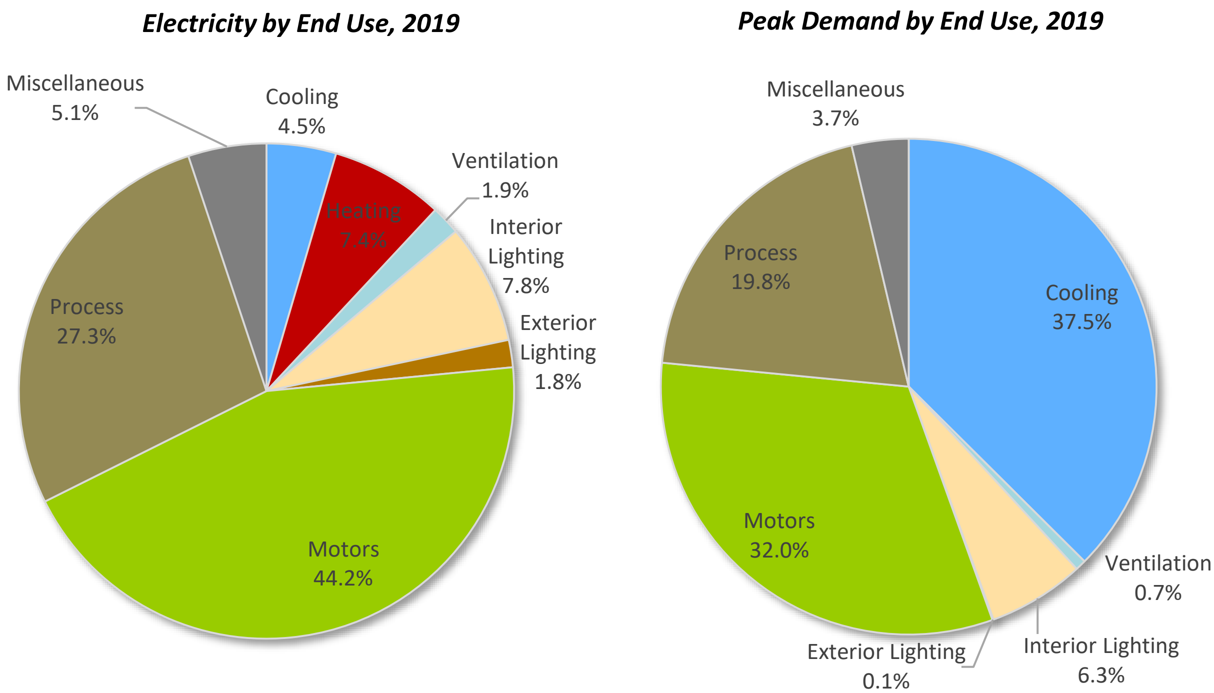


Figure ES-6 shows the distribution of annual electricity consumption and summer peak demand by end use for all industrial customers, not including the special contracts. Motors are the largest overall end use for the industrial sector, accounting for 44% of annual energy use. Note that this end use includes a wide range of industrial equipment, such as air compressors and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 27% 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 ES-6 *Industrial Sector Electricity Consumption by End Use (2019), All Industries*



The total electricity used in 2019 by Idaho Power's irrigation customers was 1,759 GWh, while summer peak demand was 739 MW and winter peak demand was 5.1 MW. Idaho Power billing data were used to develop estimates of energy intensity (annual kWh/service point). For the irrigation sector, all of the energy use is for the motors end use.

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 those past programs cease to exist in the future. Possible savings from future programs are captured by the potential estimates.

The baseline projection incorporates assumptions about:

- 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

Table ES-2 and Figure ES-7 provide a summary of the baseline projection by sector and for Idaho Power as a whole. Electricity use across all sectors is expected to increase by 22% between the base year 2019 and 2040, for an average annual growth rate of 1.1%, consistent with assumptions from Idaho Power's load forecast.

- The commercial sector has the highest growth, with a 32% increase (1.5% annual growth rate) over the projection horizon.
- The residential and irrigation sectors have moderate growth at 22.7% and 20.2%, respectively. The annual growth rate is approximately 1% for both sectors.
- The industrial sector continues to remain flat with less than 1% average annual growth over the forecast period.

Table ES-2 Baseline Projection Summary (GWh)

Sector	2021	2025	2030	2035	2040	% Change ('21-'40)
Residential	5,304	5,466	5,779	6,130	6,507	22.7%
Commercial	3,720	3,885	4,183	4,528	4,911	32.0%
Industrial	3,863	3,980	4,133	4,270	4,390	13.7%
Irrigation	1,790	1,858	1,950	2,048	2,152	20.2%
Total	**14,677**	**15,189**	**16,045**	**16,977**	**17,961**	**22.4%**

Figure ES-7 Baseline Projection Summary (GWh)

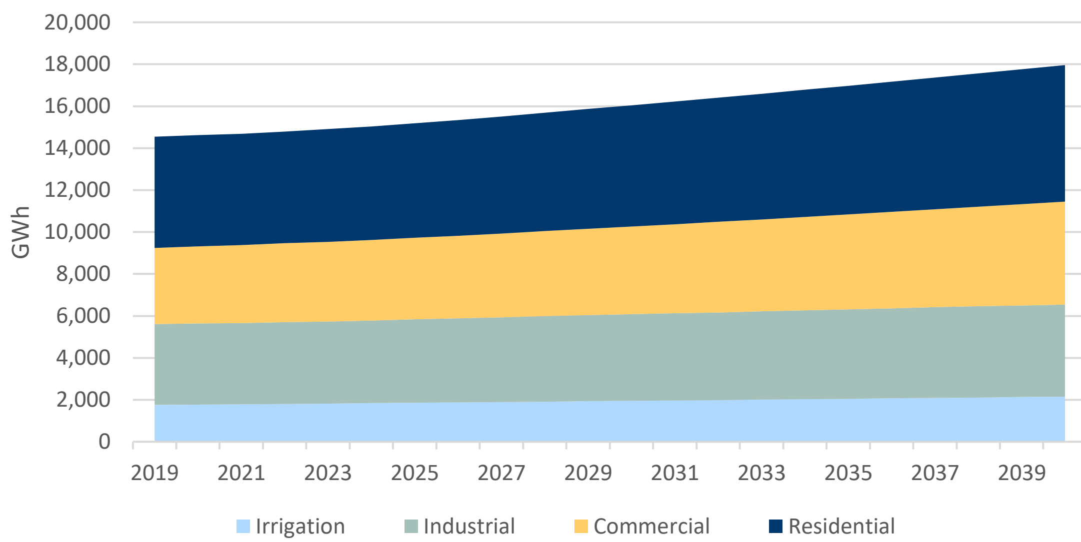


Figure ES-8 through Figure ES-11 present the baseline end-use projections for the residential, commercial, industrial, and irrigation sectors respectively.

Figure ES-8 Residential Baseline Projection by End Use (GWh)

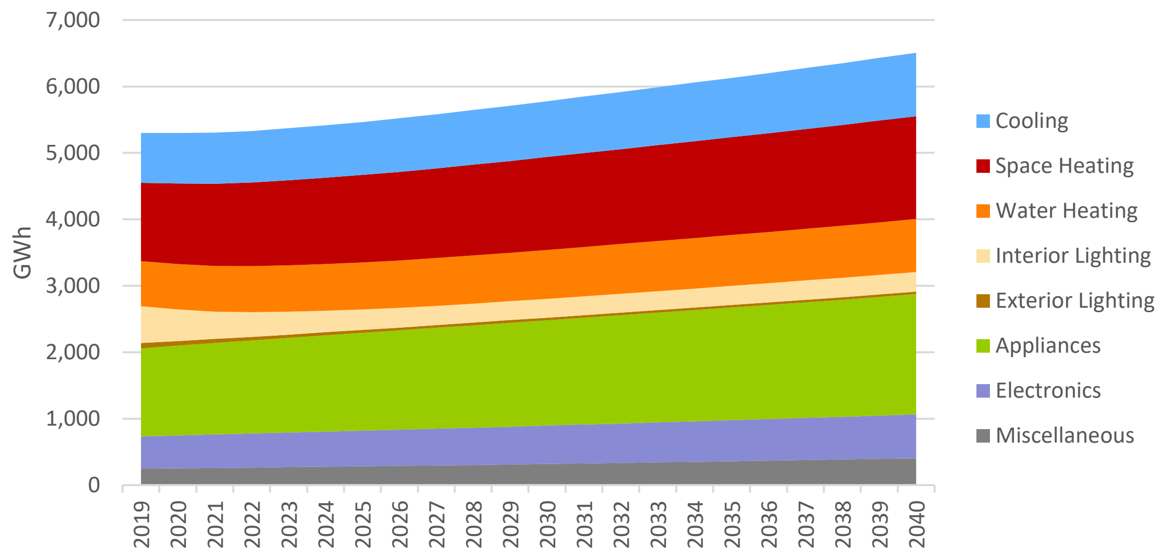


Figure ES-9 Commercial Baseline Projection by End Use (GWh)

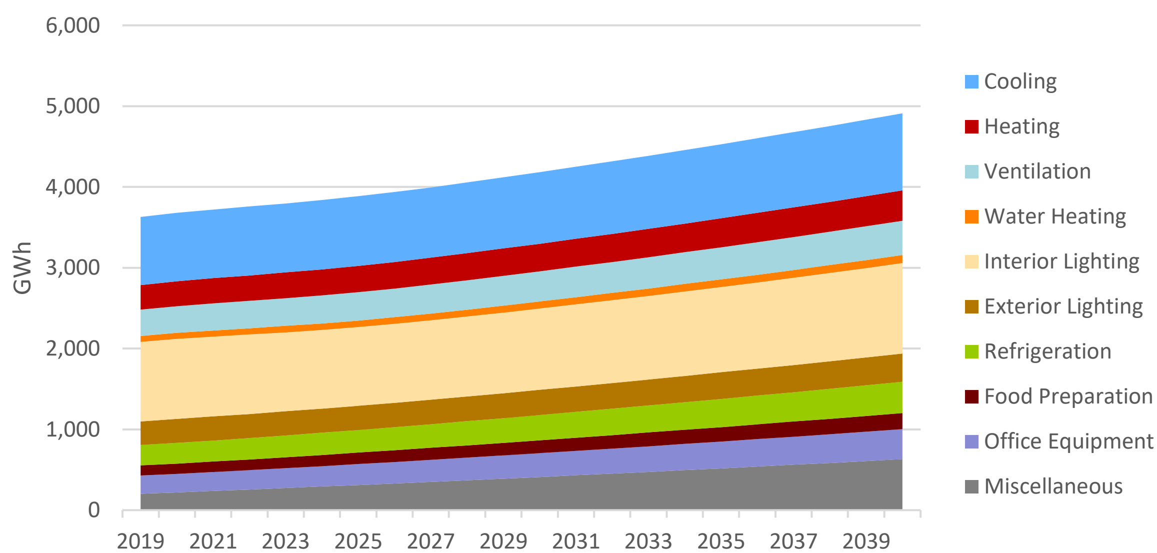


Figure ES-10 Industrial Baseline Projection by End Use (GWh)

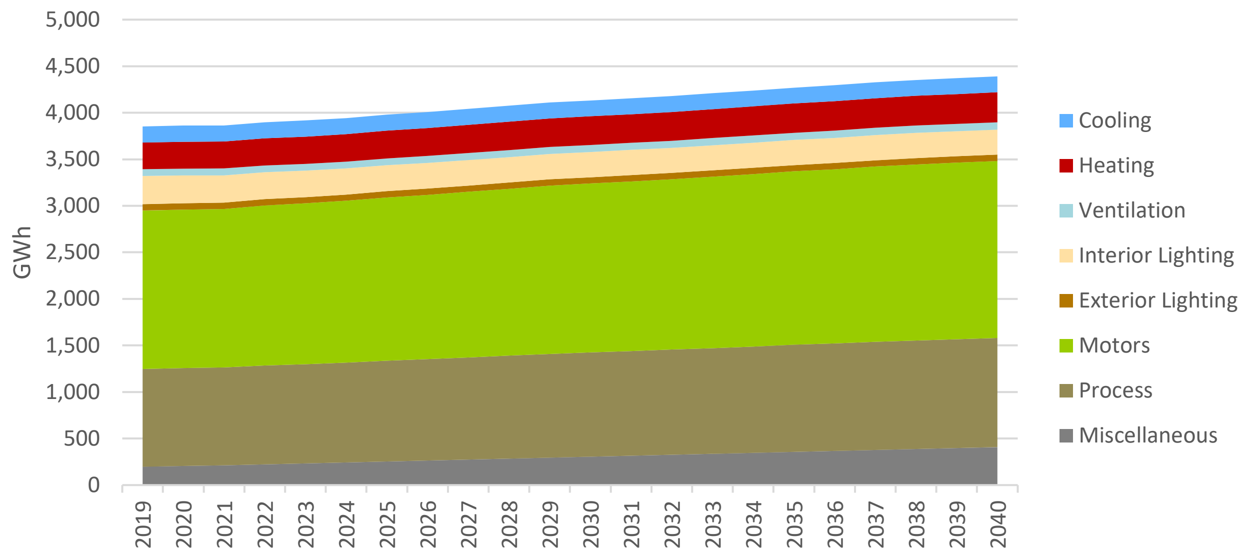
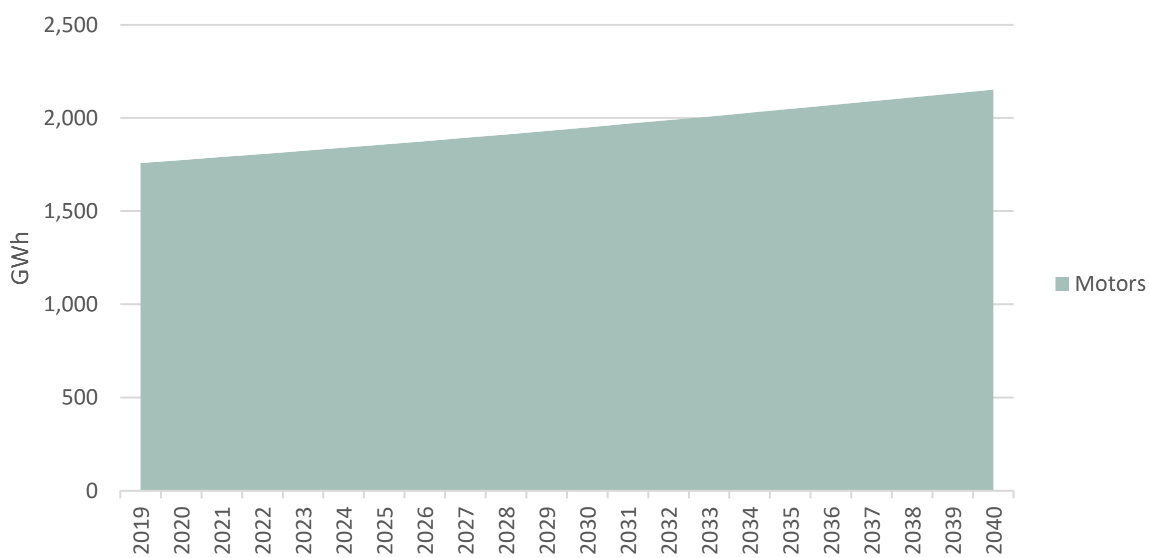


Figure ES-11 Irrigation Baseline Projection by End Use (GWh)



Energy Efficiency Measures

The first step of the energy efficiency measure analysis was to identify the list of all relevant EE measures that should be considered for the potential assessment. Sources for selecting and characterizing measures included Idaho Power's programs, the Northwest Power and Conservation Council's Regional Technical Forum (RTF) deemed measure databases, and AEG's measure databases from previous studies and program work. The 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. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard, Seasonal Energy Efficiency Ratio (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)

Table ES-3 summarizes the number of equipment and non-equipment measures evaluated for each sector.

Table ES-3 Number of Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ Segments
Residential	98	196	532
Commercial	125	250	2,729
Industrial	111	222	3,331
Irrigation	26	52	52
Total Measures Evaluated	360	720	6,644

Summary of Energy Savings

Table ES-4 and Figure ES-12 summarize the cumulative EE savings in terms of annual energy use for all measures for two levels of potential relative to the baseline projection. Table ES-5 summarizes the incremental EE savings in terms of annual energy use for all measures. Figure ES-13 displays the EE projections.

- Technical potential reflects the adoption of all EE measures regardless of cost-effectiveness. First-year savings are 435 GWh, or 3.0% of the baseline projection. Cumulative technical savings in 2040 are 4,258 GWh, or 25.1% 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 2021 are 291 GWh, or 2.0% of the baseline projection. By 2040, cumulative economic savings reach 3,669 GWh, or 20.4% of the baseline projection.
- Achievable potential represents savings that are possible when considering the availability, knowledge and acceptance of the measure. Achievable potential is 135 GWh savings in the first year, or 0.9% of the baseline, and reaches 2,626 GWh cumulative achievable savings by 2040, or 14.6% of the baseline projection. This results in average annual savings of 0.3% of the baseline each year. Achievable potential reflects 72% of economic potential by the end of the forecast horizon.

Table ES-4 Summary of EE Potential (Cumulative and Incremental Energy Savings, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	14,677	15,189	16,045	16,977	17,961
Cumulative Savings (GWh)					
Achievable Potential	135	727	1,532	2,223	2,626
Economic Potential	291	1,374	2,488	3,275	3,669
Technical Potential	435	1,947	3,385	4,258	4,679
Cumulative Savings as a % of Baseline					
Achievable Potential	0.9%	4.8%	9.5%	13.1%	14.6%
Economic Potential	2.0%	9.0%	15.5%	19.3%	20.4%
Technical Potential	3.0%	12.8%	21.1%	25.1%	26.1%
Incremental Savings (GWh)					
Achievable Potential	135	167	159	131	63
Economic Potential	291	273	207	137	72
Technical Potential	435	391	266	153	80

Figure ES-12 Summary of Cumulative EE Potential as % of Baseline Projection (Energy)

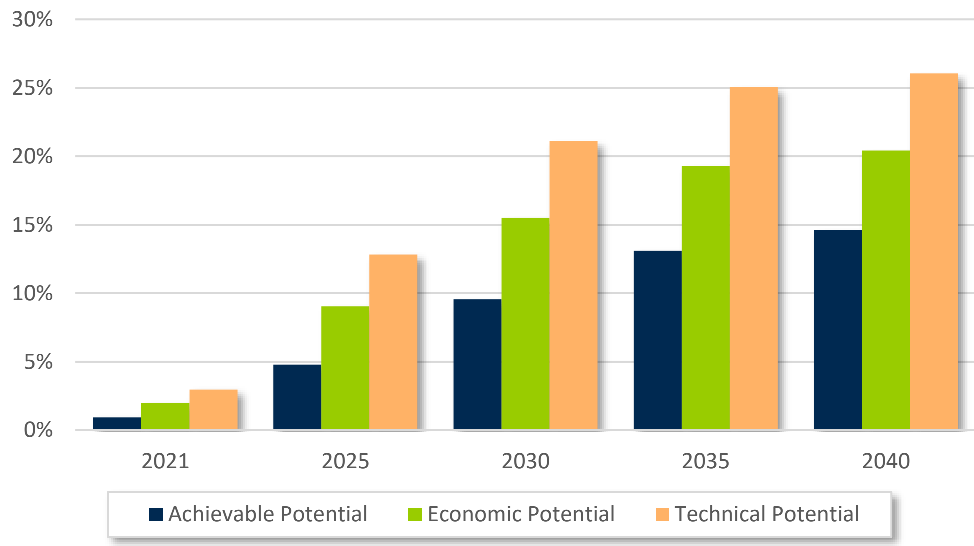
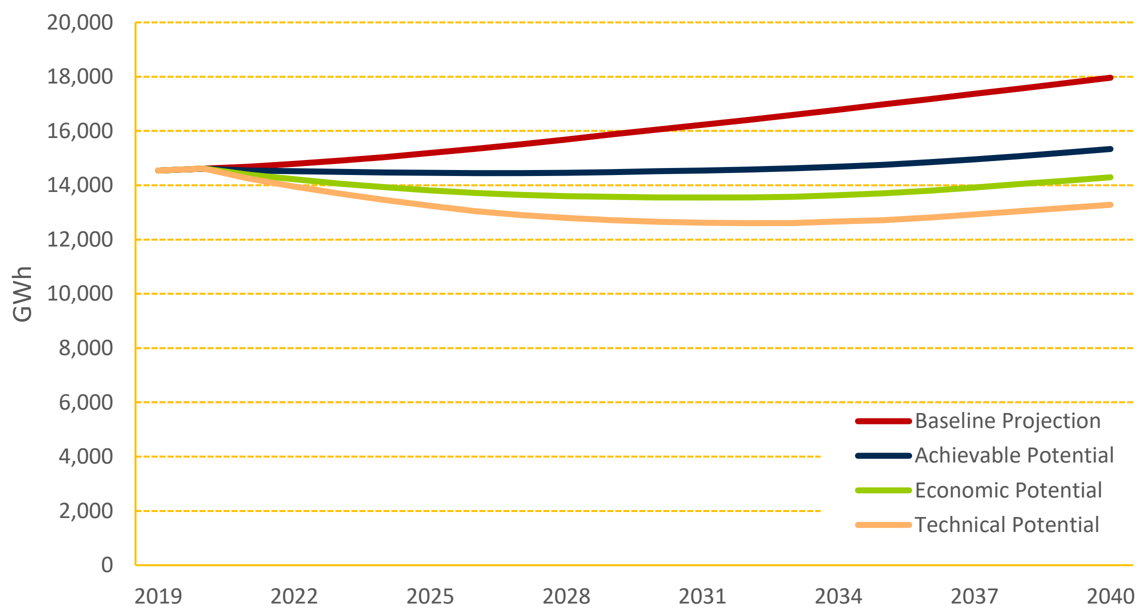


Figure ES-13 Baseline Projection and EE Forecast Summary (Energy, GWh)



Summary of Summer Peak Demand Savings

Table ES-5 and Figure ES-14 summarize the summer peak demand savings from all EE measures for three levels of potential relative to the baseline projection. Figure ES-15 displays the EE forecasts of summer peak demand.

- Technical potential for summer peak demand savings is 60 MW in 2021, or 1.9% of the baseline projection. This increases to 694 MW by 2040, or 18.2% of the summer peak demand baseline projection.

- Economic potential is estimated at 39 MW or a 1.3% reduction in the 2021 summer peak demand baseline projection. In 2040, savings are 523 MW or 13.7% of the summer peak baseline projection.
- Achievable potential is 18 MW by 2021, or 0.6% of the baseline projection. By 2040, cumulative savings reach 376 MW, or 9.8% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	3,137	3,253	3,422	3,613	3,822
Cumulative Savings (MW)					
Achievable Potential	18	96	214	315	376
Economic Potential	39	189	357	470	523
Technical Potential	60	278	501	632	694
Cumulative Savings as a % of Baseline					
Achievable Potential	0.6%	3.0%	6.3%	8.7%	9.8%
Economic Potential	1.3%	5.8%	10.4%	13.0%	13.7%
Technical Potential	1.9%	8.5%	14.6%	17.5%	18.2%

Figure ES-14 Summary of Cumulative EE Potential as % of Summer Peak Baseline Projection

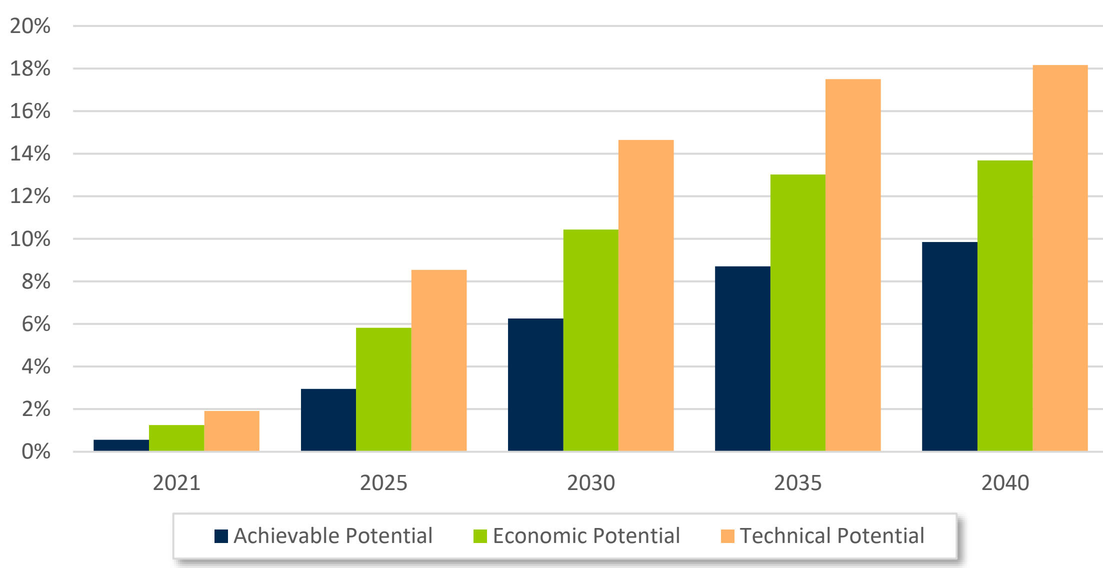
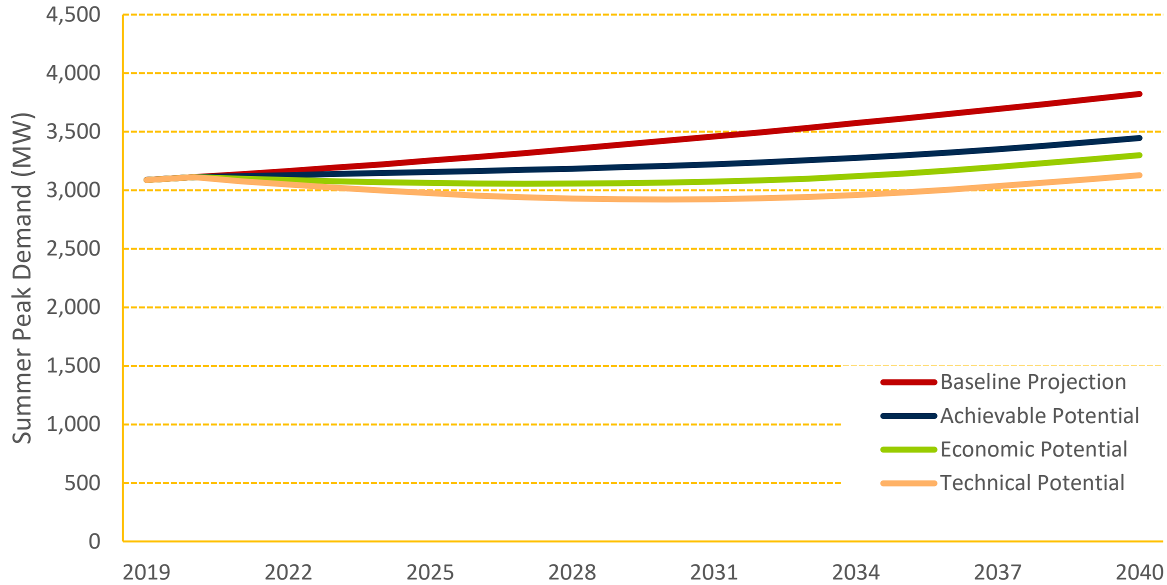


Figure ES-15 Summer Peak Baseline Projection and EE Forecast Summary



Summary of 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.

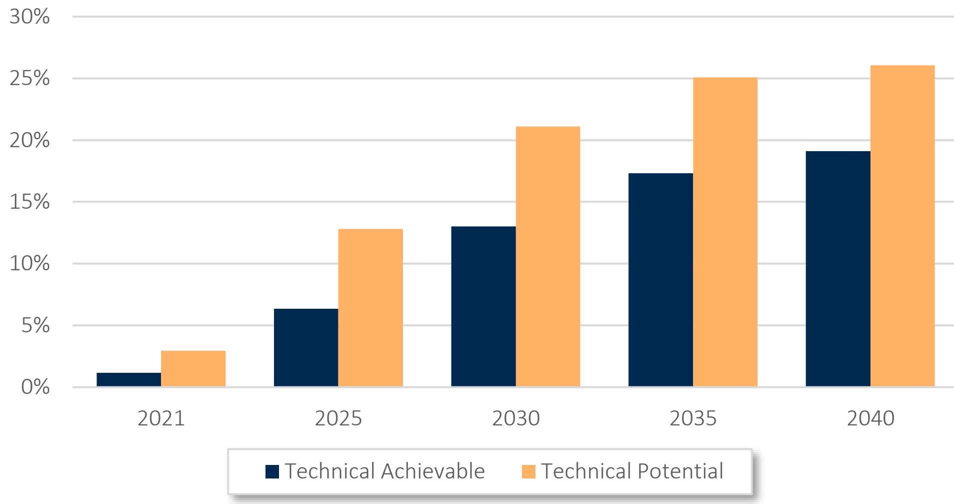
Estimated technical achievable potential principally serves as a planning guideline since the measures have not yet been screened for cost-effectiveness, which is assessed within IPC's IRP modeling.

A high-level summary of the technical achievable potential results is presents below. Detail is provided in Appendix A.

Table ES-6 Summary of Technical and Technical Achievable Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	14,677	15,189	16,045	16,977	17,961
Cumulative Savings (GWh)					
Technical Achievable Potential	170	964	2,089	2,939	3,433
Technical Potential	435	1,947	3,385	4,258	4,679
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.2%	6.3%	13.0%	17.3%	19.1%
Technical Potential	3.0%	12.8%	21.1%	25.1%	26.1%

Figure ES-16 Summary of Cumulative Technical and Technical Achievable Potential as % of Baseline Projection (Energy)



Summary of Energy Efficiency by Sector

Table ES-6, Figure ES-16, and Figure ES-17 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 ES-7 Technical Achievable EE Potential by Sector (Energy and Summer Peak)

	2021	2025	2030	2035	2040
Cumulative Energy Savings (GWh)					
Residential	21	118	331	569	737
Commercial	53	306	647	968	1,153
Industrial	50	243	431	534	572
Irrigation	10	60	123	153	164
Total	135	727	1,532	2,223	2,626
Cumulative Summer Peak Demand Savings (MW)					
Residential	4.0	16.1	46.1	80.4	102.9
Commercial	5.8	37.1	83.7	128.1	157.3
Industrial	3.4	17.6	32.8	42.0	47.0
Irrigation	4.4	25.2	51.5	64.4	69.0
Total	18	96	214	315	376

Figure ES-17 Achievable EE Potential by Sector (Energy, Cumulative GWh)

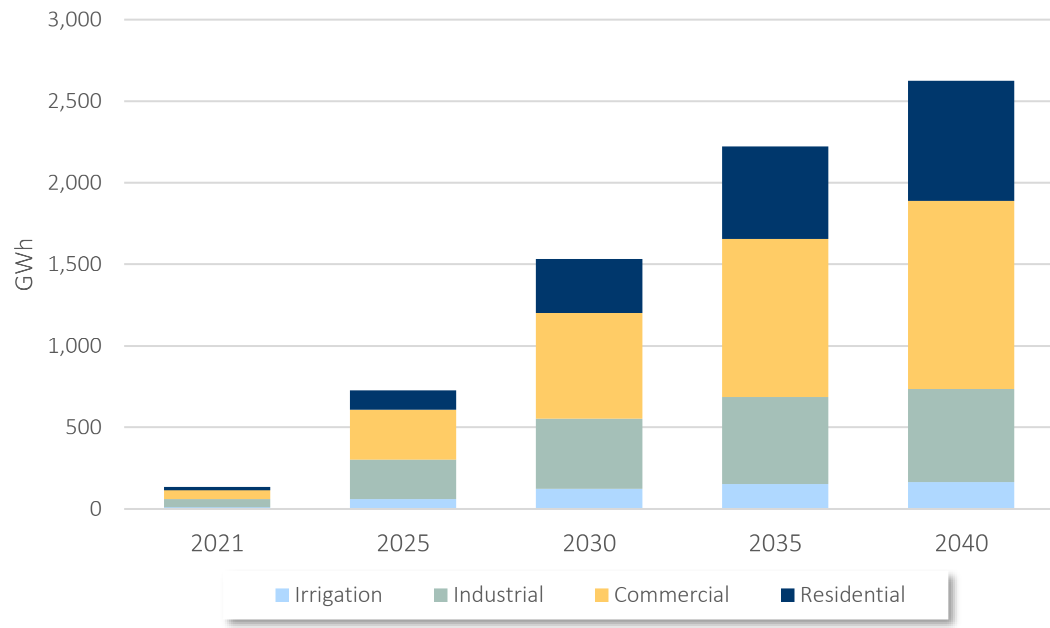
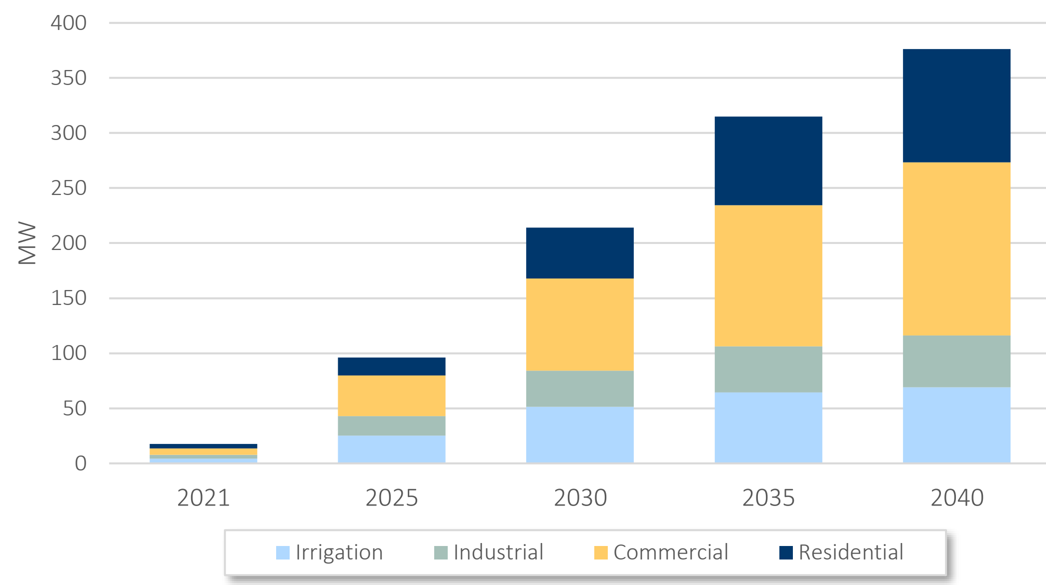


Figure ES-18 Achievable EE Potential by Sector (Summer Peak Demand, Cumulative MW)



Residential Sector Potential Savings

Table ES-7 shows the estimates for measure-level EE potential for the residential sector in terms of cumulative energy savings. Achievable potential in the first year, 2019 is 21 GWh, or 0.4% of the baseline projection. By 2040, cumulative achievable savings are 737 GWh, or 11.3% of the baseline projection.

Table ES-8 Residential EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	5,304	5,466	5,779	6,130	6,507
Cumulative Savings (GWh)					
Achievable Potential	21	118	331	569	737
Economic Potential	90	454	849	1,120	1,271
Technical Potential	176	799	1,403	1,704	1,840
Cumulative Savings as a % of Baseline					
Achievable Potential	0.4%	2.2%	5.7%	9.3%	11.3%
Economic Potential	1.7%	8.3%	14.7%	18.3%	19.5%
Technical Potential	3.3%	14.6%	24.3%	27.8%	28.3%

Commercial Sector Potential Savings

Table ES-8 shows the estimates for the three levels of EE potential for the commercial sector from the perspective of cumulative energy savings. In 2021, achievable potential is 53 GWh, or 1.4% of the baseline projection. By 2040, savings are 1,153 GWh, or 23.5% of the baseline projection. Commercial potential is driven mainly by linear, high-bay, and area lighting.

Table ES-9 Commercial EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,720	3,885	4,183	4,528	4,911
Cumulative Savings (GWh)					
Achievable Potential	53	306	647	968	1,153
Economic Potential	100	473	878	1,235	1,429
Technical Potential	140	641	1,128	1,517	1,734
Cumulative Savings as a % of Baseline					
Achievable Potential	1.4%	7.9%	15.5%	21.4%	23.5%
Economic Potential	2.7%	12.2%	21.0%	27.3%	29.1%
Technical Potential	3.8%	16.5%	27.0%	33.5%	35.3%

Industrial Sector Potential Savings

Table ES-9 presents potential estimates for the industrial sector, from the perspective of cumulative energy savings. Achievable savings in the first year, 2021, are 50 GWh, or 1.3% of the baseline projection. In 2040, savings reach 572 GWh, or 13.0% of the baseline projection. Long-term potential is higher than in the previous study, due to the inclusion of the special contract customers.

Table ES-10 Industrial EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,863	3,980	4,133	4,270	4,390
Cumulative Savings (GWh)					
Achievable Potential	50	243	431	534	572
Economic Potential	88	371	605	724	760
Technical Potential	103	415	662	789	833
Cumulative Savings as a % of Baseline					
Achievable Potential	1.3%	6.1%	10.4%	12.5%	13.0%
Economic Potential	2.3%	9.3%	14.6%	17.0%	17.3%
Technical Potential	2.7%	10.4%	16.0%	18.5%	19.0%

Irrigation Sector Potential Savings

Table ES-10 shows the potential estimates for the irrigation sector, from the perspective of cumulative energy savings. Achievable savings in the first year, 2021, are 10 GWh, or 0.6% of the baseline projection. In 2040, savings reach 164 GWh, or 7.6% of the baseline projection. Incorporating updated RTF methodologies and draft updates to the irrigation measures for The Council's 2021 Power Plan reduces savings and potentially cost-effective potential compared to the previous study.

Table ES-11 Irrigation EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	1,790	1,858	1,950	2,048	2,152
Cumulative Savings (GWh)					
Achievable Potential	10	60	123	153	164
Economic Potential	13	75	156	196	209
Technical Potential	15	92	192	247	273
Cumulative Savings as a % of Baseline					
Achievable Potential	0.6%	3.2%	6.3%	7.5%	7.6%
Economic Potential	0.7%	4.1%	8.0%	9.6%	9.7%
Technical Potential	0.9%	4.9%	9.8%	12.1%	12.7%

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

Idaho Power (IPC) prepares an Annual Demand Side Management (DSM) report that describes its programs and achievements. Periodically, Idaho Power performs an energy efficiency (EE) potential study to assess the future potential for savings through its programs and to identify refinements that will enhance savings. As part of this well-established process, Idaho Power contracted with Applied Energy Group (AEG) to update the energy efficiency potential assessment completed in 2018, to quantify the amount, the timing, and the cost of electric energy efficiency resources available within the Idaho Power service area. Key objectives for the study include:

- Provide credible and transparent estimation of the technical, economic, and achievable energy efficiency potential by year over the next 20 years within the Idaho Power service area.
- Assess potential energy savings associated with each potential area by energy efficiency measure and sector.
- Provide an executable dynamic model that will support the potential assessment and allow for testing of sensitivity of all model inputs and assumptions.
- Review and update market profiles by sector, segment, and end use.
- Develop a final report including summary data tables and graphs reporting incremental and cumulative potential by year from 2021 through 2040.

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
HH	Household
HVAC	Heating Ventilation and Air Conditioning
kWh	Kilowatt hour
LED	Light emitting diode lamp
LoadMAP	AEG's Load Management Analysis and Planning™ tool
MW	Megawatt
O&M	Operations and Maintenance
RTU	Roof top unit
TRC	Total Resource 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 the 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, 2019. 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 2019 through 2040.
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 2021 through 2040.
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 2021 through 2040.

LoadMAP Model

For the energy efficiency potential analysis, we used AEG's Load Management Analysis and Planning tool (LoadMAP™) version 6.0 to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for 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.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- 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 we describe 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.

Market Characterization

The first step in the analysis approach is market characterization. In order to estimate the savings potential from energy efficient measures, it is necessary to understand how much energy is used today and what equipment is currently 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. Information from Idaho Power is primarily relied upon, although secondary sources are used 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 2019 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 with the various technologies. (e.g., homes with electric space heating).
- UEC (unit energy consumption) or EUI (energy-use index) describes the amount of energy consumed in 2019 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 2019. 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 2019.
- 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.

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

Baseline Projection

The next step was to develop the baseline projection of annual electricity use and summer peak demand for 2019 through 2040 by customer segment and end use without 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 2020 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. New construction market profiles reflect current building practices at the time of the study, which are likely in close alignment with IECC 2018 even though it was officially adopted after January 2020.
- 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

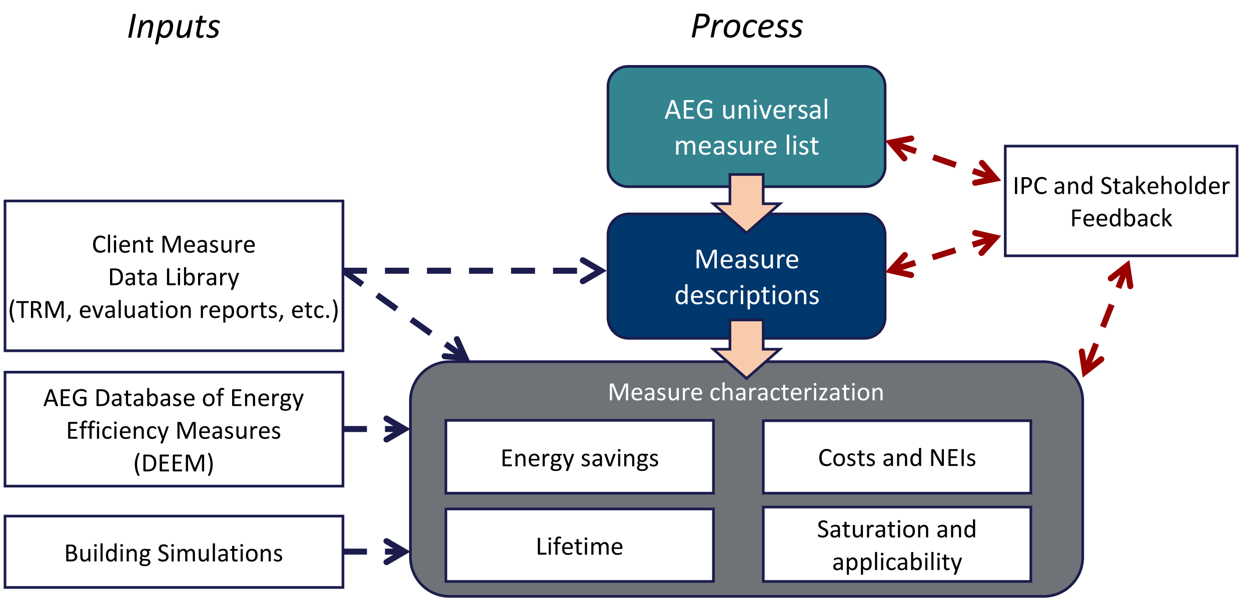
This section describes the framework used to assess the savings, costs, and other attributes of energy efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses, as well as for determining measure-level savings. For all measures, AEG assembled information 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.

Energy Efficiency Measures

Figure 2-1 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 2-1 Approach for Energy Efficiency Measure 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. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard, SEER 13 unit, and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit.
- 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)

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 and is presented in the appendix to this volume.

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.

Representative Energy Efficiency Measure Data Inputs

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

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

Efficiency Level	Useful Life	Equipment Cost	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

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.

[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.

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

End Use	Measure	Saturation in 2017	Applica-bility[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. 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 (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 summarizes the number of measures evaluated for each segment within each sector.

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

Table 2-4 Number of Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ Segments
Residential	98	196	532
Commercial	125	250	2,729
Industrial	111	222	3,331
Irrigation	26	52	52
Total Measures Evaluated	**360**	**720**	**6,644**

The appendix to this volume presents results for the economic screening process by segment, vintage, end use and measure for all sectors.

Energy Efficiency Potential

The approach used for this study to calculate the energy efficiency potential adheres to the approaches and conventions outlined in the National Action Plan for Energy Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[3] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy efficiency potential. In this study, the energy efficiency potential estimates energy and demand savings developed into three 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 from The Council's Seventh 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.

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

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 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.

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 2017 customer surveys, 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 2016 Home Energy Survey, a residential saturation survey. The lighting assumptions were updated using results from the Idaho Power customer online panel.
- 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 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 Seventh Power Plan Conservation Supply Curve Workbooks, 2016. To develop its Power Plan, The Council created workbooks with detailed information about measures, available at https://nwcouncil.box.com/7thplanconservationdatafiles

  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. This was updated since the 2011 RBSA used in the 2017 CPA. https://neea.org/data/residential-building-stock-assessment
- Commercial Building Stock Assessment: NEEA's 2014 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
- Bonneville Power Administration (BPA) Reference Deemed Measure List, version 2.5, which was the most recent available when the study was performed.

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[4].

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 2019 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 EPA, and the American Council for an Energy Efficient Economy.

Data Application

Below are the details regarding how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity 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

[4] 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

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.

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 2016 Home Energy 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 2016 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 2019 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 Seventh Plan and RTF data HVAC uses: BEST simulations using prototypes developed for Idaho Engineering Analysis AEG's DEEM Recent AEG studies AEO 2019
Appliance/equipment age distribution	Age distribution for each technology	NWPCC Seventh 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 2019 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 2019 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 2019 Regional Forecast Assumptions[5] 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 2019

In addition, AEG implemented assumptions for known future equipment standards as of January 2020, as shown in Table 2-7, Table 2-8, and Table 2-9. The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

Table 2-7 Residential Electric Equipment Standards[6]

<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="4">SEER 13.0</td><td colspan="2">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="6">SEER 14.0 / HSPF 8.2</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">Incandescent (~17 lumens/watt)</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>

[5] 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.

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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	Incandescent (~17 lumens/watt)					
	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 2-10 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 Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	Idaho Power Measure Data NWPCC Seventh Plan Conservation Workbooks BEST AEG's DEEM AEO 2019 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 Seventh Plan Conservation Workbooks RTF Deemed Measure Database AEG's DEEM AEO 2019 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 Seventh Plan Conservation Workbooks RTF Deemed Measure Database AEG's DEEM DEER AEO 2019 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 Seventh 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, 2019. 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 2019 was 14,542 GWh. Special-contract customers are included in this total, accounting for about 895 GWh.

As shown in Figure 3-1 and Table 3-1, the residential sector accounts for more than one-third (36%) of annual energy use, followed by commercial with 25%, industrial with 27%, and irrigation with 12%. In terms of summer peak demand, the total system peak in 2019 was 3,088 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 2019 was 2,138 MW, with the residential sector contributing over half of the impact (56%) at peak.

Figure 3-1 Sector-Level Electricity Use, 2019

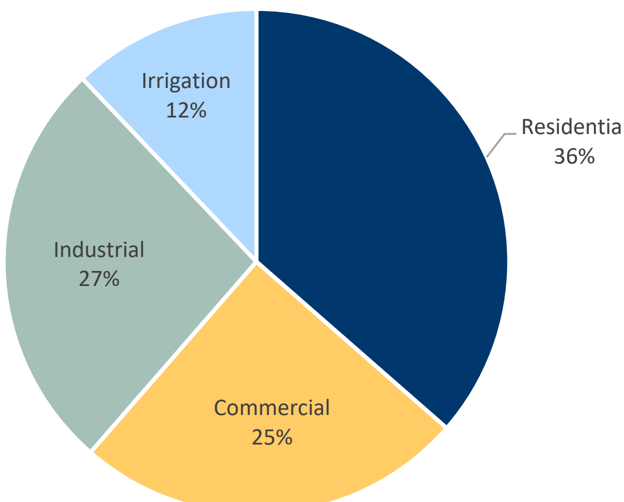


Table 3-1 Idaho Power Sector Control Totals, 2019

Sector	Annual Electricity Use (GWh)	% of Annual Use	Summer Peak Demand (MW)	% of Summer Peak	Winter Peak Demand (MW)	% of Winter Peak
Residential	5,299	36%	1,292	42%	1,192	56%
Commercial	3,629	25%	722	23%	644	30%
Industrial	3,854	27%	335	11%	297	14%
Irrigation	1,759	12%	739	24%	5	0.2%
Total	**14,542**	**100%**	**3,088**	**100%**	**2,138**	**100%**

Residential Sector

The total number of households and electricity sales for the service area were obtained from Idaho Power's customer database. In 2019, there were 471,298 households in the Idaho Power service area that used a total of 5,299 GWh with summer peak demand of 1,292 MW. Average use per customer (or household) at 11,243 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.

Table 3-2 Residential Sector Control Totals, 2019

Segment	Number of Customers	Electricity Use (GWh)	% of Annual Use	Annual Use/Customer (kWh/HH)	Summer Peak (MW)	Winter Peak (MW)
Single Family	363,973	4,175	79%	11,471	1,130	921
Multifamily	55,996	428	8%	7,636	65	96
Manufactured Home	51,330	696	13%	13,562	98	174
Total	**471,298**	**5,299**	**100%**	**11,243**	**1,292**	**1,192**

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, 2019

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Summer Peak (MW)
Cooling	Central AC	78.1%	1,686	1,316	620	630
	Room AC	11.7%	487	57	27	3
	Air-Source Heat Pump	11.0%	1,753	193	91	92
	Geothermal Heat Pump	0.9%	1,652	14	7	7
	Evaporative AC	2.4%	599	14	7	7
Space Heating	Electric Room Heat	9.2%	5,633	516	243	-
	Electric Furnace	12.9%	8,624	1,115	525	-
	Air-Source Heat Pump	11.0%	6,311	696	328	-
	Geothermal Heat Pump	0.9%	3,395	29	14	-
	Secondary Heating	36.1%	390	141	66	-
Water Heating	Water Heater (<= 55 Gal)	42.5%	2,966	1,261	595	89
	Water Heater (> 55 Gal)	5.6%	3,136	177	83	12
Interior Lighting	General Service Screw-in	100.0%	881	881	415	28
	Linear Lighting	100.0%	235	235	111	8
	Exempted Lighting	100.0%	60	60	28	2
Exterior Lighting	Screw-in	100.0%	175	175	82	6
Appliances	Clothes Washer	95.4%	73	70	33	4
	Clothes Dryer	88.7%	763	677	319	25
	Dishwasher	89.5%	377	337	159	13
	Refrigerator	100.0%	704	704	332	23
	Freezer	59.4%	505	300	141	14
	Second Refrigerator	33.2%	719	239	112	256
	Stove/Oven	82.1%	442	363	171	20
	Microwave	99.8%	116	115	54	6
Electronics	Personal Computers	74.5%	173	129	61	4
	Monitor	88.2%	67	59	28	2
	Laptops	122.1%	46	56	26	2
	TVs	270.8%	130	352	166	11
	Printer/Fax/Copier	74.5%	44	33	15	1
	Set-top Boxes/DVRs	285.8%	105	299	141	9
	Devices and Gadgets	100.0%	105	105	49	3
Miscellaneous	Electric Vehicles	0.1%	4,324	6	3	0
	Pool Pump	2.0%	3,508	70	33	2
	Pool Heater	0.5%	3,517	18	8	1
	Furnace Fan	73.6%	181	134	63	4
	Well pump	5.5%	528	29	14	1
	Miscellaneous	100.0%	270	270	127	8
Total				**11,243**	**5,299**	**1,292**

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 47% 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, air conditioning 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. Mobile homes have the highest use per customer at 13,562 kWh/year, which reflects a higher saturation of electric space heating and less efficient building shell.

Figure 3-2 Residential Electricity Use and Summer Peak Demand by End Use, 2019

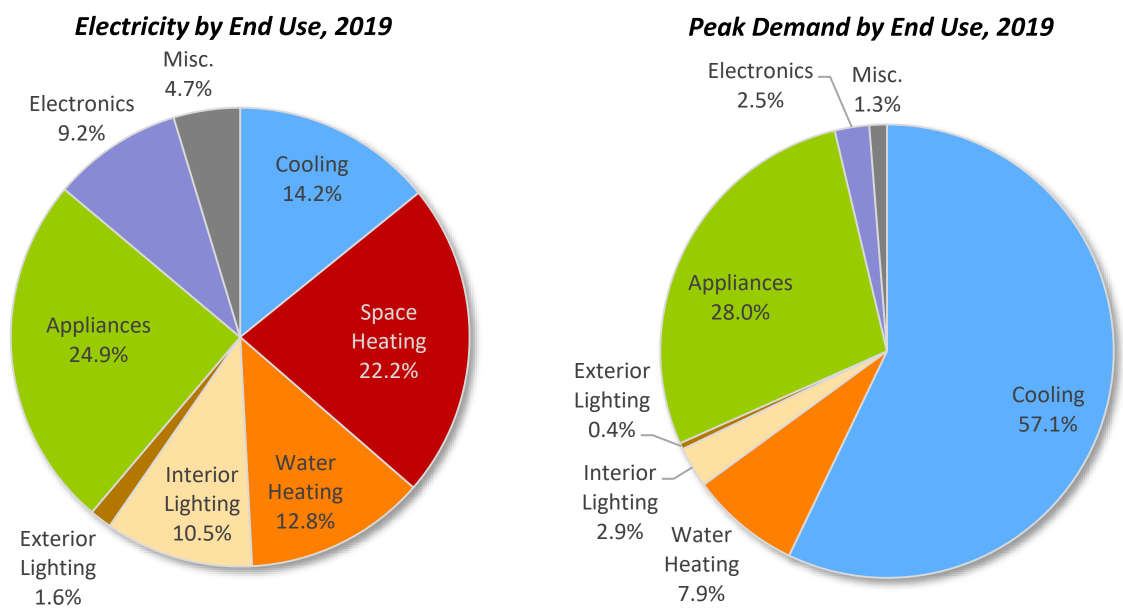
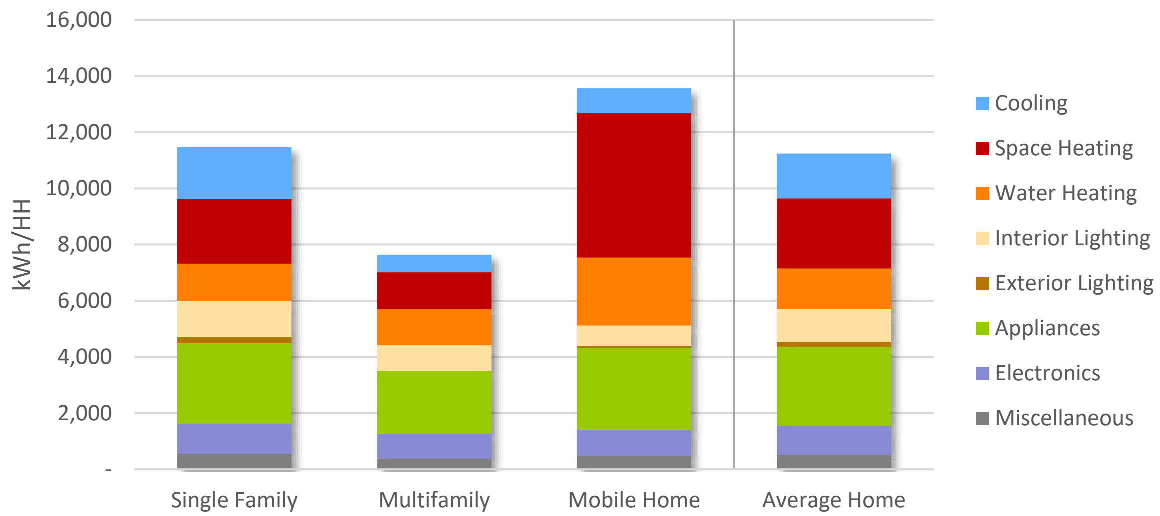


Figure 3-3 Residential Intensity by End Use and Segment (Annual kWh/HH, 2019)



Commercial Sector

The total electric energy consumed by commercial customers in Idaho Power's service area in 2019 was 3,629 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, 2019

Segment	Electricity Sales (GWh)	% of Total Usage	Intensity (Annual kWh/SqFt)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Small Office	660	18%	17.9	156	164
Large Office	230	6%	20.8	26	42
Restaurant	256	7%	38.0	36	33
Retail	475	13%	17.0	91	55
Grocery	270	7%	50.1	31	29
College	184	5%	14.0	41	31
School	252	7%	8.3	80	72
Hospital	316	9%	30.1	42	43
Lodging	166	5%	11.9	19	27
Warehouse	257	7%	5.1	71	61
Miscellaneous	563	16%	9.6	128	87
Total	**3,629**	**100%**	**13.7**	**722**	**644**

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 50% of annual electricity usage. Summer peak demand is dominated by cooling.

Figure 3-5 presents the electricity usage in annual kWh 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, 2019

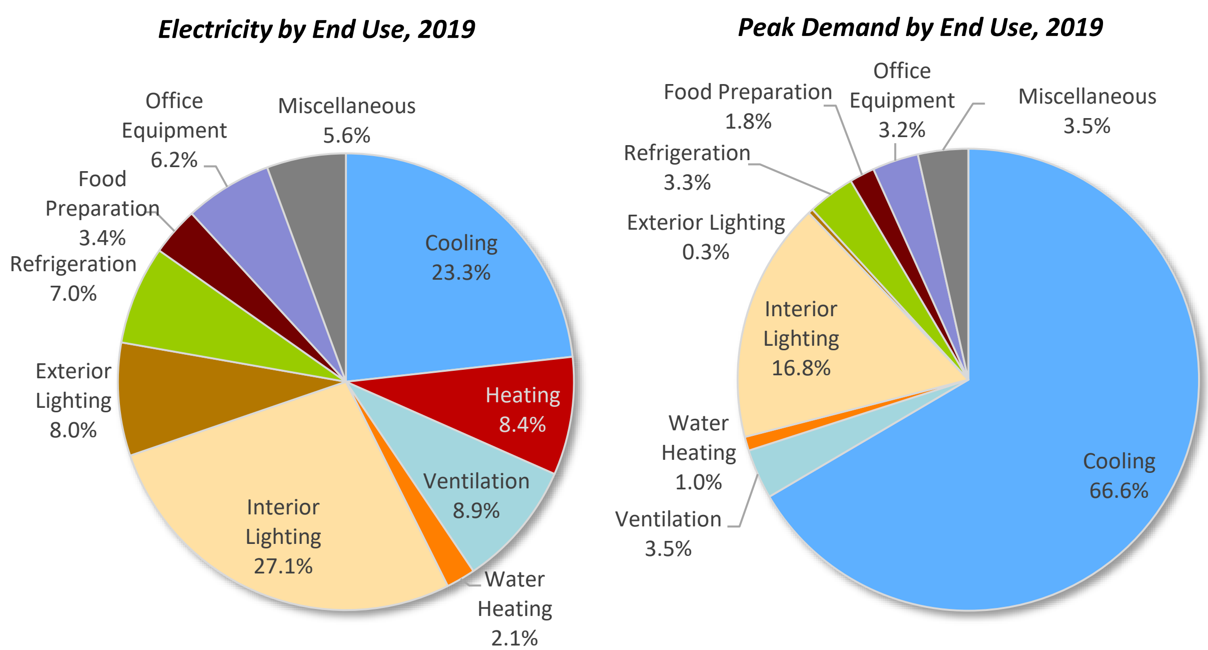


Figure 3-5 Commercial Electricity Usage by End Use and Segment (kWh/sq ft, 2019)

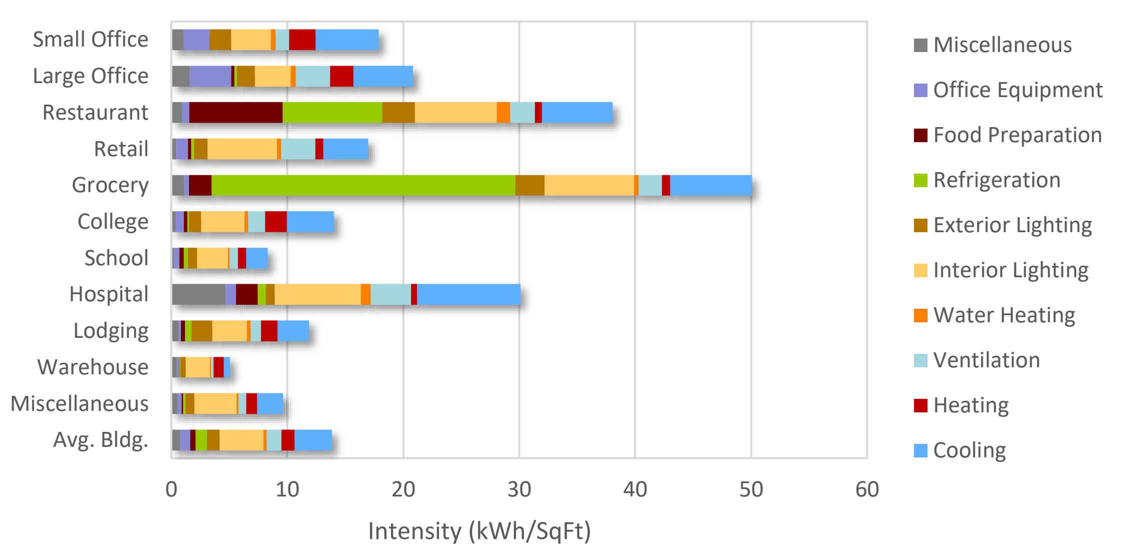


Table 3-5 shows the average market profile for electricity in the commercial as a whole representing a composite of all segments and buildings. Market profiles for each segment are presented in the appendix to this report.

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

End Use	Technology	Saturation	UEC (kWh/SqFt)	Intensity (kWh/SqFt)	Usage (GWh)	Summer Peak Demand (MW)
Cooling	Air-Cooled Chiller	7.2%	4.3	0.3	82	57
	Water-Cooled Chiller	4.7%	6.9	0.3	86	29
	RTU	39.0%	4.8	1.9	496	291
	PTAC	4.0%	4.0	0.2	42	23
	PTHP	1.7%	3.8	0.1	18	10
	Evaporative Central AC	0.1%	2.6	0.0	1	0
	Air-Source Heat Pump	8.2%	4.6	0.4	99	59
	Geothermal Heat Pump	2.6%	2.9	0.1	20	11
Heating	Electric Furnace	2.4%	5.1	0.1	33	0
	Electric Room Heat	11.5%	4.7	0.5	144	0
	PTHP	1.7%	3.0	0.1	14	-
	Air-Source Heat Pump	8.2%	4.2	0.3	91	0
	Geothermal Heat Pump	2.6%	3.3	0.1	23	0
Ventilation	Ventilation	100.0%	1.2	1.2	324	25
Water Htg.	Water Heater	27.0%	1.1	0.3	75	7
Interior Ltg.	General Service Lighting	100.0%	0.3	0.3	86	10
	Exempted Lighting	100.0%	0.2	0.2	57	6
	Linear Lighting	100.0%	1.6	1.6	423	51
	High-Bay Lighting	100.0%	1.6	1.6	419	55
Exterior Ltg.	General Service Lighting	100.0%	0.1	0.1	25	0
	Linear Lighting	100.0%	0.2	0.2	50	0
	Area Lighting	100.0%	0.8	0.8	215	2
Refrigeration	Walk-in Refrigerator/Freezer	8.2%	1.9	0.2	41	4
	Reach-in Refrigerator/Freezer	16.6%	0.1	0.0	7	1
	Glass Door Display	31.7%	0.3	0.1	23	2
	Open Display Case	31.7%	1.7	0.5	139	13
	Icemaker	34.8%	0.3	0.1	28	3
	Vending Machine	34.8%	0.2	0.1	16	1
Food Prep	Oven	43.2%	0.2	0.1	18	2
	Fryer	41.5%	0.5	0.2	51	5
	Dishwasher	23.5%	0.5	0.1	34	4
	Hot Food Container	24.6%	0.1	0.0	6	1
	Steamer	21.8%	0.3	0.1	16	1
Office Equip.	Desktop Computer	100.0%	0.4	0.4	119	12
	Laptop	99.3%	0.1	0.1	16	2
	Monitor	100.0%	0.1	0.1	21	2
	Server	87.2%	0.2	0.2	47	5
	Printer/Copier/Fax	100.0%	0.1	0.1	14	1
	POS Terminal	56.2%	0.1	0.0	9	1
Miscellaneous	Non-HVAC Motors	52.1%	0.1	0.1	18	2
	Pool Pump	10.0%	0.0	0.0	0	0
	Pool Heater	3.5%	0.0	0.0	0	0
	Clothes Washer	12.5%	0.0	0.0	0	0
	Clothes Dryer	8.1%	0.0	0.0	0	0
	Miscellaneous	100.0%	0.7	0.7	185	23
Total				**13.7**	**3,629**	**722**

Industrial Sector

The total electricity used in 2019 by Idaho Power's industrial customers was 3,854 GWh, while summer peak demand was 335 MW and winter peak demand was 297 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, 2019

Segment	Electricity Sales (GWh)	% of Total Usage	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Food Base	450	12%	34	34
Food Packaging	610	16%	47	46
Dairy	473	12%	38	36
Water Treatment	135	4%	10	10
Electronics	648	17%	72	53
Construction	207	5%	15	15
Base Manufacturing	187	5%	20	15
Gas Pipeline	17	0%	1	1
Mining	4	0%	0	0
Snow Maker	21	1%	1	2
Sugar Base	157	4%	11	12
Other Food Manufacturing	175	5%	14	13
Other Agriculture	236	6%	18	18
Other Wastewater	116	3%	8	9
Other Industrial	420	11%	45	34
Total	**3,854**	**100%**	**335**	**297**

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 44% 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 27% 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 (2019), All Industries

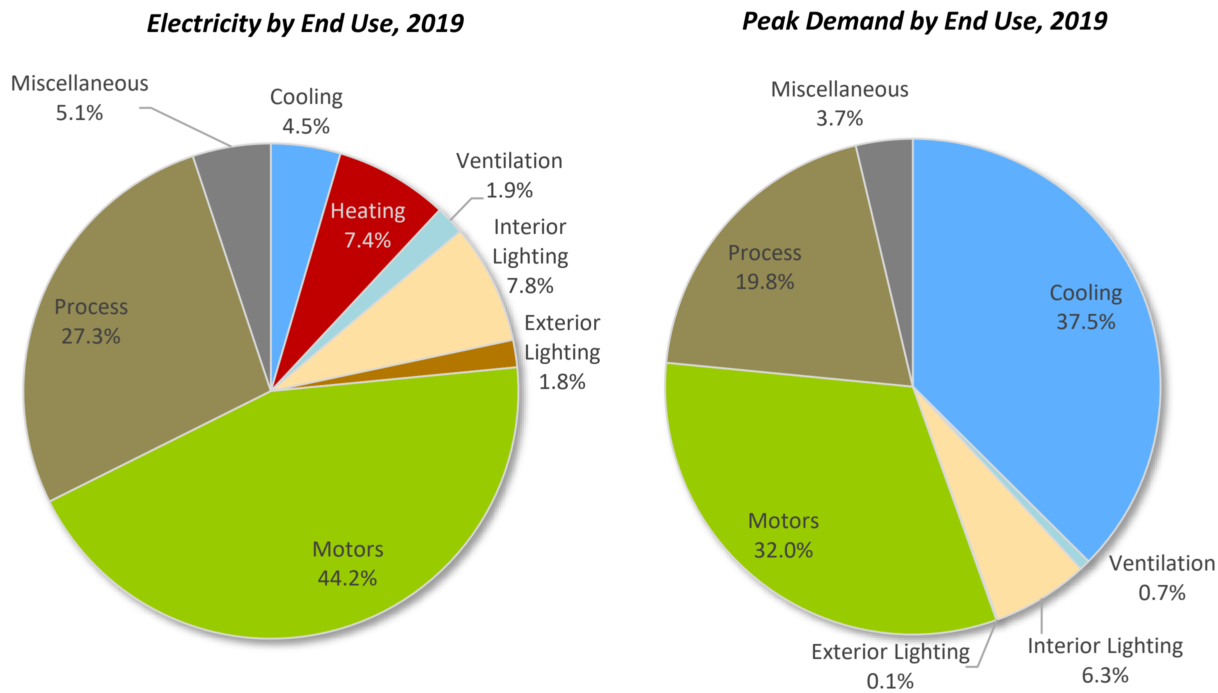


Table 3-7 shows the composite market profile for the industrial sector. The individual segment market profiles are shown in the Appendix B.

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

End Use	Technology	Saturation	UEC (kWh/ employee)	Intensity (kWh/ employee)	Usage (GWh)	Summer Peak Demand (MW)
Cooling	Air-Cooled Chiller	2.5%	9.4	0.2	17	12
	Water-Cooled Chiller	2.5%	9.7	0.2	18	13
	RTU	17.1%	10.0	1.7	124	89
	Air-Source Heat Pump	1.7%	12.9	0.2	16	11
	Geothermal Heat Pump	0.0%	-	-	-	-
Heating	Electric Furnace	2.0%	28.3	0.6	42	-
	Electric Room Heat	11.1%	27.0	3.0	218	-
	Air-Source Heat Pump	1.7%	20.6	0.3	25	-
	Geothermal Heat Pump	0.0%	-	-	-	-
Ventilation	Ventilation	100.0%	1.0	1.0	73	2
Interior Ltg.	General Service Lighting	100.0%	0.2	0.2	16	1
	High-Bay Lighting	100.0%	3.4	3.4	245	17
	Linear Lighting	100.0%	0.6	0.6	41	3
Exterior Ltg.	General Service Lighting	100.0%	0.0	0.0	3	0
	Area Lighting	100.0%	0.8	0.8	55	0
	Linear Lighting	100.0%	0.2	0.2	11	0
Motors	Pumps	100.0%	6.1	6.1	444	28
	Fans & Blowers	100.0%	5.8	5.8	421	27
	Compressed Air	99.8%	2.5	2.5	180	11
	Material Handling	99.1%	8.0	7.9	578	36
	Other Motors	72.1%	1.5	1.1	80	5
Process	Process Heating	94.5%	4.4	4.1	300	19
	Process Cooling	91.7%	4.7	4.3	315	20
	Process Refrigeration	91.7%	4.7	4.3	315	20
	Process Electrochemical	80.0%	0.4	0.3	23	1
	Process Other	84.6%	1.6	1.3	97	6
Miscellaneous	Miscellaneous	100.0%	2.7	2.7	197	12
				52.9	**3,854**	**335**

Irrigation Sector

The total electricity used in 2019 by Idaho Power's irrigation customers was 1,759 GWh, while summer peak demand was 739 MW and winter peak demand was 5.1 MW. Idaho Power billing data were used to develop estimates of energy intensity (annual kWh/service point). For the irrigation sector, all of 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, 2019

End Use	Size	Service Points	Electric Use (GWh)	Intensity (kWh/Service Point)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Motors	5 HP	2,096	12.1	599	5.1	0.0
Motors	10 HP	3,098	35.8	1,770	15.0	0.1
Motors	15 HP	1,594	27.6	1,366	11.6	0.1
Motors	20 HP	1,546	35.5	1,756	14.9	0.1
Motors	25 HP	1,457	47.4	2,347	19.9	0.1
Motors	30 HP	1,288	50.6	2,504	21.2	0.1
Motors	40 HP	1,640	84.9	4,201	35.7	0.2
Motors	50 HP	1,297	83.2	4,117	34.9	0.2
Motors	60 HP	816	58.0	2,870	24.4	0.2
Motors	75 HP	964	85.5	4,233	35.9	0.2
Motors	100 HP	955	112.7	5,577	47.3	0.3
Motors	125 HP	609	79.9	3,952	33.5	0.2
Motors	150 HP	564	88.4	4,376	37.1	0.3
Motors	200 HP	697	145.7	7,209	61.2	0.4
Motors	250 HP	370	121.2	5,998	50.9	0.4
Motors	300 HP	330	128.7	6,367	54.0	0.4
Motors	350 HP	228	103.1	5,102	43.3	0.3
Motors	400 HP	217	112.3	5,555	47.1	0.3
Motors	450 HP	119	69.1	3,420	29.0	0.2
Motors	500 HP	113	73.1	3,617	30.7	0.2
Motors	600 HP	92	65.3	3,233	27.4	0.2
Motors	>600 HP	118	139.0	6,876	58.3	0.4
	Total	**20,210**	**1,759**	**87,045**	**739**	**5.1**

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 those past programs cease to exist in the future. Possible savings from future programs are captured by the potential estimates.

The baseline projection incorporates assumptions about:

- 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 Idaho Power'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

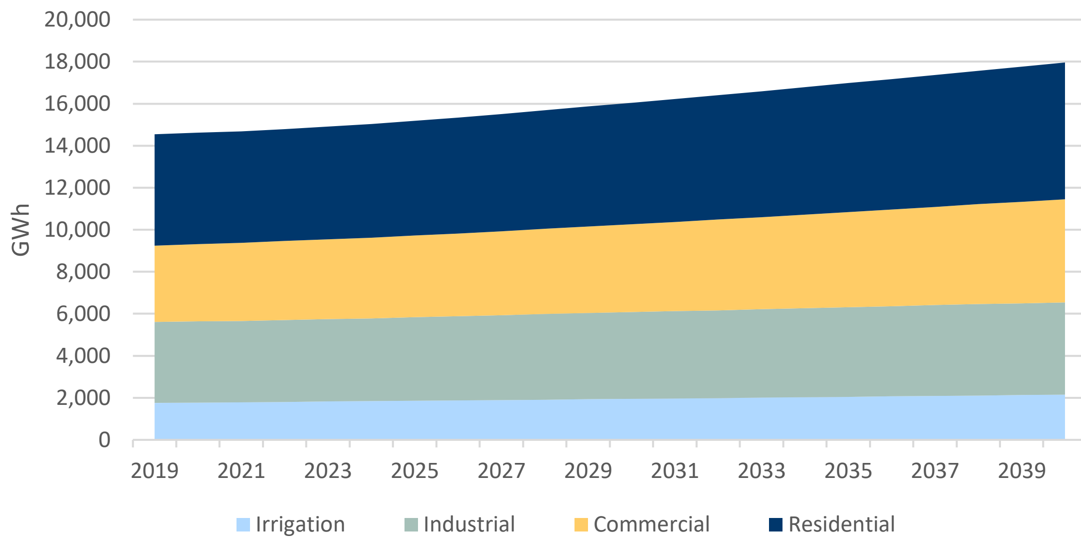
Annual Use

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	2021	2025	2030	2035	2040	% Change ('21-'40)
Residential	5,304	5,466	5,779	6,130	6,507	22.7%
Commercial	3,720	3,885	4,183	4,528	4,911	32.0%
Industrial	3,863	3,980	4,133	4,270	4,390	13.7%
Irrigation	1,790	1,858	1,950	2,048	2,152	20.2%
Total	**14,677**	**15,189**	**16,045**	**16,977**	**17,961**	**22.4%**

Figure 4-1 Baseline Projection Summary (GWh)



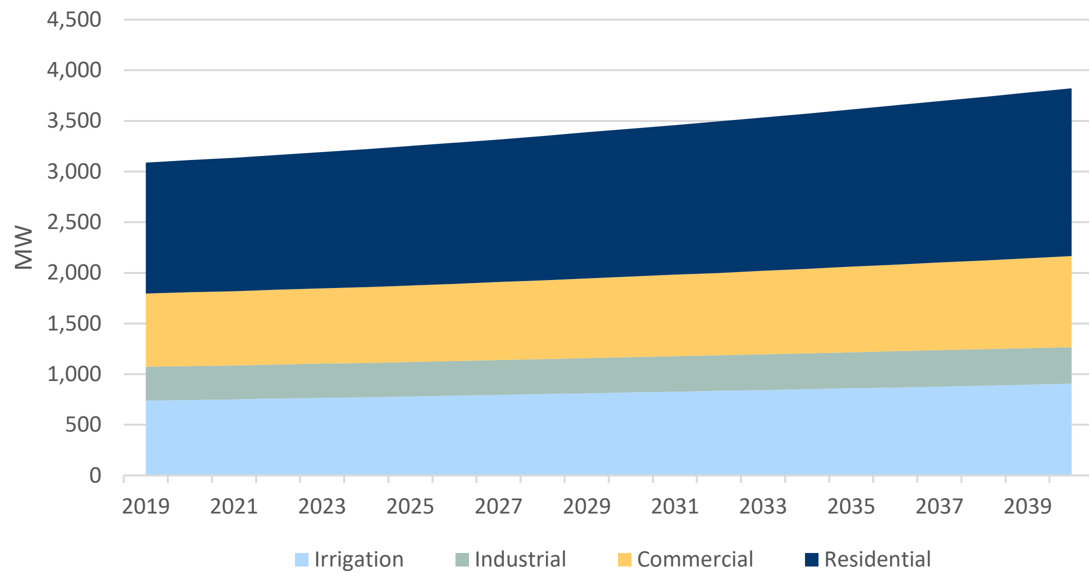
Summer Peak Demand Projection

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	2021	2025	2030	2035	2040	% Change ('21-'40)
Residential	1,318	1,377	1,460	1,552	1,656	26%
Commercial	732	755	795	844	899	23%
Industrial	335	341	349	356	363	9%
Irrigation	752	780	819	860	904	20%
Total	**3,137**	**3,253**	**3,422**	**3,613**	**3,822**	**22%**

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



Residential Sector Baseline Projection

Annual Use

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 5,304 GWh in 2021 to 6,507 GWh in 2040, an increase of 22.7%. 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.

Table 4-4 shows the end-use forecast at the technology level for select years. 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.[7]
2. Growth in the water heating end use is lower than average, reflecting the efficient 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[8] 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.

[7] *"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

[8] 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.).

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

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	768	798	842	894	956	25%
Heating	1,237	1,315	1,397	1,472	1,547	25%
Water Heating	688	710	737	766	797	16%
Interior Lighting	411	308	283	287	295	-28%
Exterior Lighting	61	42	40	39	38	-37%
Appliances	1,377	1,474	1,585	1,694	1,808	31%
Electronics	503	536	578	619	661	31%
Miscellaneous	259	282	318	358	404	56%
Total	**5,304**	**5,466**	**5,779**	**6,130**	**6,507**	**23%**

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

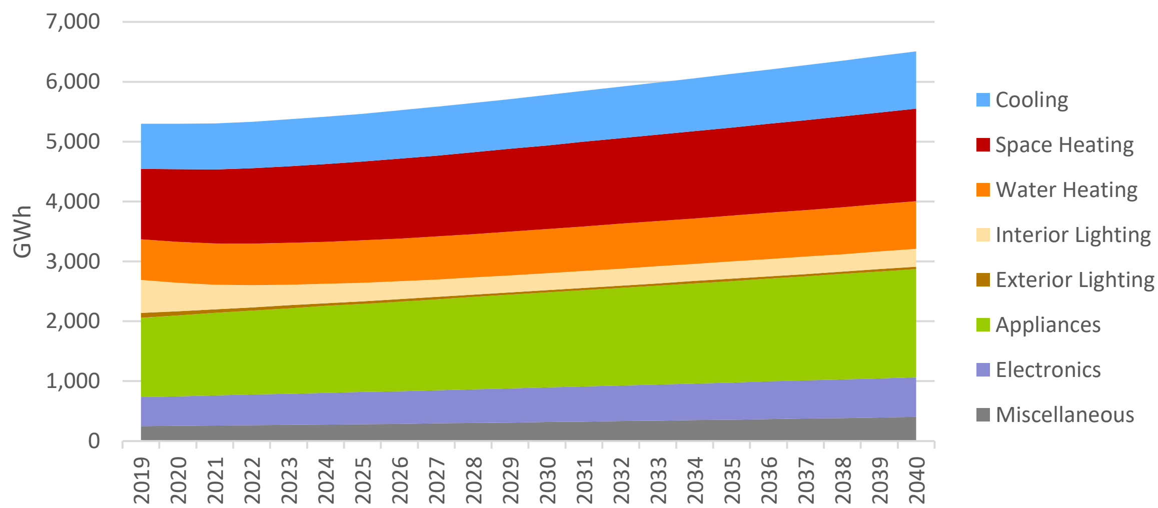


Figure 4-4 Residential Baseline Projection by End Use – Annual Use per Household

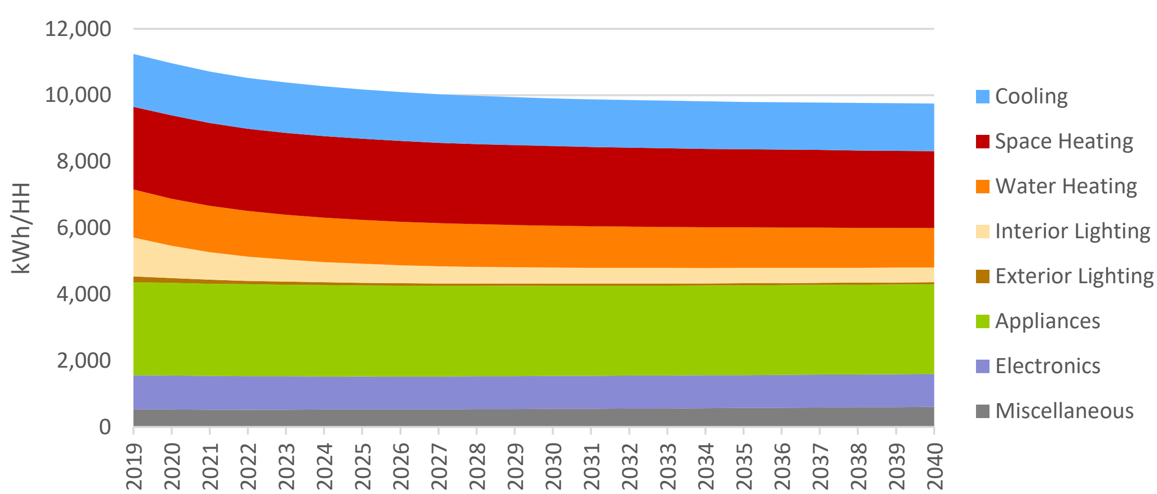


Table 4-4 Residential Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	Central AC	635	662	700	747	802	26%
	Room AC	26	25	24	23	23	-11%
	Air-Source Heat Pump	94	98	103	109	115	23%
	Geothermal Heat Pump	7	7	7	7	8	11%
	Evaporative AC	7	7	8	8	9	28%
Heating	Electric Room Heat	263	293	330	367	406	55%
	Electric Furnace	545	562	572	575	576	6%
	Air-Source Heat Pump	344	365	389	413	438	27%
	Geothermal Heat Pump	14	15	16	16	17	18%
	Secondary Heating	72	80	90	100	111	55%
Water Heating	Water Heater (<= 55 Gal)	603	620	643	668	694	15%
	Water Heater (> 55 Gal)	85	89	94	99	103	21%
Interior Lighting	General Service Screw-in	277	177	145	143	142	-49%
	Linear Lighting	115	123	131	139	148	28%
	Exempted Lighting	19	8	6	5	5	-73%
Ext. Lighting	Screw-in	61	42	40	39	38	-37%
Appliances	Clothes Washer	35	37	40	43	46	32%
	Clothes Dryer	334	361	393	426	460	38%
	Dishwasher	166	180	195	211	227	36%
	Refrigerator	343	362	383	404	428	25%
	Freezer	146	155	164	172	180	23%
	Second Refrigerator	118	126	136	145	154	31%
	Stove/Oven	179	193	209	225	241	35%
	Microwave	56	60	65	69	73	31%
Electronics	Personal Computers	62	66	71	76	82	31%
	Monitor	29	31	33	35	38	31%
	Laptops	27	30	33	36	39	42%
	TVs	171	182	196	210	224	30%
	Printer/Fax/Copier	16	17	19	21	23	44%
	Set-top Boxes/DVRs	146	155	167	178	190	30%
	Devices and Gadgets	51	55	59	63	67	30%
Miscellaneous	Electric Vehicles	4	10	25	45	69	1548%
	Pool Pump	34	36	39	42	44	31%
	Pool Heater	9	9	10	10	11	30%
	Furnace Fan	66	71	77	83	89	36%
	Well pump	14	15	16	17	19	30%
	Miscellaneous	132	141	151	161	172	30%
Total		**5,304**	**5,466**	**5,779**	**6,130**	**6,507**	**23%**

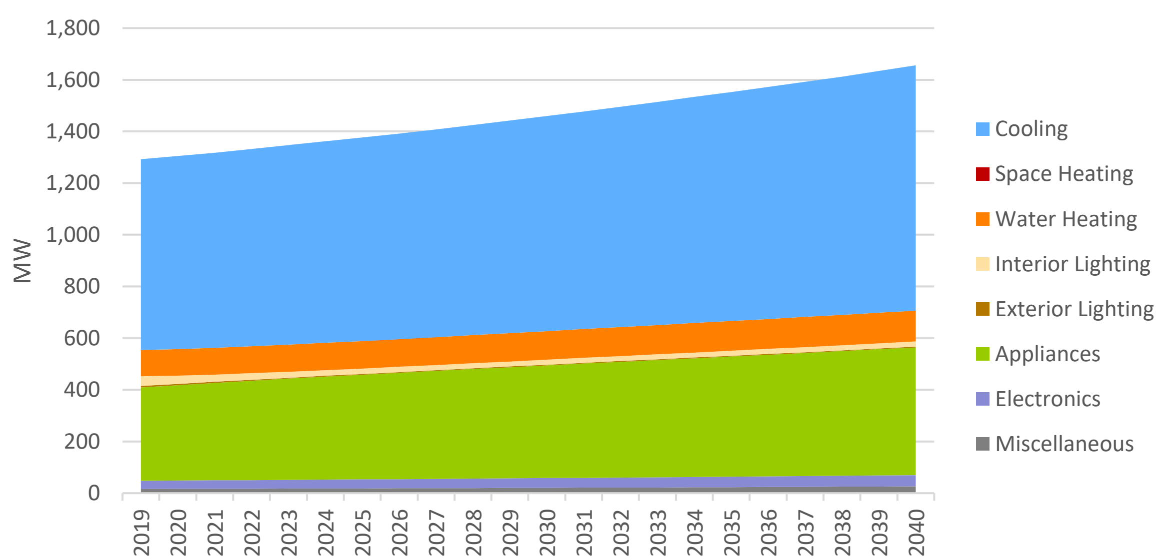
Residential Summer Peak Demand Projection

Table 4-5 and Figure 4-5 present the residential baseline projection for summer peak demand at the end-use level. Overall, residential summer peak increases from 1,318 MW in 2021 to 1,656 MW in 2040, an increase of 26%. All end uses except lighting show increases in the baseline peak projections. The summer peak associated with electronics, appliances, and miscellaneous uses increases substantially, in correspondence with growth in annual energy use.

Table 4-5 Residential Summer Peak Baseline Projection by End Use (MW)

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	756	788	832	886	950	26%
Heating	-	-	-	-	-	0%
Water Heating	103	106	111	115	120	16%
Interior Lighting	28	21	19	20	20	-28%
Exterior Lighting	4	3	3	3	3	-37%
Appliances	377	405	436	465	495	31%
Electronics	33	35	38	40	43	31%
Miscellaneous	17	18	21	23	26	56%
Total	**1,318**	**1,377**	**1,460**	**1,552**	**1,656**	**26%**

Figure 4-5 Residential Summer Peak Baseline Projection by End Use (MW)



Commercial Sector Baseline Projection

Annual Use

Annual electricity use in the commercial sector grows during the overall forecast horizon, starting at 3,720 GWh in 2021 and increasing by 32% to 4,911 GWh in 2040. Table 4-6 and Figure 4-6 present the baseline projection at the end-use level for the commercial sector.

Table 4-7 presents the commercial sector annual forecast by technology for select years.

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

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	849	862	885	916	953	12%
Heating	313	326	342	360	378	21%
Ventilation	333	351	373	397	422	27%
Water Heating	77	82	88	94	101	31%
Interior Lighting	988	973	1,005	1,055	1,118	13%
Exterior Lighting	297	300	312	329	349	17%
Refrigeration	260	280	312	349	388	49%
Food Preparation	130	142	160	179	200	54%
Office Equipment	235	259	295	332	371	58%
Miscellaneous	238	311	411	517	632	166%
Total	**3,720**	**3,885**	**4,183**	**4,528**	**4,911**	**32%**

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

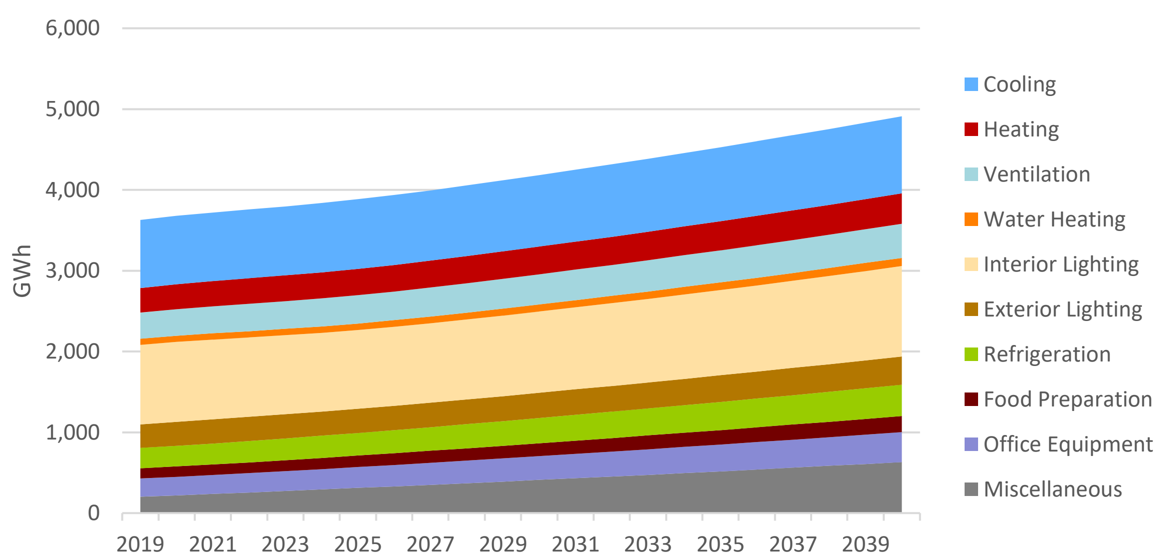


Table 4-7 Commercial Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	Air-Cooled Chiller	82	84	86	89	92	12%
	Water-Cooled Chiller	86	86	87	88	91	5%
	RTU	502	514	532	552	575	15%
	PTAC	42	42	43	45	47	13%
	PTHP	18	18	18	19	20	12%
	Evaporative Central AC	0.98	1.00	1.03	1.08	1.15	17%
	Air-Source Heat Pump	98	98	99	102	107	9%
	Geothermal Heat Pump	20	19	19	19	20	1%
Heating	Electric Furnace	34	36	38	39	41	22%
	Electric Room Heat	150	159	169	180	190	27%
	PTHP	14	15	16	17	18	28%
	Air-Source Heat Pump	92	92	94	97	101	10%
	Geothermal Heat Pump	23	24	25	26	28	19%
Ventilation	Ventilation	333	351	373	397	422	27%
Water Heating	Water Heater	77	82	88	94	101	31%
Interior Lighting	General Service Lighting	85	57	45	41	42	-51%
	Exempted Lighting	45	21	15	14	14	-69%
	Linear Lighting	431	449	475	505	539	25%
	High-Bay Lighting	427	446	470	496	524	23%
Exterior Lighting	General Service Lighting	27	16	12	11	11	-57%
	Linear Lighting	51	53	56	60	64	25%
	Area Lighting	220	230	244	258	274	25%
Refrigeration	Walk-in Refrigerator/Freezer	43	48	56	66	76	78%
	Reach-in Refrigerator/Freezer	7	8	10	12	15	108%
	Glass Door Display	24	25	28	31	34	41%
	Open Display Case	142	151	165	182	200	41%
	Icemaker	29	30	33	37	41	41%
	Vending Machine	16	17	19	21	23	45%
Food Preparation	Oven	18	20	23	26	30	63%
	Fryer	51	53	57	61	65	28%
	Dishwasher	36	42	50	58	65	80%
	Hot Food Container	6	7	7	8	9	49%
	Steamer	18	20	23	26	30	69%
Office Equipment	Desktop Computer	122	132	146	162	178	46%
	Laptop	16	18	20	22	24	46%
	Monitor	21	23	26	29	31	46%
	Server	51	60	72	86	100	98%
	Printer/Copier/Fax	15	17	20	22	25	67%
	POS Terminal	9	10	10	11	12	35%
Miscellaneous	Non-HVAC Motors	18	18	20	21	23	31%
	Pool Pump	0.25	0.26	0.28	0.30	0.32	30%
	Pool Heater	0.11	0.12	0.13	0.14	0.15	33%
	Clothes Washer	0.09	0.10	0.11	0.11	0.12	29%
	Clothes Dryer	0.19	0.20	0.21	0.23	0.24	27%
	Miscellaneous	219	292	390	495	608	177%
Total		**3,720**	**3,885**	**4,183**	**4,528**	**4,911**	**32%**

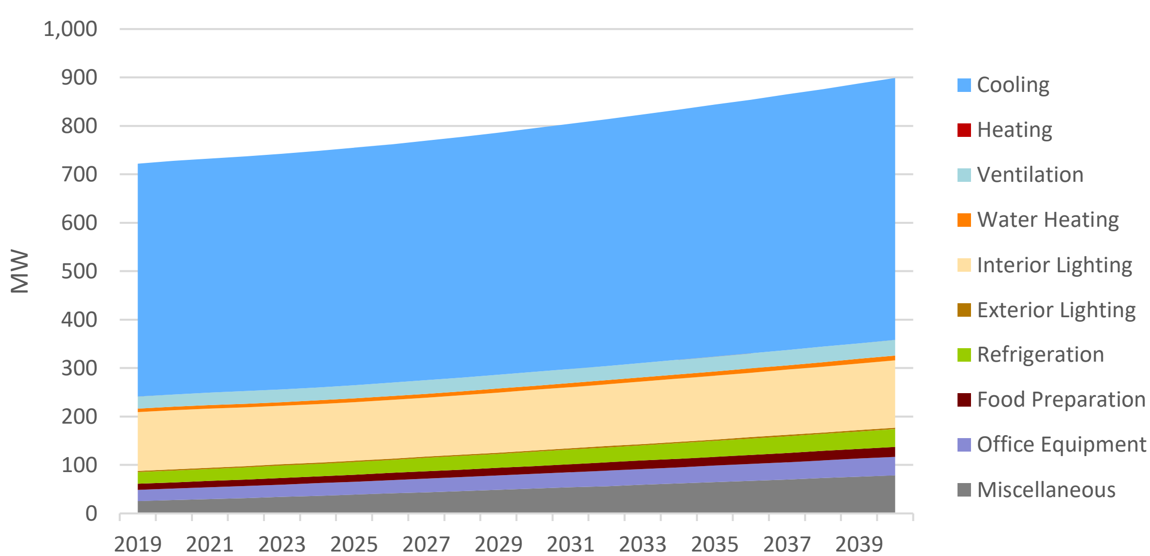
Commercial Summer Peak Demand Projection

Table 4-8 and Figure 4-7 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 732 MW in 2021 and increasing by 23% to 899 in 2040.

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

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	483	490	503	520	541	12%
Heating	0	0	0	0	0	21%
Ventilation	26	27	29	31	33	26%
Water Heating	7	8	8	9	9	31%
Interior Lighting	122	121	125	131	139	14%
Exterior Lighting	3	3	3	3	3	17%
Refrigeration	24	26	29	33	37	49%
Food Preparation	13	14	16	18	20	54%
Office Equipment	24	27	30	34	38	58%
Miscellaneous	30	39	51	64	79	166%
Total	**732**	**755**	**795**	**844**	**899**	**23%**

Figure 4-7 Commercial Summer Peak Baseline Projection by End Use (MW)



Industrial Sector Baseline Projection

Annual Use

Table 4-9 and Figure 4-8 present the projection of electricity use in the industrial sector at the end-use level. Overall, industrial annual electricity use increases from 3,863 GWh in 2021 to 4,390 GWh in 2040. This comprises an overall increase of 14% over the 20-year period. Table 4-10 presents the industrial sector annual forecast by technology for select years.

Table 4-9 Industrial Baseline Projection by End Use (GWh)

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	173	173	171	170	170	-2.0%
Heating	289	297	307	315	322	11.4%
Ventilation	73	74	76	78	79	8.4%
Interior Lighting	292	278	271	269	269	-7.8%
Exterior Lighting	69	67	68	68	69	-0.2%
Motors	1,703	1,754	1,814	1,863	1,901	11.7%
Process	1,050	1,082	1,119	1,150	1,173	11.7%
Miscellaneous	214	254	306	357	407	90.6%
Total	**3,863**	**3,980**	**4,133**	**4,270**	**4,390**	**13.7%**

Figure 4-8 Industrial Baseline Projection by End Use (GWh)

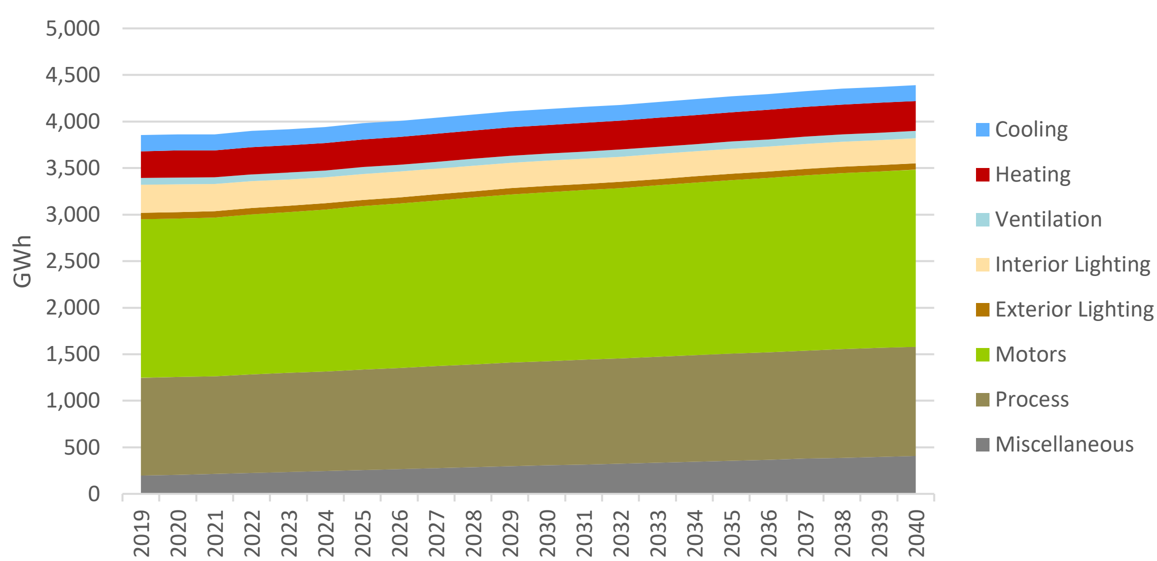


Table 4-10 Industrial Baseline Projection by End Use and Technology (GWh)

End Use	Technology	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	Air-Cooled Chiller	17	18	19	20	20	17%
	Water-Cooled Chiller	18	18	18	19	19	9%
	RTU	123	122	119	117	115	-6%
	Air-Source Heat Pump	15	15	15	15	15	-1%
	Geothermal Heat Pump	-	-	-	-	-	0%
Heating	Electric Furnace	43	44	46	47	48	12%
	Electric Room Heat	220	227	235	241	246	12%
	Air-Source Heat Pump	25	26	26	27	28	8%
	Geothermal Heat Pump	-	-	-	-	-	0%
Ventilation	Ventilation	73	74	76	78	79	8%
Interior Lighting	General Service Lighting	15.3	9.1	7.9	7.1	7.0	-54%
	High-Bay Lighting	236	227	221	219	219	-7%
	Linear Lighting	41	41	42	43	43	7%
Exterior Lighting	General Service Lighting	3.9	2.2	1.9	1.7	1.7	-57%
	Area Lighting	54	54	55	55	56	3%
	Linear Lighting	11	11	11	11	12	4%
Motors	Pumps	444	457	473	486	496	12%
	Fans & Blowers	421	434	448	460	470	12%
	Compressed Air	180	186	192	197	201	12%
	Material Handling	578	596	616	633	646	12%
	Other Motors	80	82	85	87	89	12%
Process	Process Heating	300	309	320	328	335	12%
	Process Cooling	315	325	336	345	352	12%
	Process Refrigeration	315	325	336	345	352	12%
	Process Electrochemical	23	23	24	25	25	12%
	Process Other	97	100	104	106	109	12%
Miscellaneous	Miscellaneous	214	254	306	357	407	91%
Total		**3,863**	**3,980**	**4,133**	**4,270**	**4,390**	**14%**

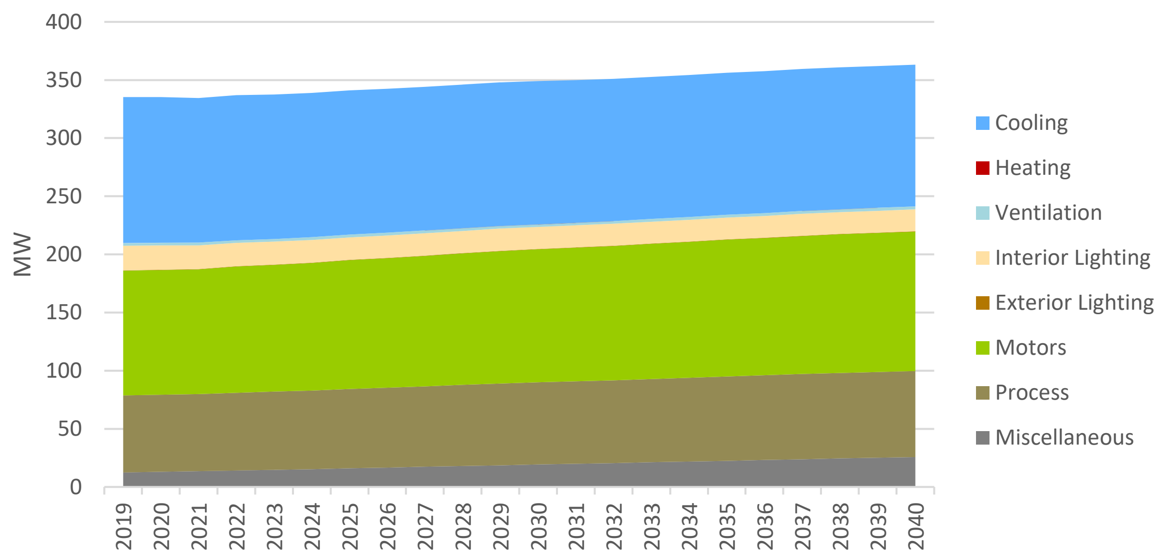
Industrial Summer Peak Demand Projection

Table 4-11 and Figure 4-9 present the projection of summer peak demand for the industrial sector. Summer peak usage is 335 MW in the 2021, increasing by 8.5% to 363 MW in 2040.

Table 4-11 Industrial Summer Peak Baseline Projection by End Use (MW)

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Cooling	124	124	123	122	122	-2.0%
Heating	-	-	-	-	-	0.0%
Ventilation	2	2	2	2	3	8.4%
Interior Lighting	20	19	19	19	19	-7.8%
Exterior Lighting	0	0	0	0	0	-0.2%
Motors	107	111	114	118	120	11.7%
Process	66	68	71	73	74	11.7%
Miscellaneous	13	16	19	23	26	90.6%
Total	**335**	**341**	**349**	**356**	**363**	**8.5%**

Figure 4-9 Industrial Summer Peak Baseline Projection by End Use (MW)



Irrigation Sector Baseline Projection

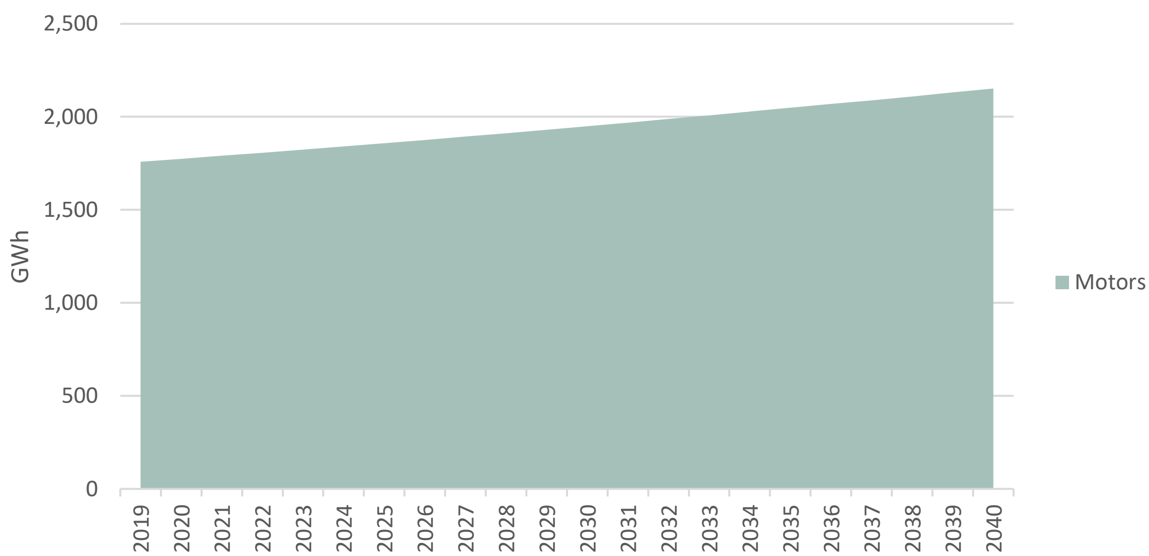
Annual Use

Annual irrigation use increases throughout the forecast horizon by approximately 20%. However, use per service point decreases by 3.3% by 2040. Table 4-12 and Figure 4-10 present the projection. It is not broken out by end use since all usage is due to motors. Overall, irrigation annual electricity use increases from 1,790 GWh in 2021 to 2,152 GWh in 2040.

Table 4-12 Irrigation Baseline Projection (GWh)

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Total Energy Use (GWh)	1,790	1,858	1,950	2,048	2,152	20.2%
Use per service point (kWh/service point)	86,370	85,272	84,342	83,803	83,496	-3.3%

Figure 4-10 Irrigation Baseline Projection (GWh)



Irrigation Summer Peak Demand Projection

Table 4-12 and Figure 4-11 present the projection of summer peak demand for the irrigation sector. This projection looks similar to the energy forecast largely because the irrigation sector has a high load factor.

Table 4-13 Irrigation Summer Peak Baseline Projection (MW)

End Use	2021	2025	2030	2035	2040	% Change ('21-'40)
Total Energy Use (MW)	752	780	819	860	904	20.2%
Use per service point (kW/service point)	36	36	35	35	35	-3.3%

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 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 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.

Overall Summary of Energy Efficiency Potential

Summary of Cumulative Energy Savings

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.

- Technical potential reflects the adoption of all EE measures regardless of cost-effectiveness. First-year savings are 435 GWh, or 3.0% of the baseline projection. Cumulative technical savings in 2040 are 4,258 GWh, or 25.1% 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 2021 are 291 GWh, or 2.0% of the baseline projection. By 2040, cumulative economic savings reach 3,669 GWh, or 20.4% of the baseline projection.
- Achievable potential represents savings that are possible when considering the availability, knowledge and acceptance of the measure. Achievable potential is 135 GWh savings in the first year, or 0.9% of the baseline, and reaches 2,626 GWh cumulative achievable savings by 2040, or 14.6% of the baseline projection. This results in average annual savings of 0.3% of the baseline each year. Achievable potential reflects 72% of economic potential by the end of the forecast horizon.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	**14,677**	**15,189**	**16,045**	**16,977**	**17,961**
Cumulative Savings (GWh)					
Achievable Potential	135	727	1,532	2,223	2,626
Economic Potential	291	1,374	2,488	3,275	3,669
Technical Potential	435	1,947	3,385	4,258	4,679
Cumulative Savings as a % of Baseline					
Achievable Potential	0.9%	4.8%	9.5%	13.1%	14.6%
Economic Potential	2.0%	9.0%	15.5%	19.3%	20.4%
Technical Potential	3.0%	12.8%	21.1%	25.1%	26.1%

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

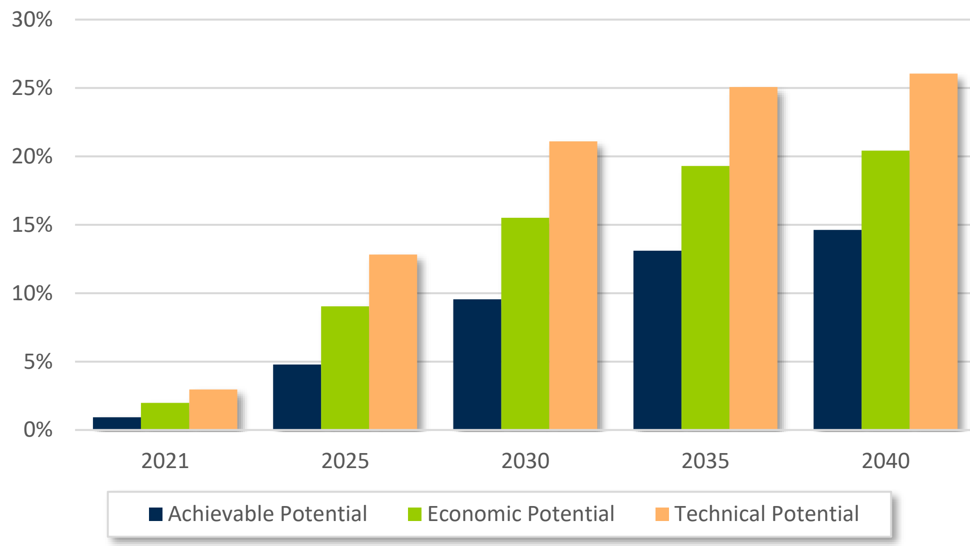
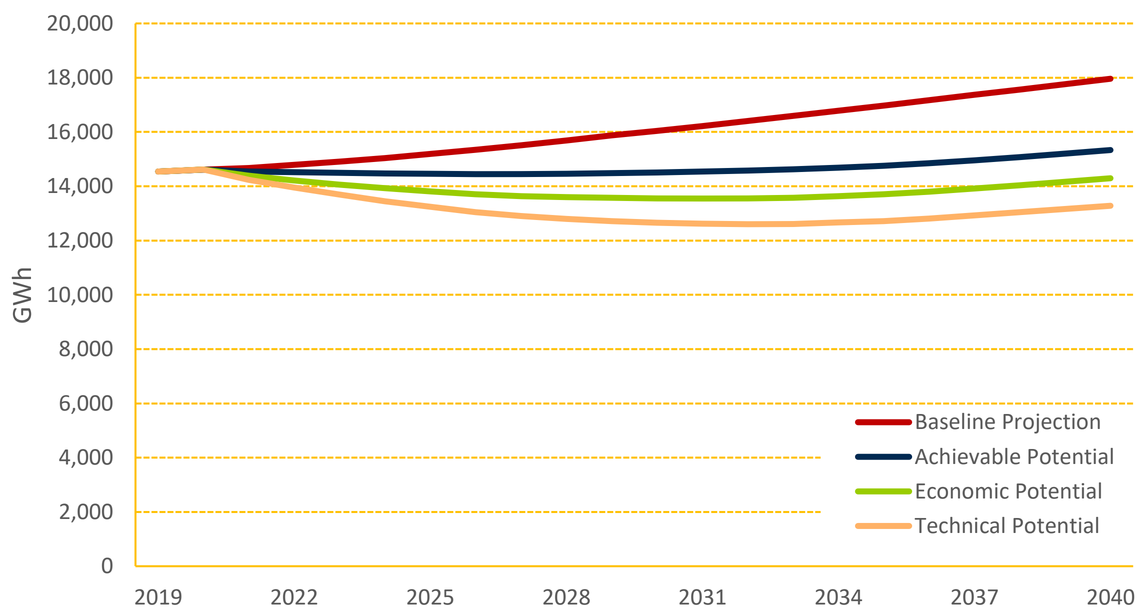


Figure 5-2 Baseline Projection and EE Forecast Summary (Energy, GWh)



Summary of Summer Peak Demand Savings

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 60 MW in 2021, or 1.9% of the baseline projection. This increases to 694 MW by 2040, or 18.2% of the summer peak demand baseline projection.

- Economic potential is estimated at 39 MW or a 1.3% reduction in the 2021 summer peak demand baseline projection. In 2040, savings are 523 MW or 13.7% of the summer peak baseline projection.
- Achievable potential is 18 MW by 2021, or 0.6% of the baseline projection. By 2040, cumulative savings reach 376 MW, or 9.8% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	3,137	3,253	3,422	3,613	3,822
Cumulative Savings (MW)					
Achievable Potential	18	96	214	315	376
Economic Potential	39	189	357	470	523
Technical Potential	60	278	501	632	694
Cumulative Savings as a % of Baseline					
Achievable Potential	0.6%	3.0%	6.3%	8.7%	9.8%
Economic Potential	1.3%	5.8%	10.4%	13.0%	13.7%
Technical Potential	1.9%	8.5%	14.6%	17.5%	18.2%

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

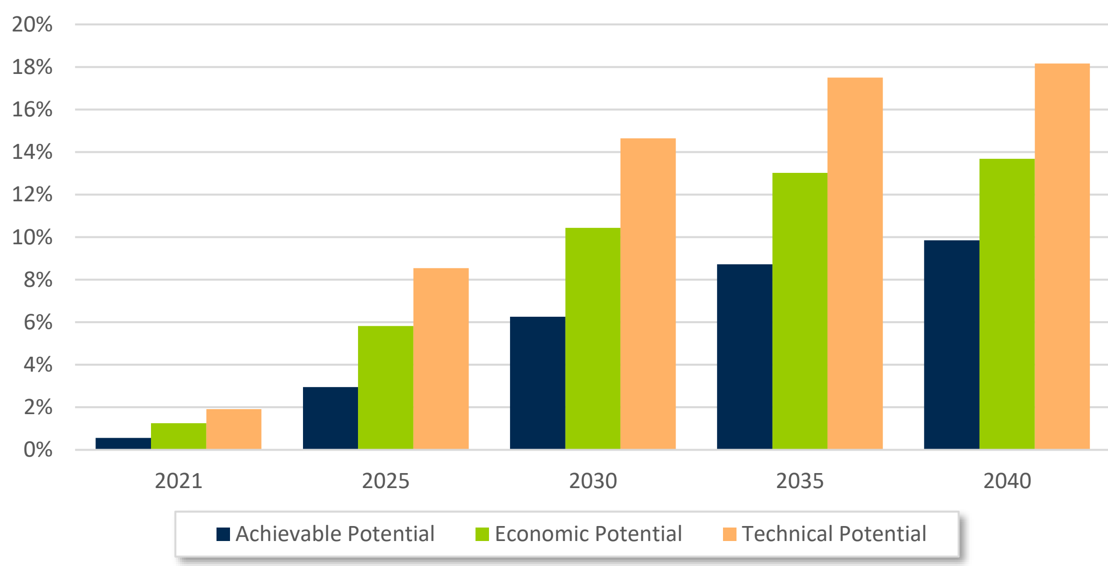
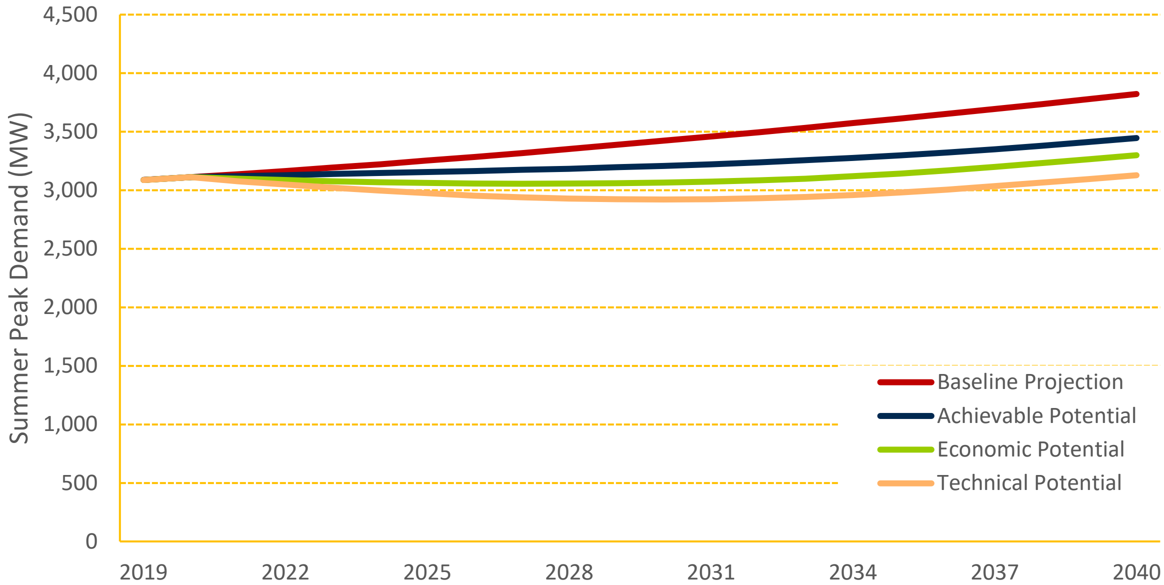


Figure 5-4 Summary Peak Baseline Projection and EE Forecast Summary



Summary of 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 Technical Achievable EE Potential by Sector (Energy and Summer Peak Demand)

	2021	2025	2030	2035	2040
Cumulative Energy Savings (GWh)					
Residential	21	118	331	569	737
Commercial	53	306	647	968	1,153
Industrial	50	243	431	534	572
Irrigation	10	60	123	153	164
Total	**135**	**727**	**1,532**	**2,223**	**2,626**
Cumulative Summer Peak Demand Savings (MW)					
Residential	4.0	16.1	46.1	80.4	102.9
Commercial	5.8	37.1	83.7	128.1	157.3
Industrial	3.4	17.6	32.8	42.0	47.0
Irrigation	4.4	25.2	51.5	64.4	69.0
Total	**18**	**96**	**214**	**315**	**376**

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

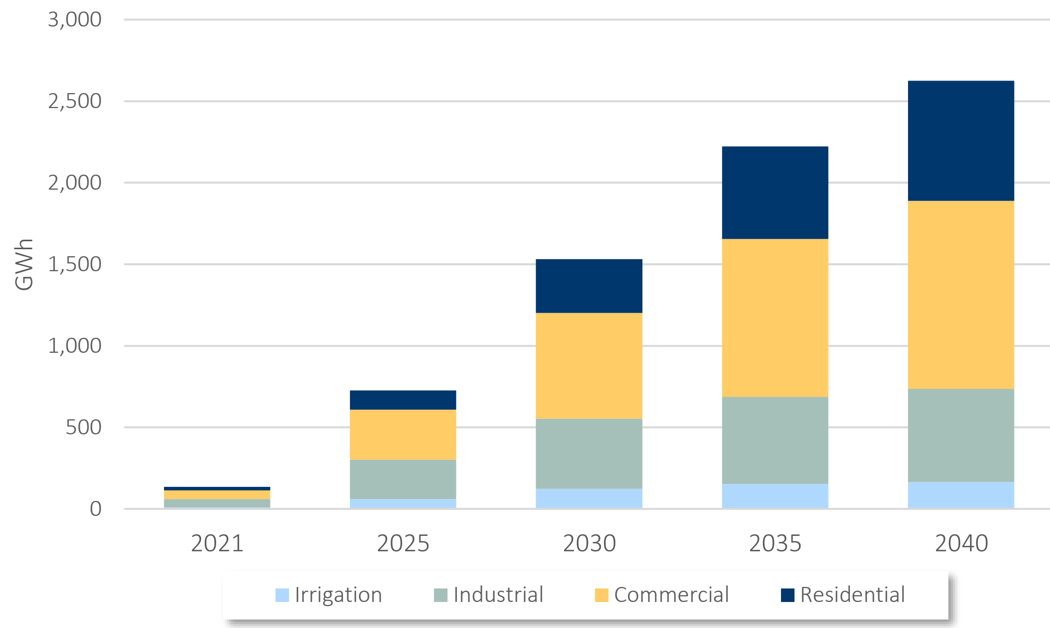
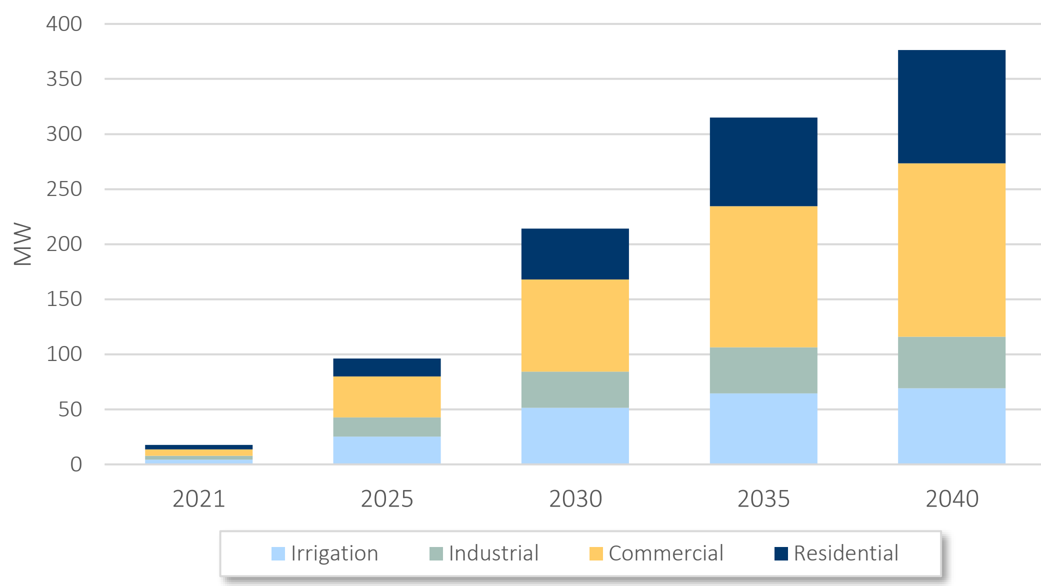


Figure 5-6 Achievable Cumulative EE Potential by Sector (Summer Peak Demand, MW)



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, 2019 is 21 GWh, or 0.4% of the baseline projection. By 2040, cumulative achievable savings are 737 GWh, or 11.3% of the baseline projection. At this level, it represents just over half of economic potential.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	5,304	5,466	5,779	6,130	6,507
Cumulative Savings (GWh)					
Achievable Potential	21	118	331	569	737
Economic Potential	90	454	849	1,120	1,271
Technical Potential	176	799	1,403	1,704	1,840
Cumulative Savings as a % of Baseline					
Achievable Potential	0.4%	2.2%	5.7%	9.3%	11.3%
Economic Potential	1.7%	8.3%	14.7%	18.3%	19.5%
Technical Potential	3.3%	14.6%	24.3%	27.8%	28.3%

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

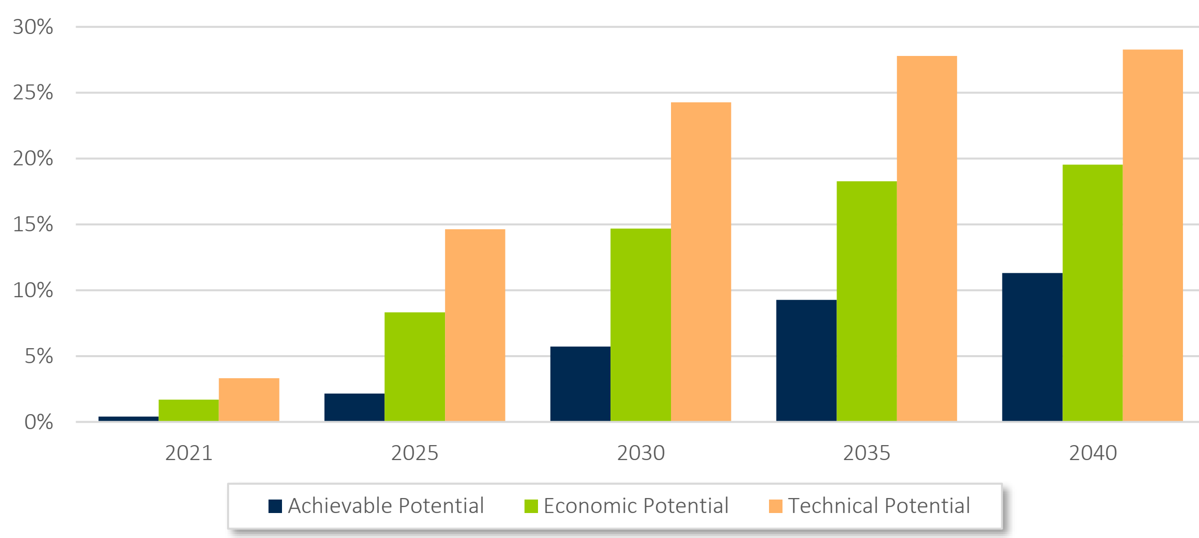
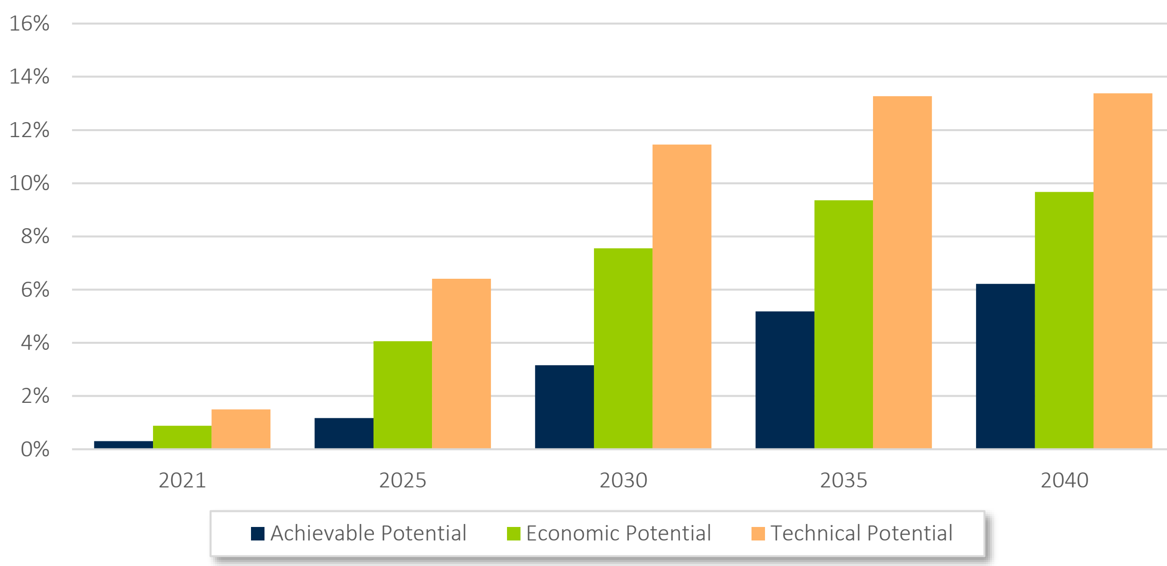


Table 5-5 and Figure 5-8 show residential EE potential in terms of summer peak savings. In the first year, 2021, achievable summer peak savings are 4 MW, or 0.3% of the baseline summer peak projection. By 2040, cumulative achievable savings are 103 MW, or 6.2% of the baseline summer peak projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	1,318	1,377	1,460	1,552	1,656
Cumulative Savings (MW)					
Achievable Potential	4	16	46	80	103
Economic Potential	12	56	110	145	160
Technical Potential	20	88	167	206	221
Cumulative Savings as a % of Baseline					
Achievable Potential	0.3%	1.2%	3.2%	5.2%	6.2%
Economic Potential	0.9%	4.1%	7.5%	9.4%	9.7%
Technical Potential	1.5%	6.4%	11.4%	13.3%	13.4%

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



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 2021. The top measures are behavioral programs, followed by water heating conservation measures and lighting.

Table 5-6 Residential Top Measures in 2021 (Energy, MWh)

Rank	Residential Measure	Cumulative Energy Savings (MWh)	% of Total
1	Behavioral Programs	9,344	44.2%
2	Water Heater - Thermostatic Shower Restriction Valve	2,050	9.7%
3	General Service Screw-in	1,849	8.7%
4	Water Heater (<= 55 Gal)	1,642	7.8%
5	Water Heater - Faucet Aerators	1,289	6.1%
6	Insulation - Wall Cavity Installation	1,119	5.3%
7	Linear Lighting	939	4.4%
8	MH LI - HVAC and Wx	546	2.6%
9	SF LI - HVAC and Wx	353	1.7%
10	Water Heater (> 55 Gal)	318	1.5%
11	Insulation - Ceiling Installation	239	1.1%
12	Exempted Lighting	209	1.0%
13	Dishwasher	207	1.0%
14	Screw-in	183	0.9%
15	Pool Pump	168	0.8%
16	TVs	140	0.7%
17	Monitor	137	0.6%
18	SF LI - Wx Only	85	0.4%
19	Room AC	81	0.4%
20	MH LI - Wx Only	58	0.3%
	Subtotal	**20,956**	**99.1%**

Figure 5-9 presents forecasts of 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, 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)

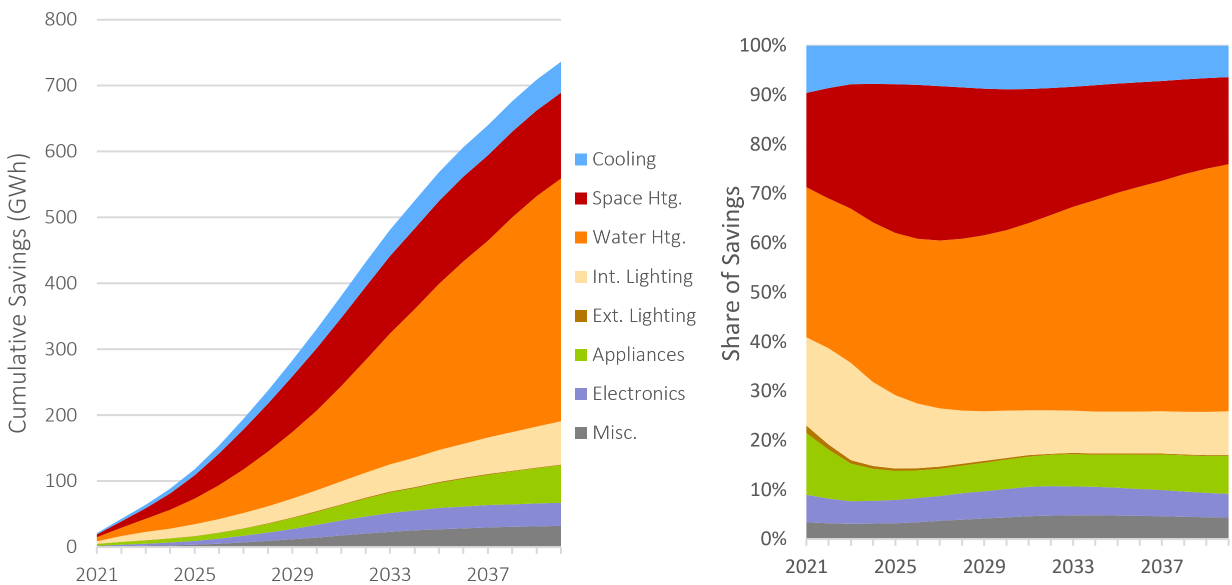
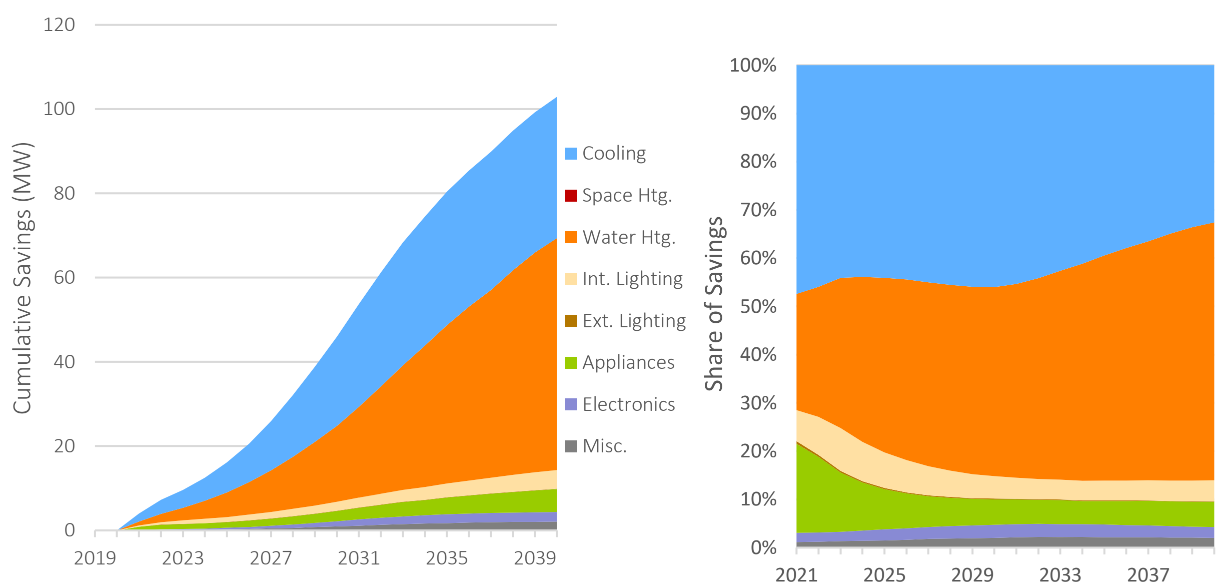


Table 5-7 identifies the top 20 residential measures from the perspective of summer peak savings in 2021. The top measure is behavioral programs, accounting for 64.4% of cumulative peak achievable savings. Water heating conservation measures account for approximately 20% of the achievable savings. Figure 5-10 presents forecasts of summer peak savings by end use as a percent of total savings per year and cumulative savings. 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 2021 (Summer Peak Demand, MW)

Rank	Residential Measure	2021 Cumulative Summer Peak Savings (MW)	% of Total
1	Behavioral Programs	2.6	64.4%
2	Water Heater - Thermostatic Shower Restriction Valve	0.3	7.6%
3	Water Heater (<= 55 Gal)	0.2	6.1%
4	Water Heater - Faucet Aerators	0.2	4.8%
5	MH LI - HVAC and Wx	0.2	3.9%
6	General Service Screw-in	0.1	3.1%
7	SF LI - HVAC and Wx	0.1	2.8%
8	Linear Lighting	0.1	1.6%
9	Water Heater (> 55 Gal)	0.0	1.2%
10	SF LI - Wx Only	0.0	0.7%
11	Insulation - Ceiling Installation	0.0	0.6%
12	Dishwasher	0.0	0.4%
13	Insulation - Wall Cavity Installation	0.0	0.4%
14	MH LI - Wx Only	0.0	0.4%
15	Exempted Lighting	0.0	0.4%
16	Screw-in	0.0	0.3%
17	Pool Pump	0.0	0.3%
18	TVs	0.0	0.2%
19	Monitor	0.0	0.2%
20	Room AC	0.0	0.2%
	Subtotal	**4.0**	**99.6%**

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 2021, achievable potential is 53 GWh, or 1.4% of the baseline projection. By 2040, savings are 1,153 GWh, or 23.5% of the baseline projection. By the end of the forecast horizon, achievable potential represents about 81% of economic potential.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,720	3,885	4,183	4,528	4,911
Cumulative Savings (GWh)					
Achievable Potential	53	306	647	968	1,153
Economic Potential	100	473	878	1,235	1,429
Technical Potential	140	641	1,128	1,517	1,734
Cumulative Savings as a % of Baseline					
Achievable Potential	1.4%	7.9%	15.5%	21.4%	23.5%
Economic Potential	2.7%	12.2%	21.0%	27.3%	29.1%
Technical Potential	3.8%	16.5%	27.0%	33.5%	35.3%

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

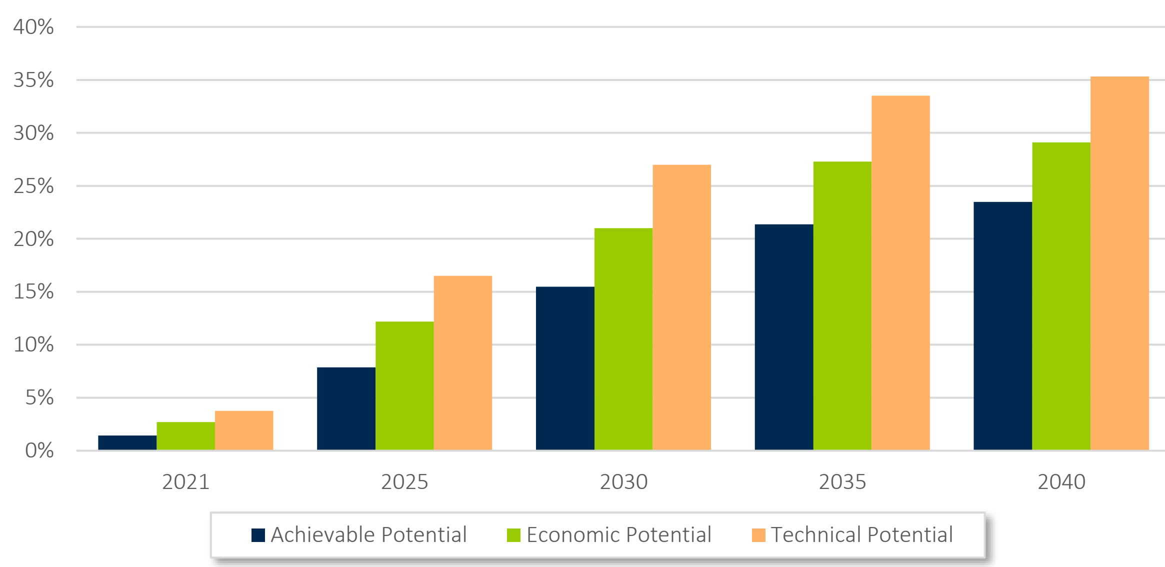


Table 5-9 and Figure 5-12 present savings estimates from the perspective of summer peak demand. In 2021, achievable potential is 6 MW, or 0.8% of the baseline summer peak projection. By 2040, savings are 157 MW, or 17.5% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	732	755	795	844	899
Cumulative Savings (MW)					
Achievable Potential	6	37	84	128	157
Economic Potential	15	71	131	181	209
Technical Potential	25	115	195	252	282
Cumulative Savings as a % of Baseline					
Achievable Potential	0.8%	4.9%	10.5%	15.2%	17.5%
Economic Potential	2.0%	9.4%	16.5%	21.5%	23.2%
Technical Potential	3.4%	15.2%	24.6%	29.9%	31.4%

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

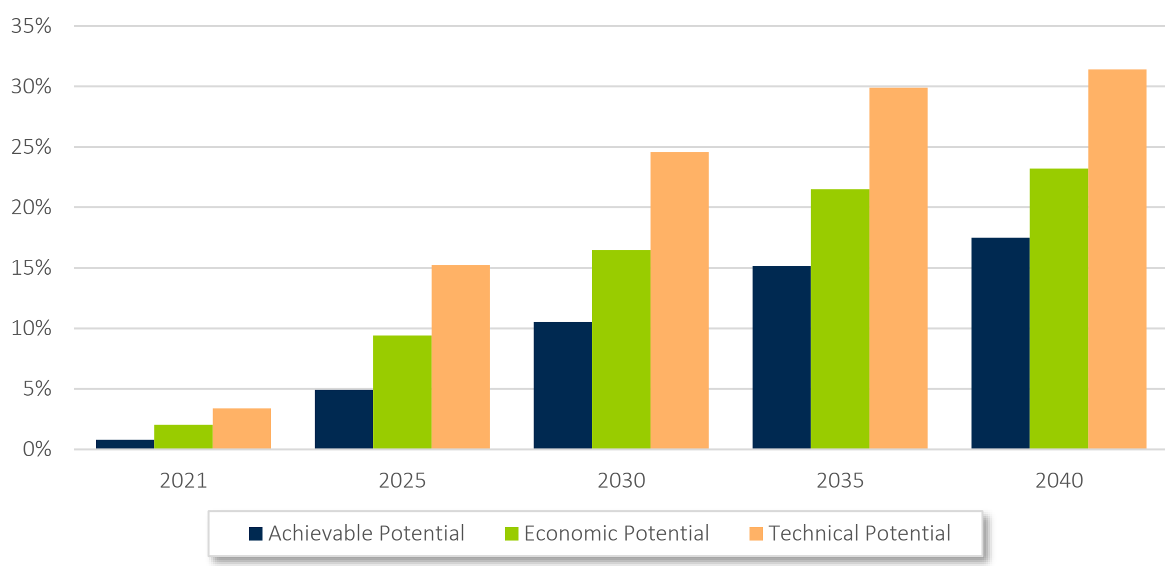


Table 5-10 identifies the top 20 commercial-sector measures from the perspective of energy savings in 2021. The top measures are interior LED replacements for high-bay, area, and linear-fluorescent-style lighting applications. Lighting dominates the top 5 measures, followed by strategic energy management and retrocommissioning.

Table 5-10 Commercial Top Measures in 2021 (Energy, MWh)

Rank	Commercial Measure	2021 Cumulative Energy Savings (MWh)	% of Total
1	Linear Lighting	16,491	31.2%
2	High-Bay Lighting	13,611	25.7%
3	Area Lighting	7,602	14.4%
4	Strategic Energy Management	2,190	4.1%
5	Retrocommissioning	2,130	4.0%
6	General Service Lighting	1,700	3.2%
7	Refrigeration - Evaporative Condenser	1,033	2.0%
8	Refrigeration - Replace Single-Compressor with Subcooled Multiplex	946	1.8%
9	Ventilation	857	1.6%
10	Interior Fluorescent - Delamp and Install Reflectors	839	1.6%
11	Exterior Lighting - Bi-Level Parking Garage Fixture	631	1.2%
12	Desktop Computer	513	1.0%
13	Refrigeration - Evaporator Fan Controls	432	0.8%
14	Refrigeration - ECM Compressor Head Fan Motor	425	0.8%
15	RTU	315	0.6%
16	Vending Machine - Occupancy Sensor	308	0.6%
17	Refrigeration - Demand Defrost	281	0.5%
18	Grocery - Display Case - LED Lighting	223	0.4%
19	Server	206	0.4%
20	Interior Fluorescent - Bi-Level Stairwell Fixture	190	0.4%
	Subtotal	**50,923**	**96.3%**

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

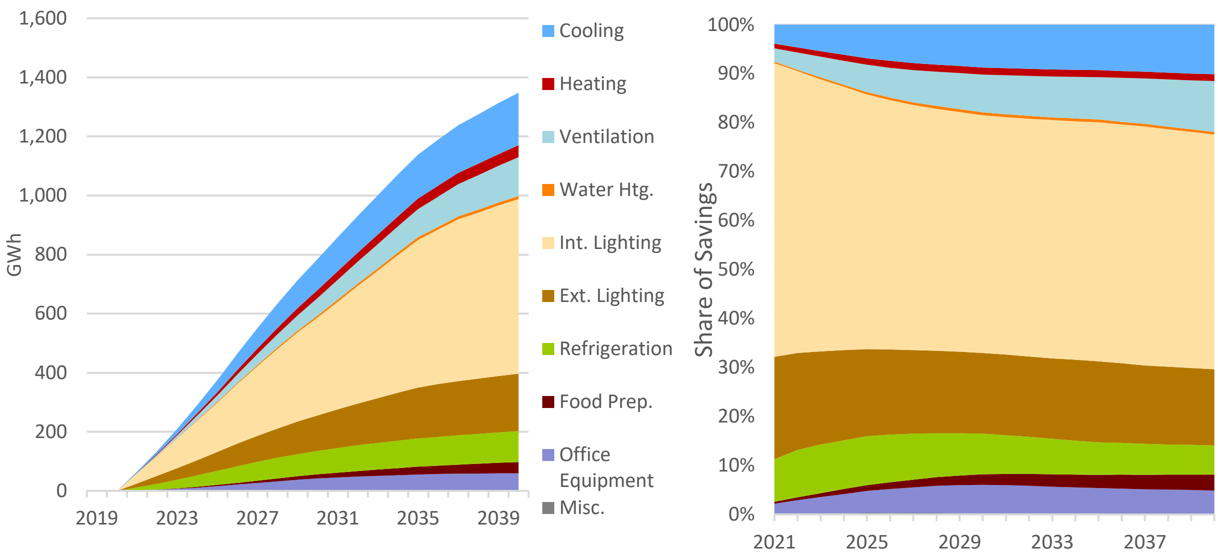


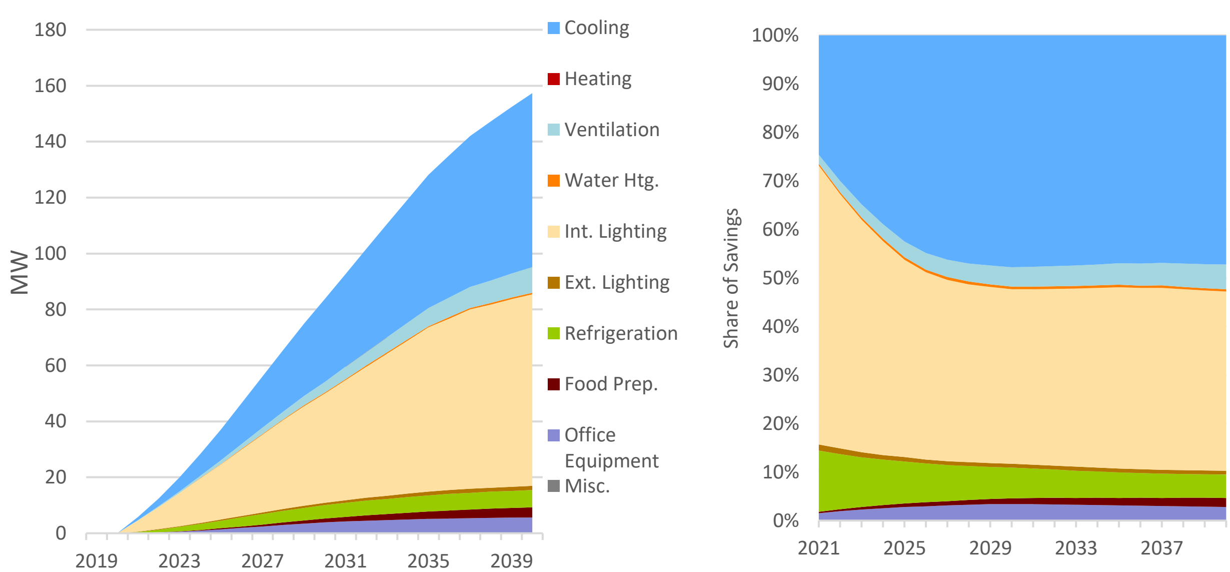
Table 5-11 identifies the top 20 commercial-sector measures from the perspective of summer peak savings in 2021. The top two measures are linear LED lighting and High-Bay LED lighting, each with cumulative peak savings of 1.8 MW in 2021. This is because commercial lighting use is coincident with the system peak hour. The top 20 measures account for nearly all of total summer peak savings in 2021.

Table 5-11 Commercial Top Measures in 2021 (Summer Peak Demand, MW)

Rank	Commercial Measure	2021 Cumulative Summer Peak Savings (MW)	% of Total
1	Linear Lighting	1.8	30.4%
2	High-Bay Lighting	1.8	30.4%
3	Area Lighting	0.5	8.1%
4	Strategic Energy Management	0.5	8.0%
5	Retrocommissioning	0.2	3.2%
6	General Service Lighting	0.1	2.1%
7	Refrigeration - Evaporative Condenser	0.1	1.7%
8	Refrigeration - Replace Single-Compressor with Subcooled Multiplex	0.1	1.7%
9	Ventilation	0.1	1.6%
10	Interior Fluorescent - Delamp and Install Reflectors	0.1	1.5%
11	Exterior Lighting - Bi-Level Parking Garage Fixture	0.1	1.1%
12	Desktop Computer	0.1	1.1%
13	Refrigeration - Evaporator Fan Controls	0.1	1.1%
14	Refrigeration - ECM Compressor Head Fan Motor	0.1	0.9%
15	RTU	0.0	0.8%
16	Vending Machine - Occupancy Sensor	0.0	0.7%
17	Refrigeration - Demand Defrost	0.0	0.7%
18	Grocery - Display Case - LED Lighting	0.0	0.5%
19	Server	0.0	0.4%
20	Interior Fluorescent - Bi-Level Stairwell Fixture	0.0	0.4%
	Subtotal	**5.6**	**96.4%**

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, 2021, are 50 GWh, or 1.3% of the baseline projection. In 2040, savings reach 572 GWh, or 13.0% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,863	3,980	4,133	4,270	4,390
Cumulative Savings (GWh)					
Achievable Potential	50	243	431	534	572
Economic Potential	88	371	605	724	760
Technical Potential	103	415	662	789	833
Cumulative Savings as a % of Baseline					
Achievable Potential	1.3%	6.1%	10.4%	12.5%	13.0%
Economic Potential	2.3%	9.3%	14.6%	17.0%	17.3%
Technical Potential	2.7%	10.4%	16.0%	18.5%	19.0%

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

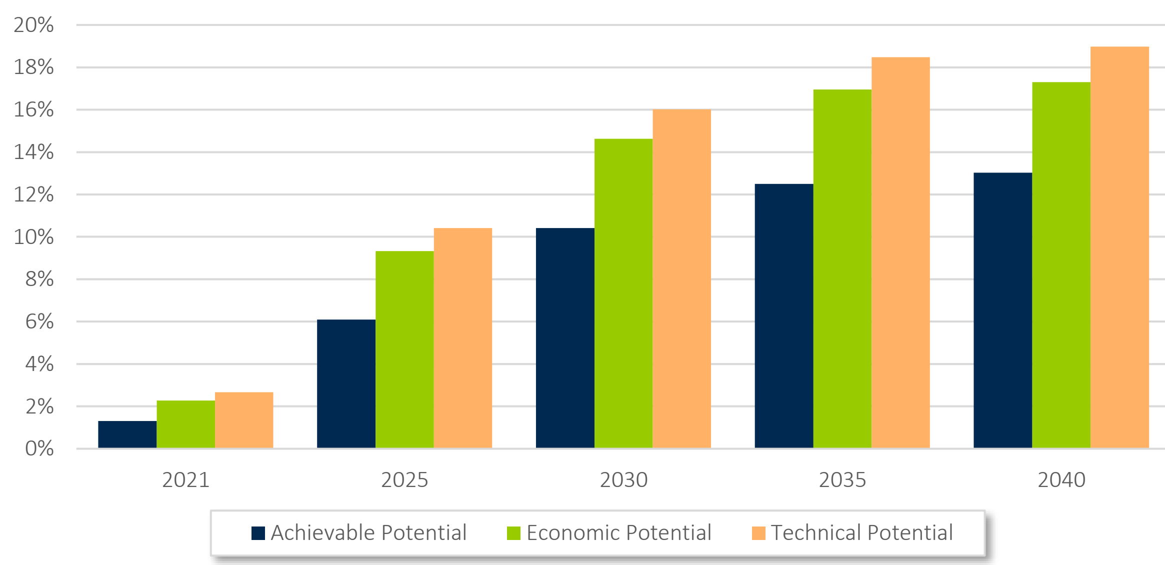


Table 5-13 and Figure 5-16 present potential estimates from the perspective of summer peak savings. In 2021, the first year of the potential forecast, achievable savings are 3 MW, or 1.0% of the baseline projection. By 2040, savings have increased to 47 MW, or 12.9% of the baseline summer peak projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	335	341	349	356	363
Cumulative Savings (MW)					
Achievable Potential	3	18	33	42	47
Economic Potential	7	31	50	61	66
Technical Potential	9	36	58	70	76
Cumulative Savings as a % of Baseline					
Achievable Potential	1.0%	5.2%	9.4%	11.8%	12.9%
Economic Potential	2.2%	9.1%	14.5%	17.2%	18.2%
Technical Potential	2.7%	10.7%	16.7%	19.7%	20.9%

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

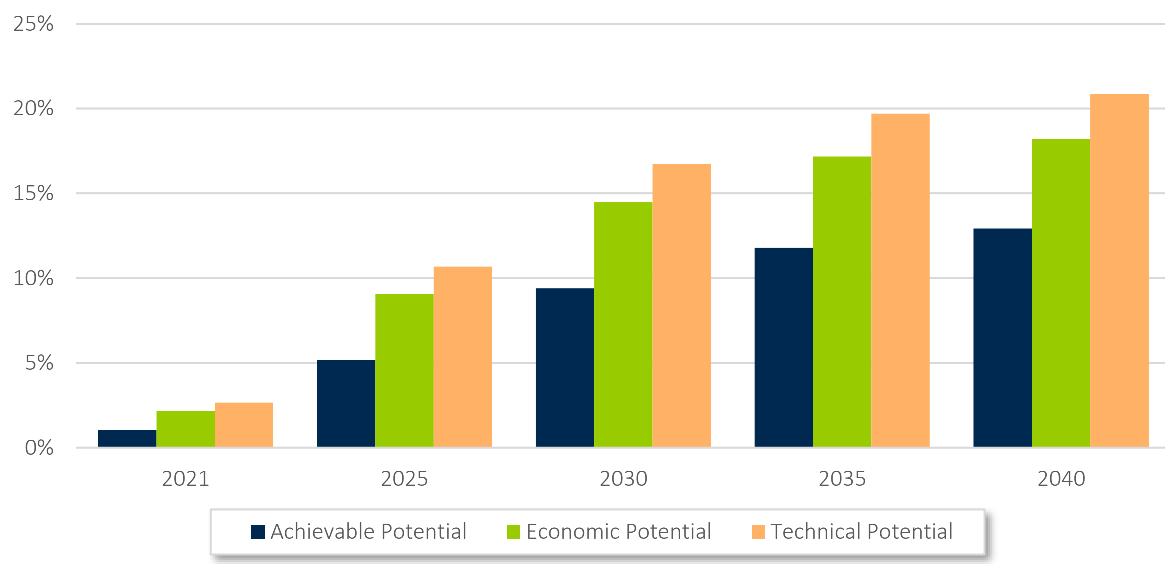


Table 5-14 identifies the top 20 industrial measures from the perspective of energy savings in 2021. The top measure is strategic energy management, followed by refrigeration optimization and variable speed drives on material handling systems.

Table 5-14 Industrial Top Measures in 2021 (Energy, MWh)

Rank	Industrial Measure	2021 Cumulative Energy Savings (MWh)	% of Total
1	Strategic Energy Management	7,357	14.6%
2	Refrigeration - System Optimization	4,423	8.8%
3	Material Handling - Variable Speed Drive	3,305	6.5%
4	High-Bay Lighting	2,778	5.5%
5	Refrigeration - Floating Head Pressure	2,751	5.4%
6	Fan System - Variable Speed Drive	2,580	5.1%
7	Compressed Air - Raise Compressed Air Dryer Dewpoint	2,421	4.8%
8	Pumping System - System Optimization	2,120	4.2%
9	Switch from Belt Drive to Direct Drive	2,052	4.1%
10	Pumping System - Variable Speed Drive	2,030	4.0%
11	Fan System - Flow Optimization	1,898	3.8%
12	Retrocommissioning	1,873	3.7%
13	Compressed Air - End Use Optimization	1,689	3.3%
14	Compressed Air - Equipment Upgrade	1,674	3.3%
15	Compressed Air - Leak Management Program	1,652	3.3%
16	Fan System - Equipment Upgrade	1,610	3.2%
17	Municipal Water Supply Treatment - Optimization	1,414	2.8%
18	Motors - Synchronous Belts	843	1.7%
19	Pumping System - Equipment Upgrade	815	1.6%
20	Area Lighting	741	1.5%
	Subtotal	**46,026**	**91.1%**

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 (Cumualtive Energy)

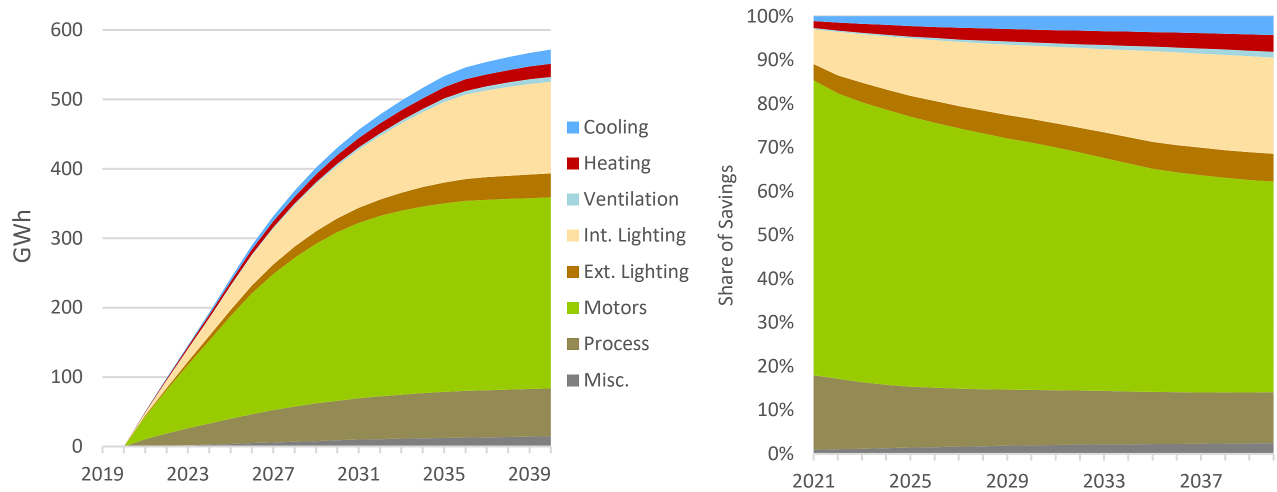


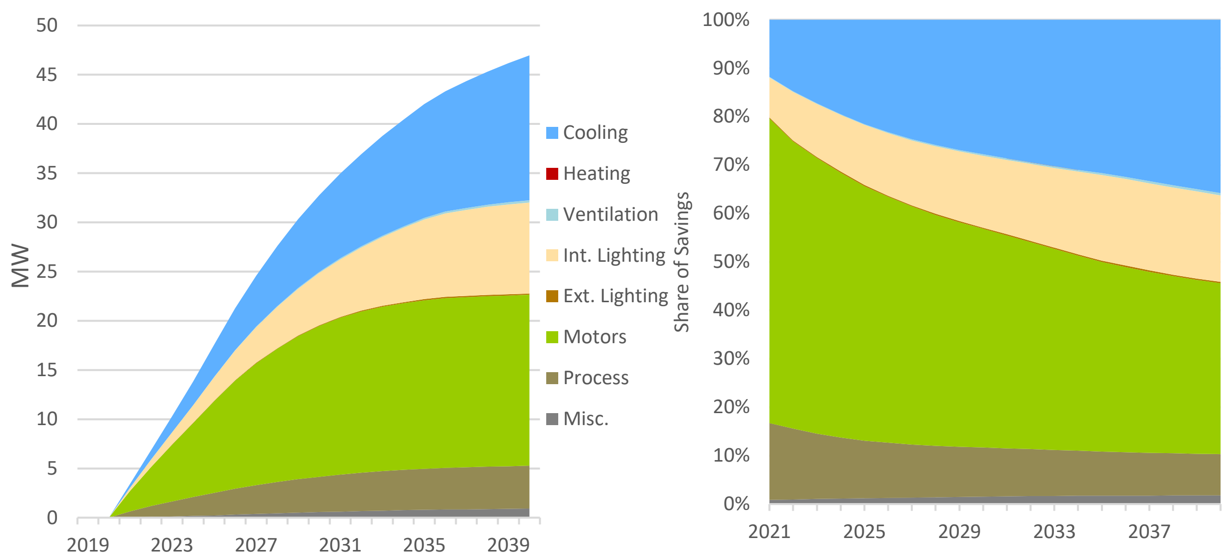
Table 5-15 identifies the top 20 industrial measures from the perspective of summer peak savings in 2021. The top measure, strategic energy management, accounts for 18.6% of the cumulative peak savings in 2021. Similar to the energy top-saving measures, motor optimization measures also provide significant summer peak demand savings.

Table 5-15 Industrial Top Measures in 2023 (Summer Peak Demand, MW)

Rank	Industrial Measure	2023 Cumulative Energy Savings (MW)	% of Total
1	Strategic Energy Management	0.6	18.6%
2	Refrigeration - System Optimization	0.3	8.1%
3	Material Handling - Variable Speed Drive	0.2	6.1%
4	High-Bay Lighting	0.2	5.6%
5	Refrigeration - Floating Head Pressure	0.2	5.0%
6	Fan System - Variable Speed Drive	0.2	4.7%
7	Compressed Air - Raise Compressed Air Dryer Dewpoint	0.2	4.4%
8	Pumping System - System Optimization	0.1	3.9%
9	Switch from Belt Drive to Direct Drive	0.1	3.8%
10	Pumping System - Variable Speed Drive	0.1	3.7%
11	Fan System - Flow Optimization	0.1	3.5%
12	Retrocommissioning	0.1	3.4%
13	Compressed Air - End Use Optimization	0.1	3.1%
14	Compressed Air - Equipment Upgrade	0.1	3.1%
15	Compressed Air - Leak Management Program	0.1	3.0%
16	Fan System - Equipment Upgrade	0.1	3.0%
17	Municipal Water Supply Treatment - Optimization	0.1	2.6%
18	Motors - Synchronous Belts	0.1	2.3%
19	Pumping System - Equipment Upgrade	0.1	1.5%
20	Area Lighting	0.1	1.5%
	Subtotal	**3.1**	**90.9%**

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



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, 2021, are 10 GWh, or 0.6% of the baseline projection. In 2040, savings reach 164 GWh, or 7.6% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	1,790	1,858	1,950	2,048	2,152
Cumulative Savings (GWh)					
Achievable Potential	10	60	123	153	164
Economic Potential	13	75	156	196	209
Technical Potential	15	92	192	247	273
Cumulative Savings as a % of Baseline					
Achievable Potential	0.6%	3.2%	6.3%	7.5%	7.6%
Economic Potential	0.7%	4.1%	8.0%	9.6%	9.7%
Technical Potential	0.9%	4.9%	9.8%	12.1%	12.7%

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

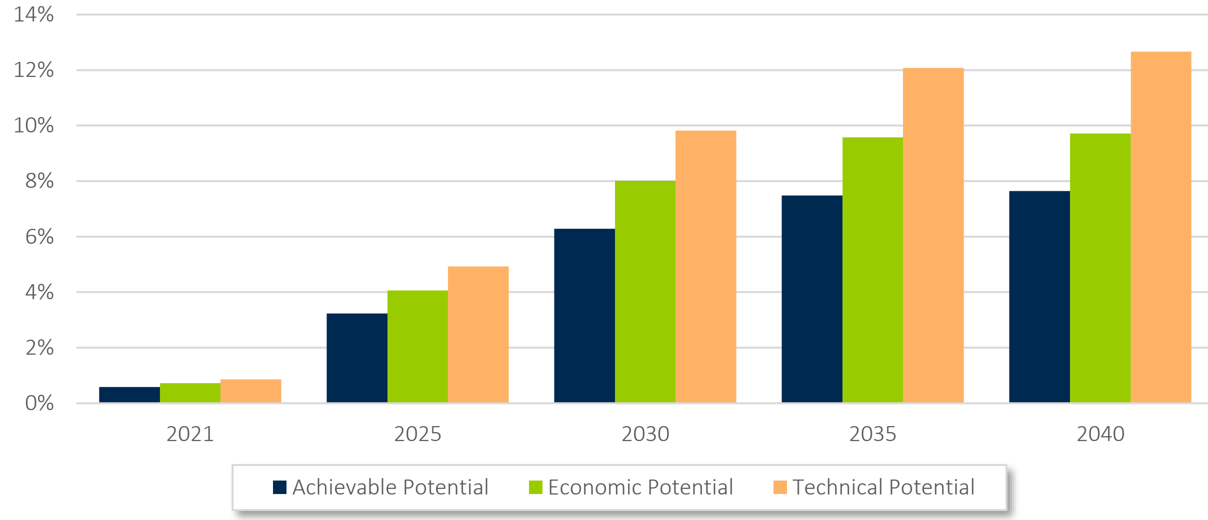


Table 5-17 and Figure 5-20 present potential estimates from the perspective of summer peak savings. In 2021, the first year of the potential forecast, achievable savings are 4 MW, 0.2% of the baseline projection. By 2040, cumulative peak savings have increased to 69 MW, or 3.2% of the baseline summer peak projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	752	780	819	860	904
Cumulative Savings (MW)					
Achievable Potential	4	25	51	64	69
Economic Potential	5	32	66	82	88
Technical Potential	7	38	80	104	115
Cumulative Savings as a % of Baseline					
Achievable Potential	0.2%	1.4%	2.6%	3.1%	3.2%
Economic Potential	0.3%	1.7%	3.4%	4.0%	4.1%
Technical Potential	0.4%	2.1%	4.1%	5.1%	5.3%

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

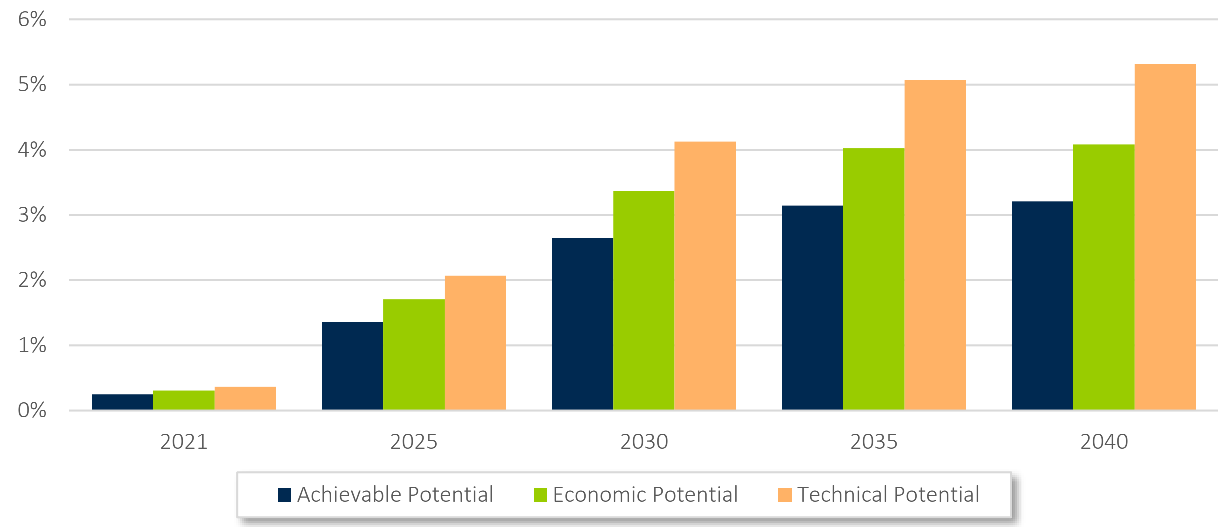


Table 5-18 identifies the top irrigation measures from the perspective of energy savings in 2021. The top measure is variable frequency drives for motors, which accounts for 35% cumulative savings by 2021. The next two measures in ranking are a pump replacements and lower energy spray application center pivot system.

Table 5-18 Irrigation Top Measures in 2021 (Energy, MWh)

Rank	Irrigation Measure	2021 Cumulative Energy Savings (MWh)	% of Total
1	Motors - Variable Frequency Drive	3,682	35.1%
2	CS to CS Pump Replacement	2,766	26.4%
3	Center Pivot/Linear - Medium P to Low P	1,172	11.2%
4	Center Pivot/Linear - High P to Medium P	780	7.4%
5	Wheel/Hand - Pipe Maintenance	412	3.9%
6	Center Pivot/Linear - Boot Gasket Replacement	355	3.4%
7	VS to VS Pump Replacement	269	2.6%
8	Wheel/Hand - Nozzle Replacement	229	2.2%
9	Center Pivot/Linear - Upgrade High P to MESA	211	2.0%
10	Green Motor Rewind - Surface and Tailwater Pump	155	1.5%
	Total	**10,031**	**95.7%**

Table 5-19 identifies the top irrigation measures from the perspective of summer peak savings in 2021. 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 2021 (Summer Peak Demand, MW)

Rank	Irrigation Measure	2021 Cumulative Energy Savings (MW)	% of Total
1	Motors - Variable Frequency Drive	1.5	35.1%
2	CS to CS Pump Replacement	1.2	26.4%
3	Center Pivot/Linear - Medium P to Low P	0.5	11.2%
4	Center Pivot/Linear - High P to Medium P	0.3	7.4%
5	Wheel/Hand - Pipe Maintenance	0.2	3.9%
6	Center Pivot/Linear - Boot Gasket Replacement	0.1	3.4%
7	VS to VS Pump Replacement	0.1	2.6%
8	Wheel/Hand - Nozzle Replacement	0.1	2.2%
9	Center Pivot/Linear - Upgrade High P to MESA	0.1	2.0%
10	Green Motor Rewind - Surface and Tailwater Pump	0.1	1.5%
	Total	**4.2**	**95.7%**

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.

Overall Summary of Technical Achievable EE Potential

Summary of Cumulative Energy Savings

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

- Technical potential reflects the adoption of all EE measures regardless of cost-effectiveness. First-year savings are 435 GWh, or 3.0% of the baseline projection. Cumulative technical savings in 2040 are 4,679 GWh, or 26.1% 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 2021 are 170 GWh, or 1.2% of the baseline projection. By 2040, cumulative technical achievable savings reach 3,433 GWh, or 19.1% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	14,677	15,189	16,045	16,977	17,961
Cumulative Savings (GWh)					
Technical Achievable Potential	170	964	2,089	2,939	3,433
Technical Potential	435	1,947	3,385	4,258	4,679
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.2%	6.3%	13.0%	17.3%	19.1%
Technical Potential	3.0%	12.8%	21.1%	25.1%	26.1%

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

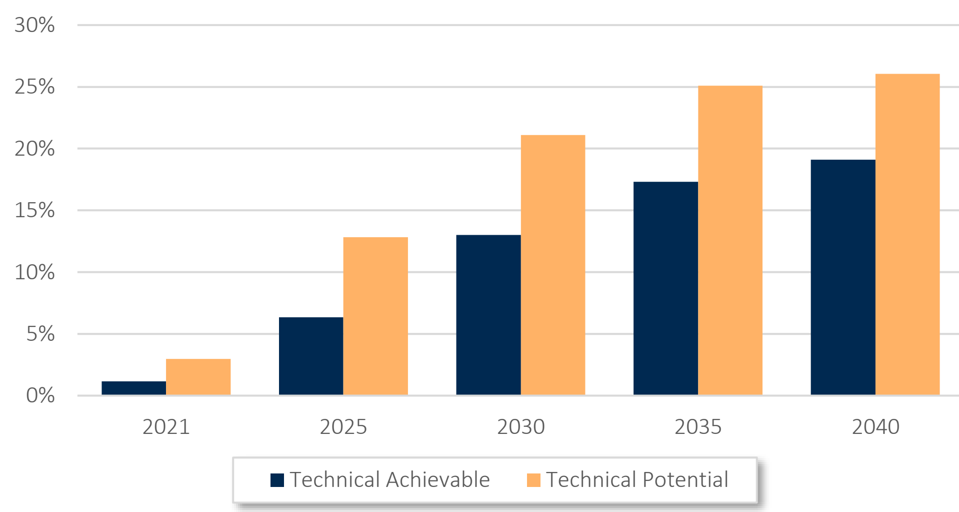
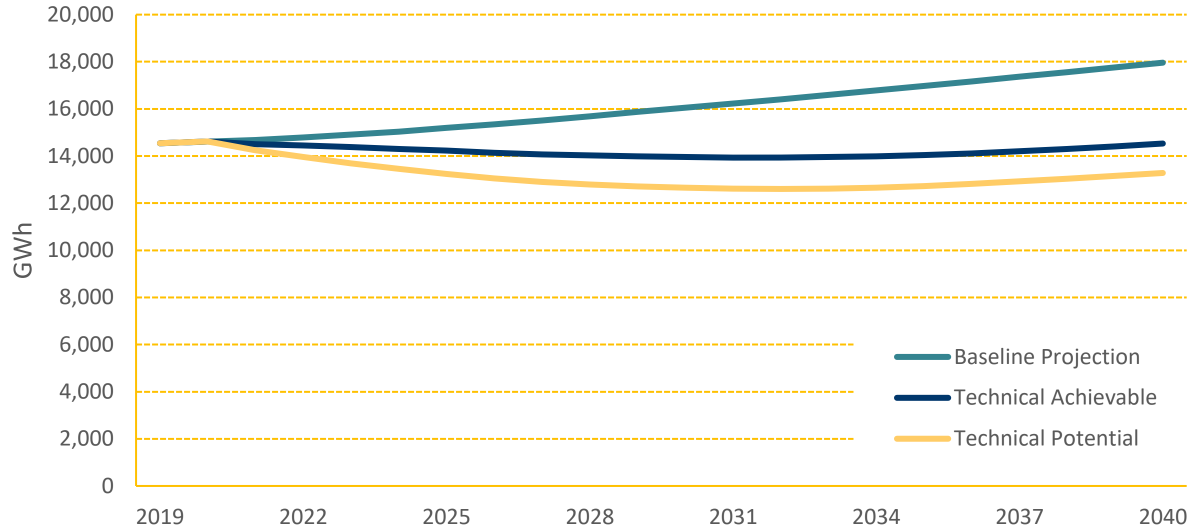


Figure A-2 Baseline Projection and EE Forecast Summary (Annual Energy (GWh)



Summary of Summer Peak Demand Savings

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

- Technical potential for summer peak demand savings is 60 MW in 2021, or 1.9% of the baseline projection. This increases to 694 MW by 2040, or 18.2% of the summer peak demand baseline projection.
- Technical achievable potential is estimated at 21 MW or a 0.7% reduction in the 2021 summer peak demand baseline projection. In 2040, savings are 481 MW or 12.6% of the summer peak baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	3,137	3,253	3,422	3,613	3,822
Cumulative Savings (MW)					
Technical Achievable Potential	21	126	286	407	481
Technical Potential	60	278	501	632	694
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	0.7%	3.9%	8.4%	11.3%	12.6%
Technical Potential	1.9%	8.5%	14.6%	17.5%	18.2%

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

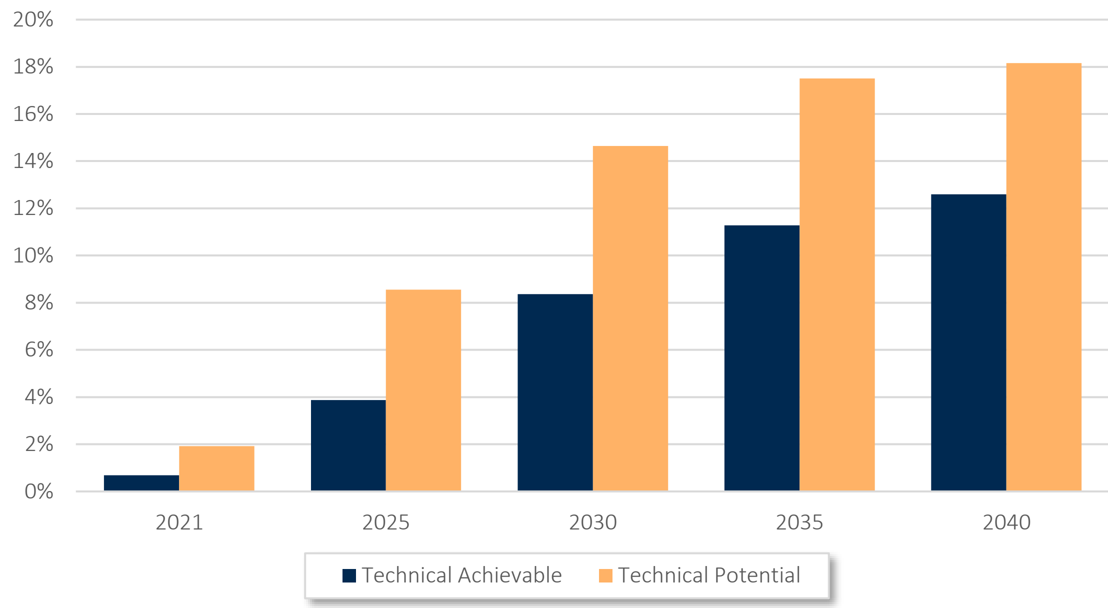
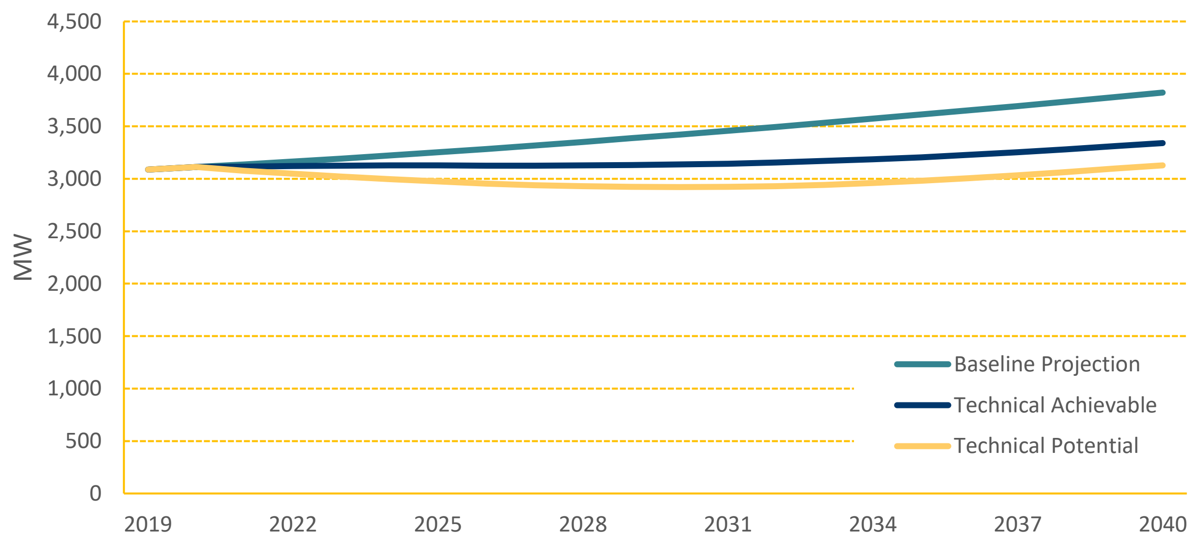


Figure A-4 Summary Peak Baseline Projection and EE Forecast Summary



Summary of Energy Efficiency by Sector

Table A-3, Figure A-5, and Figure A-6 summarize the range of electric achievable potential summer peak savings by sector. The industrial sector contributes the most savings throughout the forecast, followed by the commercial sector.

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

	2021	2025	2030	2035	2040
Cumulative Energy Savings (GWh)					
Residential	35	256	706	1,056	1,278
Commercial	65	376	785	1,139	1,348
Industrial	58	263	456	561	603
Irrigation	12	69	142	183	204
Total	**170**	**964**	**2,089**	**2,939**	**3,433**
Cumulative Summer Peak Demand Savings (MW)					
Residential	5	27	76	118	146
Commercial	7	51	114	166	198
Industrial	4	19	36	46	52
Irrigation	5	29	60	77	85
Total	**21**	**126**	**286**	**407**	**481**

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

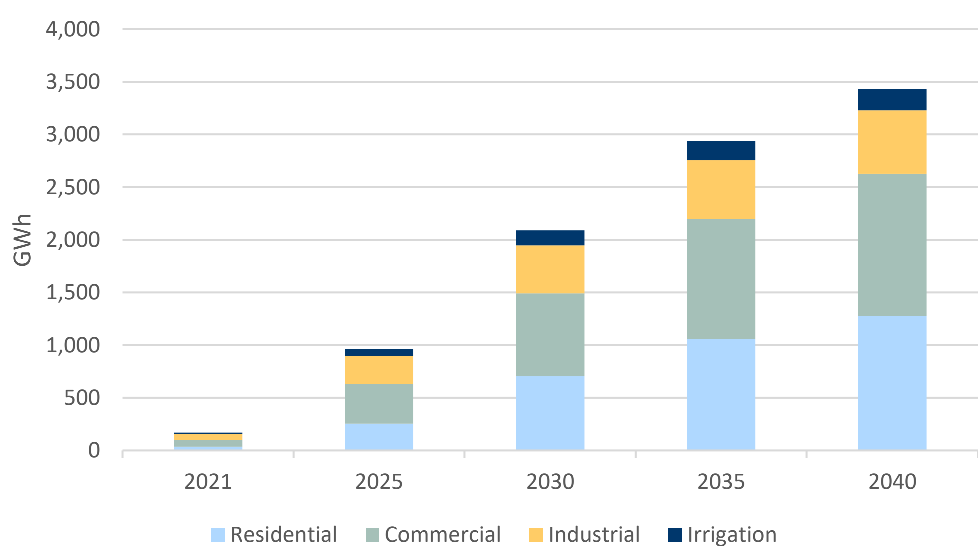
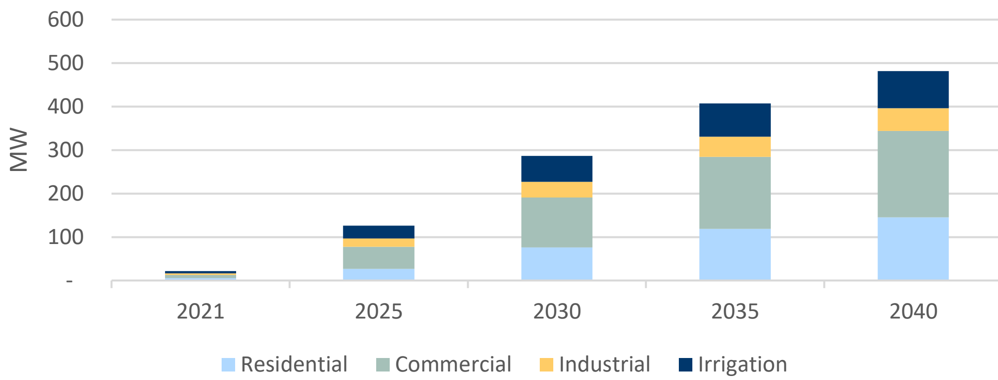


Figure A-6 Achievable EE Potential by Sector (Summer Peak Demand, MW)



Residential EE Potential

Table A-4 and Figure A-7 present estimates for measure-level EE potential for the residential sector in terms of cumulativel energy savings. Technical achievable potential in the first year, 2021, is 35 GWh, or 0.7% of the baseline projection. By 2040, cumulative achievable savings are 1,278 GWh, or 19.6% of the baseline projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	5,304	5,466	5,779	6,130	6,507
Cumulative Savings (GWh)					
Technical Achievable Potential	35	256	706	1,056	1,278
Technical Potential	176	799	1,403	1,704	1,840
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	0.7%	4.7%	12.2%	17.2%	19.6%
Technical Potential	3.3%	14.6%	24.3%	27.8%	28.3%

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

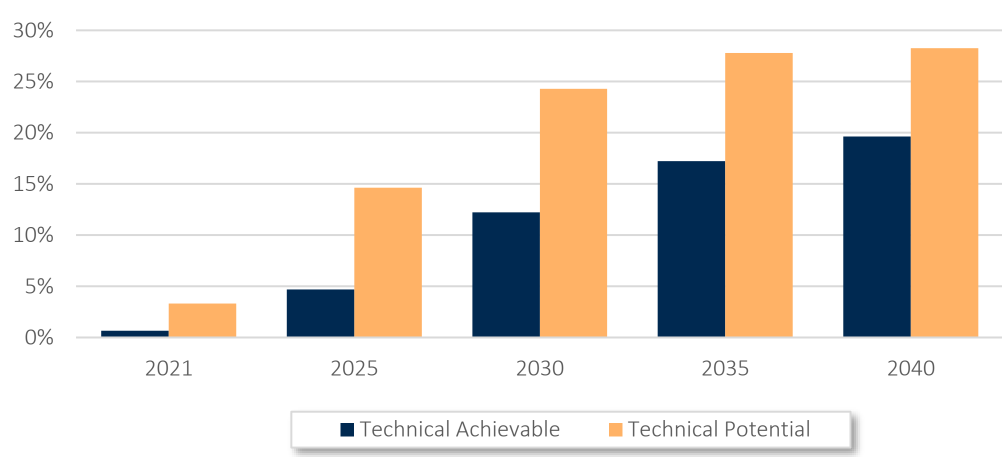


Table A-5 and

Figure A-8 show residential EE potential in terms of summer peak savings. In the first year, 2021, achievable summer peak savings are 5 MW, or 0.4% of the baseline summer peak projection. By 2040, cumulative achievable savings are 146 MW, or 8.8% of the baseline summer peak projection.

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

	2021	2025	2030	2035	2040
Baseline Projection (MW)	1,318	1,377	1,460	1,552	1,656
Cumulative Savings (MW)					
Technical Achievable Potential	5	27	76	118	146
Technical Potential	20	88	167	206	221
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	0.4%	1.9%	5.2%	7.6%	8.8%
Technical Potential	1.5%	6.4%	11.4%	13.3%	13.4%

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

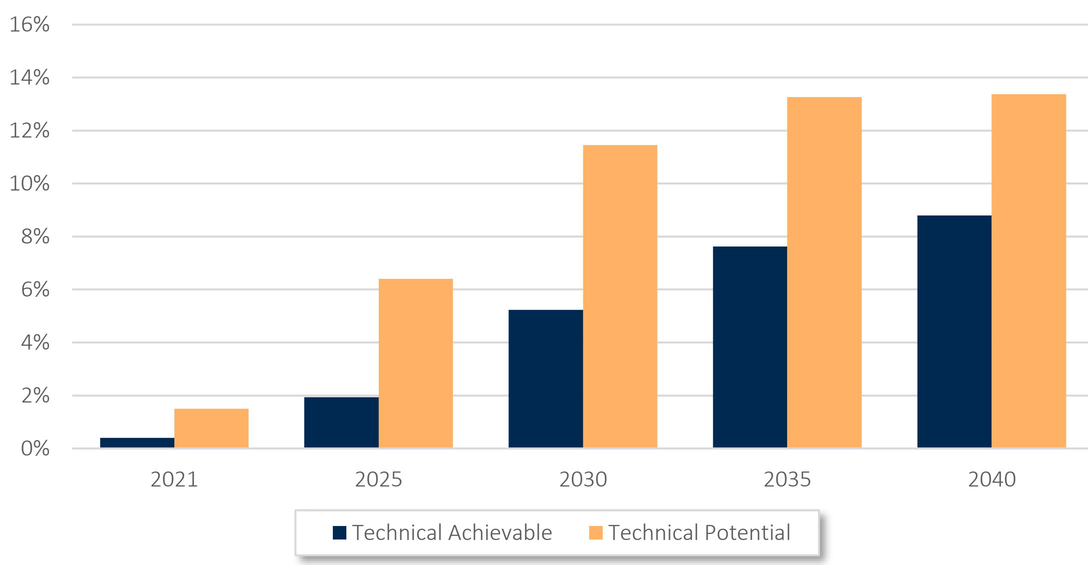


Figure A-9 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Lighting savings account for a substantial portion of the savings throughout the forecast horizon, but the share declines over time as the market is transformed. The same is true for exterior lighting. Water heater savings contribute a large portion, 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 A-9 Residential Achievable Savings Forecast (Energy, GWh)

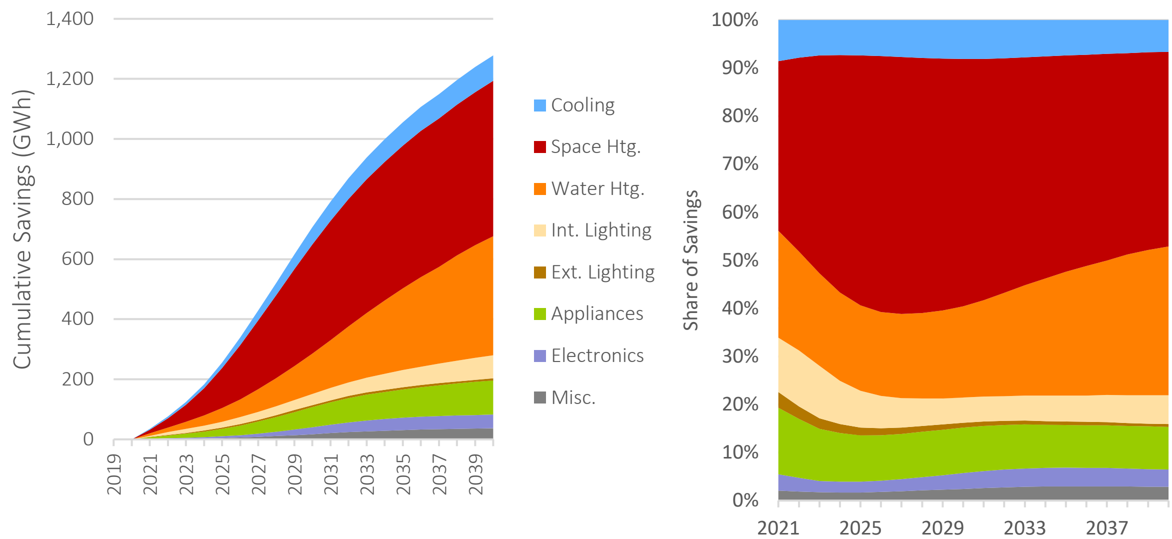
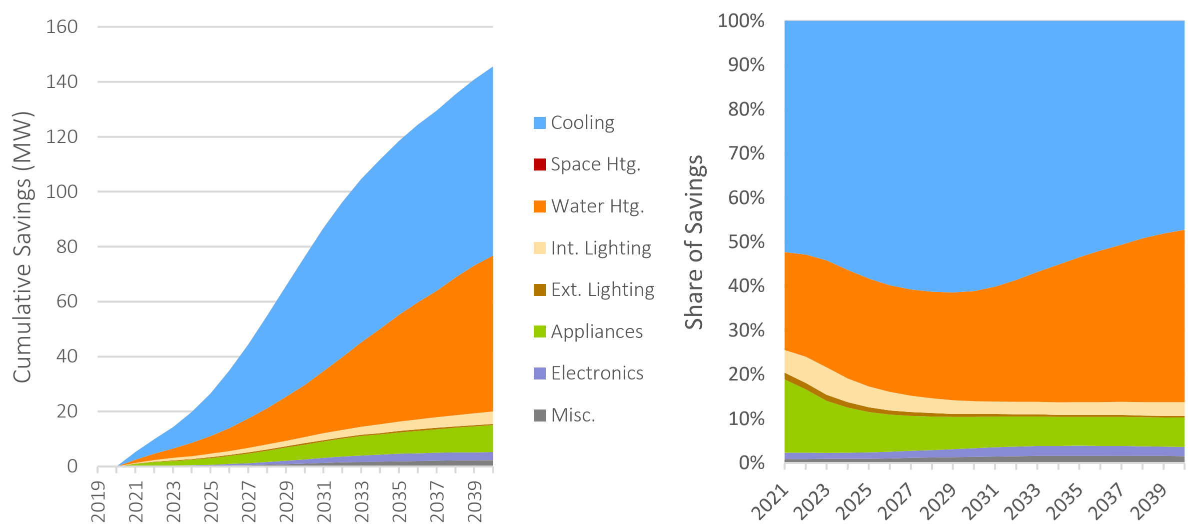


Figure A-10 Residential Achievable Savings Forecast (Summer Peak, MW)



Commercial EE Potential

Table A-6 and Figure A-11 present estimates for the three levels of EE potential for the commercial sector from the perspective of cumulative energy savings. In 2021, the first year of the projection, achievable potential is 65 GWh, or 1.7% of the baseline projection. By 2040, savings are 1,348 GWh, or 27.5% of the baseline projection.

Table A-6 Commercial EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,720	3,885	4,183	4,528	4,911
Cumulative Savings (GWh)					
Technical Achievable Potential	65	376	785	1,139	1,348
Technical Potential	140	641	1,128	1,517	1,734
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.7%	9.7%	18.8%	25.2%	27.5%
Technical Potential	3.8%	16.5%	27.0%	33.5%	35.3%

Figure A-11 Commercial Cumulative EE Savings as a % of the Baseline Projection (Energy)

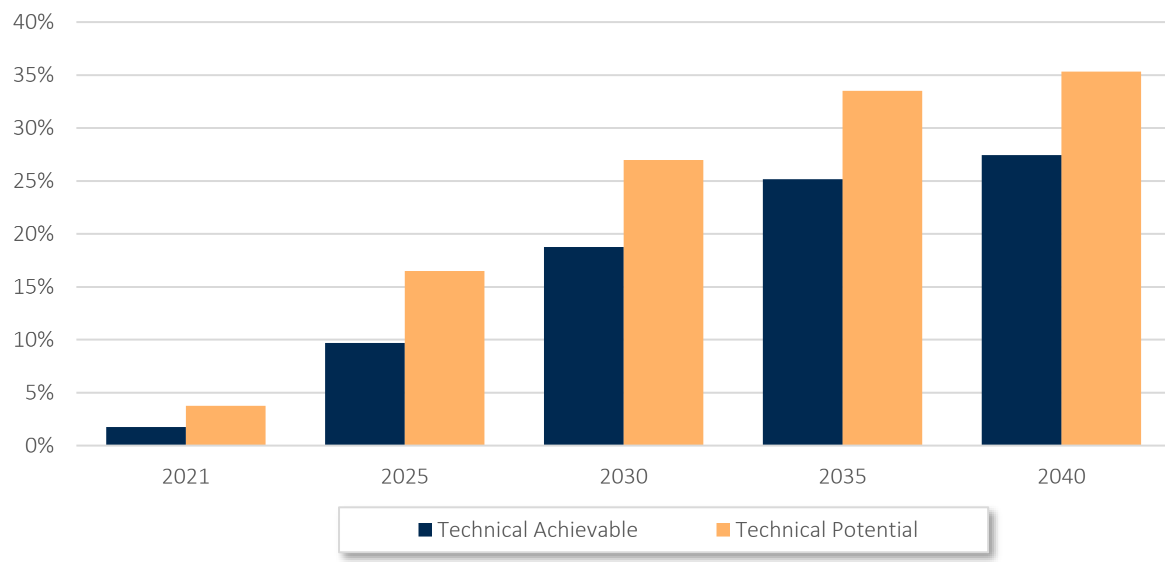


Table A-7 and Figure A-12 present savings estimates from the perspective of summer peak demand. In 2021, the first year of the projection, achievable potential is 7 MW, or 1.0% of the baseline summer peak projection. By 2040, savings are 198 MW, or 22.1% of the baseline projection.

Table A-7 Commercial EE Potential (Summer Peak Demand, MW)

	2021	2025	2030	2035	2040
Baseline Projection (MW)	732	755	795	844	899
Cumulative Savings (MW)					
Technical Achievable Potential	7	51	114	166	198
Technical Potential	25	115	195	252	282
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.0%	6.7%	14.4%	19.7%	22.1%
Technical Potential	3.4%	15.2%	24.6%	29.9%	31.4%

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

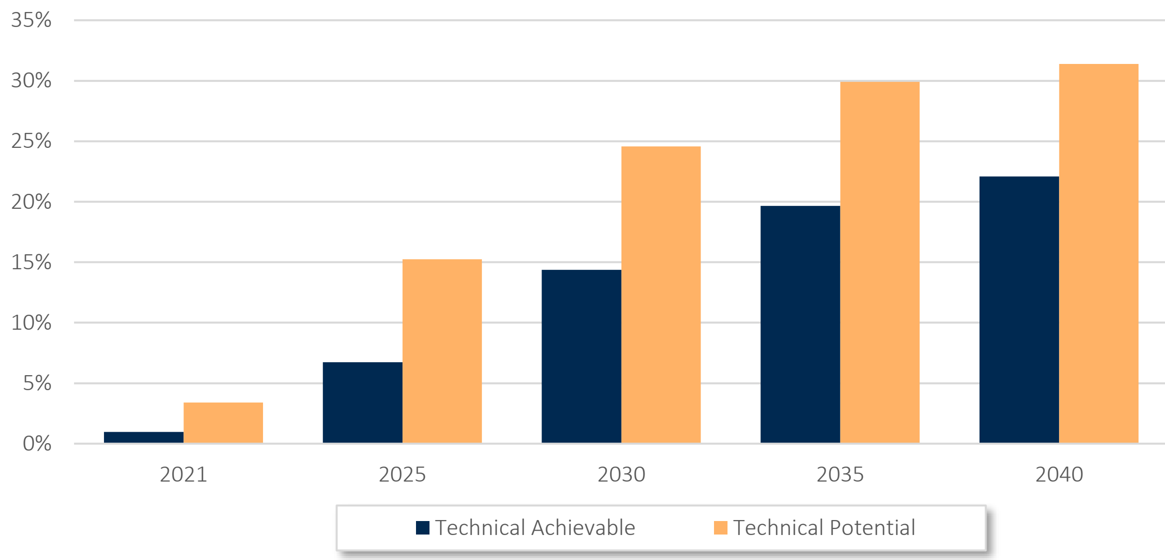


Figure A-13 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Lighting savings from interior and exterior applications account for a substantial portion of the savings throughout the forecast horizon.

Figure A-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 A-13 Commercial Achievable Savings Forecast (Energy, GWh)

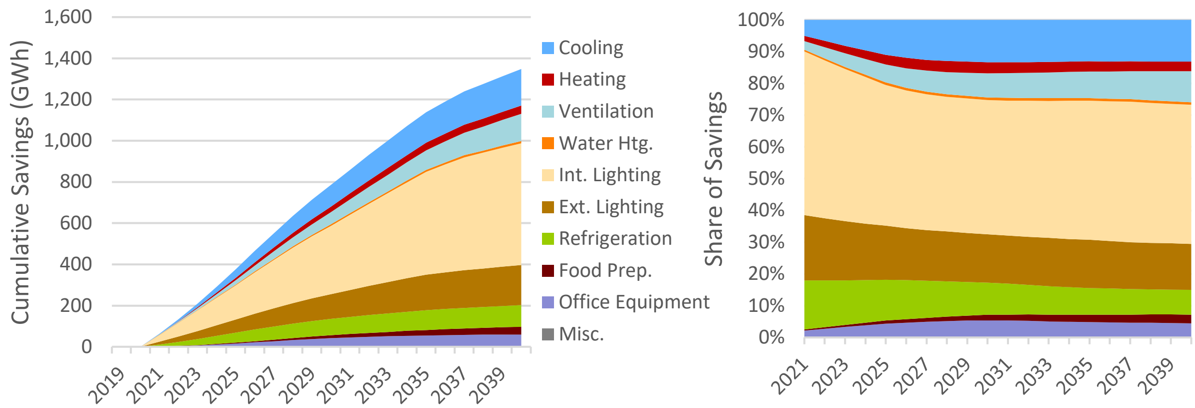
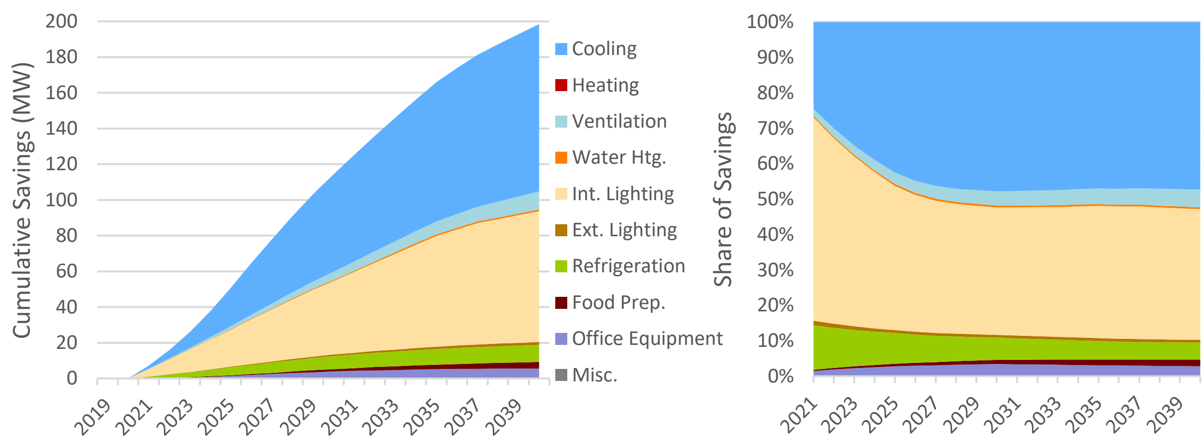


Figure A-14 Commercial Achievable Savings Forecast (Summer Peak, MW)



Industrial EE Potential

Table A-8 and Figure A-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, 2021, are 58 GWh, or 1.5% of the baseline projection. In 2040, savings reach 603 GWh, or 13.7% of the baseline projection.

Table A-8 Industrial EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	3,863	3,980	4,133	4,270	4,390
Cumulative Savings (GWh)					
Technical Achievable Potential	58	263	456	561	603
Technical Potential	103	415	662	789	833
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.5%	6.6%	11.0%	13.1%	13.7%
Technical Potential	2.7%	10.4%	16.0%	18.5%	19.0%

Figure A-15 Industrial Cumulative EE Savings as a % of the Baseline Projection (Energy)

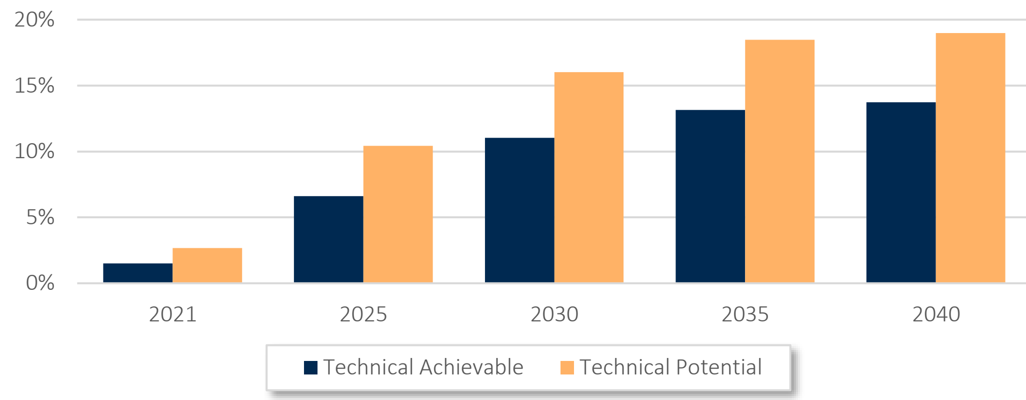


Table A-9 and Figure A-16 present potential estimates from the perspective of summer peak savings. In 2021, the first year of the potential forecast, achievable savings are 4 MW, or 1.2% of the baseline projection. By 2040, savings have increased to 52 MW, or 14.3% of the baseline summer peak projection.

Table A-9 Industrial EE Potential (Summer Peak Demand, MW)

	2021	2025	2030	2035	2040
Baseline Projection (MW)	335	341	349	356	363
Cumulative Savings (MW)					
Technical Achievable Potential	4	19	36	46	52
Technical Potential	9	36	58	70	76
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.2%	5.7%	10.3%	13.0%	14.3%
Technical Potential	2.7%	10.7%	16.7%	19.7%	20.9%

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

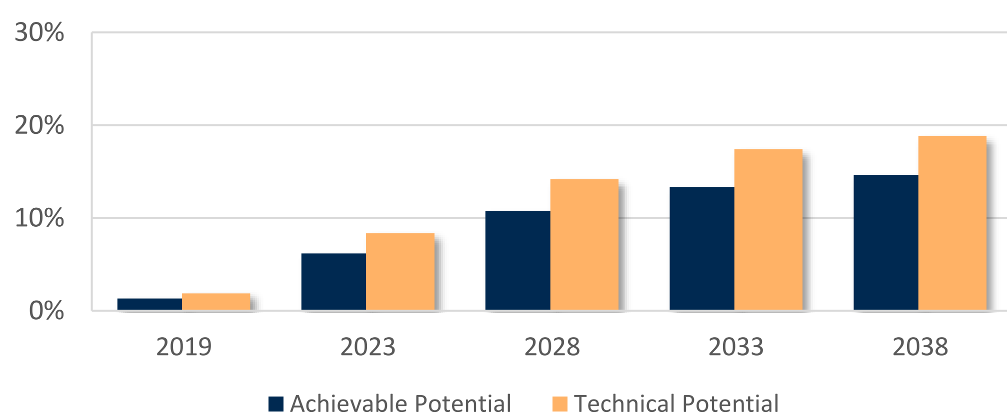


Figure A-17 presents forecasts of energy savings by end use as a percent of total savings per year and cumulative savings. Motor-related measures account for a substantial portion of the savings throughout the forecast horizon. The share of savings by end use remains fairly similar throughout the forecast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

Figure A-17 Industrial Achievable Savings Forecast (Energy, GWh)

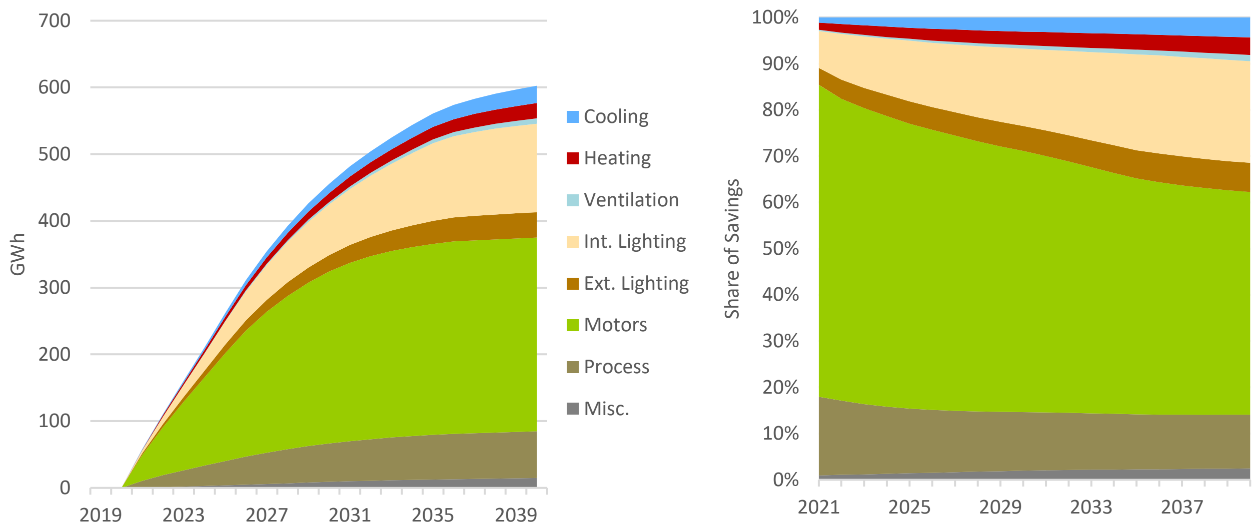
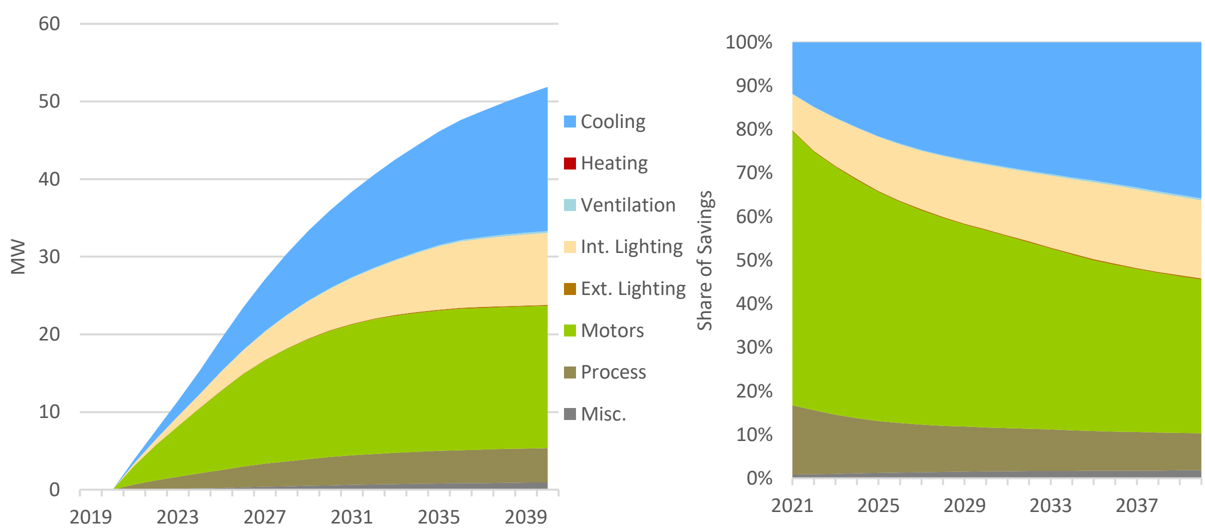


Figure A-18 presents forecasts of summer peak savings by end use as a percent of total summer peak savings and cumulative savings. Cooling, lighting, motors and process all contribute to the savings throughout the forecast horizon.

Figure A-18 Industrial Achievable Savings Forecast (Summer Peak, MW)



Irrigation EE Potential

Table A-10 and Figure A-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, 2021, are 12 GWh, or 1.6% of the baseline projection. In 2040, savings reach 204 GWh, or 22.5% of the baseline projection.

Table A-10 Irrigation EE Potential (Energy, GWh)

	2021	2025	2030	2035	2040
Baseline Projection (GWh)	1,790	1,858	1,950	2,048	2,152
Cumulative Savings (GWh)					
Technical Achievable Potential	12	69	142	183	204
Technical Potential	15	92	192	247	273
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	1.6%	8.9%	17.4%	21.3%	22.5%
Technical Potential	2.1%	11.7%	23.4%	28.8%	30.2%

Figure A-19 Irrigation Cumulative EE Savings as a % of the Baseline Projection (Energy)

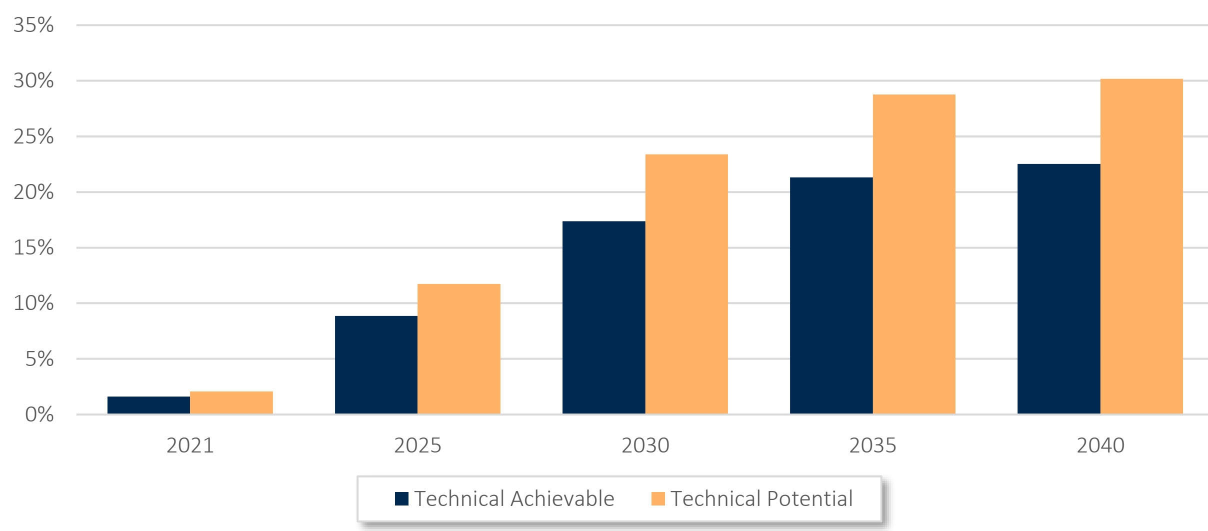
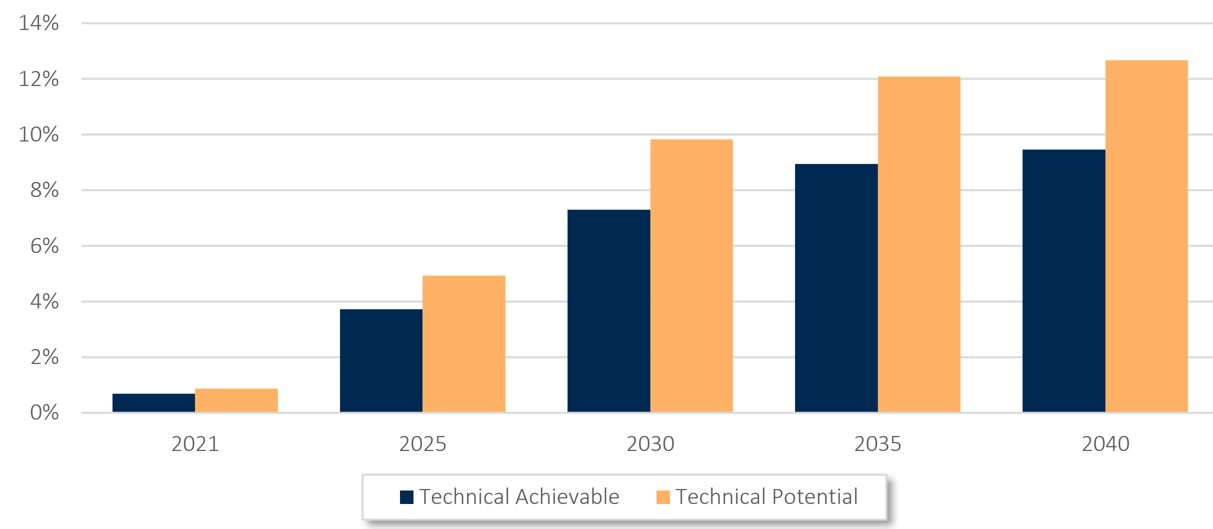


Table A-11 and Figure A-20 present potential estimates from the perspective of summer peak savings. In 2021, the first year of the potential forecast, achievable savings are 5 MW, 0.7% of the baseline projection. By 2040, cumulative peak savings have increased to 85 MW, or 9.5% of the baseline summer peak projection.

Table A-11 Irrigation EE Potential (Summer Peak Demand, MW)

	2021	2025	2030	2035	2040
Baseline Projection (MW)	752	780	819	860	904
Cumulative Savings (MW)					
Technical Achievable Potential	5	29	60	77	85
Technical Potential	7	38	80	104	115
Cumulative Savings as a % of Baseline					
Technical Achievable Potential	0.7%	3.7%	7.3%	8.9%	9.5%
Technical Potential	0.9%	4.9%	9.8%	12.1%	12.7%

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



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

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