Evergy
2019 DSM Potential Study

Final Report

Volume 3: Potential Study

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Eureka Facts supported ICF in conducting the appliance saturation survey.

Introduction

Evergy engaged ICF to conduct this demand side management (DSM) potential study. It assessed technical, economic and achievable potential in the residential, commercial, and industrial sectors within Evergy's service areas in Missouri, Evergy Missouri Metro and Evergy Missouri West. The study covers energy efficiency, demand response, demand-side rates, and combined heat and power.

ICF assessed five achievable potential scenarios including Realistic Achievable Potential (RAP), RAP-, RAP+, Missouri Energy Efficiency Investment Act (MEEIA), and Maximum Achievable Potential (MAP) for energy efficiency, demand response and demand side rates. ICF modeled additional stand-alone scenarios for demand response and demand side rates.

As part of the study, ICF conducted an appliance saturation analysis to collect a variety of appliance and end-use data from customers across multiple service territories in Missouri and Kansas, including residential, commercial, and industrial accounts. It included a web and mail survey of residential customers and a computer-assisted telephone interviewing (CATI) survey of business customers. The results of this analysis were used in the market characterization and baseline electricity load analysis in the study.

This study will be used to satisfy the demand-side analysis requirements of the Missouri resource planning regulations at 4 CSR 240-22, particularly Chapter 22.050. In addition, the study also takes into consideration the requirements of demand-side programs under the MEEIA regulations at 4 CSR 240-20.092, 20.093, and 20.094.

Report Organization

This report includes five volumes:

- Volume 1: Executive Summary
- Volume 2: Appliance Saturation Analysis
- Volume 3: Potential Study
- Volume 4: Program Descriptions
- Volume 5: Appendices

This document is Volume 3: Potential Study. It includes the study results for all resources that were assessed in this study: energy efficiency, demand response and demand-side rates, and combined heat and power, as well as the sensitivity and uncertainty analysis.

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I. Energy Efficiency Potential

1. Introduction

1.1 Summary

This energy efficiency potential study assessed technical, economic and achievable potential in the residential, commercial, and industrial sectors within Evergy's service areas. The study will be used to satisfy the demand-side analysis requirements of the Missouri resource planning regulations at 4 CSR 240-22, particularly Chapter 22.050. In addition, the study also takes into consideration the requirements of demand-side programs under the Missouri Energy Efficiency Investment Act (MEEIA) regulations at 4 CSR 240-20.092, 20.093, and 20.094.

ICF conducted the study as follows:

1. Calculated electricity use baselines in Evergy's service areas using primary data gathered during the study and secondary data from the U.S. Department of Energy.
2. Performed baseline analyses for each sector and end use.
3. Combined this baseline data with measure data to calculate the eligible stock, which is the market size for each efficiency measure.
4. Estimated technical potential by calculating the energy savings from implementing the most technically efficient measures.
5. Estimated economic potential as the cost-effective subset of technical potential.
6. Estimated five achievable potential scenarios: Realistic Achievable Potential (RAP), RAP-, RAP+, MEEIA, and Maximum Achievable Potential (MAP).

RAP is the reference case, as it is based on historical Evergy program performance; RAP- and RAP+ are variants of RAP that assume lower or higher performance levels. In the MEEIA scenario, Evergy has an energy savings target of 1.9% of sales. MAP is the upper limit of achievable potential where customer incentives equal 100% of measure incremental costs.

This report provides details on the assumptions, approach, and results of each element of this study.

Appendix D of Volume 5 contains detailed program and portfolio savings, costs, and cost-effectiveness results.

1.2 Reference guide

The following key assumptions were made in the study:

- **Technical potential** is the level of energy and demand savings that would result from installing the most technically efficient measures available for each end-use, regardless of cost. It is the upper bound of how much could theoretically be saved.
- **Economic potential** is the cost-effective subset of technical potential based on the Total Resource Cost test.
- **Achievable potential** is the amount of energy savings that can realistically be achievable by energy efficiency programs.
- **Level of savings used in the analysis:**
  - **Savings at meter** are reported only in the baseline analysis.

  - For all other purposes, including cost-effectiveness testing and reporting, savings are **at generator.**
- **Low income/income eligible**: Defined for the purposes of the study consistent with Evergy's income eligible program requirements.[1]
- **Dollar denomination**: Program costs are reported in nominal dollars in the Appendix. Evergy's assumption for inflation is 2.5% per year.
- **Opt-outs**: Savings impact levels, e.g. megawatt hour (MWh) savings as a % of MWh sales, do not account for opt-outs[2].
- **Economic screening**: All measures were screened for cost effectiveness using the Total Resource Cost (TRC) test. All programs were screened for cost effectiveness using the Societal Test, the TRC test, the Program Administrator Cost (PAC) test, the Participant Cost Test (PCT), and the Ratepayer Impact Measure (RIM) test. Benefits and costs used in these tests are consistent with Missouri Public Service Commission rules. The primary benefit-cost test is the TRC.
- **Gross program kWh savings**: Program kilowatt hour (kWh) savings for a specific period of performance as calculated and reported by the administrator in the conduct of program evaluation, measurement and verification (EM&V), prior to application of any "ex post"/net savings adjustments specific to the program for the same performance period. Additionally, gross savings do not account for any net-to-gross assumptions/factors developed for the purposes of program planning; "ex ante" program kWh savings if the jurisdictional definition of "ex ante" excludes the application of all net-to-gross planning assumptions.
- **Net program kWh savings**: Program kWh savings for a specific period of performance as calculated in the conduct of program EM&V, inclusive of all net savings adjustments or factors (free-ridership, spillover, etc.) required by the administrator's regulator for calculating program net-to-gross ratios and/or net savings; "ex post" program kWh savings.
- **Naturally occurring energy efficiency**: Energy savings resulting from actions taken by Evergy customers in the absence of any help from Evergy's energy efficiency programs.
- **Codes & standards assumptions**:
  - Energy Independence and Security Act of 2007 (EISA 2007): due to pending litigation over Tier 2 of EISA 2007 it was assumed that minimum energy performance standards for general service light bulbs do not change over the time horizon of the study. The exception is the RAP- scenario where it was assumed that Tier 2 is implemented in 2023.
  - New Federal minimum energy performance standards for heat pumps go into effect in 2023.
    Building new construction: the ICC 2018 International Energy Conservation Code (IECC) is the current energy code in Missouri. It references ASHRAE Standard 90.1-2016 for commercial construction.
- **Fallback**: It was assumed that customers implementing energy efficiency measures as a result of Evergy programs would implement the same measures in the future once the existing measures expire, but without help from Evergy programs.

[1] https://www.evergy.com/ways-to-save/programs/energy-efficiency/income-eligible-weatherization
[2] A customer may opt-out of funding DSM programs in Missouri if (a) they have at least one account with 5MW of demand or more, (b) the sum of all their accounts have at least 2.5 MW of demand, or (c) they are an interstate pipeline pumping station.

1.3 Key takeaways

Technical potential equals one-fifth of load in 2023, three-quarters of which is economic. Residential economic potential is 68% of technical potential, commercial economic potential is 82% of technical potential, and industrial economic potential is 86% of technical potential.

Technical and economic potential by end use widely varies by sector. **Space heating and cooling comprise 69% of technical potential and 62% of economic potential in the residential sector**, while lighting accounts for 11% of technical and 15% of economic, followed by water heating (7% of technical and 9% of economic). **Lighting is the most important end use in the commercial sector**, with 38% of technical potential and 40% of economic potential, followed by space cooling, which accounts for a 234% of technical and 18% of economic, then refrigeration (16% of technical and 18% of economic). **In the industrial sector, measures that improve plant efficiency, such as pumps, fans and process heating, constitute 64% of technical potential and 57% of economic potential**, and measures that address facility efficiency (space lighting, heating and cooling) account for 36% of technical potential and 43% of economic.

If Evergy continues with its current program designs, load growth could flatten in the short run before starting to climb through the remainder of the forecast period. In the RAP scenario, load is 4% lower than the baseline over the long run.

If Evergy expands current programs and adds new programs, load growth could decline in the short run before flattening in the medium run, then slowly increasing through 2042. In the MEEIA scenario, load is 8% lower than baseline in the long run.

Savings levels in the RAP scenario are at the 57th percentile of a benchmarking class energy efficiency program portfolios administered by 26 investor owned utilities (IOUs) in the U.S. Central region in the short-term. This means short-term RAP savings levels are higher than more than half of the comparison group. This increases to the 96th percentile in the MEEIA scenario, meaning **performance levels in the MEEIA scenario are higher than 96% of comparable utilities**.

Residential savings in the RAP scenario is dominated by lighting. However, in the MEEIA scenario heating, ventilation and air conditioning (HVAC) is equally important as lighting and overall savings are more diverse than RAP. For example, savings from water heating measures triples in the MEEIA scenario because heat pump water heaters are modeled midstream, and appliance recycling adds freezer and refrigerator savings.

In the RAP scenario prescriptive measures through the Standard program account for most commercial savings; in the MEEIA scenario, moving prescriptive lighting midstream and expanding the Custom program pushes Custom ahead of Standard. The Small Business program nearly doubles in the MEEIA scenario.

Lighting drives commercial savings in both the RAP and MEEIA scenarios, although savings by end use diversifies in the MEEIA scenario. For example, savings from motors grows 350%.

Industrial savings is mostly Standard lighting in the RAP scenario, but Custom becomes the most important industrial offering in the MEEIA scenario as the program expands three-fold over RAP levels, mostly through efficiency improvements to pumps and process heating.

2. Baseline energy use

2.1 Data Sources and Methodology

This section presents the data used, its sources, and how it was applied. Data was localized when possible. For example, estimates of energy use by commercial segment from the Energy Information Administration (EIA) are for the "West North Central" region that contains Evergy's service territories. In some cases, however, national-level estimates are used.

First, Evergy provided data for the market characterization, including:

- Current and forecasted customers and total energy use by segment (residential, commercial, industrial) and service territory (Missouri Metro and Missouri West); and
- Monthly billing data for a subset of customers by segment and service territory Line loss estimates.

Next, ICF conducted a customer survey that provided suitable end use saturation data for the residential sector. Responses among the commercial and industrial sectors did not provide a suitable sample size to generate reliable estimates. ICF paired this saturation data with billing data provided by Evergy to econometrically estimate unit energy consumption (UEC) for a number of end uses, exploiting the variation across customer energy use and end uses, controlling for weather variation using Heating Degree Day (HDD) and Cooling Degree Day (CDD) data from NOAA.[3]

When estimating saturations and UECs from ICF's survey and Evergy billing data was not possible, ICF relied on public estimates from sources such as:

- Residential Energy Consumption Survey (RECS);
- Commercial Buildings Energy Consumption Survey (CBECS);
- Manufacturing Energy Consumption Survey (MECS); and
- Energy Information Administration (EIA)'s Annual Energy Outlook (AEO).[4]

ICF used segment- and territory- specific saturation and UEC/ Energy use intensity (EUI) estimates to develop a statistically adjusted end use model of energy use. More specifically, UEC/EUI estimates for each end use were first refined using billing and end use saturation data to calibrate estimated total energy use to historical levels of energy use.[5,6] Next, segment- and service territory- specific UEC estimates were further refined via statistical regression. Actual monthly billing data was regressed on estimated heating, cooling, and other loads (constructed from saturation and UEC/EUI estimates),

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[3]ICF retrieved daily HDD and CDD data (both base 65) from NOAA (https://w2.weather.gov/climate/xmacis.php?wfo=eax) for the Kansas City Area, which covers 40 weather stations in the Kansas City area. ICF then constructed custom monthly HDD/CDD data for each survey respondent based on their monthly billing period (i.e., if they were billed on July 3rd and then August 5th, their July CDD covers between those dates). ICF also calculated a traditional month of HDD/CDD days (i.e., July 1-31 for July) based on the daily data for use in the regression model. To produce the forecast of HDD/CDD ICF used its calculated historical monthly HDD/CDD for the Kansas City area, along with forecasted annual HDD/CDD for the West North Central region in the EIA AEO forecast, to produce a series that was based on the monthly historical data but allowed for growth in CDD and decrease in HDD, which AEO shows occurring as climate warms.

[4] Residential Energy Consumption Survey, 2015. Retrieved from: https://www.eia.gov/consumption/residential/data/2015/. Commercial Buildings Energy Consumption Survey, 2012. Retrieved from: https://www.eia.gov/consumption/commercial/data/2012/. Manufacturing Energy Consumption Survey, 2014. Retrieved from: https://www.eia.gov/consumption/manufacturing/data/2014/. EIA Annual Energy Outlook, 2019. Retrieved from: https://www.eia.gov/outlooks/archive/aeo19/.

[5] Note, for the commercial and industrial segments, the quantity of survey responses prevented statistically valid characterizations of energy use by service territory. For these segments, the baseline market characterization and forecast combine the Missouri Metro and Missouri West service territories.

[6] Note: total energy was calculated by summing the value of each end use saturation multiplied by its respective UEC/EUI.

controlling for demographics and weather, to identify whether these loads were overestimated or underestimated in the model. The regression coefficients on the heating, cooling, and other loads were then used to scale these groups of UEC/EUIs. For example, a coefficient of 0.98 (less than one) on heating load suggests that energy use due to heating is overestimated in our model and as such, heating UEC/EUIs were adjusted (multiplied by 0.98) to more accurately estimate the energy use of heating end uses.

ICF also relied on the following sources:

- Evergy's previous market potential study for baseline UEC and/or saturation data when not available from other sources.
- EIA's AEO/National Energy Modeling System (NEMS) for baseline values and forecasts of electricity prices, equipment stock, equipment efficiencies, HDD/CDD days, income, population, and building shell indices.
- County Business Patterns data for assumptions used to divide commercial and industrial energy use across sectors.[7]

Next, with an understanding of baseline energy use and end use saturation, ICF generated segment-specific forecasts of energy use through 2040. For the residential segment, this included both the Missouri Metro and Missouri West service territories. For the commercial and industrial segments, these forecasts were generated for the combined Missouri Metro and Missouri West territories. ICF paired the end use saturations and statistically-adjusted UEC estimates generated in the market characterization portion of the study with publicly available forecasts of equipment saturations and efficiencies, as well as forecasted weather, demographic, and economic controls, to forecast annual energy use and annual end use energy intensities through 2040 for the residential, commercial, and industrial segments.[8]

2.2 Market Characterization

The first step in forecasting energy use and end use intensities is to identify how much energy is being used today and what types of end uses are currently being used. The market characterization was developed for Evergy Missouri Metro and Evergy Missouri West. The analysis presents results for the two service territories combined as well as individually. When combined, the results are referred to as "Evergy" and when discussed individually as each service territory's name.

[7] County Business Patterns, 2017. Retrieved from: https://www.census.gov/programs-surveys/cbp/data/datasets.html

[8] Note, additional electricity demand from a Nucor metal products plant coming online was not included in the forecast model. Instead, ICF relied on a forecast of Nucor use provided by Evergy, which is added to forecasted energy use as an exogenous increase.

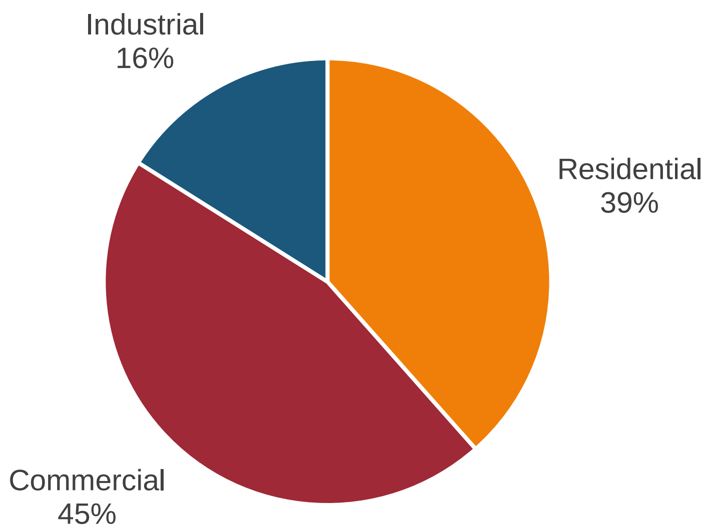


Figure I-1 Evergy electricity use by sector, 2019

Energy Use Summary

Total energy use across the residential, commercial, and industrial sectors for Evergy in 2019 was 17,028 gigawatt hours (GWh). As shown in Figure I-1, the commercial and residential sectors are somewhat comparable in size, with 45% and 39% of use respectively. The industrial sector is slightly smaller in terms of overall consumption, at just 16%. In terms of peak demand, the total summer peak in 2019 was 3,049 MW and the winter peak was 2,202 MW.

Table I-1 Evergy Electricity Use by Sector, 2019

Sector	Annual Electricity Use (GWh)	% of Sales	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Residential	6,552	38%	1,521	982
Commercial	7,743	45%	1,183	911
Industrial	2,733	16%	345	309
Total	**17,028**	**100%**	**3,049**	**2,202**

2.2.1 Residential Market Characterization

ICF paired the residential customer survey data with Evergy's customer billing and total sales data to generate estimates of energy use by four segments: Single Family, Multifamily, Single Family Low Income (LI), and Multifamily Low Income (LI) in both the Missouri Metro and Missouri West service territories. ICF estimated the number of customers and usage in each segment based on ICF's survey and all reported residential energy sales in 2019. In 2019, there were 542,541 households in the Evergy territory that used a total of 6,552 GWh with a summer peak demand of 1,521 MW. The results are shown in Table I-2. Overall, the average household in the residential segment uses an average of 12,079 kWh per year.

Table I-2 Sector Control Total

(a) Residential Sector Control Totals, 2019 (Metro)

Segment	Households	Electricity Sales (GWh)	% of Total Usage (kwh)	Avg. Use / Household (kwh)	Summer Peak (MW)	Winter Peak (MW)
Single Family	128,310	1,590	24%	12,394	395	223
Multifamily	79,035	760	12%	9,610	179	122
Single Family LI	21,553	202	3%	9,392	50	28
Multifamily LI	26,811	190	3%	7,102	45	31
Total	**255,709**	**2,742**	**42%**	**38,498**	**669**	**404**

(b) Residential Sector Control Totals, 2019 (West)

Segment	Households	Electricity Sales (GWh)	% of Total Usage (kwh)	Avg. Use / Household (kwh)	Summer Peak (MW)	Winter Peak (MW)
Single Family	190,096	2,786	43%	14,655	629	407
Multifamily	50,059	599	9%	11,966	129	103
Single Family LI	22,207	229	4%	10,327	52	34
Multifamily LI	24,382	195	3%	8,011	42	34
Total	**286,744**	**3,809**	**58%**	**44,959**	**852**	**578**

The top three end uses, cooling, heating, and appliances, make up 70% and 72% of residential electric use in the Evergy Missouri Metro and Evergy Missouri West service territories, respectively, as shown in Figure I-2 and Figure I-3. Appliances include end uses such as washing machines, clothes dryers, electric ovens and ranges, and refrigerators. Electronics constitute 12% and 11% of energy use in Evergy Missouri Metro and Evergy Missouri West, respectively, and include items such as televisions, tablets, and computers. Miscellaneous, the smallest end use in both territories, includes devices and gadgets such as gaming systems and set top boxes, as well as more uncommon end uses such as hot tubs and pool pumps.

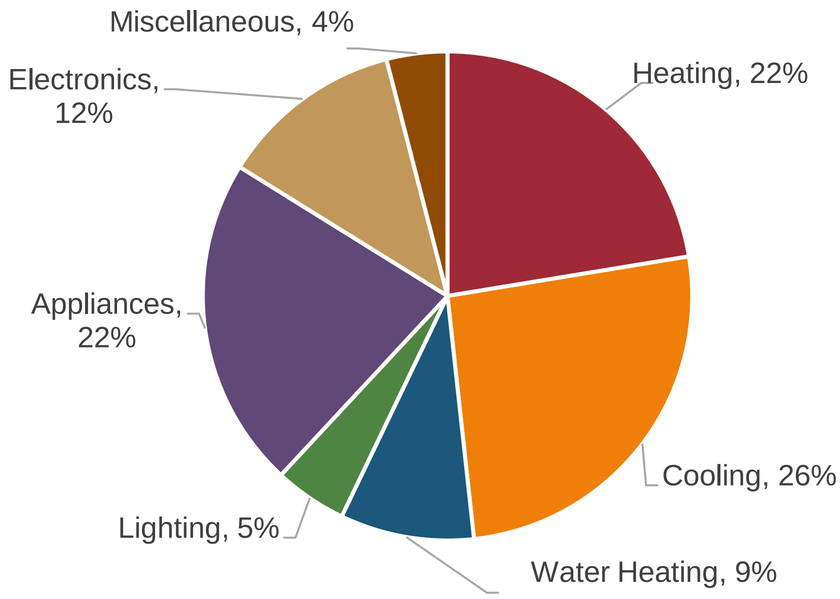


Figure I-2 Evergy Missouri Metro residential electricity use by end use, 2019

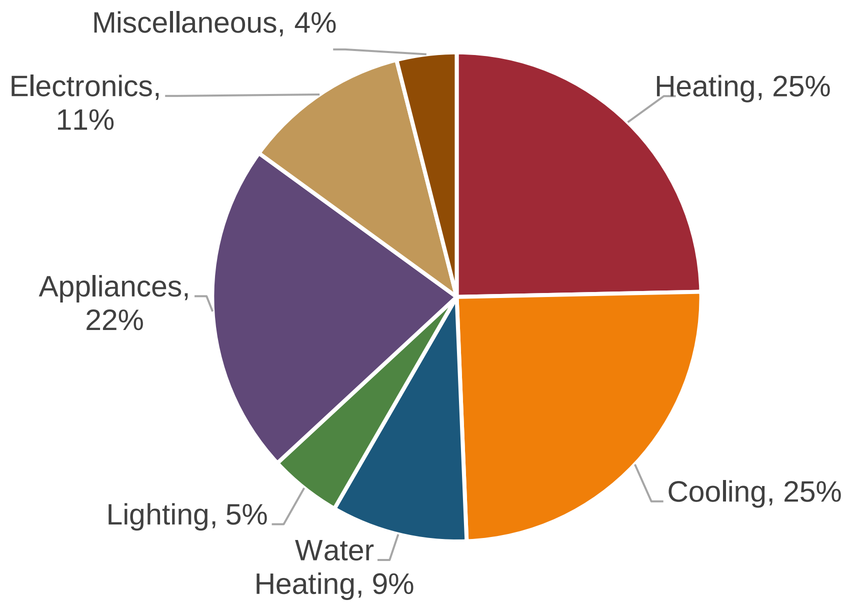


Figure I-3 Evergy Missouri West residential electricity use by end use, 2019

Table I-3 and Table I-4 present the average market profiles for the Evergy Missouri and Metro Evergy Missouri West service territories. The market profiles include both the saturation rates of various end uses and the respective UEC, intensity, and total energy usage for each end use.

Table I-3 Evergy Missouri Metro Residential Average Market Profile

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Heating	Electric Furnace	28%	6,395	1,805	437
Heating	Electric Heaters	2%	5,226	80	19
Heating	Heat Pump Heating	2%	7,329	152	35
Heating	Geothermal Heat Pump Heating	0%	2,993	4	1
Heating	Furnace Fan	86%	542	464	119
Cooling	Central Air Conditioner	83%	3,052	2,536	654
Cooling	Window Air Conditioner	9%	1,222	115	31
Cooling	Heat Pump Cooling	2%	3,218	79	19
Cooling	Geothermal Heat Pump Cooling	0%	2,799	8	2
Water Heating	Electric Water Heater Small	27%	3,125	852	213
Water Heating	Electric Water Heater Large	0%	3,404	17	2
Water Heating	Heat Pump Water Heater	2%	2,964	65	15
Water Heating	Electric Tankless Water Heater	1%	4,267	53	12
Appliances	First Fridge	99%	746	736	186
Appliances	Second Fridge	28%	799	221	56
Appliances	Third Fridge	3%	716	24	6
Appliances	Microwave	100%	189	190	47
Appliances	Electric Cooktop	67%	465	312	76
Appliances	Dishwasher	81%	401	327	82
Appliances	Freezer	35%	597	210	53
Appliances	Washer	89%	88	78	19
Appliances	Dryer	78%	374	291	73
Electronics	Tube TV	20%	724	145	37
Electronics	LED TV	196%	157	307	77
Electronics	Plasma TV	9%	382	34	9
Electronics	Desktop PC	54%	174	93	26
Electronics	Laptop	110%	46	50	13
Electronics	Tablet	84%	194	163	43
Electronics	Monitor	58%	73	42	11
Miscellaneous	Solar	1%	-1,543	-22	-5
Miscellaneous	Well Pump	1%	579	7	3
Miscellaneous	Hot Tub	4%	2,325	89	23
Miscellaneous	Pool	3%	2,829	72	18
Miscellaneous	Electric Vehicle Outlet	2%	3,687	79	18
Miscellaneous	Devices and Gadgets	302%	101	306	76
Miscellaneous	Set Top Box	99%	109	107	27
Miscellaneous	Printer Fax Machine	79%	62	49	12
Miscellaneous	Miscellaneous	92%	230	211	52
Lighting	Conventional Lamp	923%	10	93	23
Lighting	CFL	425%	8	33	8
Lighting	Tube Fluorescent	147%	50	73	18
Lighting	LED	888%	9	78	20
Lighting	Halogen	198%	78	154	39
Lighting	Other Lamp	59%	13	8	23
Total				**10,792**	**2,728**

Table I-4 Evergy Missouri West Residential Average Market Profile

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Heating	Electric Furnace	24%	7,625	1,806	540
Heating	Electric Heaters	2%	6,232	141	39
Heating	Heat Pump Heating	8%	8,739	692	195
Heating	Geothermal Heat Pump Heating	1%	3,569	28	8
Heating	Furnace Fan	77%	646	496	142
Cooling	Central Air Conditioner	76%	3,671	2,793	803
Cooling	Window Air Conditioner	11%	1,471	169	50
Cooling	Heat Pump Cooling	6%	3,871	230	64
Cooling	Geothermal Heat Pump Cooling	1%	3,367	25	7
Water Heating	Electric Water Heater Small	33%	3,396	1,137	320
Water Heating	Electric Water Heater Large	1%	3,698	55	12
Water Heating	Heat Pump Water Heater	1%	3,221	23	5
Water Heating	Electric Tankless Water Heater	0%	0	0	0
Appliances	First Fridge	98%	811	798	226
Appliances	Second Fridge	38%	868	327	92
Appliances	Third Fridge	5%	778	39	11
Appliances	Microwave	105%	206	216	60
Appliances	Electric Cooktop	68%	505	345	95
Appliances	Dishwasher	86%	436	374	108
Appliances	Freezer	56%	648	360	102
Appliances	Washer	95%	95	91	26
Appliances	Dryer	86%	407	350	99
Electronics	Tube TV	18%	787	138	39
Electronics	LED TV	207%	170	353	99
Electronics	Plasma TV	8%	415	34	10
Electronics	Desktop PC	58%	189	109	34
Electronics	Laptop	110%	50	55	16
Electronics	Tablet	89%	211	187	55
Electronics	Monitor	61%	80	49	14
Miscellaneous	Solar	2%	-1,676	-34	-9
Miscellaneous	Well Pump	2%	629	10	3
Miscellaneous	Hot Tub	5%	2,526	121	36
Miscellaneous	Pool	4%	3,073	115	31
Miscellaneous	Electric Vehicle Outlet	1%	4,006	57	14
Miscellaneous	Devices and Gadgets	310%	110	342	95
Miscellaneous	Set Top Box	103%	118	122	35
Miscellaneous	Printer Fax Machine	86%	67	57	16
Miscellaneous	Miscellaneous	105%	250	262	73
Lighting	Conventional Lamp	1223%	11	135	38
Lighting	CFL	522%	8	44	12
Lighting	Tube Fluorescent	213%	54	115	32
Lighting	LED	1190%	10	114	32
Lighting	Halogen	148%	85	125	35
Lighting	Other Lamp	62%	14	9	29
Total				**13,012**	**3,743**

2.2.2 Commercial Market Characterization

The commercial sector was divided into twelve segments, as shown in Table I-5, using data from ICF's survey on business type and county-level County Business Patterns data. Commercial customers in Evergy's service area consumed a total of 7,743 GWh in 2019, with an average intensity of 14.0 kWh per square foot. Summer and winter peak demands are comparable, at 1,183 and 911 MW, respectively.

Missouri regulations allow certain large C&I customers to opt out of energy efficiency programs. However, all customers are maintained in our baseline control and market characterization.

Table I-5 Evergy Commercial Control Totals

Segment	Electricity Sales (GWh)	% of Total Usage	Avg. Use / Square Foot (kWh/SqFt)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Small Office	230	3%	11.6	95	94
Large Office	947	12%	18.2	22	27
Restaurant	336	4%	55.6	57	34
Retail	1,341	17%	9.8	240	158
Grocery	374	5%	21.1	54	39
School	1,194	15%	13.7	183	163
College	127	2%	8.2	19	17
Healthcare	880	11%	8.2	99	84
Lodging	218	3%	14.4	33	19
Data Center	306	4%	186.7[9]	30	27
Warehouse	122	2%	5.7	11	9
Miscellaneous	1,667	22%	12.3	340	240
Total	**7,743**		**14.0**	**1,183**	**911**

Figure I-4Table I-4 and Figure I-5 show the breakdown of commercial electricity use by segment and by end use. The miscellaneous category, which includes churches, non-profit organizations and membership clubs, professional organizations (such as labor unions), and other non-specific commercial entities, is estimated to account for 22% of commercial energy use in Evergy's territory in 2019. Next, the retail (17%), school (15%), large office (12%), and healthcare (11%) segments make up more than half of all commercial energy use. Most of this use is related to miscellaneous (23%), ventilation (19%), interior lighting (15%), and cooling (11%) loads.

[9] Survey responses provided an estimated average electricity intensity of 10.3 kWh/SqFt for data centers; however, very few survey responses were from customers that self-classified as data centers. Instead, ICF relied on an average electricity use per square foot estimate from EnergyStar of 186.7 kWh/SqFt, retrieved from: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/benchmarking-rendement/DataCenter-US-and-Canada-EN-Feb2018.pdf

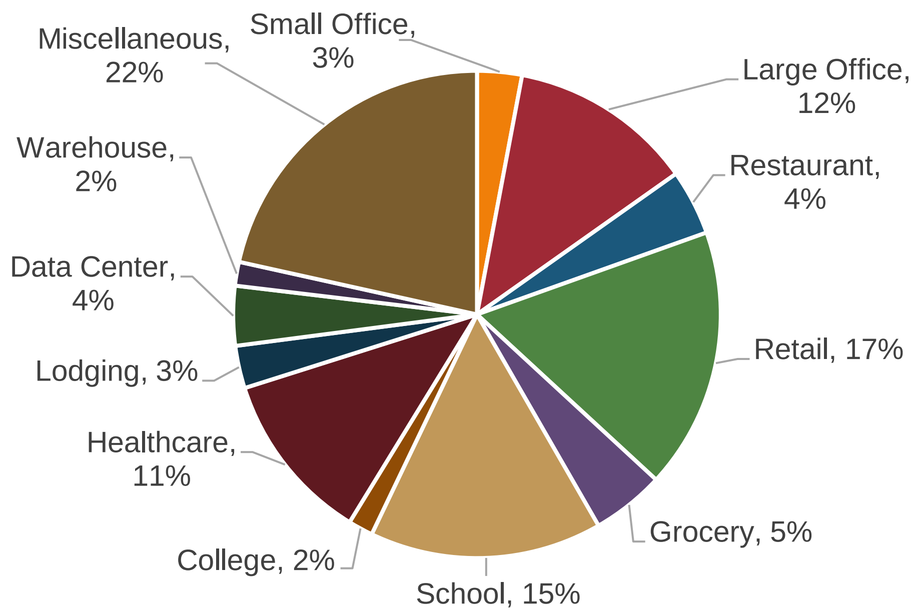


Figure I-4 Evergy commercial electricity use by segment, 2019

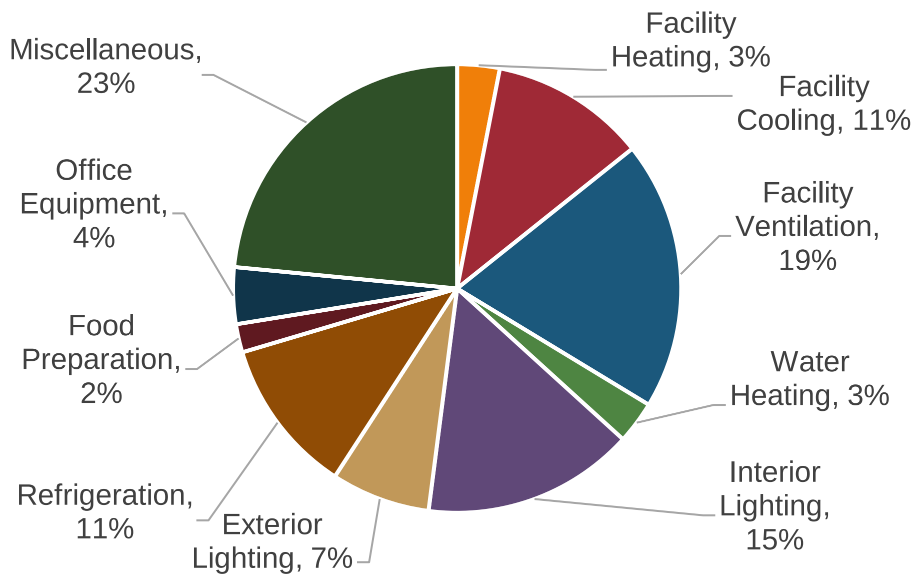


Figure I-5 Evergy commercial electricity use by end use, 2019

While the miscellaneous and retail segments both have very large footprints in terms of square footage in the Evergy service territory and thus rank at the top in terms of total energy use, the restaurant and data center segments have the highest electricity intensities in terms of energy use per square foot due to a higher saturation of high intensity end uses.

The commercial sector market profile is presented in Table I-6.

Table I-6 Evergy Commercial Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/SqFt)	Usage (GWh)
Facility Heating	Electric Furnace	17.3%	1.7	0.29	197
Facility Heating	Electric Heaters	4.2%	1.4	0.06	39
Facility Heating	Air Source Heat Pump	0.7%	1.1	0.01	5
Facility Heating	Ground Source Heat Pump	1.1%	0.6	0.01	4
Facility Cooling	Air Cooled Chiller	2.5%	2.3	0.06	40
Facility Cooling	Water Cooled Chiller	0.1%	3.5	0.00	3
Facility Cooling	Central Air	46.9%	1.9	0.88	600
Facility Cooling	Room Air Conditioner	12.1%	2.3	0.28	187
Facility Cooling	Air Source Heat Pump	0.7%	2.5	0.02	13
Facility Cooling	Geothermal Heat Pump	1.4%	0.5	0.01	5
Facility Ventilation	Ventilation	100.0%	2.1	2.11	1433
Water Heating	Water Heater	23.7%	1.7	0.40	269
Lighting	Interior Lighting	100.0%	1.7	1.73	1175
Lighting	Exterior Lighting	100.0%	0.8	0.84	569
Office Equipment	Computer Monitors	16.1%	0.2	0.03	19
Office Equipment	Desktop Computers	15.6%	0.9	0.14	97
Office Equipment	Laptops	9.8%	0.1	0.01	8
Office Equipment	Tablet	4.1%	0.1	0.00	3
Office Equipment	Servers	8.4%	3.1	0.26	179
Office Equipment	Printers, Copiers, Scanner, Fax	11.5%	0.1	0.01	8
Office Equipment	Point-of-sale	1.3%	0.1	0.00	1
Food Preparation	Electric Cooking	37.8%	0.4	0.16	107
Food Preparation	Electric Fryer	170.3%	0.5	0.83	560
Food Preparation	Dishwasher	1.2%	0.6	0.01	5
Refrigeration	Standalone Refrigerators and Freezers	16.5%	0.7	0.12	84
Refrigeration	Walk-in Freezers / Refrigerators	19.0%	1.5	0.28	188
Refrigeration	Vending Machines	22.7%	0.2	0.06	37
Refrigeration	Standalone Ice Makers	23.8%	0.6	0.13	89
Miscellaneous	Pool or spa	0.7%	0.1	0.00	0
Miscellaneous	Other Miscellaneous	100.0%	2.7	2.68	1820
Total				**11.41**	**7,743**

2.2.3 Industrial Market Characterization

The industrial sector contributed 2,733 GWh of sales in 2019, significantly smaller than both the residential and commercial sectors.

Table I-7 Evergy Industrial Totals

Segment	Electricity Sales (GWh)	% of Total Usage	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Food Production	432	16%	55	49
Chemicals and Pharmaceuticals	330	12%	42	37
Transportation Equipment	268	10%	34	30
Electronic Equipment	120	4%	15	14
Stone, Clay, Glass	104	4%	13	12
Primary Metals	115	4%	14	14
Rubber & Plastics	254	9%	32	28
Other Industrial	1,110	41%	140	125
Total	**2,733**		**345**	**309**

Figure I-6 and Figure I-7 show the breakdown of industrial electricity use by segment and by end use. The other industrial (41%), food production (16%), chemicals and pharmaceuticals (12%), and transportation equipment (10%) sectors make up more than three quarters of the total industrial electricity use in the Evergy service territory. The other industrial category includes all types of industrial activity not explicitly mentioned. This may include pulp and paper manufacturing, clothing manufacturing, and other types of light manufacturing. Over 80% of this energy use powers motors (52%) and process use (30%), or electricity used specifically in the manufacture of products. These categories are distinct from electricity used to heat or cool the facility or to provide lighting.

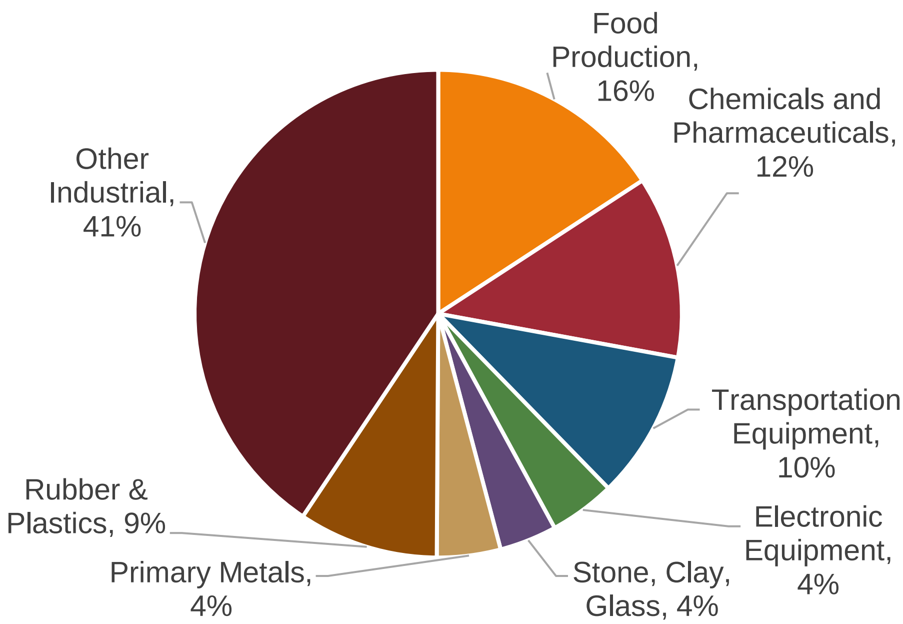


Figure I-6 Evergy industrial electricity use by segment

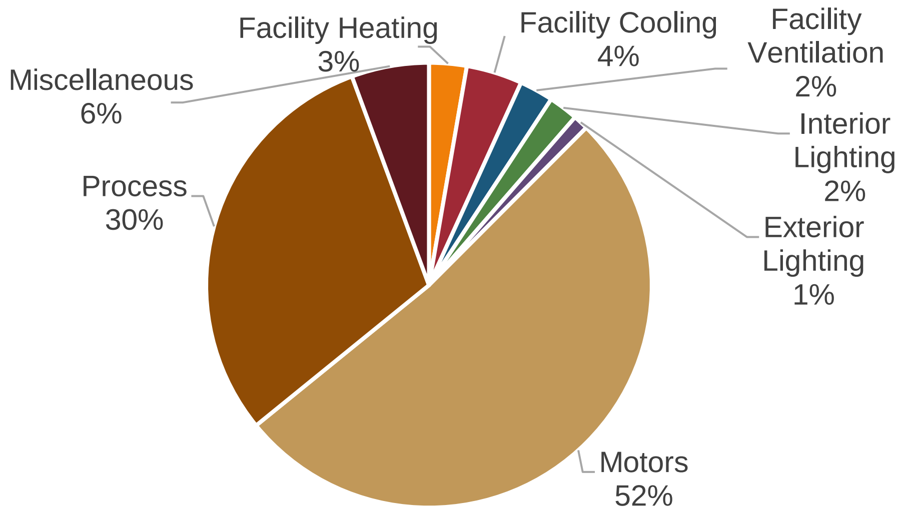


Figure I-7 Evergy industrial energy use by end use

The industrial market profile for the Evergy service territory is presented in Table I-8.

Table I-8 Evergy Industrial Market Profile

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/employee)	Usage (GWh)
Heating	Electric Furnace	10.7%	6,884	733	31.14
Heating	Electric Room Heat	3.1%	23,209	719	30.54
Heating	Air-Source Heat Pump	4.0%	6,972	279	11.86
Cooling	Air Cooled Chiller	2.6%	2,401	64	2.73
Cooling	Water Cooled Chiller	0.0%	2,228	1	0.04
Cooling	Rooftop Unit	73.5%	3,139	2,329	99.00
Cooling	Air-Source Heat Pump	5.8%	2,623	153	6.51
Ventilation	Ventilation	100.0%	1,559	1,583	67.29
Lighting	Interior Lighting	100.0%	1,348	1,377	58.51
Lighting	Exterior Lighting	100.0%	693	707	30.06
Motors	Pumps	100.0%	7,751	7,751	329.40
Motors	Fans & Blowers	100.0%	5,473	5,473	232.62
Motors	Compressed Air	100.0%	5,501	5,501	233.78
Motors	Material Handling	100.0%	13,226	13,226	562.10
Motors	Other Motors	100.0%	1,315	1,315	55.89
Process	Process Heating	100.0%	9,630	9,630	409.26
Process	Process Cooling	100.0%	3,538	3,538	150.35
Process	Process Refrigeration	100.0%	3,538	3,538	150.35
Process	Process Electrochemical	100.0%	1,618	1,618	68.75
Process	Process Other	100.0%	1,155	1,155	49.09
Miscellaneous	Miscellaneous	100.0%	3,618	3,618	153.75
Total				**64,307**	**2,733.00**

2.3 Baseline Projection

ICF developed a baseline projection of annual electricity use for each segment from 2020 through 2040. As in Section 2.2, Market Characterization, “Evergy” references the combined service territories of Evergy Missouri Metro and Evergy Missouri West, and not all Evergy service territories. This baseline projection assumes the status quo and as such, does not include any energy efficiency nor other utility programs. The projection was developed using the baseline market characterization and several inputs, including:

- Customer growth forecasts provided by Evergy;
- Population, income per capita, and electricity price growth forecasts from EIA AEO 2019; and
- Projected changes in equipment saturations and efficiencies from EIA.

The baseline projections (annual use in GWh) are presented in the following sections. Overall, the baseline projection for electricity use in the Evergy service territory increases 9%, from 16,808 GWh in 2020 to 18,331 GWh in 2040. Evergy provided ICF with their load forecast for comparison.

Baseline Summary

Table I-9 Evergy Baseline Projection for Selected Years (GWh)

Sector	2020	2025	2030	2035	2040	% Change '20-'40
Residential – Missouri Metro	2,654	2,815	2,920	3,021	3,121	18%
Residential - Missouri West	3,570	3,781	3,931	4,081	4,230	18%
Commercial	7,672	7,885	8,001	8,056	8,218	7%
Industrial	2,912	2,843	2,796	2,767	2,762	-5%
Total	**16,808**	**17,324**	**17,648**	**17,925**	**18,331**	**9%**

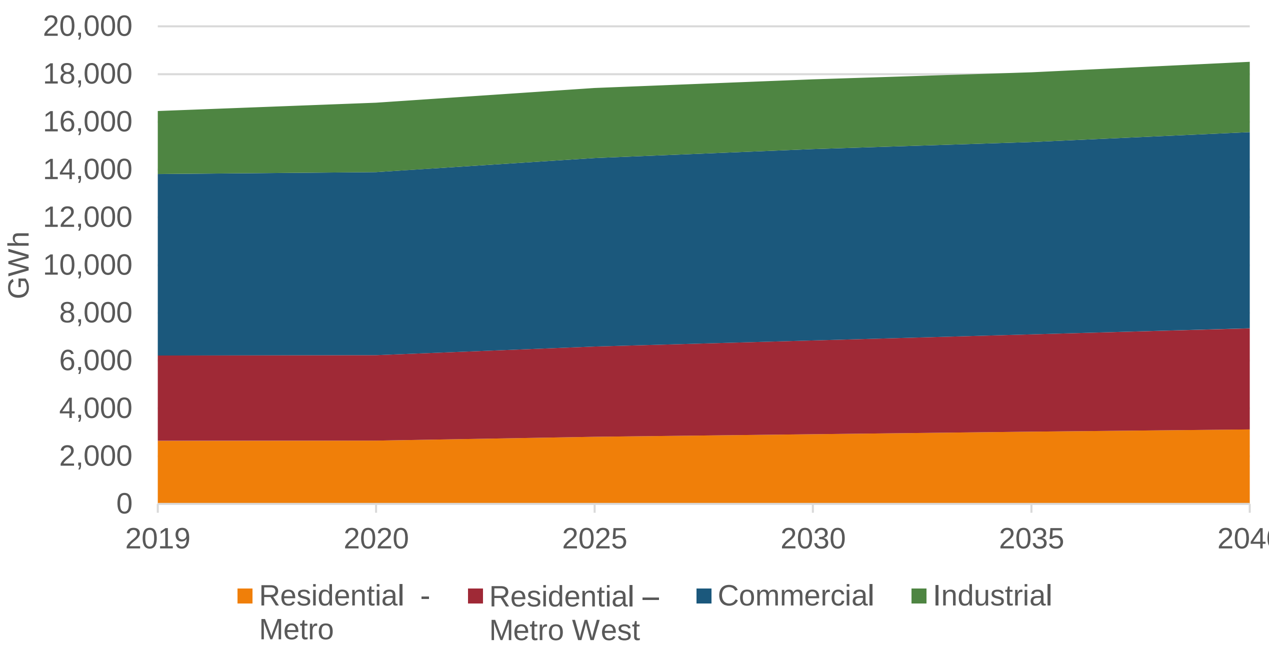


Figure I-8 Evergy baseline projection (GWh)

2.3.1 Residential Baseline Projection

Table I-10 and Figure I-9 present the baseline projection for electricity at the end-use level for the residential sector in the Evergy Missouri Metro service territory. Similarly,Table I-11 Evergy Missouri West Residential Baseline Electricity Use by End Use, Selected Years (GWh) Table I-11 and Figure I-10 present the baseline projection for electricity at the end-use level for the residential sector in the Evergy Missouri West service territory. Definitions of categories are consistent with the end-use aggregation from the market characterization section Table I-3 and Table I-4. That is, electronics consists of various types of TVs and computer equipment, whereas miscellaneous contains some explicit categories but is also a catch-all of small household gadgets requiring charging, as well as unknown technologies that households may acquire in the next decades. Overall, residential use increases from 6,224 GWh in 2020 to 7,351 GWh in 2040, an increase of 18%. The increase in residential use is due to a moderate customer growth forecast, tempered by natural efficiency increases in appliances and electronics.

The baseline projection is generally similar to Evergy's residential load forecast. Specific observations include:

- Efficiency improvements in electronics and appliances reduce the total electricity use for those end uses.
- Growth in other miscellaneous use is substantial. This end use grows consistently over time as new technologies and appliances are adopted. ICF incorporates future growth assumptions from the EIA AEO.
- Water heating use grows as electric water heater adoption increases.

Table I-10 Evergy Missouri Metro Residential Baseline Electricity Use by End Use, Selected Years (GWh)

End Use	2020	2025	2030	2035	2040	% Change
Cooling	616	637	655	677	702	14%
Heating	607	657	690	710	724	19%
Water Heating	261	311	345	375	406	56%
Lighting	113	120	125	128	130	15%
Appliances	611	625	629	634	645	6%
Electronics	330	324	312	307	300	-9%
Miscellaneous	115	140	165	190	215	87%
Total	**2,654**	**2,815**	**2,920**	**3,021**	**3,121**	**18%**

Table I-11 Evergy Missouri West Residential Baseline Electricity Use by End Use, Selected Years (GWh)

End Use	2020	2025	2030	2035	2040	% Change
Cooling	810	848	886	929	977	21%
Heating	855	922	970	1,003	1,029	20%
Water Heating	356	411	445	476	508	43%
Lighting	156	165	173	178	182	17%
Appliances	828	847	853	864	882	7%
Electronics	410	403	390	386	378	-8%
Miscellaneous	155	185	214	244	275	77%
Total	**3,570**	**3,781**	**3,931**	**4,081**	**4,230**	**18%**

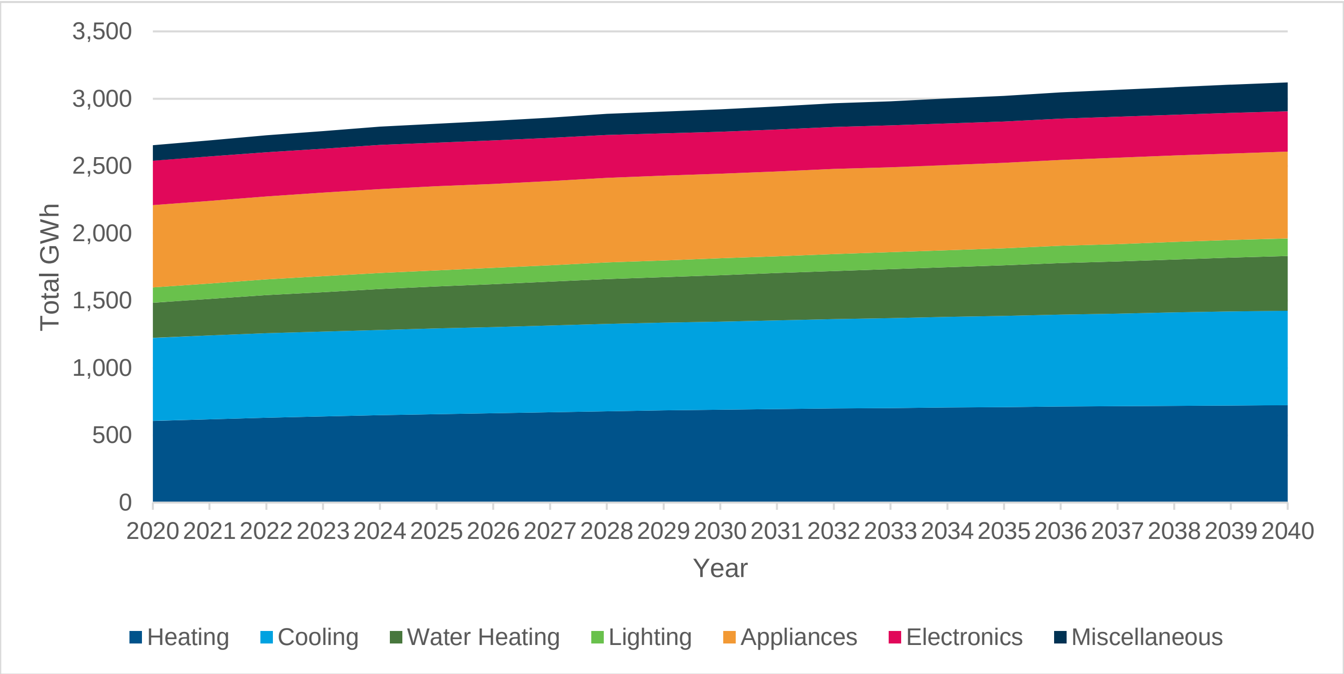


Figure I-9 Evergy Missouri Metro residential baseline electricity projection by end use

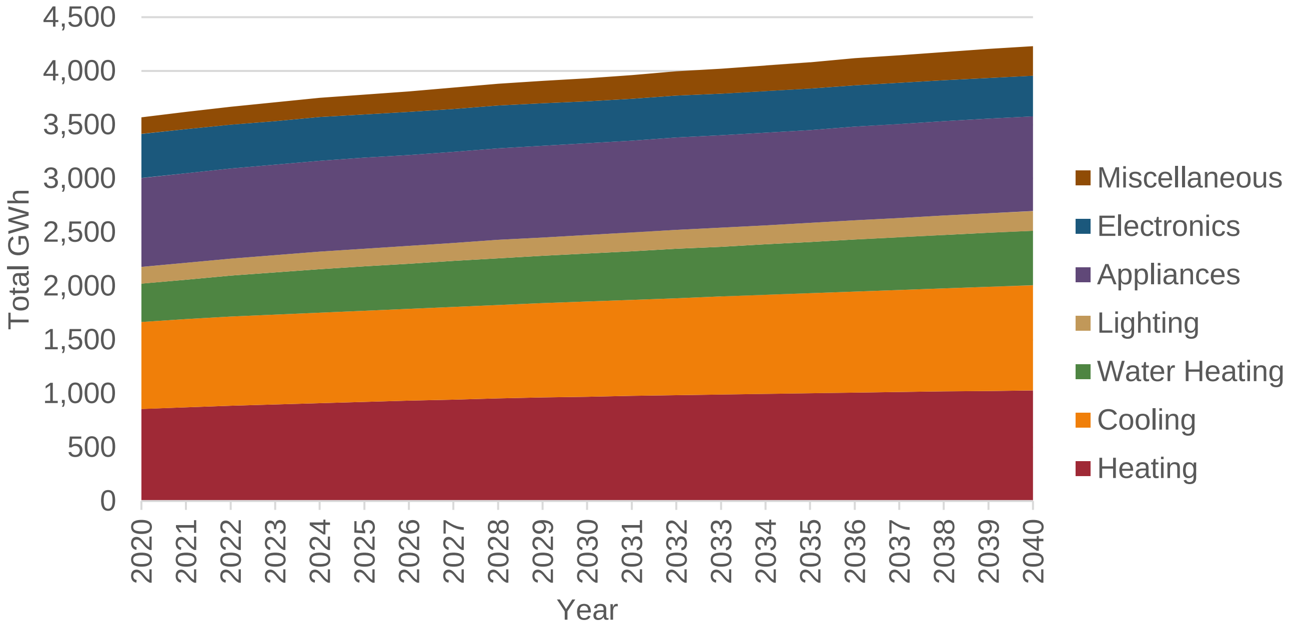


Figure I-10 Evergy Missouri West residential baseline electricity projection by end use

Figure I-11 and Figure I-12 present the intensity projections, in kWh per household, by end use for the residential sector in the Evergy Missouri Metro and Evergy Missouri West service territories. In Evergy Missouri Metro, there is modest growth in the overall baseline projection, yet intensity per household only increases from 10,089 kWh to 10,249 kWh over the time horizon, a 2% increase. However, in Evergy Missouri West, intensity per household decreases from 12,399 kWh to 12,261 kWh over the time horizon, a 1% decrease. This is mainly a result of higher initial electric furnace and central AC saturation rates in Every Missouri Metro compared to Every Missouri West.

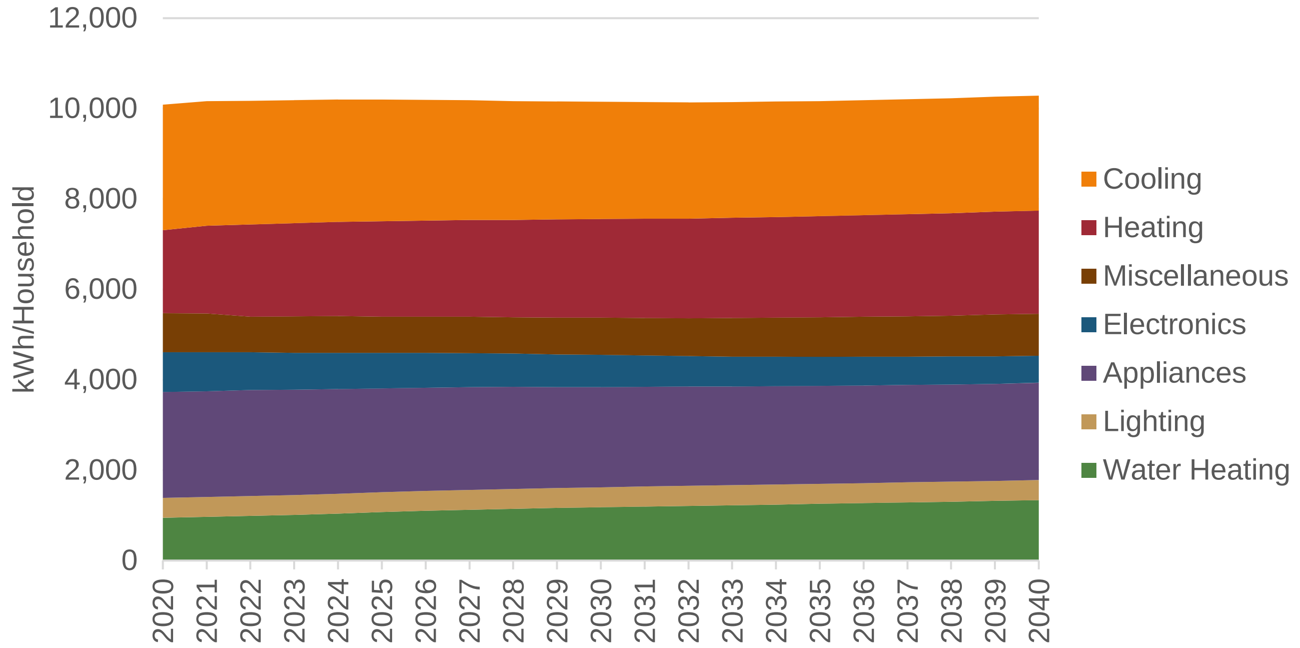


Figure I-11 Evergy Missouri Metro average residential electricity intensity by end use (kWh per household)

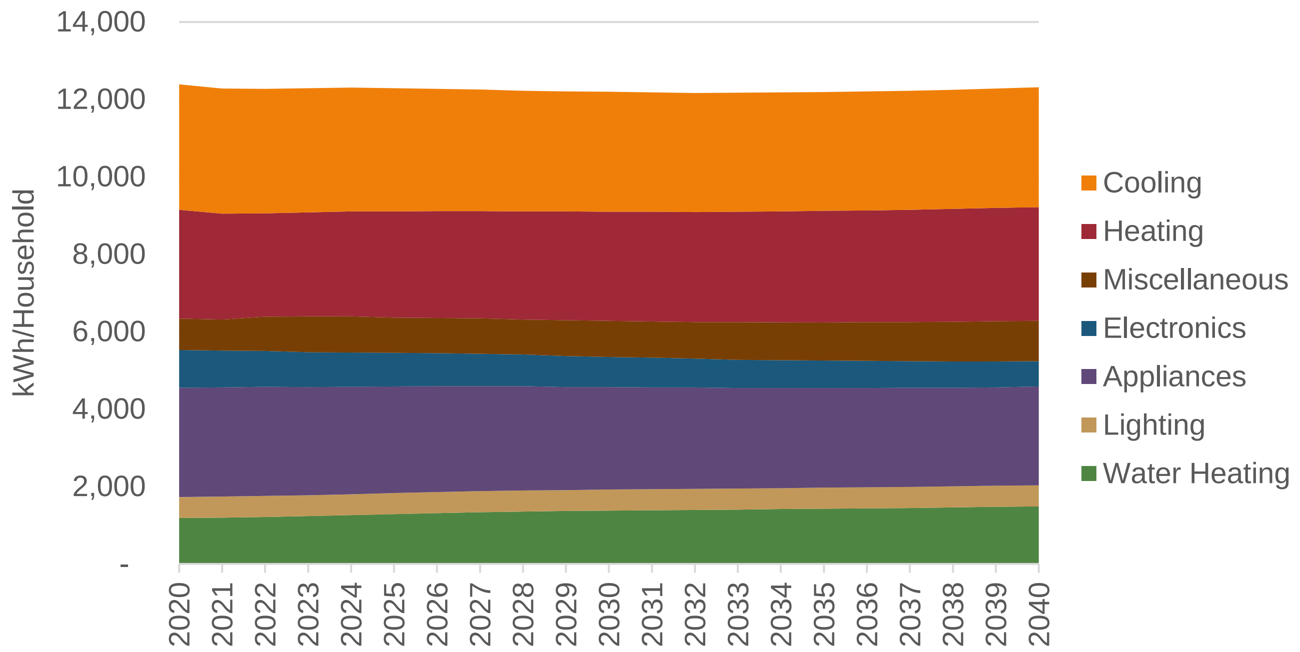


Figure I-12 Evergy Missouri West average residential electricity intensity by end use (kWh per household)

Next, ICF compared the baseline forecast with Evergy's 20-year historical load forecast. Figure I-13 and Figure I-14 present the ICF and Evergy forecasts for the Evergy Missouri Metro and Evergy Missouri West service territories. Overall, the ICF and Evergy forecasts are very similar, both projecting modest growth between 2020 and 2040.

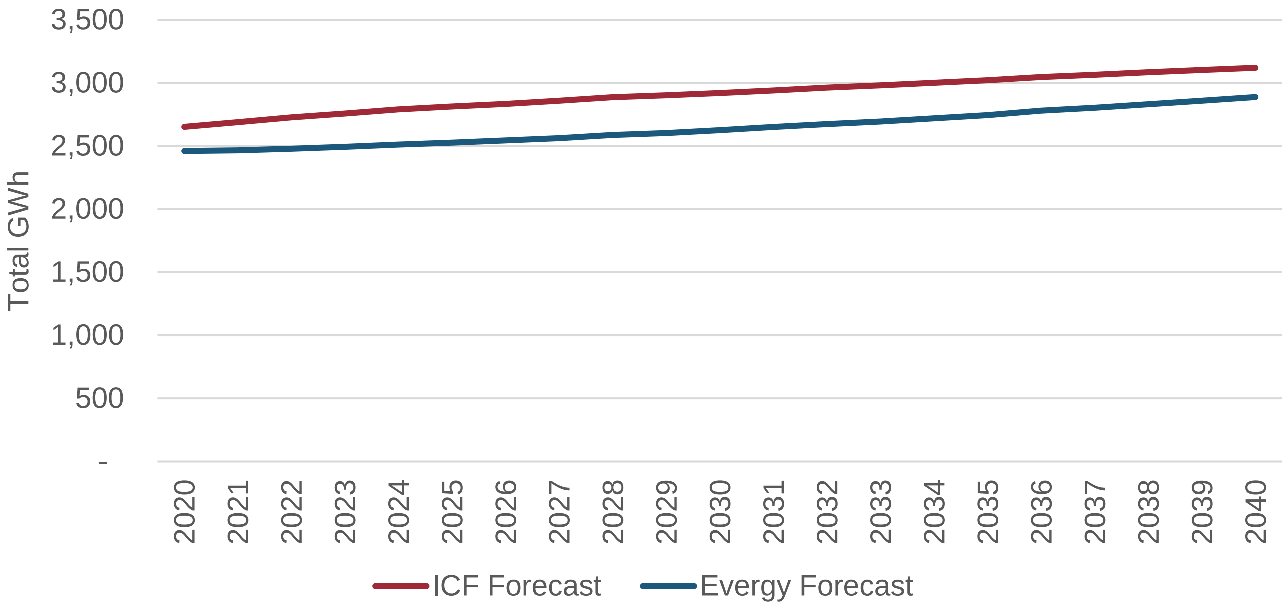


Figure I-13 Evergy Missouri Metro residential sector electricity use forecasts (GWh)

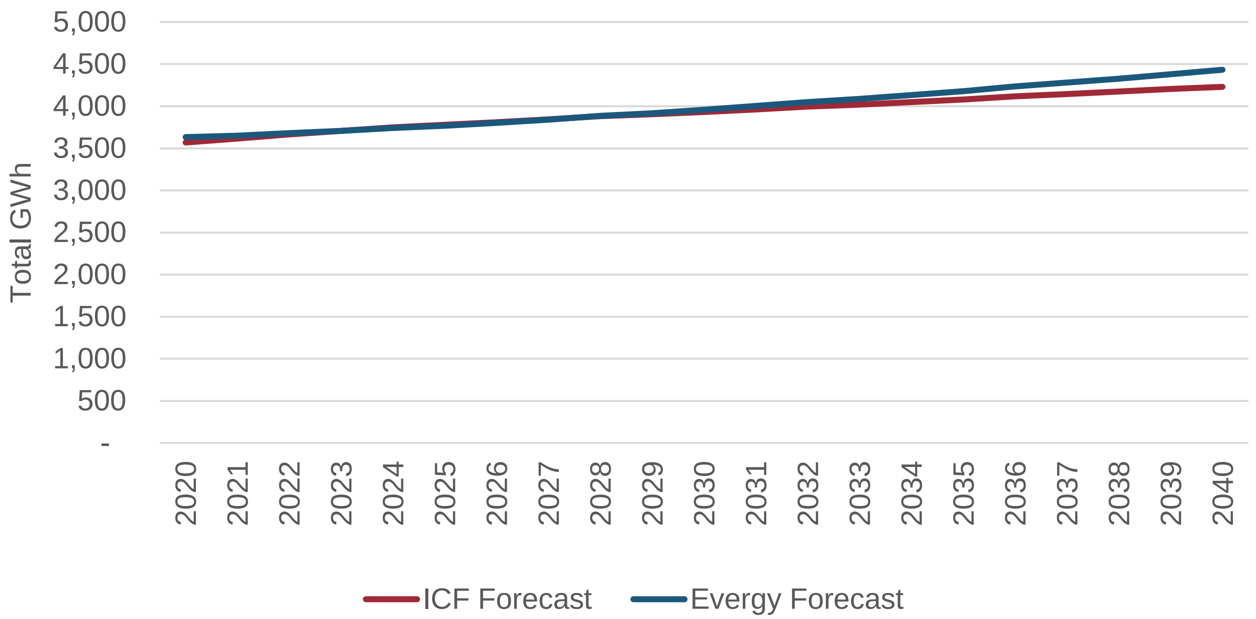


Figure I-14 Evergy Missouri West residential sector electricity use forecasts (GWh)

2.3.2 Commercial Baseline Projection

Table I-12 and Figure I-15 present the baseline projection for electricity at the end-use level for the commercial sector. Overall, commercial use increases from 7,672 GWh in 2019 to 8,218 GWh in 2040, an increase of 7%. This reflects a moderate customer growth forecast.

Table I-12 Evergy Commercial Baseline Electricity Use by End Use, Selected Years (GWh)

End Use	2020	2025	2030	2035	2040	% Change
Cooling	759	837	908	978	1,051	38%
Heating	233	248	260	267	271	16%
Ventilation	1,426	1,377	1,206	1,071	972	-32%
Water Heating	269	267	263	258	253	-6%
Interior Lighting	1,143	1,035	957	833	751	-34%
Exterior Lighting	553	501	463	403	364	-34%
Refrigeration	887	915	948	978	1,016	15%
Food Preparation	198	206	212	216	219	11%
Office Equipment	321	346	367	386	404	26%
Miscellaneous	1,882	2,154	2,417	2,667	2,917	55%
Total	**7,672**	**7,885**	**8,001**	**8,056**	**8,218**	**7%**

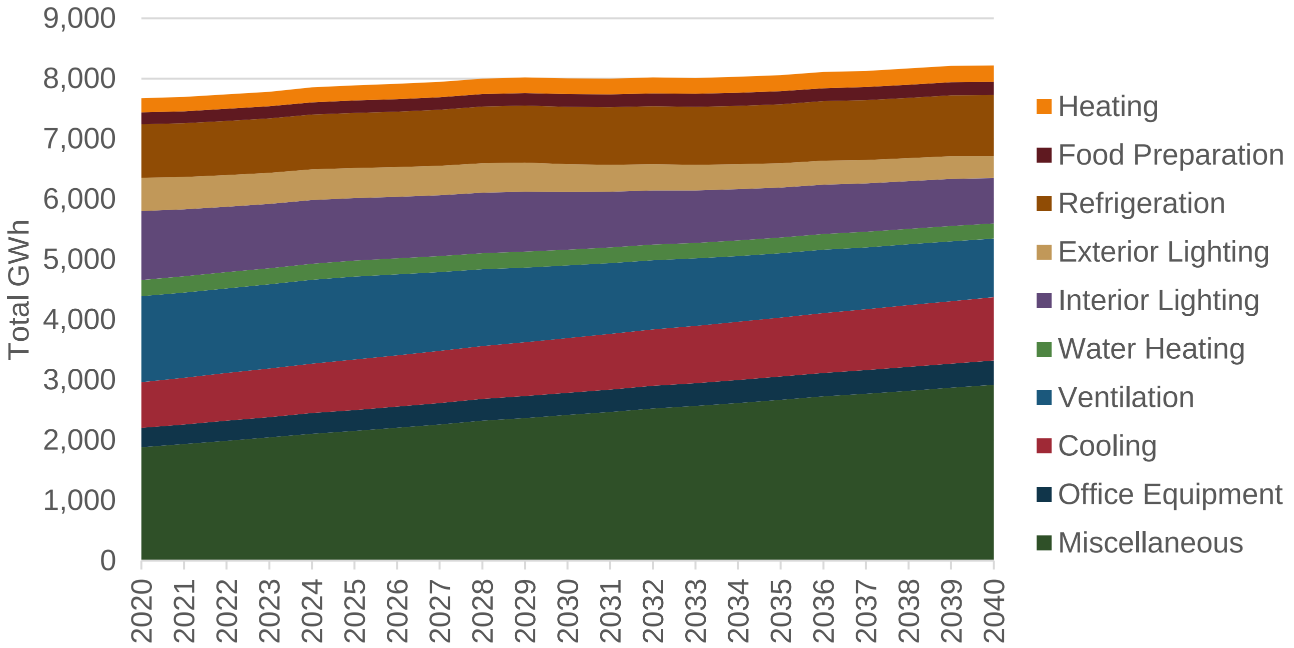


Figure I-15 Evergy commercial baseline electricity projection by end use

Figure I-16 presents the intensity projection, in kWh per square foot, by end use for the commercial sector. There is modest growth in the overall baseline projection. However, intensity per square foot decreases from 11.6 kWh to 10.8 kWh over the time horizon, a 7% decrease.

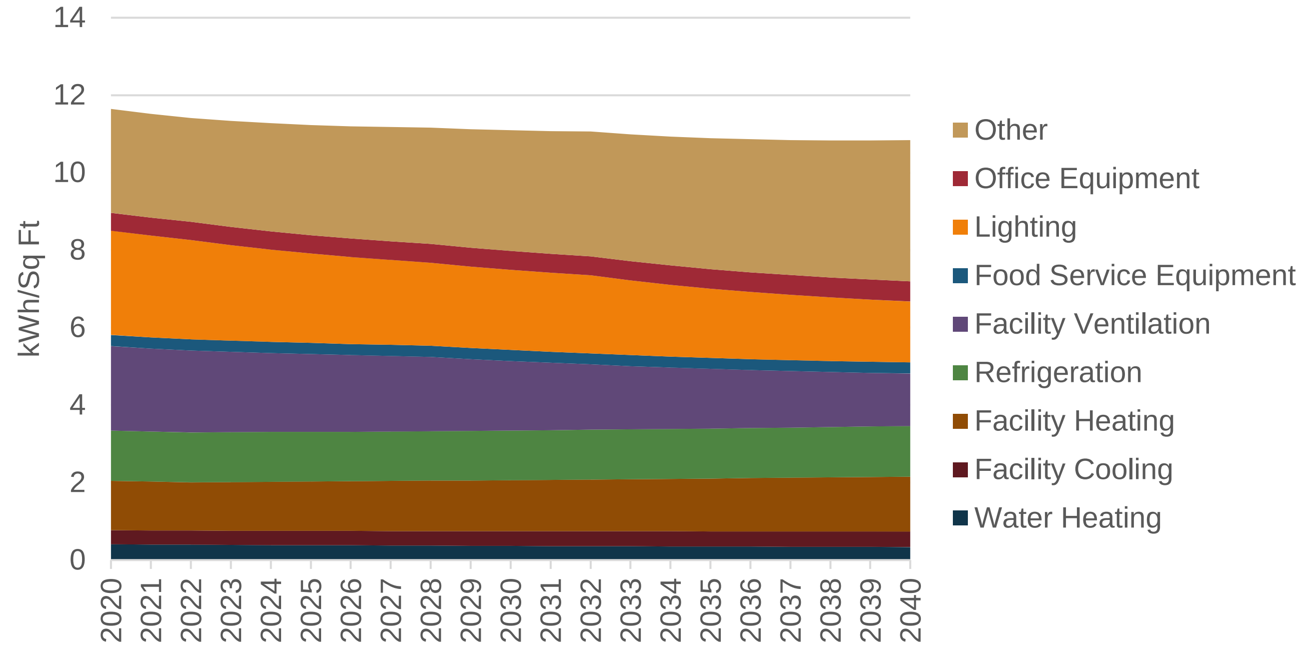


Figure I-16 Evergy commercial electricity intensity by end use (kWh/SqFt)

Next, ICF compared the baseline commercial forecast with Evergy's 20-year historical load forecast for the commercial sector. Figure I-17 presents the ICF and Evergy forecasts for the Evergy service territory. Overall, the ICF and Evergy forecasts are very similar. Of note, the ICF forecast falls below the Evergy forecast in the latter half of the modeling period. This is most likely due to natural efficiency improvement that is captured in ICF's forecast.

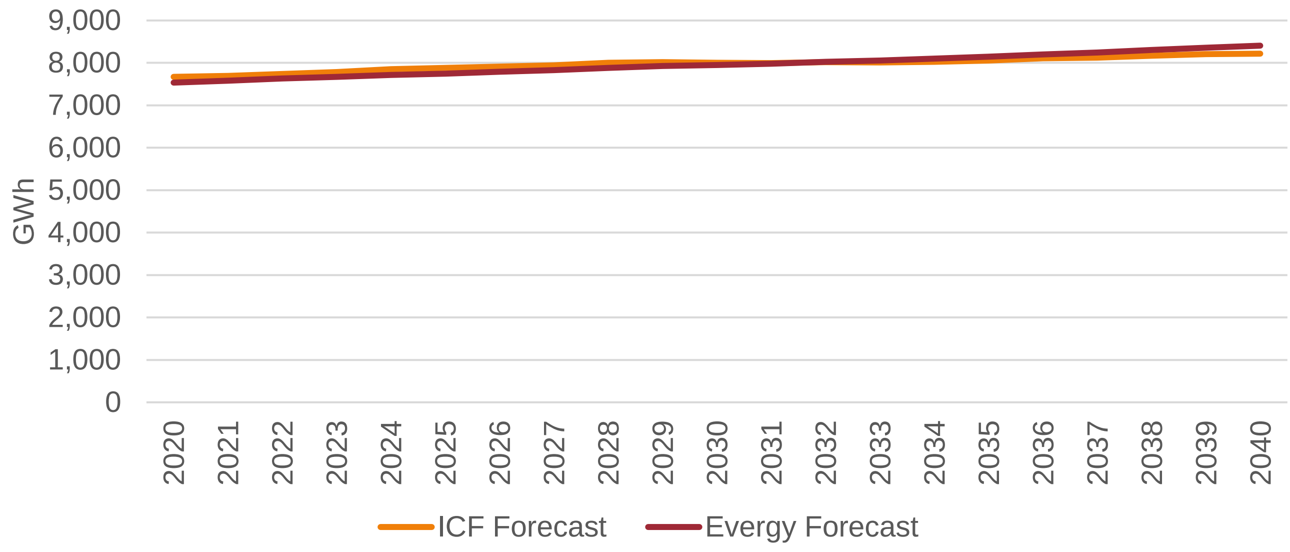


Figure I-17 Evergy commercial sector electricity use forecasts (GWh)

2.3.3 Industrial Baseline Projection

Table I-13 and Figure I-18 present the baseline projection for electricity use at the end-use level for the industrial sector. Overall, industrial use decreases from 2,910 GWh in 2020 to 2,762 GWh in 2040, a decrease of 5%. This reflects a projected decrease in the level of industrial employment in the Evergy service territory, combined with naturally occurring energy efficiency gains. Figure I-19 presents average electricity intensity by end use for the industrial sector.

Table I-13 Evergy Industrial Baseline Electricity Use by End Use, Selected Years (GWh)

End Use	2020	2025	2030	2035	2040	% Change
Cooling	100	96	93	91	91	-9%
Heating	73	72	70	69	67	-8%
Ventilation	96	89	76	67	60	-38%
Interior Lighting	68	60	54	48	44	-35%
Exterior Lighting	35	31	28	25	23	-34%
Motors	1,442	1,416	1,401	1,395	1,400	-3%
Process	869	854	845	842	844	-3%
Miscellaneous	227	226	227	230	232	2%
Total	**2,910**	**2,843**	**2,796**	**2,767**	**2,762**	**-5%**

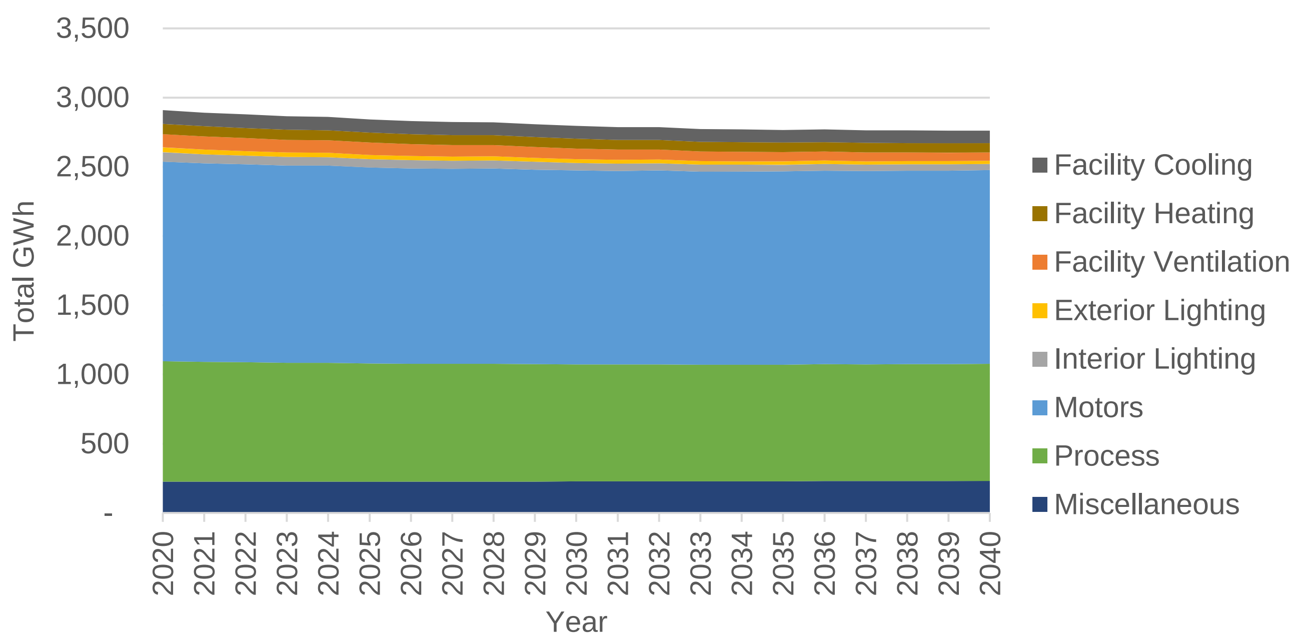


Figure I-18 Evergy industrial baseline electricity projection by end use

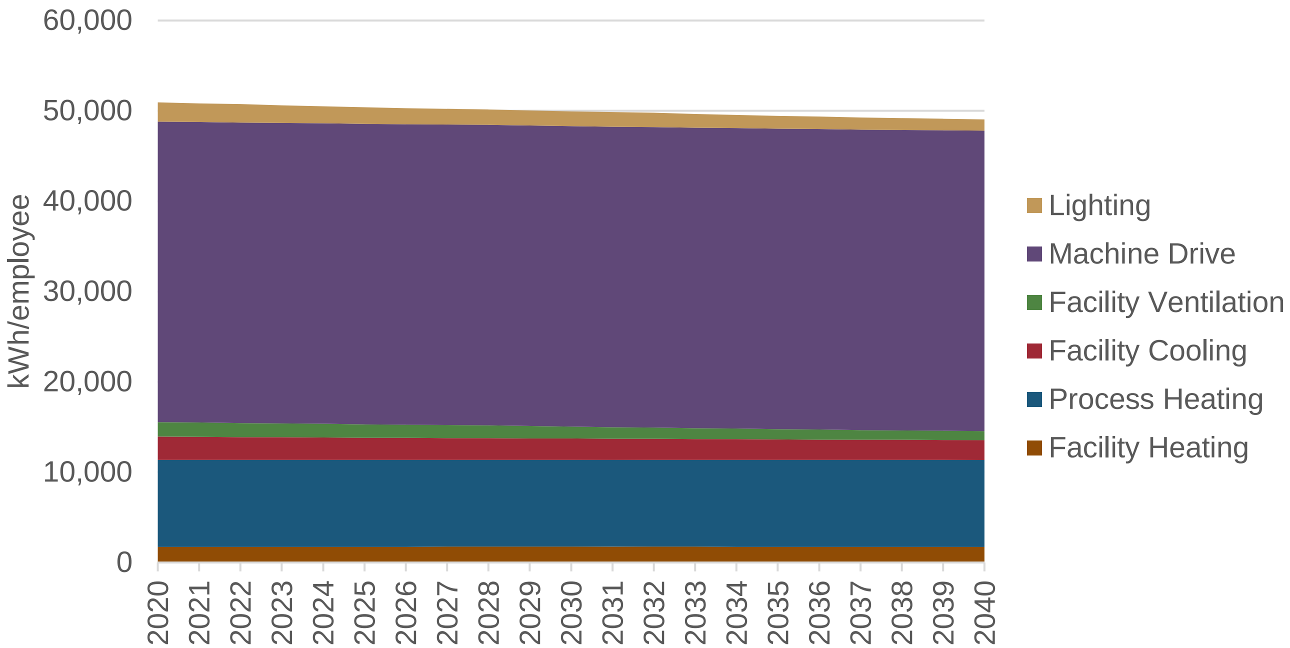


Figure I-19 Evergy industrial electricity intensity by end use (kWh per employee)

Next, ICF compared the baseline industrial forecast with Evergy's 20-year historical load forecast for the industrial sector. Figure I-20 presents the ICF and Evergy forecasts for the Evergy service territory. The forecasts are generally similar, however ICF incorporates naturally occurring energy efficiency improvements, leading to a larger decrease in overall electricity use in the industrial sector.

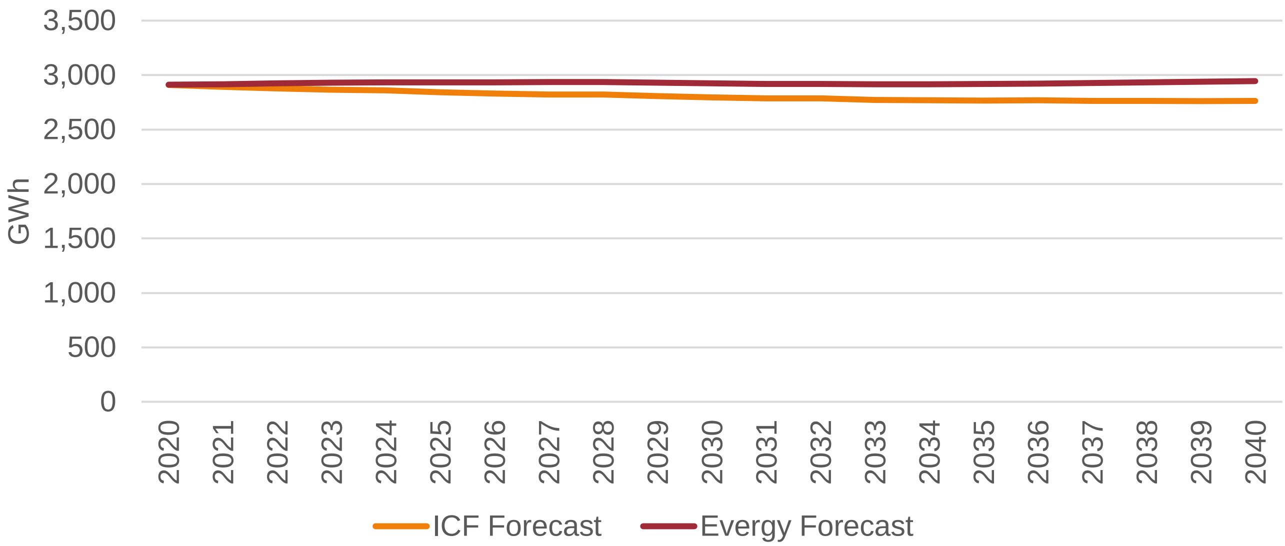


Figure I-20 Evergy industrial sector electricity use forecasts (GWh)

3. Technical and Economic Potential

3.1 Technical potential approach

Technical potential is the level of energy and demand savings that would result from installing the most technically efficient measures available for each end-use, regardless of cost. It is the upper bound of how much could theoretically be saved.

To calculate technical potential, ICF used its Demand Side Resource Potential Model (DSRPM). This R-based model applies an industry-standard, bottom-up approach to estimate DSM potential based on stock turnover.[10] Built upon the principles outlined by the National Action Plan for Energy Efficiency, the model enables detailed accounting of savings and costs by program, sector, building type, and end use. DSRPM is a measure-based model. Therefore, the first step in estimating technical potential was to input the measure database constructed in the previous phase of the analysis into the model. For ease of modeling and reporting, separate models were constructed for each sector: residential, commercial, and industrial. The potential study was also segmented into the two territories outlined by Evergy—Missouri Metro and Missouri West, resulting in a total of 6 models for the study.

As a stock-based turnover model, DSRPM uses a combination of savings per measure unit and total number of measure units, or total eligible stock, to quantify technical potential, as shown in Figure I-21.

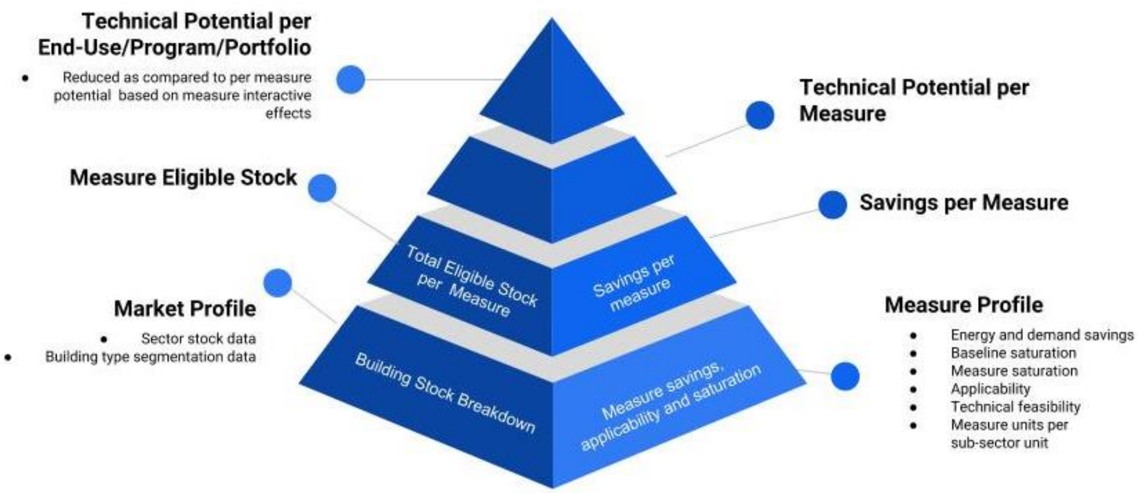


Figure I-21 DSRPM methodology for calculating measure technical potential based on savings per measure and total eligible stock

After inputting the measure characteristic data into DSRPM, the next step was to calculate the eligible stock for each measure. This requires a combination of measure-specific data, such as baseline and efficient measure saturation, as well as market-specific data, such as the total number of households. Table I-14 shows an example of how the eligible stock is calculated. The measure-specific applicability and saturation variables (factor a and factors d through g) are part of the measure database, whereas

[10] R Programming Language (https://www.r-project.org/)

the additional utility territory specific variables (factors b and c) are taken from the results of the market characterization study.

Table I-14 Example Calculation of Eligible Stock for a Measure

	Variable	Value	Calculation (if applicable)
	Efficient unit	13W LED Downlight	
	Baseline unit	45W Incandescent or Halogen Tracklight	
A	Baseline unit effective useful life (years)	2	
B	Residential customers	150,000	
C	Applicable Building Type – Single family Homes (%)	94%	
D	Bulbs per home	57	
E	Applicability (% of bulbs that are specialty applications)	6%	
F	Efficient unit saturation	12%	
G	Not yet adopted rate	88%	1 – f
H	Total hypothetical stock in 2019 (bulbs)	424,354	b × c × d × e × g
I	Annual replacement eligibility (stock turnover rate)	50%	1 / a
J	Total eligible stock to be replaced in 2019 (bulbs)	212,177	h × i

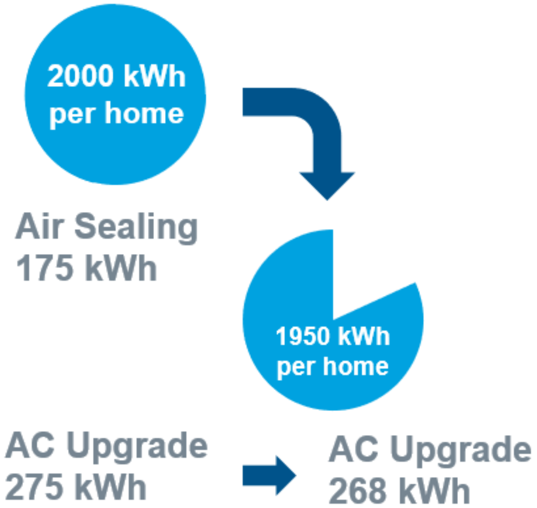
Often this information is further broken down, since multiple measures may apply to the same baseline opportunity. For example, the eligible stock for residential central air conditioners is further broken down by efficiency rating (SEER level) and decision type (replace-on-burnout or "ROB," retrofit, and new construction). When considering different measures that apply to the same baseline opportunity, ICF applied the methodology described in section 3.1.1 for the calculation of technical, economic, and achievable potentials.

When estimating technical potential, the measure with the highest total savings for a given baseline opportunity was selected. In the case of energy efficiency (EE) measures, this means the highest efficiency level was selected, such as SEER 21 AC unit. Similarly, for demand response (DR), when two different time of use rates are analyzed for the same customer, the rate that results in more aggressive savings was chosen. In contrast, the estimations of economic potential use the measure with the highest savings level that is also cost-effective.

3.1.1 Measure Cascading for Technical and Economic Potential

ICF accounted for the interactions between measure types within each resource type (EE, DR, and demand side resource (DSR)), as well as between measure types across these categories. For instance, an air sealing measure will reduce the overall heating and cooling load of a building, which will impact the savings obtainable from the implementation of an efficient heat pump and the savings obtainable from an AC cycling DR program.

To account for these interactions, ICF implemented a cascading approach, in which savings from the first measure decrease the baseline end-use EUI for the next measure, and therefore, the savings opportunity for the next measure. We assumed an implementation hierarchy to allow for a straightforward cascade of impacts between measures. Figure I-22 illustrates this concept and shows the order in which measures were assumed to be implemented. The order of the hierarchy was established with an explicit preference for long life measures that reduce building loads, such as envelope improvements, in accordance with the foundational principles of efficient building design. Next, more permanent long-life measures such as HVAC system upgrades were prioritized, followed by more easily removable equipment. The lowest priority energy efficiency measures were behavioral. Due to their single measure year lives and absence of lasting material impact to the physical building, DR and DSR are last in the hierarchy.



Hierarchy Position	*Measure Type*
1	Envelope Upgrades
2	System Upgrades (such as HVAC)
3	Equipment Upgrades (such as motors, light fixtures, water heaters)
4	Removable Equipment Upgrades (such as clothes washers, refrigerators)
5	Easily removable/low cost equipment (light bulbs, plug loads)
6	Behavioral EE Measures
7	Demand Side Rates
8	Demand Response

Figure I-22 Cascading example for interaction between air sealing and AC upgrade; hierarchy of cascading factors for different measure types

3.2 Economic potential approach

Economic potential is the cost-effective subset of technical potential. An initial economic screening process based on the Total Resource Cost (TRC) test was used to assess cost-effectiveness and filter out any measures with a benefit-cost ration below one. For measures that were not cost-effective on a TRC basis, a second level screening was conducted using the Program Administrator Cost (PAC) test. If the measure had a PAC of one or greater, the measure was included in the economic potential. This is based on MEEIA criteria that, “The commission shall approve demand side programs which have a TRC test ratio less than one (1), if the commission finds the utility has met the filing and submission requirements of this rule and the costs of such demand-side programs above the level determined to be cost-effective are funded by the customers participating in the demand-side programs.”[11] Therefore, it was appropriate to use the PAC to screen measures that were not deemed initially cost-effective with the TRC, since the PAC uses the incentive costs and excludes the remainder of the measure incremental cost, which is the cost covered by the program participant.

The sole non-energy benefit (NEB) included in the measure TRC test for the purpose of estimating economic potential was avoided probable environmental compliance costs, which is the only category of NEB currently approved by the Missouri Public Service Commission. To account for changing economics over time, the cost-effectiveness of each measure was assessed in each year of the forecast period. Therefore, if a measure was not found to be economic until 2032, then it was not included in economic potential estimates until 2032.

[11] Missouri Energy Efficiency Investment Act (MEEIA) (4 CSR 240-20.094 subsection (4)(K)) https://s1.sos.mo.gov/cmsimages/adrules/csr/current/4csr/4c240-20.pdf

Each economic potential estimate was based on the most efficient, cost-effective measure available for a given baseline opportunity. Exceptions to this rule were made for two measure types: low-income measures and measures within general education programs. This is because neither of these programs are subject to cost-effectiveness screening per Missouri Electric Utility Resource Planning regulations.[12]

3.3 Results

Technical potential equals 20% of load in 2023, and three-quarters of this is economic. Residential economic potential is 68% of technical potential, commercial economic potential is 82% of technical, and in the industrial sector economic potential is 86% of technical potential (Figure I-23).

In the residential sector, technical potential is 26% of load, and economic potential is 17% of load. Technical potential equals 18% of load in the commercial sector, while economic potential is 15% of load. And in the industrial sector, technical and economic potential equal 14% and 12% of industrial load, respectively (Figure I-24).

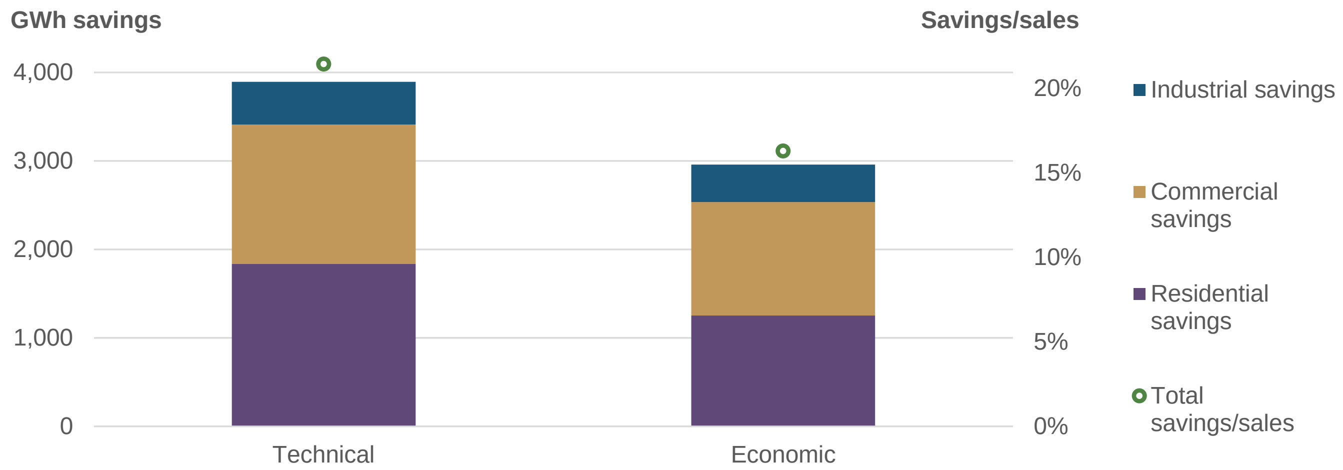


Figure I-23 Technical and economic potential by sector (2023)

Table I-15 Share of Electricity Use (load) Technical and Economic Potential, by Sector (2023)

Sector	Load	Technical Potential	Economic Potential
Residential	17%	47%	42%
Commercial	45%	41%	44%
Industrial	37%	12%	14%

[12] Missouri Energy Efficiency Investment Act (MEEIA) (4 CSR 240-20.094 subsections (3)(A)4., (4)(J), and (6)(B)) https://s1.sos.mo.gov/cmsimages/adrules/csr/current/4csr/4c240-20.pdf

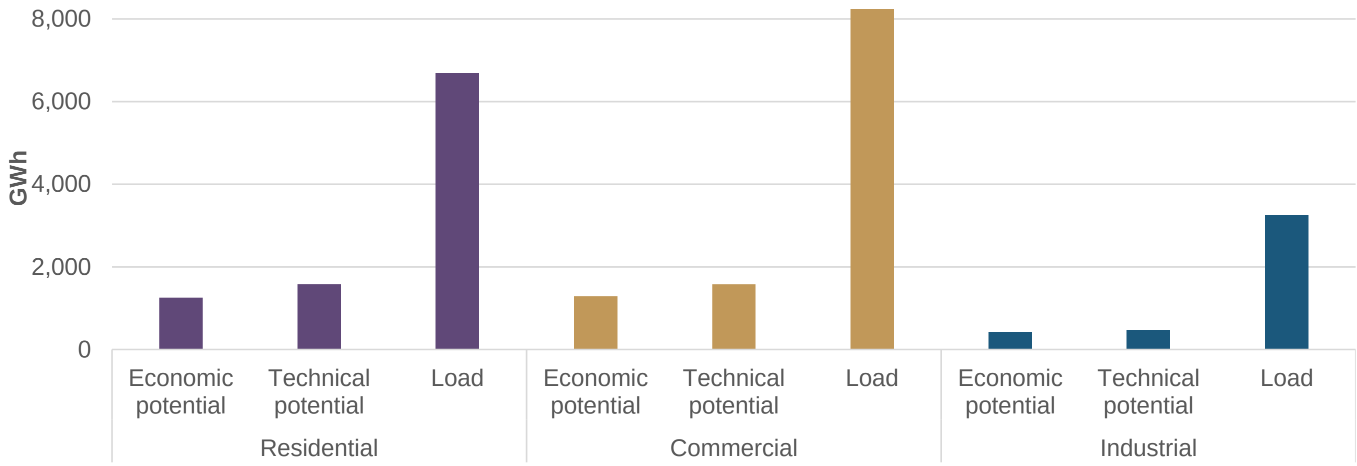


Figure I-24 Economic potential, technical potential, and electric load by sector (2023)

Technical and economic potential by end use widely varies between sectors. As shown in Table I-16, space heating and cooling comprise 69% of technical potential and 62% of economic potential in the residential sector, while lighting accounts for 11% of technical and 15% of economic, followed by water heating (7% and 8% for technical and economic, respectively). Lighting is the most important end use in the commercial sector, with 36% of technical potential and 37% of economic, followed by space cooling, which accounts for 25% of technical potential and 19% of economic, then refrigeration (16% and 19% for technical and economic, respectively). In the industrial sector, measures that improve plant efficiency, such as pumps, fans and process heating, constitute 61% of technical potential and 60% of economic potential, and measures that address facility efficiency (space lighting, heating, and cooling) account for 39% of technical potential and 40% of economic potential.

Table I-16 Share of Technical and Economic Potential by Sector by End Use (2023)

Sector/End use	Share potential	
	Technical	Economic
Residential	**47%**	**42%**
Clothes Washers	0%	0%
Hot Tubs	0%	0%
Other Uses	0%	0%
Televisions	0%	0%
Ventilation	0%	0%
Clothes Dryers	1%	0%
Pools	0%	0%
Personal Computer Equipment	0%	0%
Furnace Fans	2%	3%
Freezers	2%	3%
Plug Loads	4%	3%
Refrigerators	3%	4%
Water Heating	7%	8%
Lighting	11%	15%
Space Heating	34%	29%
Space Cooling	35%	33%
Commercial	**40%**	**43%**
Food Service Equipment	0%	0%
Ventilation	1%	1%
Water Heating	1%	1%
Office Equipment	2%	2%
Other	4%	2%
Space Heating	16%	18%
Refrigeration	16%	19%
Space Cooling	25%	19%
Lighting	36%	37%
Industrial	**12%**	**14%**
Other Non-Process Use	1%	1%
Motor - Other	7%	5%
Fans	7%	7%
Process Cooling & Refrigeration	10%	8%
Compressed Air	9%	10%
Space Heating	10%	11%
Facility Lighting	14%	12%
Process Heating	13%	14%
Pumps	16%	16%
Space Cooling	15%	17%

Table I-17 Share of Uneconomic MWh Savings by Sector by End Use (2023)

Sector/End Use	Share Uneconomic Savings
Residential	**74%**
Water Heating	0%
Freezers	0%
Clothes Washer	0%
Television	0%
Space Cooling	0%
Personal Computer	0%
Lighting	0%
Hot Tubs	1%
Other Uses	1%
Refrigerators	1%
Clothes Dryer	2%
Pools	3%
Space Heating	19%
Ventilation	23%
Furnace Fans	50%
Commercial	**22%**
Food Service Equipment	0%
Ventilation	0%
Office Equipment	0%
Refrigeration	2%
Space Heating	7%
Other	9%
Compressed Air	16%
Lighting	25%
Space Cooling	40%
Industrial	**4%**
Space Heating	0%
Process Cool & Refrigeration	0%
Pumps	1%
Facility Lighting	2%
Motor – Other	6%
Space Cooling	13%
Other Non-Process Use	19%
Process Heating	26%
Fans	32%

In total, 1,575 GWh of technical potential is uneconomic. 74% of uneconomic savings are residential, 23% are commercial and 4% are industrial. Space heating and cooling account for 92% of non-cost-effective savings in the residential sector; these end uses also comprise the greatest shares of technical potential. 36% of commercial space cooling is uneconomic; this end use accounts for 40% of total uneconomic commercial savings, followed by lighting (25%), although 84% of commercial lighting is cost-effective. In the industrial sector, measures for fans comprise 32% of uneconomic potential, and process heating comprises 26% (Table I-17).

4. Achievable Potential

4.1 Approach

The achievable energy efficiency potential analysis was conducted using both bottom-up and top-down approaches. The approach varied by scenario; each scenario is described below. The process for identifying programs to include in the analysis was based on Missouri electric utility resource planning rules and Missouri Energy Efficiency Investment Act (MEEIA) implementing rules. The programs identified were evaluated for cost effectiveness pursuant to the Missouri IRP rules, 4 CSR 240-22.050(5) and Missouri Demand-Side Programs, 4 CSR240-20.094(4)(C).

4.1.1 Scenarios

ICF developed five achievable energy efficiency potential scenarios for this study: Realistic achievable potential (RAP), RAP-, RAP+, MEEIA, and Maximum Achievable Potential (MAP).

RAP is the reference case forecast. It is the basis of all other achievable scenarios. It reflects a world in which Evergy continues only operating its current energy efficiency programs without substantial changes. As with all scenarios, RAP accounts for known state and Federal updates to minimum energy performance standards (MEPS) for lighting and appliances as well as energy performance standards for new buildings and major retrofits. In the RAP- scenario, Evergy continues operating only its current programs, but savings levels are lower than what Evergy historically achieved. Similarly, in RAP+ current programs achieve higher savings levels than they did historically.

There are many changes in the MEEIA scenario.[13] New economic measures are added to current programs, and where possible the performance of current programs is increased above RAP+ levels based on benchmarking and ICF expert input. Additionally, entire new programs are added.

MAP is a theoretical scenario where all customer incentives are set to 100% of measure incremental costs. The other important change in this scenario is that the cost-effectiveness threshold is changed from the program level to the sector level. This would give Evergy more flexibility to adjust programs to

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[13] The MEEIA (4 CSR 240-20.094(2)) states that :
(A) For demand-side programs and program plans that have a total resource cost test ratio greater than one (1), the commission shall approve demand-side programs or program plans, and annual demand and energy savings targets for each demand-side program it approves, provided it finds that the utility has met the filing and submission requirements of 4 CSR 240-20.094(4)(B) and the demand-side programs and program plans—
1. Are consistent with a goal of achieving all cost-effective demand-side savings;
2. Have reliable evaluation, measurement, and verification plans; and
3. Are included in the electric utility's adopted preferred resource plan or have been analyzed through the integrated resource analysis required by 4 CSR 240-22.060 to determine the impact of the demand-side programs and program plans on the net present value of revenue requirements of the electric utility.
(B) The commission shall approve demand-side programs having a total resource cost test ratio less than one (1) for demand-side programs targeted to low-income customers or general education campaigns, if the commission determines that the utility has met the filing and submission requirements of 4 CSR 240-20.094(4)(B), the program or program plan is in the public interest, and meets the requirements stated in paragraphs (3)(A)2. and 3.

Note Missouri has voluntary energy efficiency resource standards (goals) for electric utilities to aid the Commission in reviewing a utility's progress towards achieving all cost effective demand-side savings including: a) incremental annual energy and demand savings in 4 CSR 240-20.094(2), and b) cumulative annual energy and demand savings in 4 CSR 240-20.094(2)(B). For instance, 0.3% incremental annual energy savings in 2012, ramping up annually to 0.9% in 2015 and 1.7% in 2019 for cumulative annual energy savings of 9.9% by 2020. The voluntary goals are not mandatory, and no penalty or adverse consequence will accrue to a utility that is unable to achieve the annual energy and demand savings goals (Source: ACEEE).

meet overall savings targets. Emerging technologies are also added in MAP. The parameters of each scenario are shown in further detail in Table I-18.

Table I-18 Achievable Energy Efficiency Potential Scenarios

Variable/Scenario	Realistic Achievable Potential (RAP)	RAP (-)	RAP (+)	MEEIA	Max Achievable Potential (MAP)
Annual EE resource standard (% of sales)	NA	NA	NA	1.90%	1.90%
Primary BC test	TRC	TRC	TRC	TRC	TRC
Cost-effectiveness threshold	Program	Program	Program	Program	Sector-level Portfolio
Discount rate	WACC	WACC	WACC	WACC	WACC
Avoided costs	All direct utility benefits	All direct utility benefits	All direct utility benefits	All direct utility benefits	All direct utility benefits
Non-energy benefits*	Yes	Yes	Yes	Yes	Yes
Programs included	Current	Current	Current	Expanded current + new	Expanded current + new + emerging tech
Program costs	Current	< Current (varies by program)	> Current (varies by program)	> RAP(+) (varies by program)	100% of incremental

* Non-energy benefits (NEBs) include (1) Avoided probable environmental compliance costs (2) Water, wastewater, and gas (3) Other confidently quantifiable NEBs (e.g., avoided O&M costs). The NEBs are only included in the Societal Cost Test (SCT).

Realistic achievable potential (RAP)

The RAP scenario is a continuation of Evergy's current programs based on historical performance. RAP savings and costs were estimated using historical data from evaluation results and program reports. Specifically, ICF calculated average annual program savings and costs for 2016 to 2018, and these average values were used as the forecast assumptions. For example, if the average participation rate for a measure in an existing Evergy program over the 2016 to 2018 period was 5% of the eligible stock, then the analysis assumed the program would continue saving at a rate of 5% for the forecast period. This means that for most measures savings decreases over time, because the eligible stock decreases with cumulative program participation. Behavioral programs are an exception to this trend because the eligible stock for behavioral measures is number of customers, not equipment. Average historical savings were used because of regression to the mean. Performance levels in individual program years can be particularly high or low because of exogenous factors, because an unusually large project was implemented, or because program managers needed to change the program design or requirements during the year to help meet goal, meet budget, or for other reasons. Forecasted program costs in RAP are also based on historical averages.

Current Evergy offerings include the following nine programs:

- **Residential energy efficiency programs**

  - **Home energy report and income-eligible home energy report**: Provides home occupants with information about their energy use compared to that of similar homes. Based on this information they take action to conserve energy use.
  - **Home lighting rebate**: Provides upstream incentives to partnering manufacturers and retailers.[14]
  - **Income-eligible multifamily**: Delivers long-term energy savings and bill reductions to residents in multifamily housing that meet the income requirements and to multifamily housing owners whose buildings have income-eligible residents.
  - **Whole house efficiency**: Promotes whole house improvements to existing homes through home energy audits and comprehensive retrofits.
- **C&I energy efficiency programs**
  - **Standard**: Offers a diverse set of measures that have prescriptive measure savings and an incentive process that improves accessibility to the customer.
  - **Custom**: Provides incentives for energy efficient upgrades with unique energy use baselines for business customers. This program also includes new construction and retro-commissioning elements.
  - **Small business**: Provides business customers whose average monthly coincident peak demand is less than 100 kW with direct install lighting measures.
  - **Block bidding**: Provides incentives for custom energy efficiency projects that would exceed the incentive cap of the Custom program.
  - **Strategic energy management**: Implements continuous energy management improvement processes that result in energy savings and reductions in energy intensity for industrial and large commercial clients.

RAP- and RAP+

The RAP- and RAP+ scenarios are also continuations of current Evergy programs, but at lower and higher savings levels than historical. Compared to the RAP scenario, costs are generally lower in RAP- and higher in RAP+. Savings levels for RAP- and RAP+ were estimated using benchmarking and ICF expert input.

Historical performance of current Evergy programs was compared to that of peer programs operated in the following ten states in the U.S. Central region: Arkansas, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Oklahoma, and Tennessee. For example, the benchmarking class used for comparison to Evergy's Business Standard program included similar C&I Prescriptive programs operated by the following 18 program administrators: AEP - PSO – OK, AEP - Southwestern Electric Power Co. AR, Alliant Energy – Minnesota, Ameren Illinois, Ameren Missouri, ComEd, Consumers Energy Company, DTE Energy, Entergy Arkansas, Indiana Michigan Power, Indianapolis Power & Light, MidAmerican Energy – IL, Minnesota Power, NIPSCO, Oklahoma Gas & Electric – AR, Oklahoma Gas & Electric – OK, Otter Tail Power Company and Xcel Energy – Minnesota.

Evergy's Business Standard program performed well compared to its benchmarking class. Average savings levels in 2016 to 2018 were 0.6% of C&I sales for KCPL-MO, which is the 60th percentile of the benchmarking class. This means that savings levels achieved by KCPL-MO's program are higher than three-fifths of the programs in the benchmarking class. The RAP+ scenario assumed Evergy's Business

[14] The RAP, RAP+, MEEIA, and MAP scenarios assumed energy use baselines for general service LEDs do not change over the time horizon of the forecast. This is because Tier 2 of the Energy Independence and Security Act of 2007 (EISA 2007) is being litigated. The RAP- scenario assumed Tier 2 of EISA 2007 is implemented beginning in 2023.

Standard program could achieve savings levels equal to the 75th percentile of the benchmarking class, which is 0.8% of C&I sales. In the RAP- scenario, we assume the program would achieve the median level of savings, 0.5% of C&I sales. Program costs were adjusted in the same manner.

Similar benchmarking analyses were conducted for most current Evergy programs. For programs where benchmarking data was insufficient or unavailable, including Block Bidding and Strategic Energy Management (SEM), ICF used expert input to develop savings assumptions for the RAP- and RAP+ scenarios.

See the Appendix for benchmarking data specific to each program.

MEEIA

In the MEEIA scenario, Evergy has an energy savings target of 1.9% of sales. To model this, ICF added new economic measures to current Evergy programs and new programs. The portfolio was then optimized to maximize cost-effectiveness and savings.[15]

And the following additional programs were modeled:

- **Residential**
  - **Midstream HVAC and heat pump water heater**: Unitary air conditioners and heat pumps are discounted at the distributor level. This was modeled by moving the Tier 3 HVAC measures from the current whole house efficiency program to a midstream design.
  - **Multifamily**: Similar design to the current income-eligible multifamily program but targeted at non-income eligible multifamily housing. This was modeled by moving the Tier 3 HVAC measures from the current whole house efficiency program to a midstream model.
- **Commercial and industrial**
  - **Midstream lighting**: Lighting products are discounted at the distributor level. This was modeled by moving the Business standard lighting measures to a midstream design.
  - **Commercial new construction**: Design assistance and incentives for high efficiency new commercial buildings. Evergy currently includes this program within its business custom offering.

In the MEEIA scenario, for most existing measures in current Evergy programs participation was set to RAP+ scenario levels because RAP+ levels represent a reasonable upper limit of annual savings based on actual performance of the benchmarking class. For new measures added to current programs, in most cases participation levels in the MEEIA scenario were set to RAP+ scenario levels for similar existing measures. For example, if a new unitary HVAC measure was added, maximum participation was set to same level as other comparable unitary HVAC measures that are already offered by the program. If a new measure was added to a current program and there was no current measure analogous to this new measure, ICF estimated participation based on input from internal program experts. For example, participation and costs for agricultural measures were estimated based on the experience of ICF mangers who manage agricultural energy efficiency programs in the Central region.

Participation and costs for new programs was also estimated based on benchmarking and ICF expert input. Key participation and cost assumptions for each scenario are shown in section 4.1.3.

Optimization was the last step in developing the MEEIA scenario. The goal of optimization was to maximize savings and the TRC test result. Confidence intervals around participation estimates are +/-

[15] Measures not included in current Evergy programs with Total Resource Cost test results of 1.0 or higher.

10%. For example, if the estimated participation rate was 10%, the range of possible participation in the optimization was 9%-11%. ICF then ran a mathematical optimization in R and reviewed the outputs for reasonableness.

MAP

The MAP scenario represents the theoretical upper limit of participation in Evergy programs. Incentives were modeled as 100% of measure incremental costs. No actual programs set incentives this high, except for income eligible offerings. Therefore, there is no actual data for a benchmarking class that could be used to model the MAP scenario.

Increasing incentives to 100% could result in more free-ridership or other factors that lower program net savings. Free energy efficiency will certainly increase participation in the short run, but some share of additional participants would have implemented energy efficiency anyway – they are just taking advantage of the free products and services. Another possible outcome is that because efficiency is free, participants have lower incentives to take care of efficient equipment. For these reasons, the MEEIA scenario reduced program net-to-gross ratios (NTGR) from RAP+ levels by 0.1. For example, if a program NTGR was 0.8 in the RAP+ scenario, we reduced it to 0.7 in the MEEIA scenario.

In the MAP scenario, the threshold for cost-effectiveness was shifted from the program level to the sector level. This means that as long as the sector level TRC test result was 1.0 or higher, a non-economic program could be included. A sector or total portfolio level cost-effectiveness threshold gives program administrators more flexibility to reach higher savings levels because they do not have to worry about the economics of individual programs.

ICF used optimization to estimate savings in the MAP scenario. Optimization was carried out for each sector: residential, commercial and industrial. Program participation was optimized to maximize participation while ensuring sector-level cost-effectiveness (TRC or 1.0 or higher). At the upper end, participation levels were allowed to float up to 30% above MEEIA levels. For example, if program participation in the MEEIA scenario was 10%, maximum participation in the MAP scenario could increase up to 13%. At the lower end, participation could float all the way to 0%. This was to give the optimizer sufficient latitude to maximize both savings and cost-effectiveness. Mathematical optimization for the MAP scenario was run in R.

4.1.2 Measure types

Table I-19, Table I-20, and Table I-21 show which measure types were included in each program and scenario.

Table I-19 Residential Measure Types Modeled by Program by Scenario

Program Names	Scenarios	Measure Types/Bundles
Home Energy Report	All	HER Tier 1
Home Lighting Rebate	All	Specialty LEDs Standard LEDs
Income-Eligible Home Energy Report	All	HER Tier 1
Income-Eligible Multi-Family	All	Aerators
		Custom
		Insulation
		Smart Strip
		Lighting
		Lighting Giveaway
		Low Flow Shower Head
Whole House Efficiency	All	Tier 1: Energy Savings Kit
		Tier 2: Building Shell Measures
		Tier 3: HVAC Measures
	MEEIA & MAP	Tier 1: New Measures
		Tier 2: New Measures
		Tier 3: New Measures
		Tier 4: Appliance Recycling
		Midstream: Heat Pump Water Heaters
		Midstream: HVAC
		Midstream: High Efficiency HVAC
Multi-Family	MEEIA & MAP	Aerators
		Insulation
		Smart Strip
		Lighting
		Low Flow Shower Head

Table I-20 Commercial Measure Types Modeled by Program by Scenario

Program Names	Scenarios	Measure Types/Bundles
Home Energy Report	All	HER Tier 1
Home Lighting Rebate	All	Specialty LEDs Standard LEDs
Income-Eligible Home Energy Report	All	HER Tier 1
Income-Eligible Multi-Family	All	Aerators
		Custom
		Insulation
		Smart Strip
		Lighting
		Lighting Giveaway
		Low Flow Shower Head
Whole House Efficiency	All	Tier 1: Energy Savings Kit
		Tier 2: Building Shell Measures
		Tier 3: HVAC Measures
	MEEIA & MAP	Tier 1: New Measures
		Tier 2: New Measures
		Tier 3: New Measures
		Tier 4: Appliance Recycling
		Midstream: Heat Pump Water Heaters
		Midstream: HVAC
		Midstream: High Efficiency HVAC
Multi-Family	MEEIA & MAP	Aerators
		Insulation
		Smart Strip
		Lighting
		Low Flow Shower Head
Business EER - Standard	All	
		Hot Water
		HVAC
		Lighting Control
		Pumps/Fans
		Refrigeration
	MEEIA & MAP	Agricultural Measures
		Consumer Electronics
		Food Service

		New Hot Water
		New HVAC
		New Lighting Controls
		New Pumps/Fans
		New Refrigeration
		Midstream Lighting
New Construction	MEEIA & MAP	New Construction

Table I-21 Industrial Measure Types Modeled by Program by Scenario

Program Name	Scenario	Measure Types/Bundles
Business EER - Custom	All	Building Optimization
		HVAC
		Lighting
		Misc. Custom
		Motors, Drives & Compressors
		Refrigeration Upgrade
Business EER - Standard	All	Lighting
		Hot Water
		HVAC
		Lighting Control
		Pumps/Fans
		Refrigeration
Strategic Energy Management	All	Strategic Energy Management
Midstream	MEEIA & MAP	Midstream Lighting

4.1.3 Participation and cost assumptions

Savings levels and cost assumptions for each scenario are shown in Table I-22 and Table I-23. In the RAP- and RAP scenarios, programs are assumed to be able to achieve these levels of savings in 2023. But for most programs in the RAP+, MEEIA, and MAP scenarios, programs ramp-up over time to the levels shown from reference levels established in the RAP scenario. Most ramp-up periods were set to three years. The costs shown are program administrator costs per kWh. These are calculated as the total program costs over the time horizon of the study divided by total incremental (annual) savings.

Table I-22 Combined Commercial and Industrial Savings Levels and Costs

Service area	Program	Max Annual Savings as a % of Target Sector Sales					Program Annual $/kWh				
		RAP-	RAP	RAP+	MEEIA	MAP	RAP-	RAP	RAP+	MEEIA	MAP
Metro	Business custom	0.07%	0.13%	0.35%	0.38%	0.42%	$0.28	$0.36	$ 0.37	$ 0.19	$ 1.05
Metro	Business standard	0.44%	0.71%	0.95%	1.23%	1.43%	$0.10	$0.18	$ 0.18	$ 0.19	$ 0.71

Metro	Small business	0.02%	0.02%	0.07%	0.08%	0.09%	$0.60	$0.60	$ 0.58	$ 0.60	$ 0.65
Metro	Strategic energy management	0.10%	0.11%	0.11%	0.12%	0.16%	$0.06	$0.06	$ 0.06	$ 0.06	$ 0.07
Metro	Block bidding	0.00%	0.00%	0.00%	0.00%	0.00%	$3.15	$3.22	$ 3.22	$ 2.88	$ 4.88
Metro	Commercial new construction	n/a	n/a	n/a	0.02%	0.02%	n/a	n/a	n/a	$ 0.23	$ 0.76
West	Business custom	0.07%	0.11%	0.34%	0.34%	0.38%	$0.21	$0.37	$ 0.37	$ 0.19	$ 1.14
West	Business standard	0.41%	0.61%	0.92%	1.24%	1.43%	$0.12	$0.19	$ 0.19	$ 0.17	$ 0.94
West	Small business	0.02%	0.02%	0.07%	0.08%	0.09%	$0.68	$0.67	$ 0.63	$ 0.63	$ 0.67
West	Strategic energy management	0.03%	0.03%	0.03%	0.04%	0.05%	$0.22	$0.25	$ 0.25	$ 0.23	$ 0.35
West	Block bidding	0.02%	0.02%	0.02%	0.02%	0.03%	$0.64	$0.85	$ 0.85	$ 0.71	$ 0.90
West	Commercial new construction	n/a	n/a	n/a	0.04%	0.05%	n/a	n/a	n/a	$ 0.24	$ 0.74

Table I-23 Residential Savings Levels and Costs

Service area	Program	Max Annual Savings as a % of Target Sector Sales					Program Annual $/kWh				
		RAP-	RAP	RAP+	MEEIA	MAP	RAP-	RAP	RAP+	MEEIA	MAP
Metro	Home Energy Report	0.49%	0.83%	0.83%	1.21%	1.21%	$0.05	$0.05	$ 0.05	$ 0.07	$ 0.07
Metro	Home Lighting Rebate	0.06%	0.36%	0.36%	0.36%	0.31%	$0.17	$0.21	$ 0.21	$ 0.22	$ 0.30
Metro	Income-Eligible Home Energy Report	0.08%	0.08%	0.08%	0.09%	0.09%	$0.12	$0.12	$ 0.12	$ 0.13	$ 0.13
Metro	Income-Eligible Multi-Family	0.09%	0.15%	0.19%	0.20%	0.22%	$0.27	$0.22	$ 0.24	$ 0.34	$ 0.35
Metro	Whole House Efficiency	0.03%	0.15%	0.15%	0.34%	0.38%	$0.29	$0.56	$ 0.56	$ 0.33	$ 0.62
Metro	Multi-Family DI	n/a	n/a	n/a	0.09%	0.11%	n/a	n/a	n/a	$ 0.43	$ 0.42
West	Home Energy Report	0.44%	0.66%	0.66%	1.07%	1.07%	$0.07	$0.07	$ 0.07	$ 0.05	$ 0.05
West	Home Lighting Rebate	0.05%	0.28%	0.28%	0.28%	0.31%	$0.16	$0.20	$ 0.20	$ 0.21	$ 0.29
West	Income-Eligible Home Energy Report	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
West	Income-Eligible Multi-Family	0.05%	0.09%	0.12%	0.11%	0.15%	$0.26	$0.21	$ 0.22	$ 0.35	$ 0.34
West	Whole House Efficiency	0.03%	0.16%	0.16%	0.33%	0.38%	$0.27	$0.57	$ 0.57	$ 0.34	$ 0.62
West	Multi-Family DI	n/a	n/a	n/a	0.10%	0.12%	n/a	n/a	n/a	$ 0.41	$ 0.41

4.1.4 Net-to-gross ratios

Net-to-gross ratios (NTGR) for current Evergy programs were based on Evergy-evaluated NTGR. Net-to-gross ratios for new programs were estimated base on ICF expert input. Although minimizing free-ridership is an important element of program design, it is not possible to eliminate it in most programs. Exceptions include income-eligible programs and behavioral programs such as Home Energy Report. Some level of free-ridership is generally found to be acceptable by government regulators if programs are cost-effective under the state's cost-effectiveness rules. Further, there can be a trade-off between high savings levels and free-ridership. Programs that are delivered downstream with custom energy baselines—Business EER Custom, for example—tend to have less free-ridership because program managers can assess each potential participant's current status before the program pays an incentive for an efficiency project. For example, if a company has already started a project before contacting the program, then the program will not pay the incentive. But this level of due diligence is expensive and not possible with programs designed to scale-up, such as retail or distributor (midstream) programs where incentives are built into product prices. Even with higher free-ridership levels, such programs tend to be economic because they have lower administrative costs and higher savings volumes.

Table I-24 Portfolio Net-to-Gross Ratios From Around the Country (n=32)

Program Administrator	NTGR
NIPSCO	0.48
Duquesne Light	0.53
Dominion - NC	0.57
Dominion	0.57
FrstEnergy - West Penn Power	0.62
PPL Electric Utilities	0.68
FirstEnergy - Penn Power	0.68
FirstEnergy - Met-Ed	0.71
FrstEnergy - Penelec	0.73
Wisconsin Focus on Energy	0.74
PNM	0.76
NationalGrid • MA	0.77
Rocky Mountain Power - WY	0.77
Oklahoma Gas & Electric - AR	0.8
CPS Energy	0.81
Rocky Mountan Power - UT	0.81
J>EP - PSO - OK	0.81
EntergyPtkansas	0.81
J>EP - Southwestern Electric Power Co.AA	0.82
Indianapolis Power & Light	0.82
Indiana Michigan Power	0.83
Oklahoma Gas & Electric - OK	0.85
PSEG Long Island	0.88
XcelEnergy - Colorado	0.9
Pacific Power - WA	0.9
XcelEnergy- New Mexico	0.92
CenterPoint Energy - Texas	0.93
Festival H)o.:lro	0.93
Rocky Mountain Power - ID	0.94
Ameren fl/lissouri	0.97
DTE Energy	0.97
Duke Energy - OH	0.98
Median	0.81

Source: ESource

As shown in Table I-24, the median portfolio NTGR among 32 energy efficiency program administrators from around the U.S. is 0.81.[16] Evergy's average historical portfolio NTGRs have been 0.9 or higher, suggesting there is less free-ridership in Evergy's programs than in most administrators. No analysis was performed comparing evaluation methods across program administrators.

4.2 Results

4.2.1 Summary

If Evergy continues with its current program designs, load grow could flatten in the short-term before starting to climb through the remainder of the forecast period; in the RAP scenario, load is 4% lower than the baseline over the long run. If Evergy expands current programs and adds new programs, load growth could decline in the short-run before flattening in the medium-term then slowly increasing through 2042; in the MEEIA scenario, load is 8% lower than baseline in the long-run. (Figure I-25 and Table I-25). A decline in load growth cannot be sustained for the duration of the forecast because there is a limited stock of energy efficiency measures, and many of the most important measures, such as LED lighting and heat pumps, have long measure lives. A heat pump installed through an Evergy program in 2023 will not need to be replaced before the end of the forecast period.

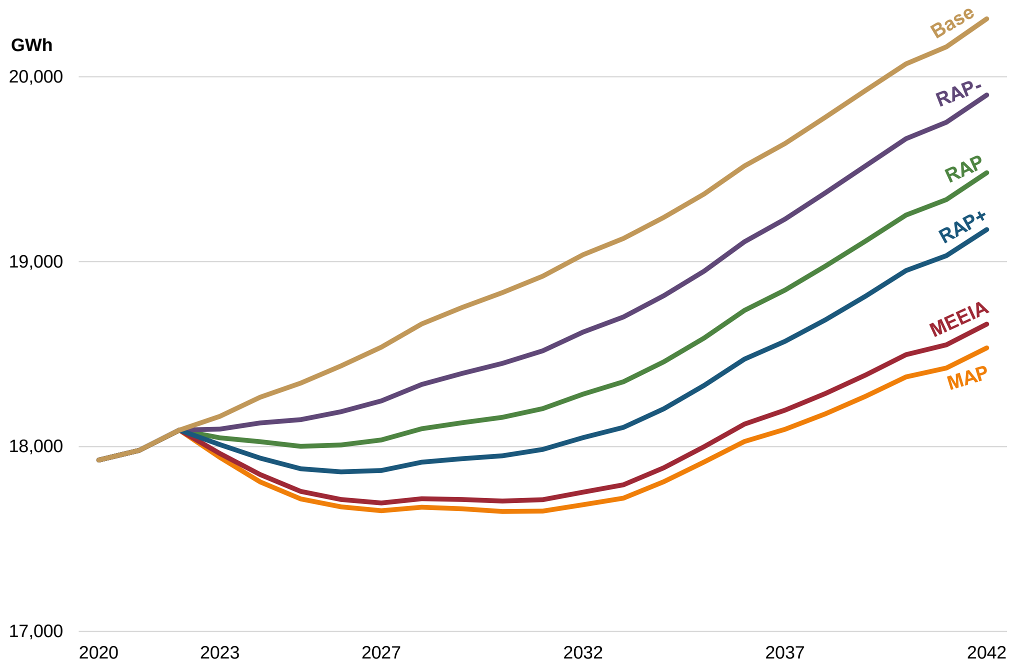


Figure I-25 Impact of achievable potential scenarios on Evergy's baseline load forecast

Table I-25 Compound Annual Load Growth Rates by Achievable Scenario

Scenario	2023-2027	2027-2032	2032-2042	2023-2042
MAP	-0.4%	0.0%	0.5%	0.2%
MEEIA	-0.4%	0.1%	0.5%	0.2%
RAP+	-0.2%	0.2%	0.6%	0.3%
RAP	0.0%	0.3%	0.6%	0.4%

[16] Based on ex-post evaluations of programs over the 2012 to 2019 period.

2032 MWh savings equals 4% of load in the RAP scenario, increasing to 7% in the MEEIA scenario (Figure I-26). RAP savings equals 23% of economic potential and 18% of technical potential, and MEEIA savings equals 39% of economic potential and 31% of technical potential (Table I-26).

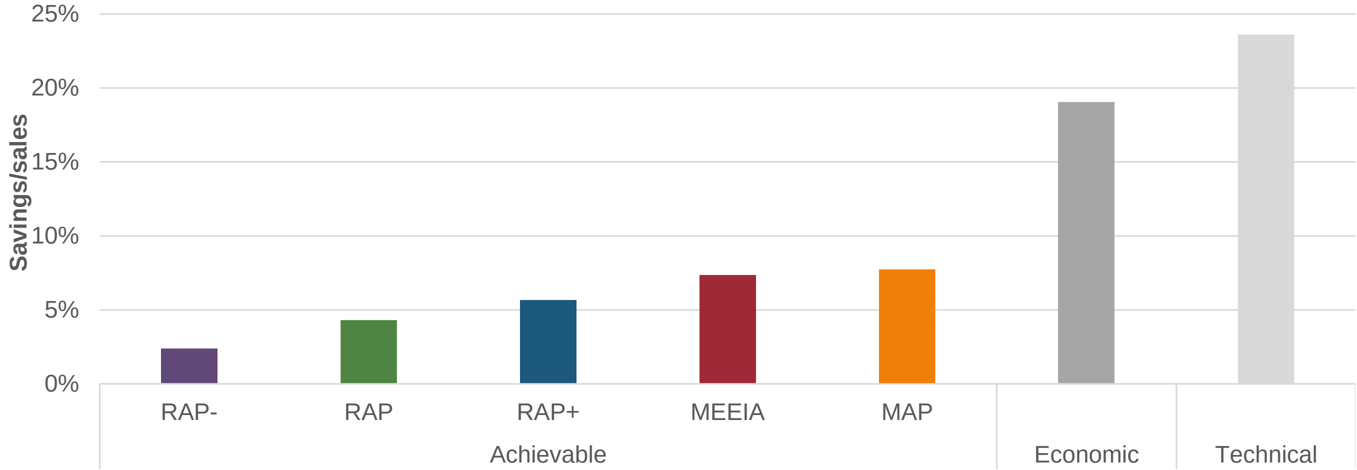


Figure I-26 Cumulative program MWh savings levels by scenario in 2032

Table I-26 Achievable Cumulative MWh Savings as a Percentage of Economic and Technical Potential in 2032

Scenario	% of economic potential	% of technical potential
RAP [-]	13%	10%
RAP	23%	18%
RAP [+]	30%	24%
MEEIA	39%	31%
MAP	41%	33%

Annual, or incremental, MWh savings levels start off at 1.0% of sales in the RAP scenario and 1.8% in the MEEIA scenario and decline to 0.6% and 1.1% of sales, respectively, by 2032 (Figure I-27). In the MAP scenario, incremental savings are about the same level as in the MEEIA scenario in 2032. This is because incentives are set to 100% of incremental costs in the MAP scenario, which results in very high participation in early years, but also cause the eligible stock to decline more quickly. Therefore, there is less energy efficiency available in the outer years. The lesson here is that more aggressive programs in the short run can result in less savings available in the long run.

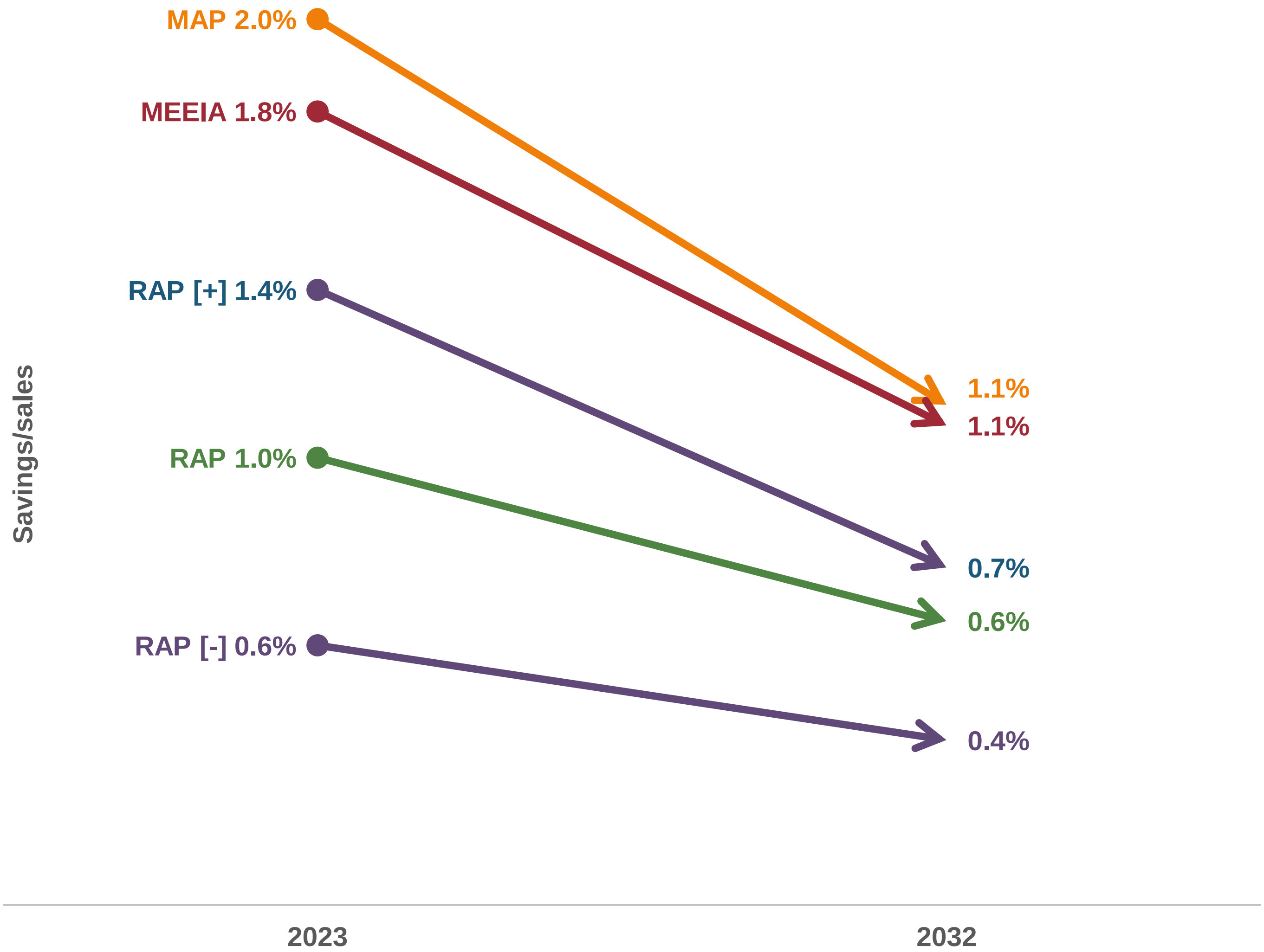


Figure I-27 Net incremental MWh savings as a percent of MWh sales by achievable scenario in 2023 and 2032

Benchmarking

Short-term savings levels in the RAP scenario are at the 57th percentile of a benchmarking class of energy efficiency program portfolios administered by 26 investor-owned utilities (IOUs) in the U.S. Central region. This means that RAP savings levels in the short term are higher than more than half of the comparison group. This increases to the 96th percentile in the MEEIA scenario, meaning that performance levels in the MEEIA scenario are higher than 96% of comparable utilities. Note that the comparison is of historical (2018) to forecasted (2023) and does not account for differences in federal energy use baselines that differ over time (Figure I-28).

See the Appendix for the list of 26 IOUs in the benchmarking class.

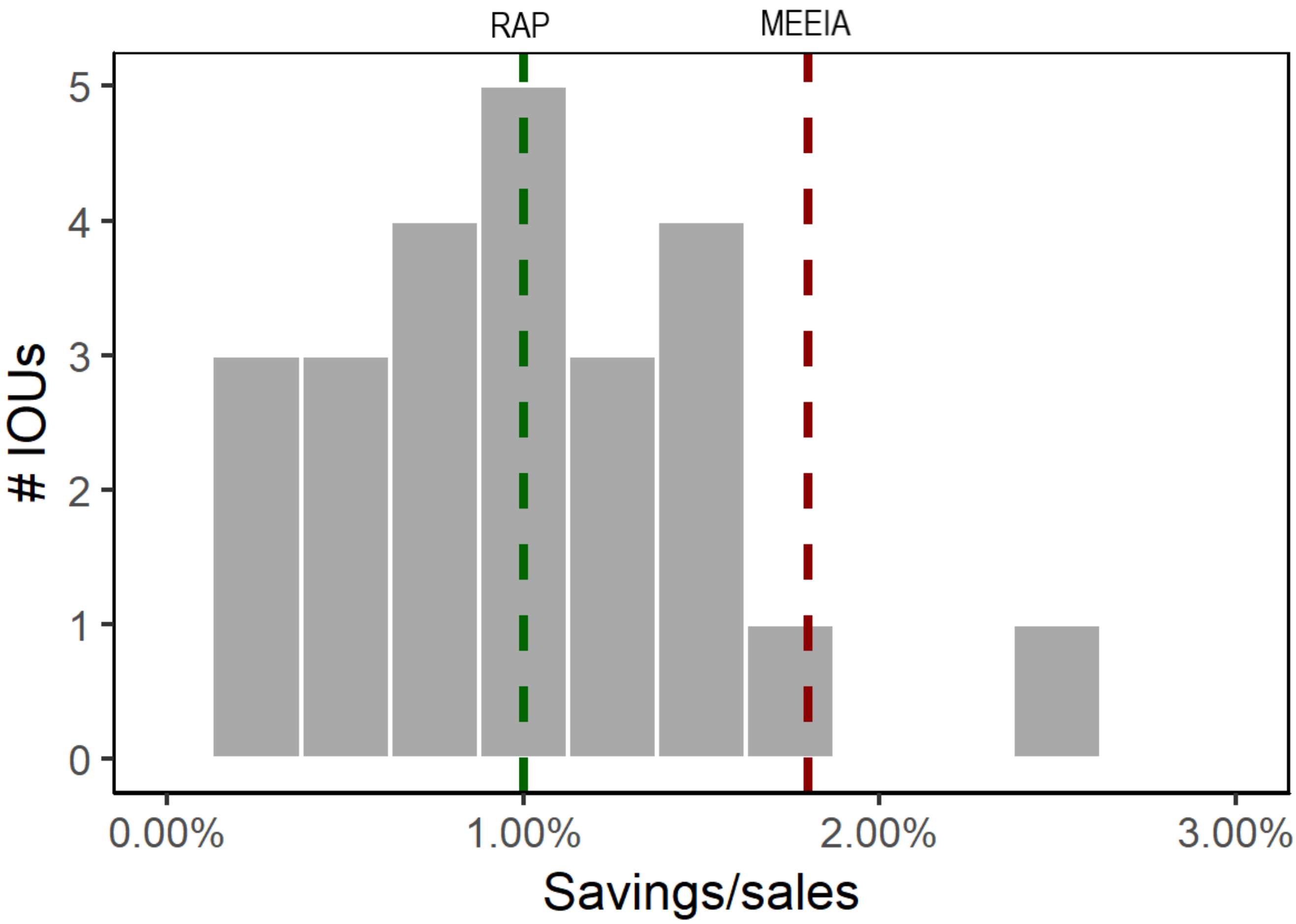


Figure I-28 Histogram of actual portfolio savings as a % sales of benchmarking class in 2018 compared to RAP and MEEIA scenarios in 2023 (n=26)

4.2.2 Residential

Savings by program

Nearly half of residential savings is from the Home Lighting Rebate program in the RAP scenario, and a quarter is from the Whole House Efficiency program. In the MEEIA scenario Whole House Efficiency becomes the biggest program mainly due to higher unitary HVAC savings that result from shifting delivery from downstream to midstream. The new Multifamily DI program significantly adds to new savings in the MEEIA scenario, as does expanded participation in the Home Energy Reports program (

Table I-27 and Figure I-29).

Table I-27 Net Cumulative Residential GWh Savings by Program in the RAP and MEEIA Scenarios in 2032

Program	RAP savings	Share RAP savings	MEEIA savings	Share MEEIA savings	Additional Savings in MEEIA	Share Additional Savings in MEEIA
Income-Eligible Home Energy Report	1.9	0.5%	2.2	0.4%	0.2	*0.2%*
Multi-Family DI	0.0	0.0%	24.8	4.8%	24.8	15.9%
Income-Eligible Multi-Family	52.5	14.5%	60.0	11.6%	7.5	4.8%
Home Energy Report	43.5	12.0%	67.4	13.0%	23.9	15.4%
Home Lighting Rebate	169.0	46.7%	169.0	32.7%	0.0	0.0%
Whole House Efficiency	94.7	26.2%	193.5	37.4%	98.9	63.7%
Total	361.6	100.0%	516.8	100.0%	155.3	

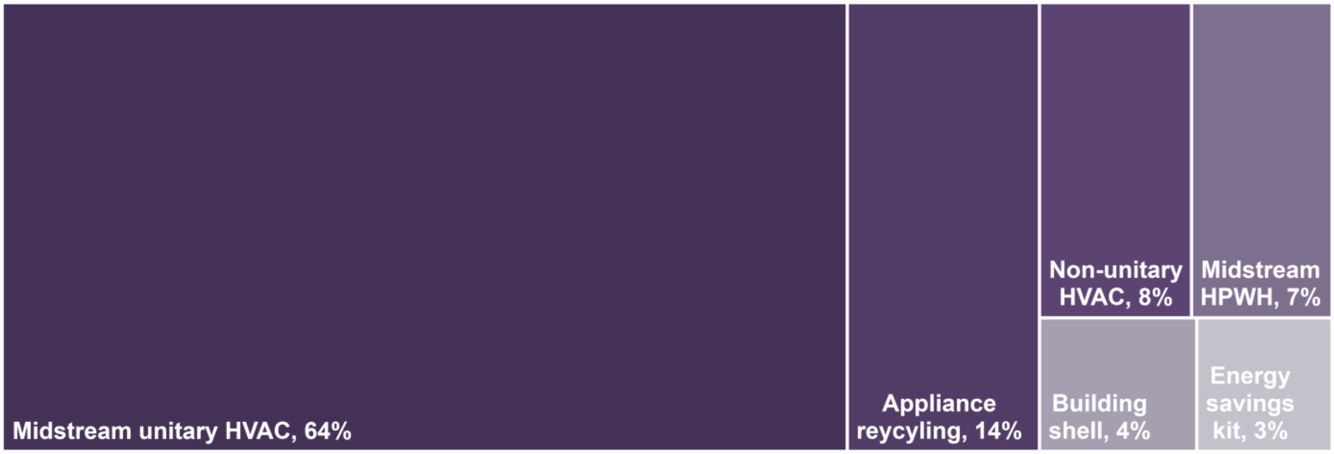


Figure I-29 Distribution of net cumulative Whole House Efficiency program savings by measure type in the MEEIA scenario in 2032

Savings by end use

Residential savings in the RAP scenario is dominated by lighting. In the MEEIA scenario, HVAC is equally important as lighting, and overall savings is more diverse. Savings from water heating measures triples because heat pump water heaters are modeled midstream and appliance recycling adds freezer and refrigerator savings (there are no savings from these appliances in the RAP scenario). 74% of additional savings in the MEEIA scenario is from equipment, and 16% behavioral because of the expanded Home Energy Report program (Figure I-30 and Figure I-31).

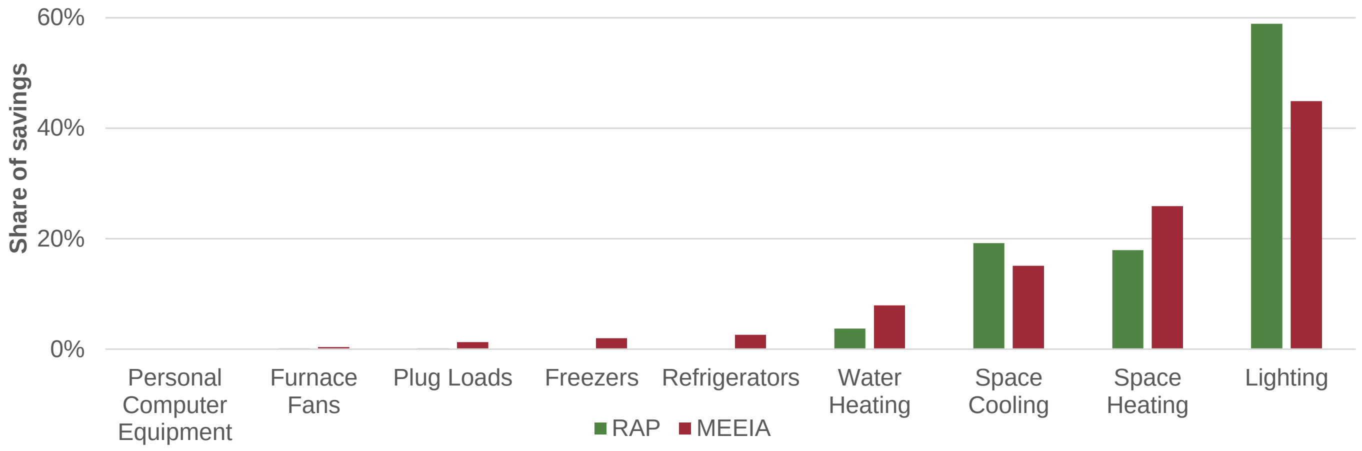


Figure I-30 Distribution of net cumulative residential MWh savings by end use in the RAP and MEEIA scenarios (2032)

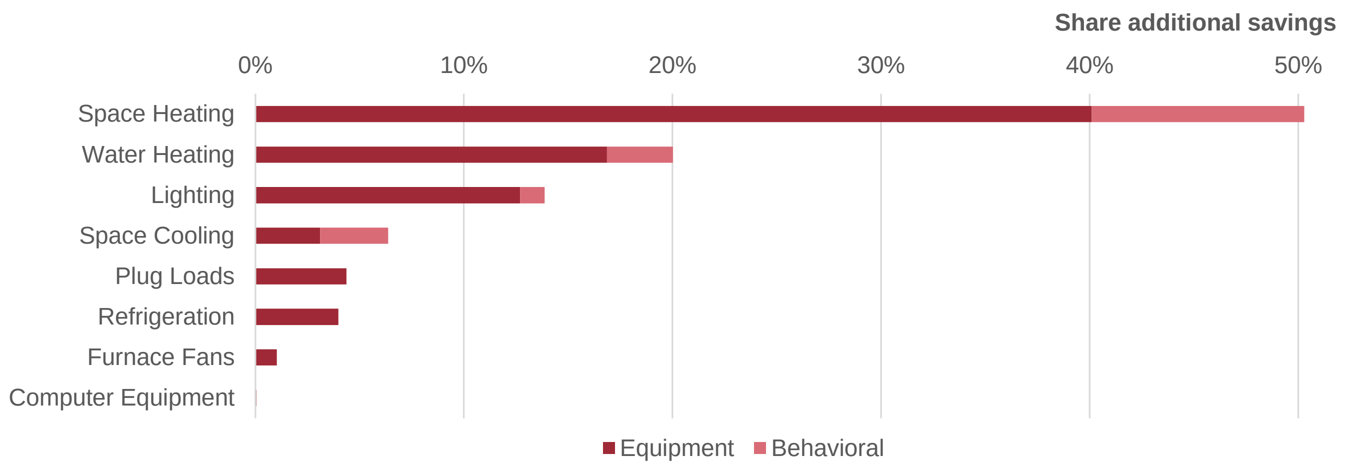


Figure I-31 Distribution of additional residential MWh savings in the MEEIA scenario relative to the RAP scenario, by end use (2032)

4.2.3 Commercial

Savings by program

Prescriptive measures through the Standard program account for most savings in the RAP scenario but moving prescriptive lighting midstream and expanding the Custom program pushes Custom ahead of Standard in the MEEIA scenario. The Small Business program nearly doubles in the MEEIA scenario (Table I-28).

Table I-28 Net Cumulative Commercial GWh Savings by Program in the RAP and MEEIA Scenarios in 2032

Program	RAP savings	Share RAP savings	MEEIA savings	Share MEEIA savings	Additional Savings in MEEIA	Share Additional Savings in MEEIA
Block Bidding	9.4	2.9%	10.3	1.6%	0.9	0.3%
Small Business Lighting	15.2	4.7%	28.3	4.3%	13.1	4.0%
Strategic Energy Management	16.5	5.1%	39.3	6.0%	22.8	6.9%
Business EE – Standard	185.9	57.9%	148.0	22.7%	-38.0	-11.5%
Midstream Lighting	0.0	0.0%	177.2	27.2%	177.2	53.7%
Business EER – Custom	94.3	29.3%	247.9	38.1%	153.6	46.6%
Total	321.3	100.0%	651.0	100.0%	329.6	

Savings by end use

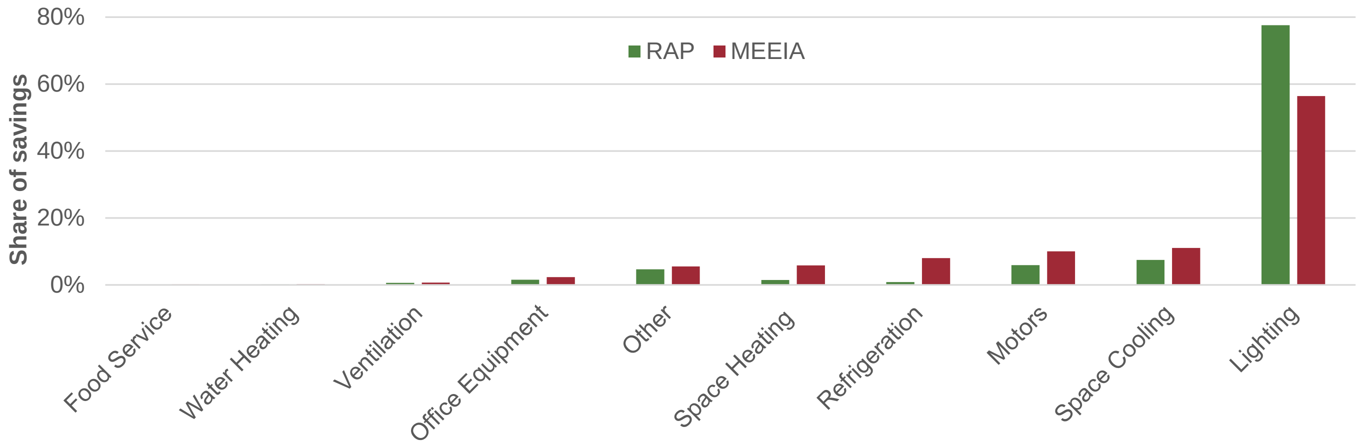


Figure I-32 Distribution of cumulative commercial MWh savings by end use in the RAP and MEEIA scenarios (2032)

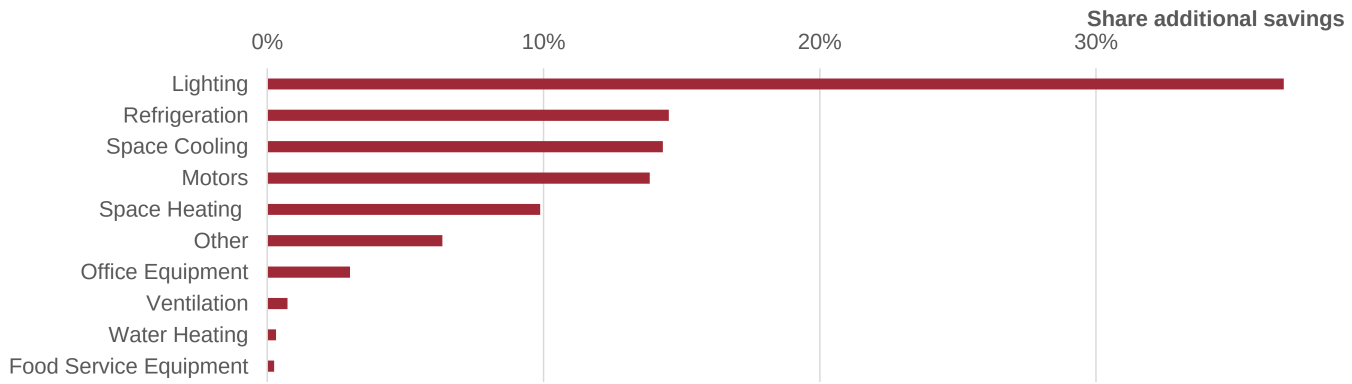


Figure I-33 Distribution of additional commercial MWh savings in the MEEIA scenario relative to the RAP scenario, by end use (2032)

Commercial savings is lighting-driven in both the RAP and MEEIA scenarios, although savings by end use diversifies in the MEEIA scenario. For example, refrigeration savings jumps 20-fold and savings from motors grows 350%. Lighting accounts for 37% of additional savings in the MEEIA scenario because Standard lighting measures are modeled midstream—still, there are significant increases in savings across several other end uses (

Figure I-32 Distribution of cumulative commercial MWh savings by end use in the RAP and MEEIA scenarios (2032) and Figure I-33).

4.2.4 Industrial

Savings by program

Industrial savings is mostly Standard lighting in the RAP scenario, but Custom becomes the most important industrial offering in the MEEIA scenario as the program expands three-fold over RAP levels (Table I-29). Moving standard lighting midstream has far less of an impact on savings in the industrial sector than it does in the commercial sector in the long run (Figure I-34). This is because the commercial sector is triple the size of the industrial sector in Evergy's service area, and because lighting comprises 7% of industrial electricity use and 15% of commercial.

Table I-29 Net Cumulative Industrial GWh Savings by Program in the RAP and MEEIA Scenarios in 2032

Program	RAP savings	Share RAP savings	MEEIA savings	Share MEEIA savings	Additional Savings in MEEIA
Strategic Energy Management	81.5	23.5%	87.4	18.7%	6.0
Business EER – Standard	210.5	60.7%	96.6	20.7%	-113.9
Midstream Lighting	0.0	0.0%	119.0	25.4%	119.0
Business EER - Custom	54.9	15.8%	164.7	35.2%	109.8
Total	346.8	100.0%	467.7	100.0%	120.9

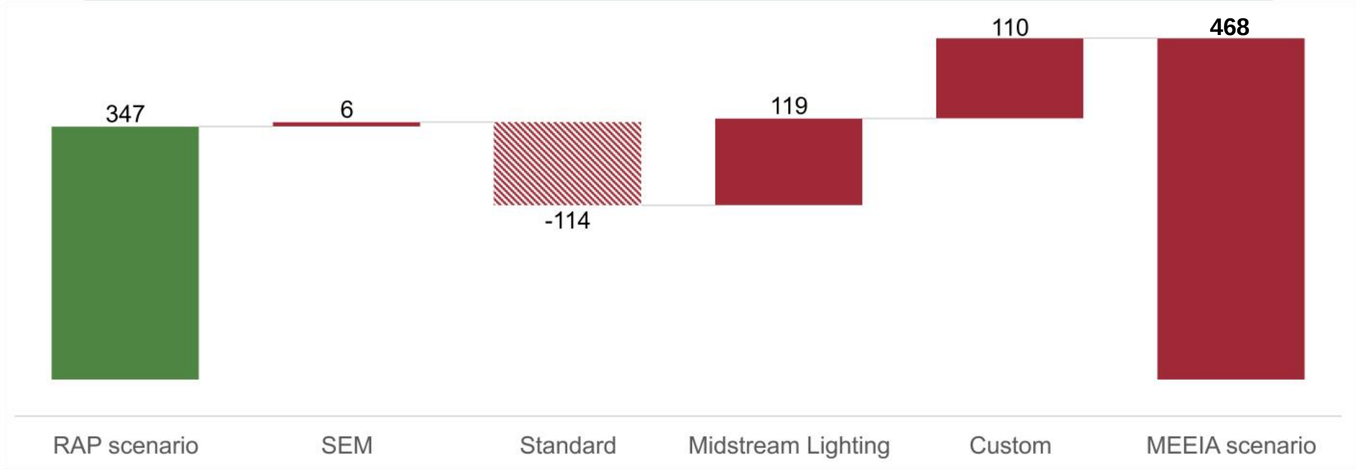


Figure I-34 Decomposition of additional net cumulative industrial GWh savings by program in the MEEIA scenario in 2032

Savings by end use

In the RAP scenario, industrial savings is primarily from measures that improve energy efficiency of the facility housing the manufacturing processes—lighting and space heating account for 69% of savings. This share drops to 56% in the MEEIA scenario as savings from manufacturing processes increase, mostly in pumps and process heating (Figure I-35 and Figure I-36).

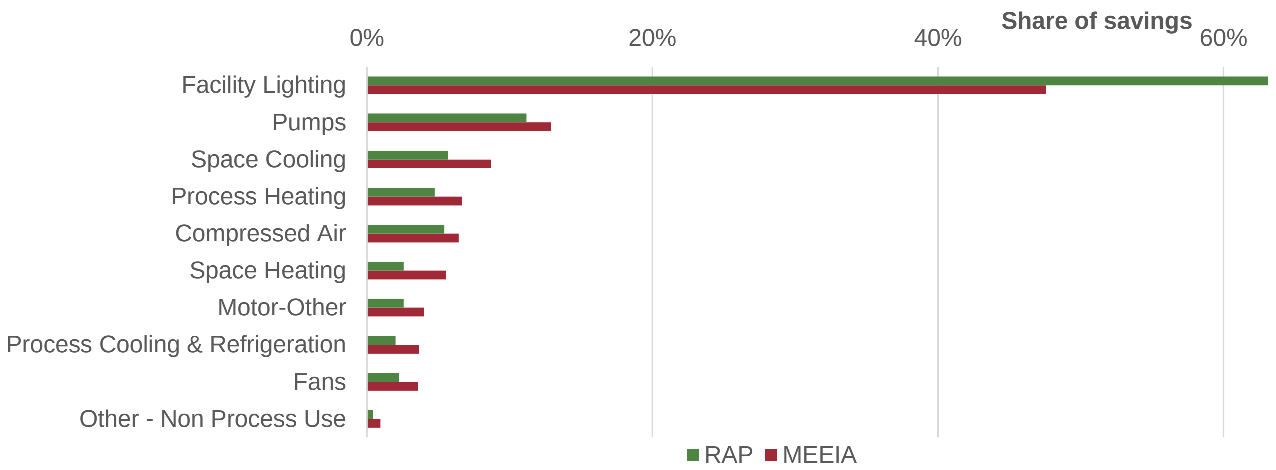


Figure I-35 Distribution of cumulative industrial MWh savings by end use in the RAP and MEEIA scenarios (2032)

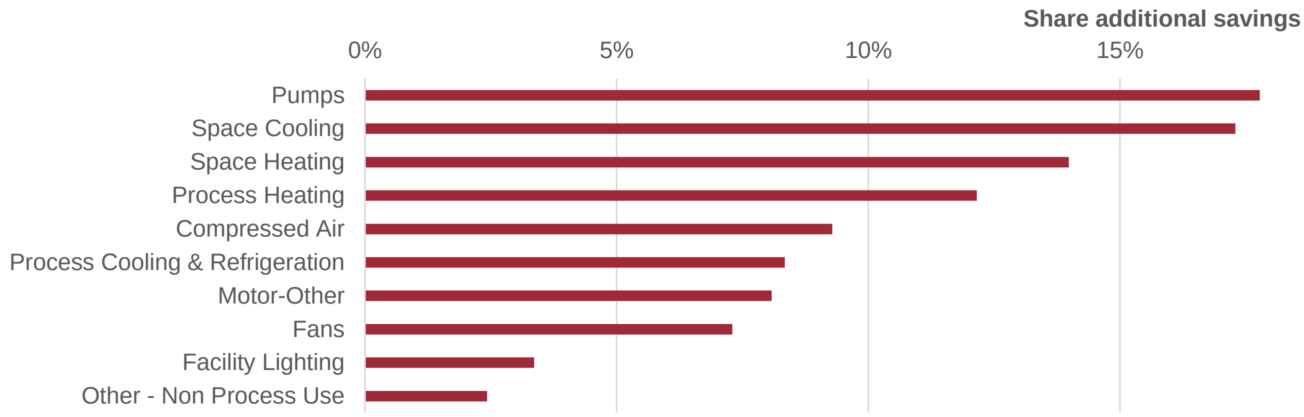


Figure I-36 Distribution of additional industrial MWh savings in the MEEIA scenario relative to the RAP scenario, by end use (2032)

5. Emerging technologies assessment

In order to consider new technologies that Evergy could include in DSM programs in the future, ICF conducted an Emerging Technologies (ET) Assessment. This assessment included reviewing a broad range of emerging energy efficiency (EE) technologies and technologies that are new to the market but not yet included in the Evergy portfolio. As building and energy codes pull the market from the back and negate EE measures that are relied upon today (such as lighting), these ETs will need to be ready to bolster the DSM portfolio for continued success.

ICF used a five-step process for ET Assessment, shown in Figure I-37. ICF tailored the approach to specifically serve Evergy's needs and service territory. This process is the foundation of Evergy's ET readiness with three core elements—identification, to assessment, to prioritization.

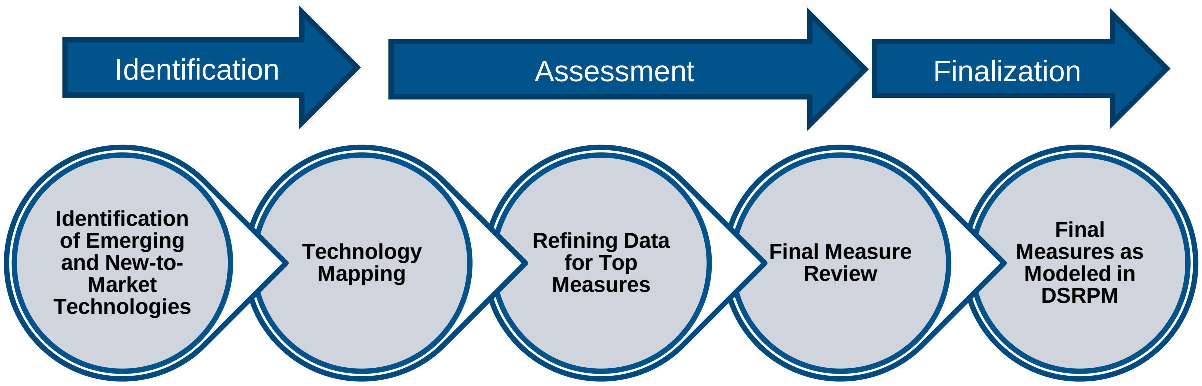


Figure I-37 Process flow for emerging technologies study

Step 1. Identification Emerging and New-to-Market Technologies

ICF started from an initial database of hundreds of ETs across all sectors. The database is continuously updated based on research from several industry-leading sources. These ETs range from technologies in the concept stage of development to those that are new to the market with low market penetration. At this stage, some additional technologies were added through research and conversations with Evergy and ICF experts to account for priorities in the Evergy DSM horizon.

Step 2. Technology Mapping

Technology Mapping was completed to compare technologies at a high-level and begin to narrow down the list based on the discussions with Evergy team. For example, on the scale of concept to newly market ready, technologies that at least had research and multiple sources of data were prioritized in order to have confidence in the estimated energy savings. ICF looked at similar scales for the following three metrics:

- Market readiness (degree of emergence in the EE market)
- Relative cost of the technology and cost effectiveness
- Energy savings potential in the Evergy service territory

Market readiness is a metric used to designate the current stage of a technology's development and will range from a score of level one to level six. A score of "one" means the technology is still in development, whereas as a score of "six" means the technology is included in programs run by other DSM program administrators. ICF calculated the cost effectiveness of each technology using the TRC calculation. This was labeled with one of three categories—low, medium, or high cost effectiveness. High-level energy saving potential was estimated for each ET based on the annual kWh savings and the market size for the technology in Evergy's service area.

The three metrics are intended to provide a quick comparison between ETs based on high-level data. A mapping of modular data centers using the three metrics is shown in Figure I-38.

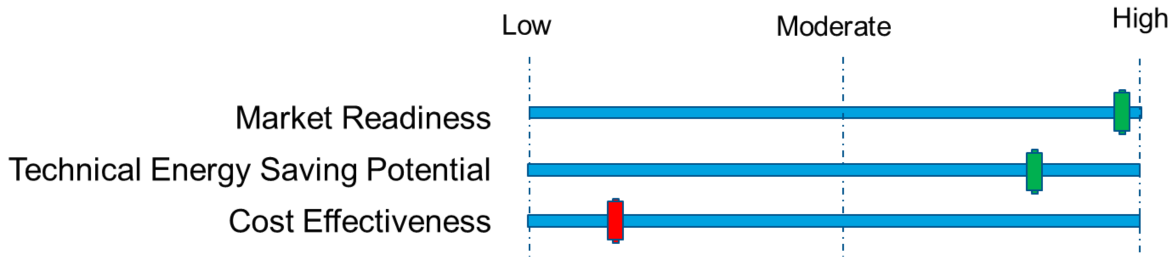


Figure I-38 Technology mapping for modular data centers

These metrics determined the top opportunities among the emerging technologies list for Evergy to pursue. At this point the following Top 20 Measures were pulled for further research, refinement, and discussion with ICF experts and the Evergy Team:

Table I-30 Top 20 Measures After Technology Mapping

Rank	Measure	Rank	Measure
1	Modular Data Centers	11	High-Efficiency UPS Equipment for a Data Center
2	Active Chilled Beam Heating and Cooling	12	Air Flow Management for Data Centers
3	Advanced Design Rooftop Unit	13	Ongoing Commissioning of Economizers in a Data Center
4	Networked Home Energy Automation Controls	14	Commercial / Industrial CO2 Heat Pumps
5	Cloud Computing	15	Web-Enabled Power Monitoring for Small and Medium-Sized Businesses
6	Indirect-Direct Stand Alone Evaporative Cooler	16	Secondary Glazing Systems
7	Direct Server Cabinet Cooling	17	Natural Ventilation for Mixed-Mode Conditioning
8	Energy Recovery Ventilator with Heat and Membrane Humidity Exchangers for Commercial Application	18	Add motorized dampers to envelope duct penetrations
9	Liquid Submersion Cooling for Data Centers	19	FANWALL Technology
10	Mirrored Light Pipes	20	Replacement of In-Service Standard Efficiency Motors with Premium Efficiency Models

Step 2. Refining Data for Top Measures

In this stage, ICF refined the measure data including energy savings, costs, measure life, and other critical data points to be as specific as possible to the Evergy service territories. Earlier stages used high level data to compare over 100 measures while this data is to the level of accuracy appropriate for potential study consideration.

The data for these measures came from an array of sources, such as Department of Energy and Environmental Protection Agency studies, case studies, and other professional sources. These measures are not recognized in many, if any, Technical Reference Manuals.

Step 4. Final Measure Review

Table I-31 shows the final measure list along with metric scores based on the updated data. The final measure rankings changed based on the measure refinement, and a few measures from outside the initial Top 10 made it into the Top 10 in this round. Some measures in this list scored low in cost effectiveness, but this is by design based on the weighting system in the rankings. Cost effectiveness for emerging technologies can be a moving target, as technologies can quickly become cheaper after they hit the market for several reasons. This would change their cost effectiveness and thus these measures may be attractive to the utility for upcoming program cycles. For this potential study, cost effectiveness is measured at this moment in time, so certain measures that might be filtered out in economic potential would warrant further research for upcoming program cycles.

Table I-31 Final Measures to be Considered in Potential Study

Measure Name	Market Readiness	Technical Potential	Cost Effectiveness	Final Score
Modular Data Centers	6	5	1	4.6
Active Chilled Beam Heating and Cooling	6	5	1	4.6
Advanced Design Rooftop Unit	5	5	2	4.5
Indirect-Direct Stand-alone Evaporative Cooler	5	5	1	4.3
Direct Server Cabinet Cooling	4	5	2	4.1
Energy Recovery Ventilator with Heat and Membrane Humidity Exchangers	3	5	3	3.9
Liquid Submersion Cooling for Data Centers	5	3	3	3.7
High-Efficiency UPS Equipment for a Data Center	6	3	1	3.7
Air Flow Management for Data Centers	2	5	3	3.5
Web-Enabled Power Monitoring for Small and Medium-Sized Businesses	4	3	3	3.4

At this stage, these measures were processed in the same manner as the rest of the potential study measures to calculate full technical, economic, and achievable potential. The bottom up approach to this modeling can be found in the DSRPM-related sections of this report.

Step 5. Final Measures as Modeled in DSRPM

The list in

Table I-32 shows the final measures from the Emerging Technologies Assessment that were passed into the DSRPM Model and where those measures were eventually mapped in the potential study results. Of the 10 ET measures, five measures passed through to the Achievable Potential Scenarios, three were filtered out in the economic potential model, and two were not included in the technical potential. Advanced Design Rooftop Unit surpassed the efficiency of an existing Rooftop Unit measure, but it was removed in this iteration due to costs that are currently prohibitive for customer participation. Indirect-Direct Stan-Alone Evaporative Coolers was removed as a measure after discussions regarding performance issues and lack of market for this technology in Evergy's territory.

Table I-32 Final Measures to be Considered in Potential Study

Measure Name	Furthest Scenario Considered	Program Name	Measure Bundle
Energy Recovery Ventilator	MAP; MEEIA	Business EER - Standard	New - HVAC
Data Center Air Flow Management	MAP; MEEIA	Business EER - Custom	New - Data Center
Efficient UPS	MAP; MEEIA	Business EER - Custom	New - Data Center
Modular Data Centers	MAP; MEEIA	Business EER - Custom	New - Data Center
Web-Enabled Power Monitoring for Small and Medium-Sized Businesses	MAP; MEEIA	Business EER - Custom	New – Misc. Custom
Active Chilled Beam Heating and Cooling	Tech/Econ	N/A	N/A
Direct Server Cabinet Cooling	Tech/Econ	N/A	N/A
Liquid Submersion Cooling for Data Centers	Tech/Econ	N/A	N/A
Advanced Design Rooftop Unit	N/A	N/A	N/A
Indirect-Direct Stand-Alone Evaporative Cooler	N/A	N/A	N/A

6. Conclusion

This study shows that Evergy's current energy efficiency programs—as modeled in the RAP scenario—perform well compared to most other utilities' programs, but there are significant extra savings achievable in all sectors. In the MEEIA scenario, residential programs expand to capture more HVAC and water heating opportunities, as well as more multifamily savings. Commercial savings is currently dominated by lighting, but extra savings from this end use could be achieved by moving prescriptive lighting measures midstream. There is also a great deal of room for expansion of the custom and small business programs. To date, industrial savings has been lighting-driven, but as with the commercial sector, there is room for growth in the custom program, particularly in pump and process heating measures.

II. Demand Response and Demand Side Rates Potential

1. Introduction

1.1 Summary

The demand response (DR) and demand side rate (DSR) component of this potential study assessed technical, economic, and achievable potential in the residential, commercial, and industrial sectors within Evergy's service areas. While technical and economic potential are theoretical concepts for DR and DSR, the achievable potential scenarios provide a comprehensive view of the potential that can be achieved under various assumptions.

The study framework follows the same basic outline as energy efficiency, but the details of the methodology adopted vary significantly for DR and DSR. Survey data was the primary source to estimate the market size for the DR programs, while AMI saturation (at 100%) determined the market size for the rates. The baseline kW usage was guided by the energy usage and simulations for various building types, and the peaks were approximated at various breakdowns— building type and end use. The technical potential and economic potential used an unconventional approach of determining the (cost-effective) mix of programs that resulted in the maximum savings.

Six achievable potential scenarios were developed: realistic achievable potential (RAP), RAP-, RAP+, Missouri Energy Efficiency Investment Act (MEEIA), Maximum Achievable Potential (MAP) and Stand-Alone Potential. As in the case of energy efficiency, RAP is the reference case, and RAP- and RAP+ are variants of RAP assuming lower/higher participation levels. MEEIA scenario was modeled to meet the target of 1% incremental demand each year, in conjunction with the energy efficiency portfolio. MAP is the upper limit of achievable potential when programs are implemented in the hierarchy assumed, while the Stand-Alone Potential aims to provide the absolute maximum potential if the programs were implemented independently and individually.

Further details on the assumptions, approach, and results of the study are provided in the following sections. Program and portfolio savings, costs, and cost-effectiveness results are in the Appendix.

1.2 Reference Guide

The study's key assumptions that are specific to DR and DSR – include:

- **Level of savings used in the analysis:**
    - Savings reported in this chapter are all **at generator.**
    - Unless the jurisdiction is specified, the results are presented for both territories (Metro and West) combined.
- **Dollar denomination**: Program costs are reported in nominal dollars in the Appendix. Evergy's assumption for inflation was 2.5% per year.
- **Economic screening**: All programs were screened for cost-effectiveness with the TRC test used as a primary cost-effectiveness test. Programs were included in the achievable potential if they cleared the TRC test for even one jurisdiction.
- **Opt-in and opt-out mode of program delivery**: It was assumed that all programs were opt-in, except Time of Use in the MAP scenario only.

1.3 Key Takeaways

Technical potential equals 41% of peak demand in 2032 and all of this is economic when the screening is done at measure level. Residential potential is 54% of residential load, commercial potential is 23% of commercial load and the industrial potential is 5% of industrial load, with the loads being calculated as system peak coincident loads.

Technical potential by end use varies widely by sector. In the residential sector space cooling comprises 81% of technical potential, while water heating accounts for 12% and the rest of the end uses take up 7%. Space Cooling is the most important end use in the commercial sector, with 65% of technical potential, followed by refrigeration, which accounts for 20%. In the industrial sector, motors account for 34% of technical potential, followed by pumps, which account for 20%.

If Evergy implements the programs in the RAP scenario and achieves the RAP participation levels, load will be 12% lower than the baseline over the long run.

RAP potential is dominated by existing programs such as Residential and Small Business Smart Thermostats and C&I Business Demand Response. Smart Thermostats contribute to 68% of residential savings, while C&I Business Demand Response constitutes 72% of C&I savings.

2. Methodology

The DR programs and demand side rates are modeled with ICF's DSRPM. As with Energy Efficiency, the DR and DSR components of DSRPM were built on principles highlighted by FERC, the National Demand Response Potential Model Guide, and Action Plans for the demand response and demand side rates Potential Evaluation.[17, 18] While the basic framework of determining potential remain the same, DR and DSR programs have key differentiating factors that mandate additional modules and modeling nuances, which are baked into DSRPM. An illustration of the overarching guideline is shown in Figure II-1.

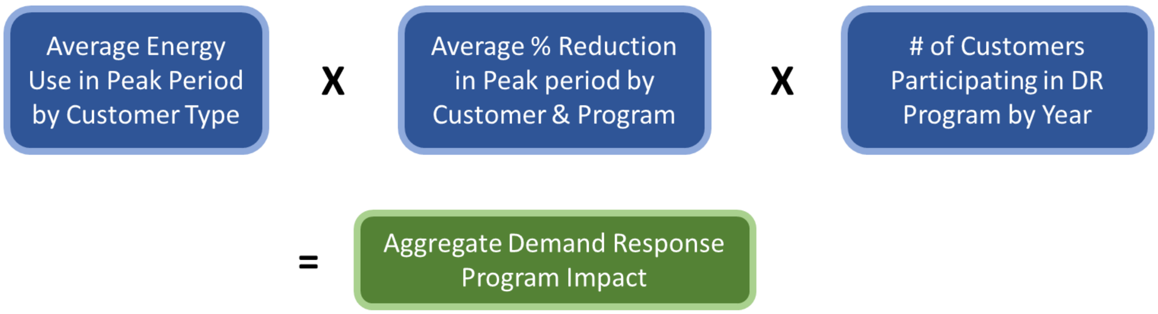


Figure II-1 DR/DSR potential evaluation—basic principle

[17] National Demand Response Potential Model Guide (2009), prepared for FERC by multiple consultants. https://www.ferc.gov/industries/electric/indus-act/demand-response/NADR-guide.pdf

[18] National Action Plan on Demand Response (2010), FERC. https://www.energy.gov/sites/prod/files/oeprod/DocumentsandMedia/FERC_NAPDR_-_final.pdf

2.1 Programs and Rates Included

For the potential study, ICF began with a larger database of programs and rates and selected only those programs and rates applicable to the Evergy territory. While the database was built over time by ICF and contains all the DR and DSR programs implemented as programs or pilots across the country, the filtered programs were chosen based on Evergy's feedback and their applicability based on the saturation of enabling equipment.

The final list of programs options was broken down into buckets characterized by their inclusion in various scenarios and start dates. The RAP scenario included programs that were expected to be implemented in the near future as well as programs that had garnered interest from stakeholders, while the MEEIA and MAP scenarios included these along with the rest of the programs. Some of the programs' start dates were pushed out to the second program cycle of the potential study to allow time for filing the rate-cases in the case of DSRs and not overwhelm customers with too many options in the case of DR programs. The start date and scenario split for all the program options chosen is shown in Table II-1. Hereinafter this report will refer to the subset of programs included in RAP as "RAP programs" and all the programs included in MAP as "MAP programs," for brevity.

Table II-1 DR/DSR Programs Included in the Potential Study with Start Dates and Scenarios

Category	Sector	Program - Measure	Start Year	Scenario	
				RAP	MAP
DR	Residential	Smart Thermostat	Existing	●	●
DR	Residential	Direct Load Control - Water Heating	2023	●	●
DR	Residential	Direct Load Control - Pool Pumps	2023	●	●
DR	Residential	Direct Load Control - Hot Tubs	2023	●	●
DR	Residential	Direct Load Control - EV Smart Chargers	2023		●
DR	Residential	Critical Peak Pricing	2026		●
DR	Residential	Peak Time Rebates	2026		●
DR	Residential	Direct Load Control - Battery Storage	2023		●
DSR	Residential	Demand Rates	2026		●
DSR	Residential	Time of Use	Existing	●	●
DR	Commercial	Business Demand Response	Existing	●	●
DR	Commercial	Critical Peak Pricing	2026		●
DR	Commercial	Direct Load Control - Pool Pumps	2023	●	●
DR	Commercial	Direct Load Control - Water Heating	2023	●	●
DR	Commercial	Smart Thermostat	Existing	●	●
DR	Commercial	Thermal Storage	2023	●	●
DSR	Commercial	Real Time Pricing	2026	●	●
DSR	Commercial	Time of Use	2023	●	●
DR	Industrial	Business Demand Response	Existing	●	●
DSR	Industrial	Real Time Pricing	2026	●	●
DSR	Industrial	Time of Use	2023	●	●

2.2 Technical and Economic Potential

Technical and economic potential for DR and DSR are theoretical concepts and were evaluated in an effort to be consistent with the energy efficiency component of this study. Consequently, the approach draws from some of the concepts within EE while recognizing and designing an approach that incorporates the factors that differentiate DR and DSR from EE. The high-level 3-step approach adopted is outlined in Figure II-2.

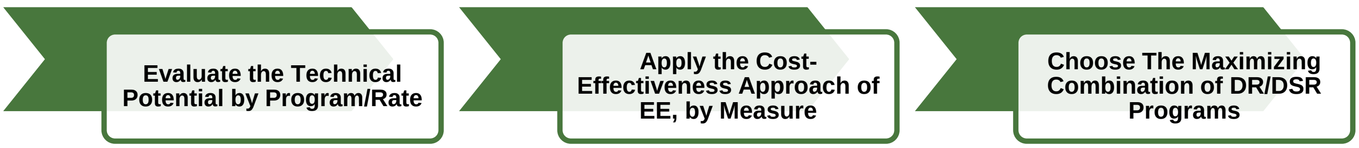


Figure II-2 Technical and economic potential approach for DR and DSR

Technical Potential: Technical potential is the theoretical upper bound for DR and DSR programs, which can be obtained with the assumption that every eligible customer would participate in the program and/or rate, subject to feasibility. Technical potential is evaluated with no regard to the cost of program implementation. Further details of the criteria and modeling assumptions used include:

- The feasibility criterion ensures that the customer does not participate in two rates at the same time, and instead enrolls him or her in the rate that produces the maximum impact. For example, a customer with AMI who is eligible for both Time of Use (ToU) and Real Time Pricing (RTP) rates, will be enrolled in RTP rate for technical potential evaluation. RTP begins in 2026, and hence the customer is on ToU rate for 2023 to 2025 and then moved to RTP.
- Cascading of impacts was considered to avoid double-counting of savings. For example, a customer enrolling in ToU rate and a Smart Thermostat (ST) program would not see as much savings from the ST program as a customer who is on a flat rate. This is because the customer would have optimized cooling usage to account for the peak rates, thus reducing the potential of the ST program. The cascading calculation is similar to the one described in the Achievable Potential approach section (II.2.3.1) but is done outside of the DSRPM for DR and DSR.
- Residential battery storage was excluded from the technical potential calculation because installing batteries of sufficient size would just make the technical potential 100% for the residential customers. This would not allow for any other programs to be considered or evaluated.

Economic Potential: Economic potential is evaluated in a similar manner to the technical potential with an additional step of screening the programs at a measure-level, mimicking the EE approach. This 'measure-level screening' includes evaluating cost-effectiveness by excluding all the non-incentive costs. All the programs and rates chosen within technical potential clear the cost-effectiveness test at the measure level, thus making economic potential the same as technical potential for DR and DSR.

2.3 Achievable Potential

Achievable potential applies expected participation levels to economic potential. Participation curves are developed as industry-standard bass diffusion curves, and ICF developed the expected ramp rate and steady-state participation levels. While the ramp rates are based on existing trends for current programs, ICF used program implementation experience to develop the rates for new programs. The steady-state participation levels are outcomes of research into various potential studies for new programs, EM&V reports for well-established programs, and ICF expert opinion.

2.3.1 Participation Hierarchy and Impact Cascading

DR and DSR programs come with associated complexity in that some programs are mutually exclusive while some are stackable. Thus, it is necessary to establish a hierarchy in order to ensure that the savings are appropriately estimated. The inputs in DSRPM are set up to follow the 'natural order' of implementation, as shown in Figure II-3, with the EE equipment upgrade impact showing up prior to the shift associated with DSRs, followed by the one-time shifts per event of the DR programs; there is also a program hierarchy within DSR and DR. This order of programs is meant to capture the programs that have maximum per-customer impact (such as battery storage), existing programs (such as smart thermostats), and other well established programs (such as DLC for water heating) first, followed by programs that are new (such as Critical Peak Pricing). Please note that the order of participation is not indicative of any suggested order of implementation; rather, it is meant to capture the eligible stock and cascading aspects for modeling purposes.

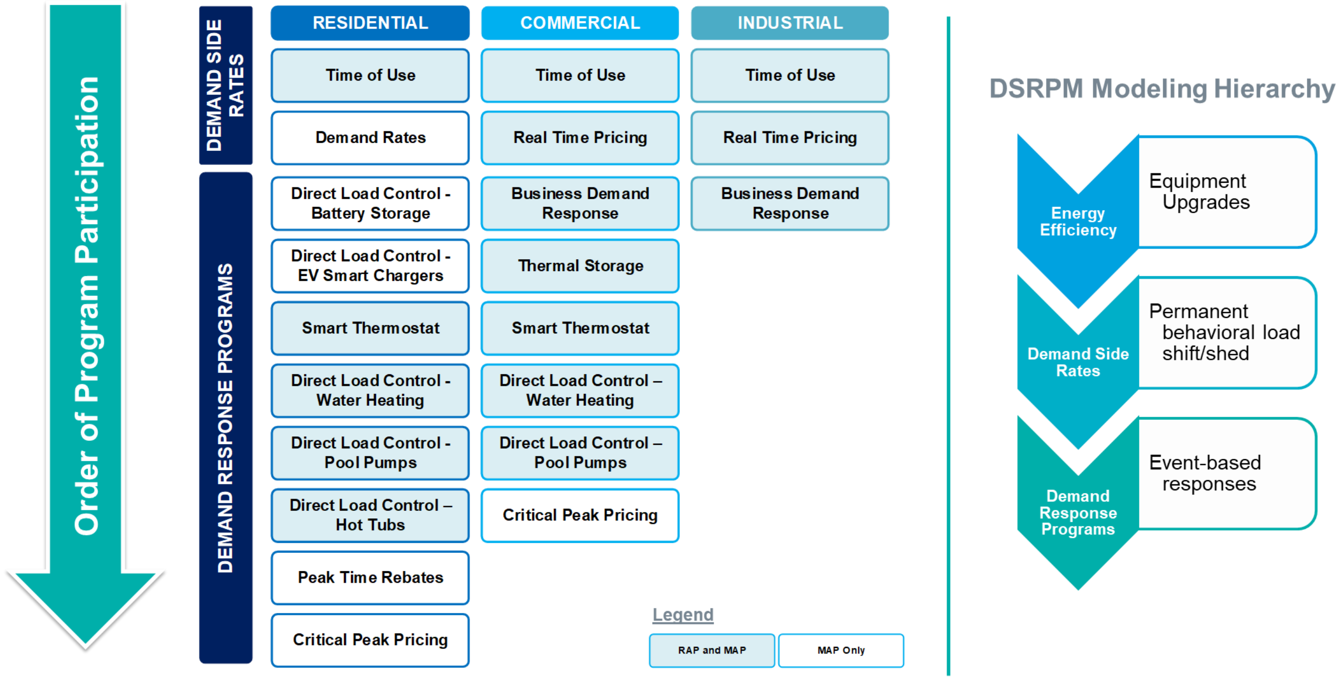


Figure II-3 DR/DSR and DSRPM hierarchy of participation

An illustrative example of how the eligible stock estimation is done for mutually exclusive programs or rates is exhibited in Figure II-4, where the "no hierarchy" row shows how the participation of RTP would have remained at 20% if a hierarchy was not considered in the modeling. The "with hierarchy" row, on the other hand, removes the 30% maximum market share value of the ToU program from the eligible stock for RTP, resulting in the maximum market share for RTP dropping from 2-% to 14%.

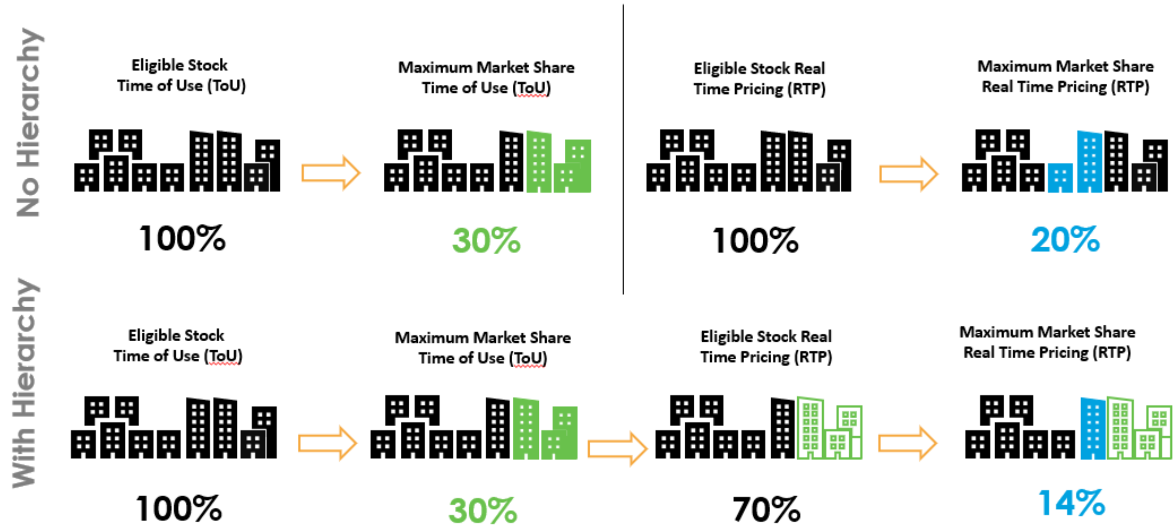


Figure II-4 Participation hierarchy example

For programs that are not mutually exclusive, cascading within DSRPM ensures there is no double-counting of savings. An illustrative example is shown in Figure II-5, wherein a customer enrolled in ToU or RTP subsequently responds to thermal storage events. If the average savings of such a customer was 6 kW in the absence of ToU/RTP programs, it now reduces to 5.2 kW, since 0.8kW of the savings otherwise attributable to thermal storage is now a part of ToU/RTP savings.

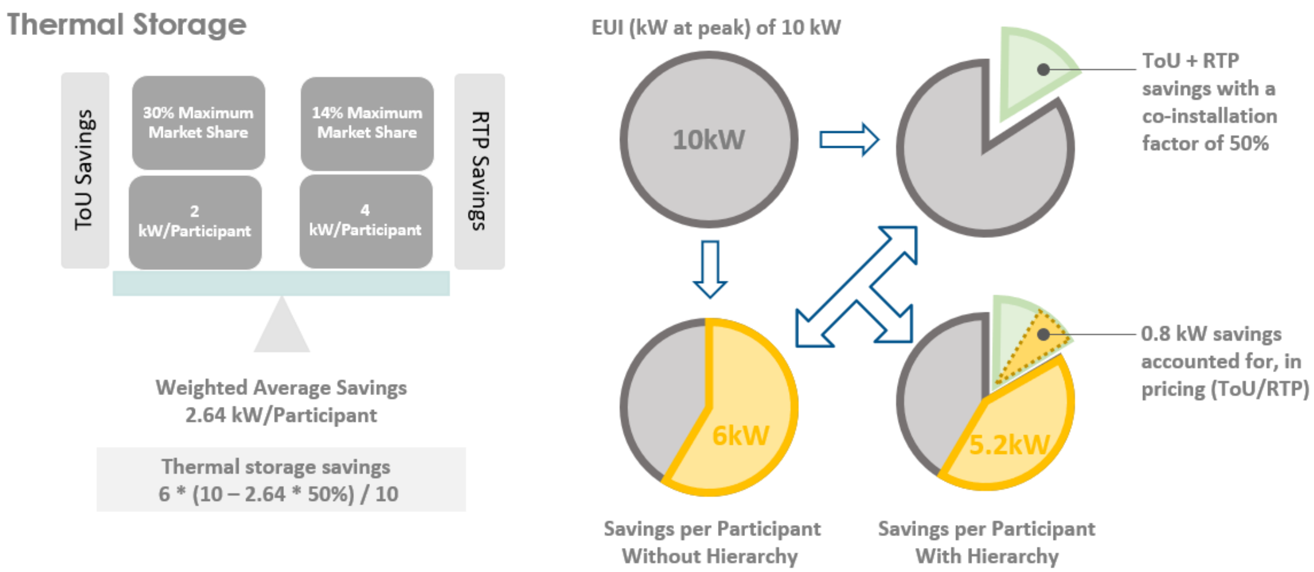


Figure II-5 Cascading effects example

2.3.2 Achievable Potential Scenarios

As with energy efficiency programs, DR and DSR was also modeled for the five scenarios—RAP, RAP-, RAP+, MAP, and MEEIA—as well as an additional scenario that shows the DR and DSR program-level stand-alone potential. Table II-2 provides a high-level summary of the parameters across the scenarios.

Table II-2 DR and DSR Achievable Potential Scenarios

Variable/Scenario	Realistic Achievable Potential (RAP)	RAP (-)	RAP (+)	MEEIA Goals	Max Achievable Potential (MAP)	Stand-Alone
Primary BC test	TRC	TRC	TRC	TRC	TRC	TRC
Cost-effectiveness threshold	Program	Program	Program	Program	Portfolio	Program
Programs included	RAP Programs	RAP Programs	RAP Programs	MAP Programs	MAP Programs	MAP Programs
Participation Curve	Medium	Low	High	High	Aggressive	Aggressive

Realistically Achievable Potential (RAP)

The Realistic Achievable Potential Scenarios, as the name suggests, are modeled to reflect the achievable participation levels for the RAP programs—i.e., the programs that were chosen after discussion with Evergy and listed in Table II-1. Participation levels for existing programs were calibrated to the existing participation levels to ensure a gradual uptake, while participation in new program started out at pilot levels and gradually reached the steady-state maximum market shares by 2042.

The RAP- scenario was modeled to have three-fourths of the steady-state maximum market shares as compared to RAP levels, and the RAP+ scenario was modeled to have a participation level between RAP and MAP. RAP- and RAP+ scenarios reflect the variations in levels of participation that generate a lower and upper bound on realistically achievable numbers.

Maximum Achievable Potential (MAP)

The MAP scenario includes all MAP programs, and the participation levels reflect the maximum possible participation, providing an upper bound on achievable participation and potential. There are a couple of key differences between RAP and MAP:

- The ToU program was modeled as an opt-out program in the MAP scenario and as opt-in in all other scenarios. This was done to ensure maximum impact and participation.
- For the MAP scenario the cost-effectiveness screening was performed at a portfolio level, in conjunction with EE programs. While the participation in the DR and DSR programs was not altered in the optimization, the programs with very low TRC, Peak Time Rebates for residential and Direct Load Control for commercial, were excluded from consideration.

MEEIA

The MEEIA scenario was modeled to meet the MEEIA goals, as specified in the energy efficiency scenarios. However, because the EE portfolios met the goals, DR and DSR portfolio was not optimized and was modeled at RAP+ participation levels, with the exception that the existing Smart Thermostat program was kept at RAP levels of participation to reflect the most realistic scenario.

Stand-Alone Potential

For each of the five scenarios described above, the outputs from DR and DSR programs reflect the cascading impact of other programs, such as EE programs, that are higher in the hierarchy. To get a sense of the true theoretical upper bound on the maximum achievable potential of a program, a "stand-alone" scenario was modeled. Because this scenario assumes that each program is run by itself, the portfolio level aggregates does not make sense for this scenario, since each program assumes the entire population as eligible stock.

2.4 Key Assumptions

Impact Estimation

Table II-3 Per Participant Impact Estimates for DR/DSR Programs

Territory	Sector	Program - Measure	Unit	Savings	
				Summer	Winter
Metro	Residential	Smart Thermostat	kW/part	1.05	0.55
Metro	Residential	Direct Load Control - Water Heating	kW/part	0.39	0.48
Metro	Residential	Direct Load Control - Pool Pumps	kW/part	1.50	1.50
Metro	Residential	Direct Load Control - Hot Tubs	kW/part	0.00	1.29
Metro	Residential	Direct Load Control - EV Smart Chargers	kW/part	0.92	0.92
Metro	Residential	Critical Peak Pricing	% part. peak	21.3%	14.4%
Metro	Residential	Peak Time Rebates	% part. peak	8.2%	8.2%
Metro	Residential	Direct Load Control - Battery Storage	% part. peak	70.2%	70.2%
Metro	Residential	Demand Rates	% part. peak	14.4%	6.9%
Metro	Residential	Time of Use	% part. peak	14.4%	8.0%
Metro	Commercial	Business Demand Response	% part. peak	22.2%	22.2%
Metro	Commercial	Critical Peak Pricing	% part. peak	13.7%	10.4%
Metro	Commercial	Direct Load Control - Pool Pumps	kW/part	2.00	2.00
Metro	Commercial	Direct Load Control - Water Heating	kW/part	19.0%	30.4%
Metro	Commercial	Smart Thermostat	kW/part	1.05	0.47
Metro	Commercial	Thermal Storage	% part. peak	33.2%	14.6%
Metro	Commercial	Real Time Pricing	% part. peak	13.7%	10.4%
Metro	Commercial	Time of Use	% part. peak	9.9%	7.2%
Metro	Industrial	Business Demand Response	% part. peak	22.2%	22.2%
Metro	Industrial	Real Time Pricing	% part. peak	8.7%	5.3%
Metro	Industrial	Time of Use	% part. peak	5.9%	3.6%
West	Residential	Smart Thermostat	kW/part	1.05	0.59
West	Residential	Direct Load Control - Water Heating	kW/part	32.0%	43.0%
West	Residential	Direct Load Control - Pool Pumps	kW/part	1.50	1.50
West	Residential	Direct Load Control - Hot Tubs	kW/part	0.00	1.29
West	Residential	Direct Load Control - EV Smart Chargers	kW/part	0.92	0.92
West	Residential	Critical Peak Pricing	% part. peak	21.4%	14.4%
West	Residential	Peak Time Rebates	% part. peak	8.2%	8.2%
West	Residential	Direct Load Control - Battery Storage	% part. peak	70.2%	70.2%
West	Residential	Demand Rates	% part. peak	17.5%	9.1%
West	Residential	Time of Use	% part. peak	14.7%	8.2%
West	Commercial	Business Demand Response	% part. peak	22.2%	22.2%
West	Commercial	Critical Peak Pricing	% part. peak	13.4%	10.5%
West	Commercial	Direct Load Control - Pool Pumps	kW/part	2.00	2.00
West	Commercial	Direct Load Control - Water Heating	kW/part	0.19	0.30
West	Commercial	Smart Thermostat	kW/part	1.05	0.44
West	Commercial	Thermal Storage	% part. peak	33.2%	14.5%
West	Commercial	Real Time Pricing	% part. peak	13.4%	10.5%
West	Commercial	Time of Use	% part. peak	9.3%	7.2%
West	Industrial	Business Demand Response	% part. peak	22.2%	22.2%
West	Industrial	Real Time Pricing	% part. peak	8.7%	5.1%
West	Industrial	Time of Use	% part. peak	5.9%	3.4%

ICF estimates the demand reduction per participant for DSRs using its proprietary Time of Use Rate Evaluation Tool (ToURET), which uses elasticity estimates and rates information to produce the peak and off-peak reduction or increase in customer loads. The DR programs on the other hand, use the kW per participant reduction derived from various programs implemented across the US, and are calibrated to the programs in Evergy territories to the extent possible. The peak reduction estimates used in this potential study for all program and rate options are provided in

Table II-3.

Participation Assumptions

Participation assumptions developed for the RAP, MAP and MEEIA scenarios are listed in Table II-4. The RAP- scenario applies a factor of 0.75 to the RAP scenario participation rates; RAP+ has the same steady state participation as MEEIA, except for Smart Thermostats, where it is the average of RAP and MAP.

Table II-4 Participation Assumptions for DR and DSR Programs

Category	Sector	Program - Measure	Steady State Participation Rate		
			RAP	MAP	MEEIA
DR	Residential	Smart Thermostat	34.5%	50.6%	34.5%
DR	Residential	Direct Load Control - Water Heating	22.0%	32.3%	27.1%
DR	Residential	Direct Load Control - Pool Pumps	19.0%	38.0%	28.5%
DR	Residential	Direct Load Control - Hot Tubs	19.0%	38.0%	28.5%
DR	Residential	Direct Load Control - EV Smart Chargers	28.0%	80.0%	54.0%
DR	Residential	Critical Peak Pricing	19.0%	34.0%	26.5%
DR	Residential	Direct Load Control - Battery Storage	1.0%	2.0%	1.5%
DSR	Residential	Demand Rates	14.0%	20.0%	17.0%
DSR	Residential	Time of Use	28.0%	80.0%	34.0%
DR	Commercial	Business Demand Response	25.0%	25.0%	25.0%
DR	Commercial	Critical Peak Pricing	19.0%	34.0%	26.5%
DR	Commercial	Direct Load Control - Pool Pumps	7.0%	14.0%	10.5%
DR	Commercial	Direct Load Control - Water Heating	5.0%	7.3%	6.2%
DR	Commercial	Smart Thermostat	11.1%	16.3%	11.1%
DR	Commercial	Thermal Storage	1.5%	2.0%	1.8%
DSR	Commercial	Real Time Pricing	9.0%	32.5%	20.8%
DSR	Commercial	Time of Use	13.0%	72.0%	24.5%
DR	Industrial	Business Demand Response	55.0%	55.0%	55.0%
DSR	Industrial	Real Time Pricing	9.0%	32.5%	20.8%
DSR	Industrial	Time of Use	13.0%	72.0%	24.5%

Demand Side Rates Assumptions

Demand side rates were determined to be consistent and align with the current rates. A representative rate was chosen for each sector and the impacts were determined accordingly. The residential ToU rate are the existing rates in the tariff documents: Schedule MORT, Sheet No, 146.5 for West and Schedule RTOU, Sheet No. 7 for Metro. The peak period and season definitions were as defined in the Residential tariff document and carried over to the Commercial and Industrial segments.

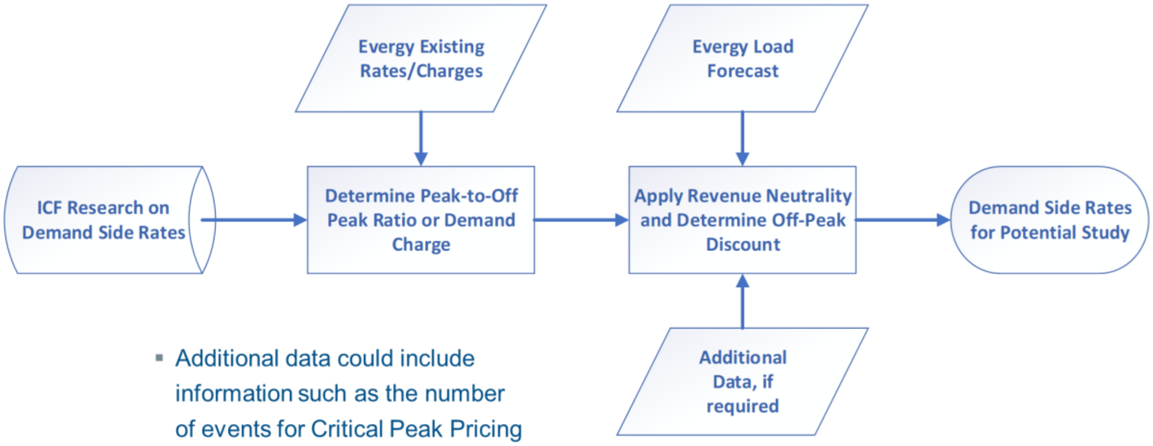


Figure II-6 Process flow for construction of demand side rates

A high-level flow showing the process for constructing the demand side rates is shown in Figure II-6. Note that the process was also applied to the Critical Peak Pricing program tariff, which would be applied to customer rates as a tariff rider. The residential, commercial and industrial demand side rates and critical peak prices are shown in Table II-5, Table II-6, and Table II-7, respectively.

Table II-5 Residential Demand Side Rates

Residential		Summer			Winter		
		Time of Use	Critical Peak Pricing	Demand Rates	Time of Use	Critical Peak Pricing	Demand Rates
West	Peak ($/kWh)	$0.266	$0.634	$0.097	$0.216	$0.514	$0.078
	Mid-Peak ($/kWh)	$0.089	$0.106	$0.097	$0.087	$0.086	$0.078
	Off-Peak ($/kWh)	$0.044	$0.106	$0.097	$0.037	$0.086	$0.078
	Demand Rate ($/kW)			$12.000			$8.300
Metro	Peak ($/kWh)	$0.325	$0.774	$0.116	$0.266	$0.612	$0.092
	Mid-Peak ($/kWh)	$0.108	$0.129	$0.116	$0.104	$0.102	$0.092
	Off-Peak ($/kWh)	$0.054	$0.129	$0.116	$0.045	$0.102	$0.092
	Demand Rate ($/kW)			$12.000			$7.500

Table II-6 Commercial Demand Side Rates

Commercial		Summer		Winter	
		Time of Use	Critical Peak Pricing	Time of Use	Critical Peak Pricing
West	Peak ($/kWh)	$0.148	$0.373	$0.101	$0.326
	Mid-Peak ($/kWh)	$0.049	$0.062	$0.041	$0.054
	Off-Peak ($/kWh)	$0.049	$0.062	$0.041	$0.054
	Demand Rate ($/kW)	$2.280	$2.280	$2.004	$2.004
Metro	Peak ($/kWh)	$0.181	$0.457	$0.131	$0.383
	Mid-Peak ($/kWh)	$0.060	$0.076	$0.052	$0.064
	Off-Peak ($/kWh)	$0.060	$0.076	$0.052	$0.064
	Demand Rate ($/kW)	$4.102	$4.102	$2.087	$2.087

Table II-7 Industrial Demand Side Rates

Industrial		Summer Time of Use	Winter Time of Use
West	Peak ($/kWh)	$0.072	$0.050
	Mid-Peak ($/kWh)	$0.036	$0.033
	Off-Peak ($/kWh)	$0.036	$0.033
	Demand Rate ($/kW)	$12.977	$8.075
Metro	Peak ($/kWh)	$0.112	$0.076
	Mid-Peak ($/kWh)	$0.056	$0.051
	Off-Peak ($/kWh)	$0.056	$0.051
	Demand Rate ($/kW)	$10.187	$7.051

3. Baseline Peak Forecast

ICF calculated the peak summer and winter loads and the split by sector using a peak vector defined with a threshold temperature within the peak period. Table II-8 shows the peak load information for 2023. While the contribution of the residential and commercial sectors is almost the same in the Metro region, residential is the more dominant sector in the West region.

Table II-8 Baseline Split of Peak Load by Sector (2023)

Service area	Sector	Number of customers	Summer MW usage	Winter MW usage	Share of summer peak load	Winter of summer peak load
KCPL-MO	Residential	257,971	693	478	48%	40%
	Commercial	32,663	710	666	49%	56%
	Industrial	938	190	166	13%	14%
	Total-MO	**291,571**	**1,593**	**1,310**		
KCPL-GMO	Residential	288,569	927	808	58%	57%
	Commercial	39,196	611	543	38%	38%
	Industrial	223	187	192	12%	14%
	Total-GMO	**327,989**	**1,724**	**1,543**		

As in the case of energy split for energy efficiency, ICF split the peak load by end use using simulations and guided by the energy split. The simulations were conducted in Open Studio. Input parameters were determined from the survey data and Evergy weather data from select weather stations for the Residential and Commercial sectors.[19] The industrial MW split was assumed to be the same as the MWh breakdown. Figure II-7 shows the breakdown by sector for 2023 for the various end uses in summer. Residential load is dominated by cooling load, which constitutes 65% of the peak. Commercial load is also predominantly cooling but with a lower percentage contribution of 39%, followed by refrigeration and other end use loads. Industrial follows the same trend as energy split: motor, pump and various process loads dominate the end use mix. Figure II-8 provides a similar breakdown by sector for 2023 for various end uses in winter.

[19] OpenStudio is a building energy modeling software developed by NREL in coordination with ANL, LBNL, ORNL and PNNL. https://www.openstudio.net/

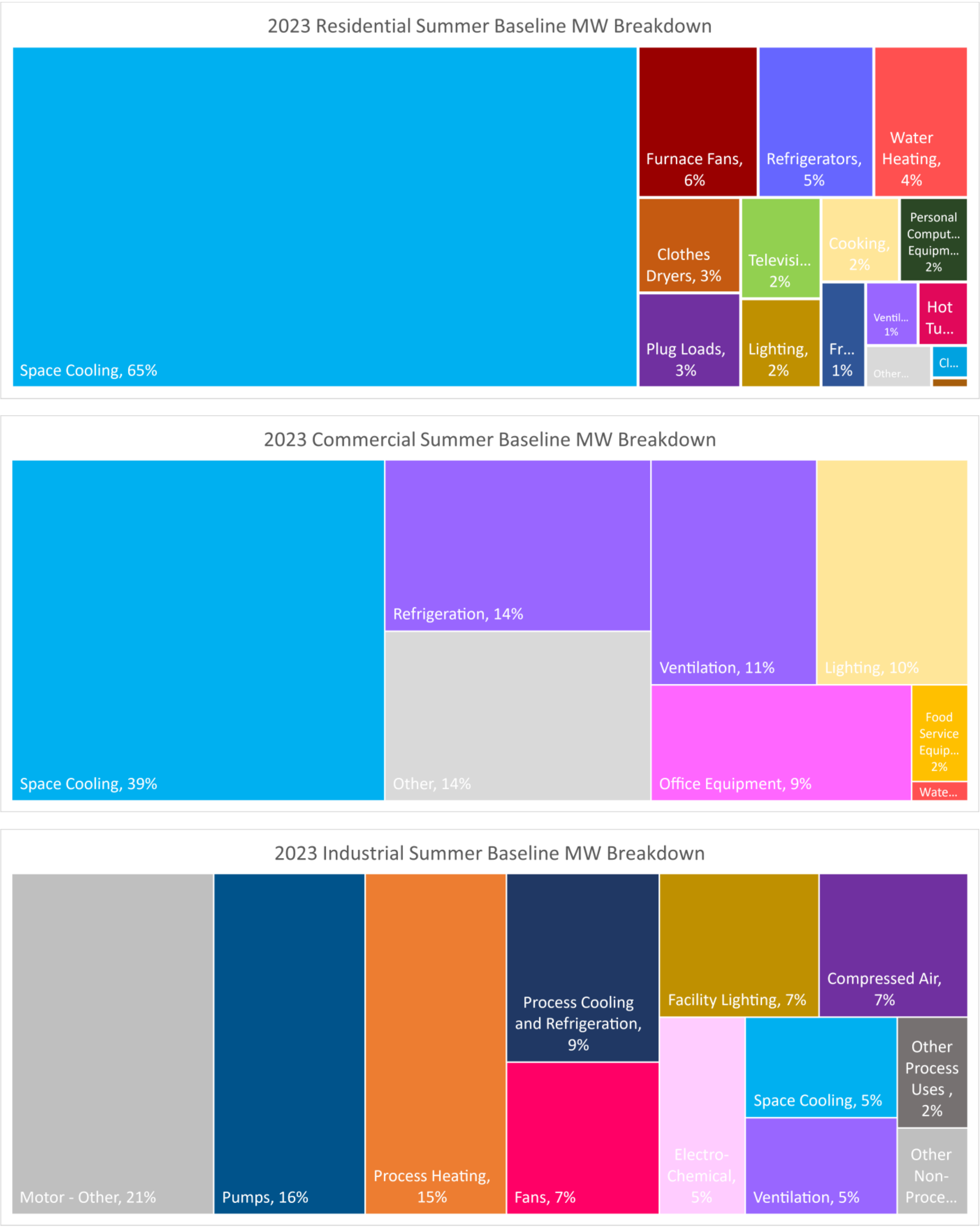
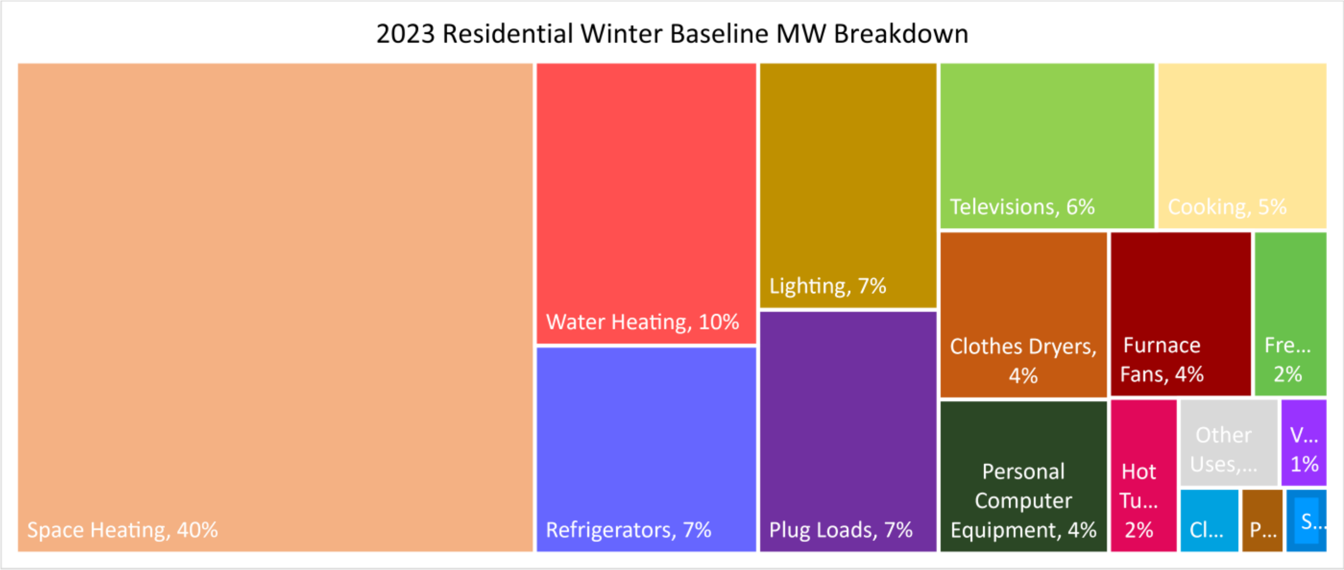
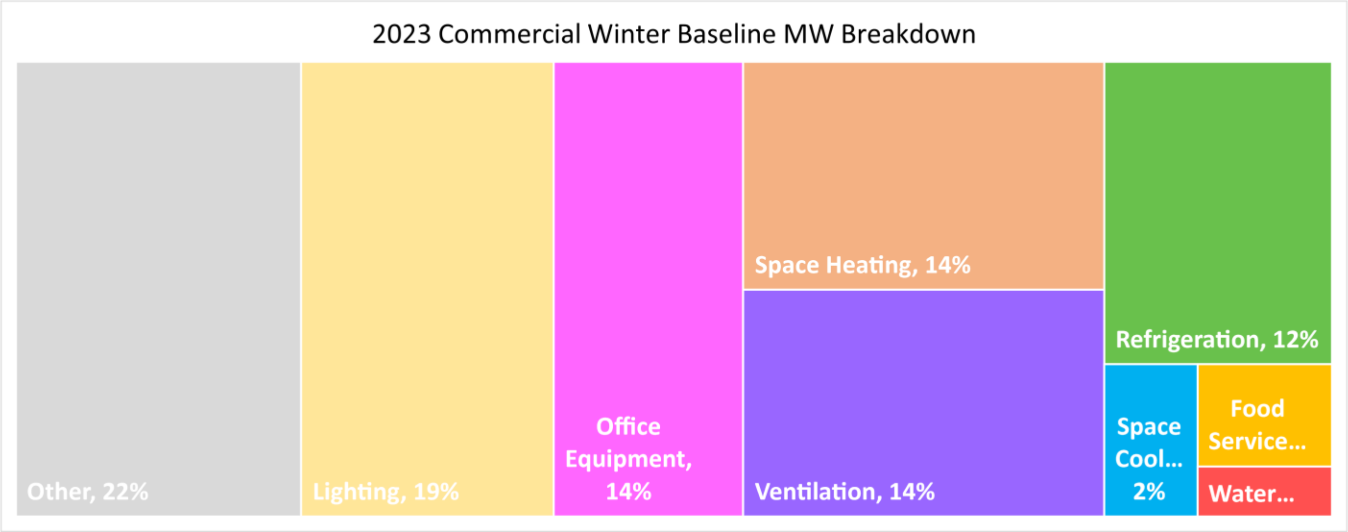


Figure II-7 Sector-wise end-use level breakdown of peak summer load





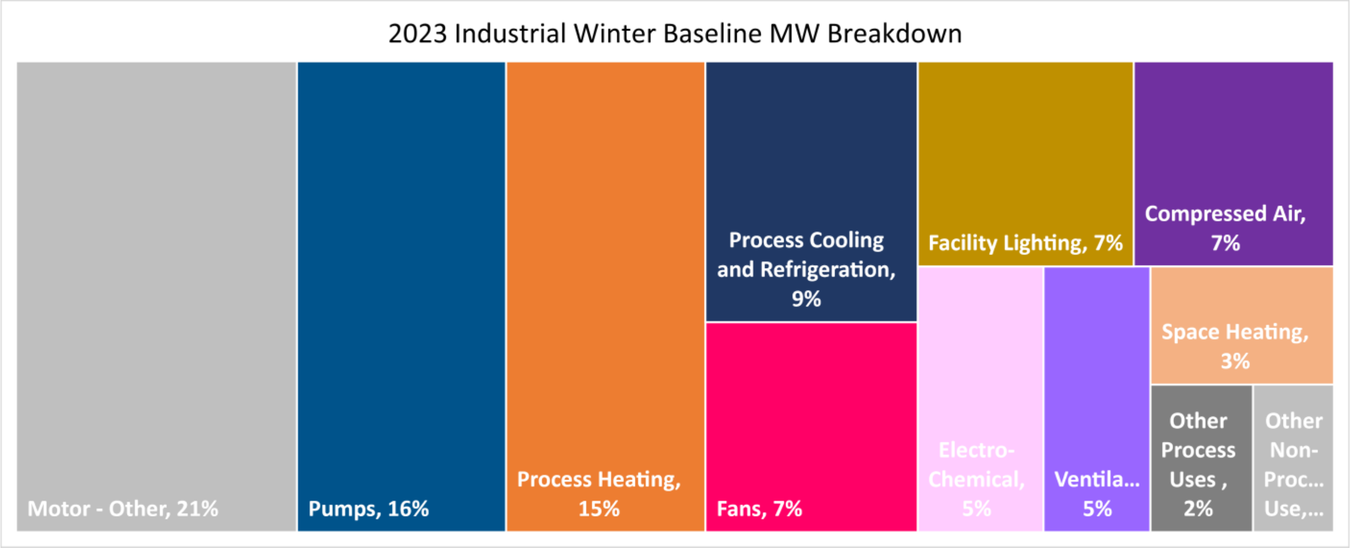


Figure II-8 Sector-wise end-use level breakdown of peak winter load

4. Technical and Economic Potential Results

In 2032 technical potential equals 41% of load in summer 34% of load in winter. For summer, the residential sector contributes 66% to technical potential, the commercial sector contributes 28%, and the industrial sector contributes the rest. The split is similar in winter with residential contributing 71%, while the commercial sector adds 21%. Figure II-9 shows the absolute MW values of the potential and their percentages of the baseline, while Table II-9 shows the breakdown by sector.

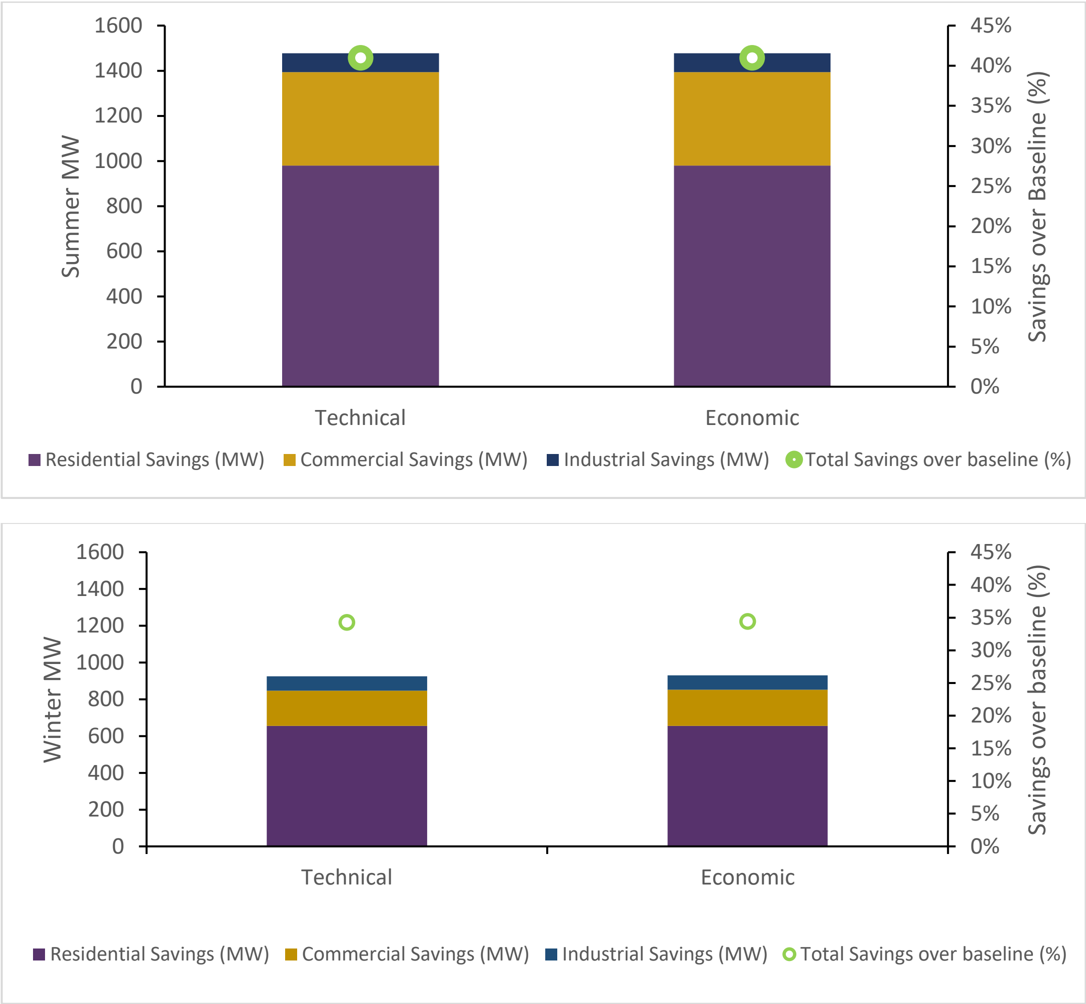


Figure II-9 Technical and economic DR and DSR potential, split by sector (2032) for summer and winter

Table II-9 Peak Summer Load and Technical Potential Contribution by Sector (2032)

Sector	Summer Peak Baseline	Summer Technical/ Economic Potential	Winter Peak Baseline	Winter Technical/ Economic Potential
Residential	50%	66%	47%	71%
Commercial	39%	28%	40%	21%
Industrial	11%	6%	14%	8%

Diving deeper into the summer technical potential results for 2032, technical potential is 50% of residential sector load, 39% of commercial sector load, and 11% of industrial sector load. Figure II-10 shows the breakdown.

Technical and economic potential by end use widely varies by sector. Space cooling comprise 81% of technical potential in the residential sector, while water heating accounts for 12% of the potential. At a program level, this means smart thermostats contribute the most to the technical potential at 55%, and the rates—ToU and demand rates—individually contribute 31% of the potential. In the commercial sector, cooling and heating still take up the bulk of the savings at 65%, followed by the refrigeration at 21%, and then the rest of the end-uses. With regards to the programs, thermal storage is the highest contributor to the savings at 57%, while the real time pricing rate adds in 42%. While the industrial end-use split is guided by the baseline kW end-use breakdown, Business Demand Response contributes the highest savings at 76% of the technical potential.

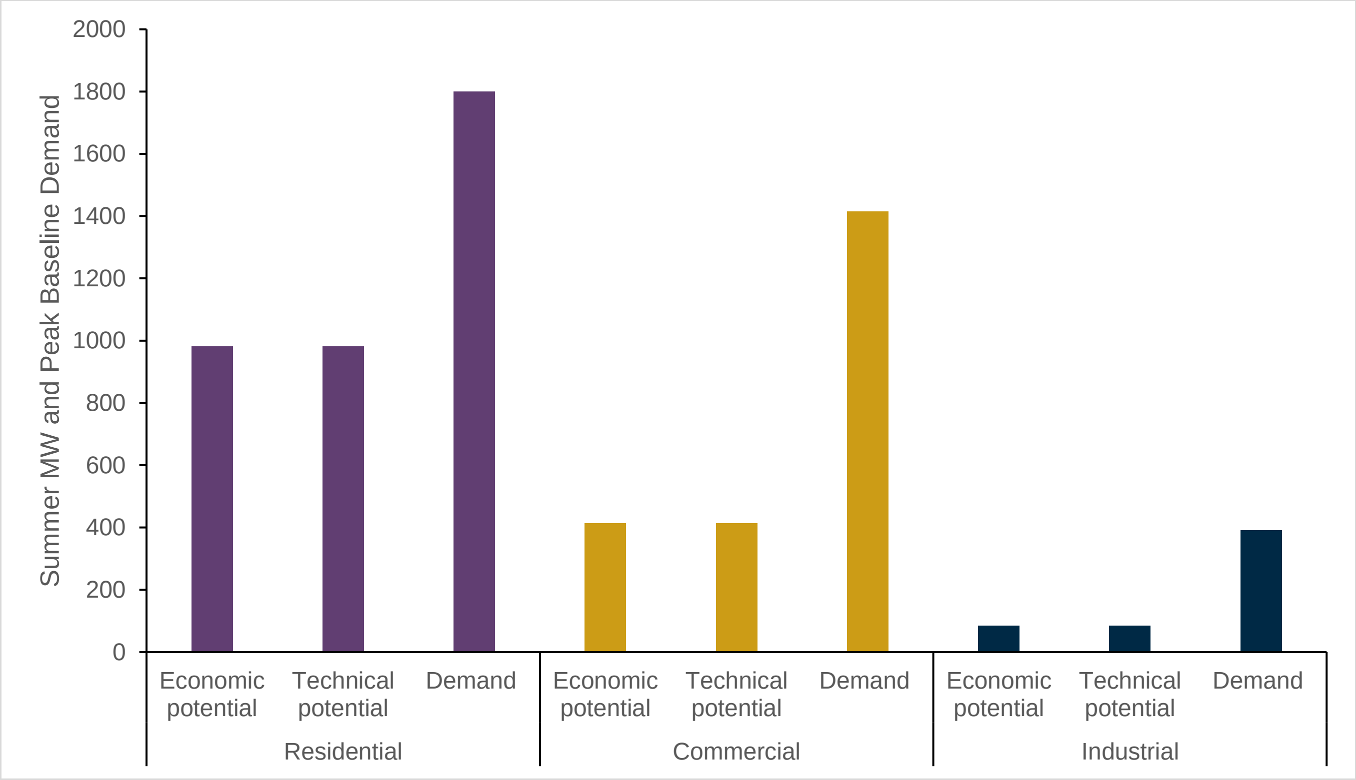


Figure II-10 Sector-level technical and economic potential alongside sector load (2032)

5. Achievable Potential Results

In the RAP scenario, DR and DSR savings are expected to reduce the summer peak loads by 12% compared to baseline by the year 2032. The savings potential in the MEEIA scenario is about 14% of baseline load in the long run. The MAP scenario has the highest potential, 19% savings compared to the baseline load in 2032, due to the inclusion of additional programs and aggressive adoption assumptions. The savings potential for each scenario flattens towards the end of the study period as the participation is modeled to reach steady state levels. MAP begins with higher savings in 2023 due to ToU being modeled as opt-out.

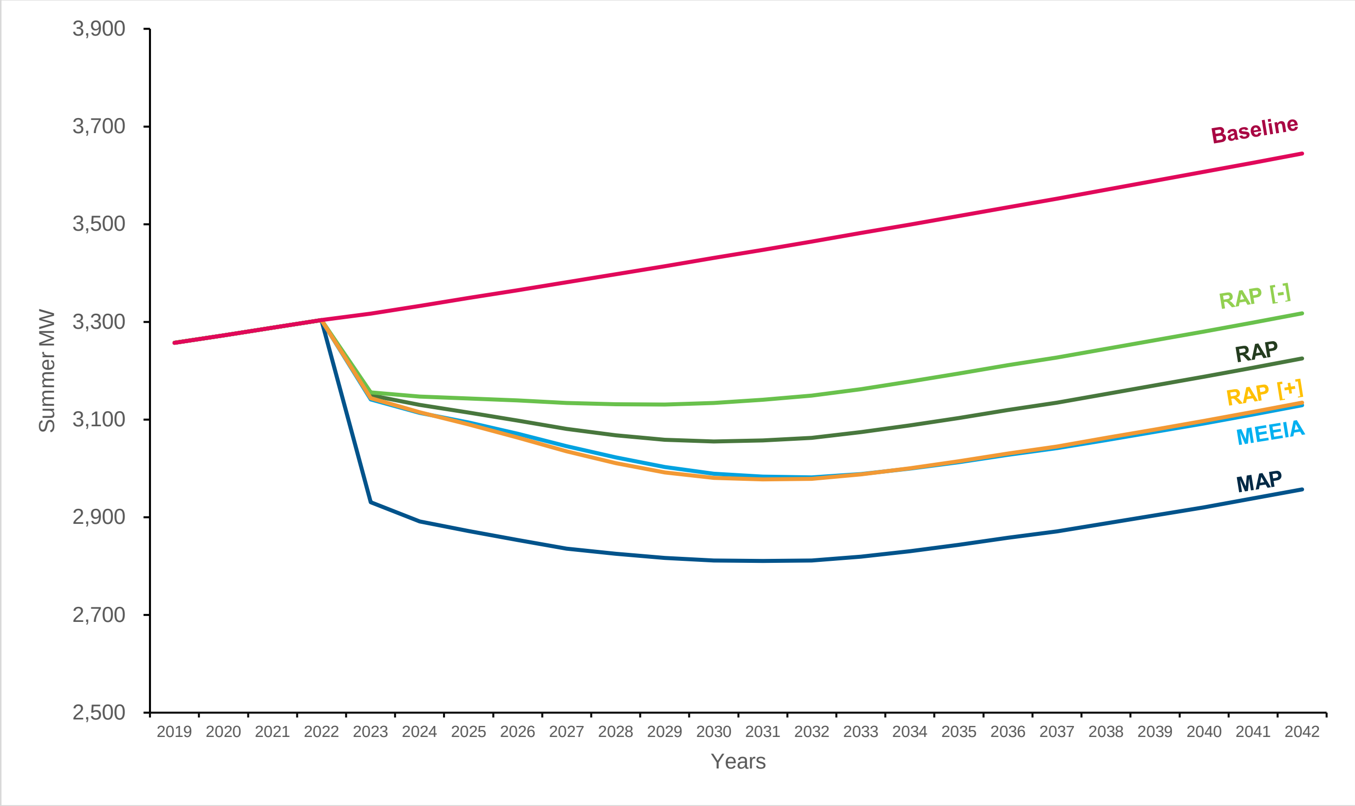


Figure II-11 Impact of achievable potential scenarios on Evergy's baseline summer peak load forecast

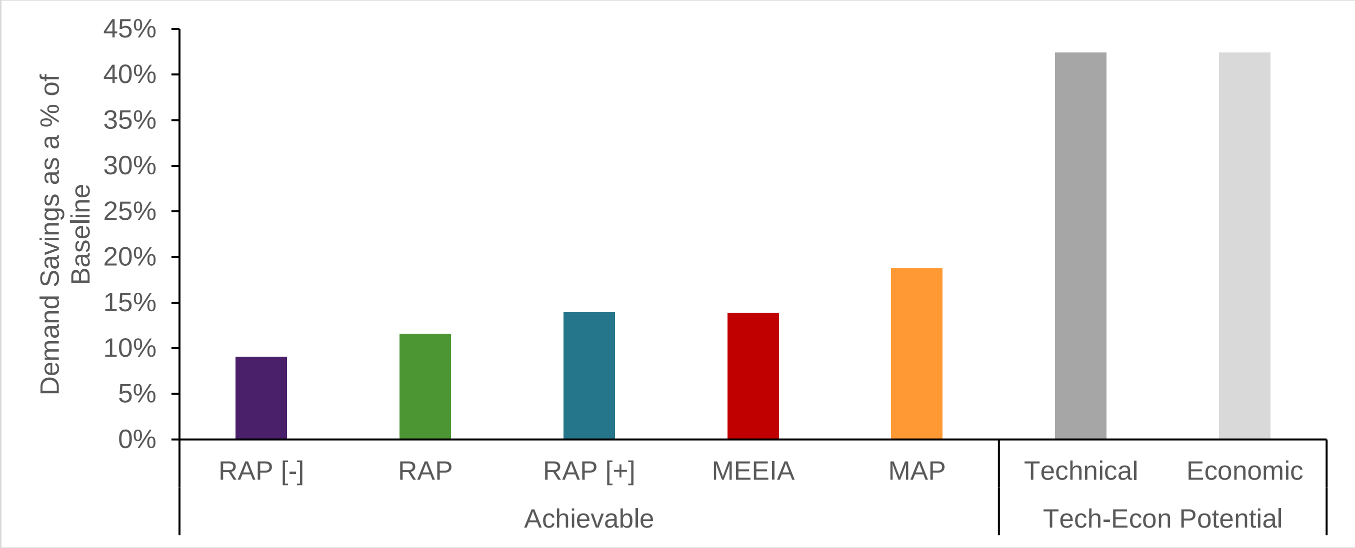


Figure II-12 Cumulative summer peak MW savings levels by scenario (2032)

Figure II-11 shows the baseline summer peak load growth and how the savings potential of each scenario reduces peak load growth from the baseline for the study period. Figure II-12 shows the summer demand savings as percentages of the baseline peak load for the various achievable scenarios alongside the technical and economic potential, and Figure II-13 shows a similar chart for the winter savings potential.

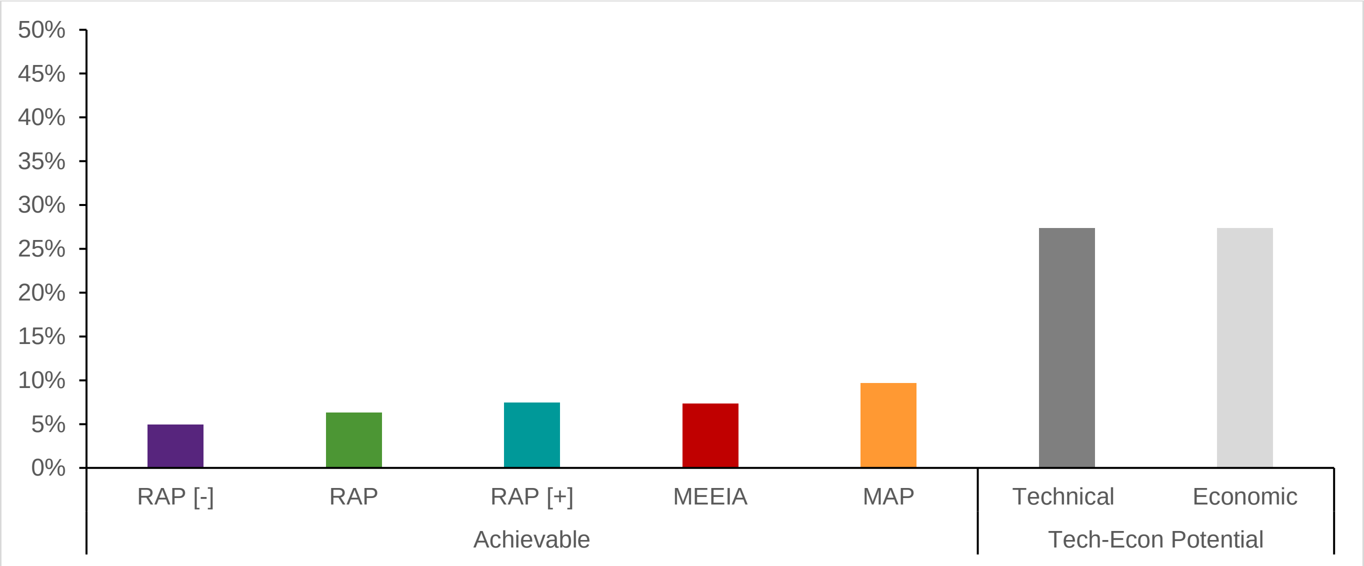


Figure II-13 Cumulative winter peak MW savings levels by scenario (2032)

5.1 Residential

Savings by Program

Residential summer demand savings are dominated by smart thermostat savings in the RAP and MEEIA scenarios, as shown in Figure II-14. Towards the end of the study period, the ToU program also contributes significantly to savings.

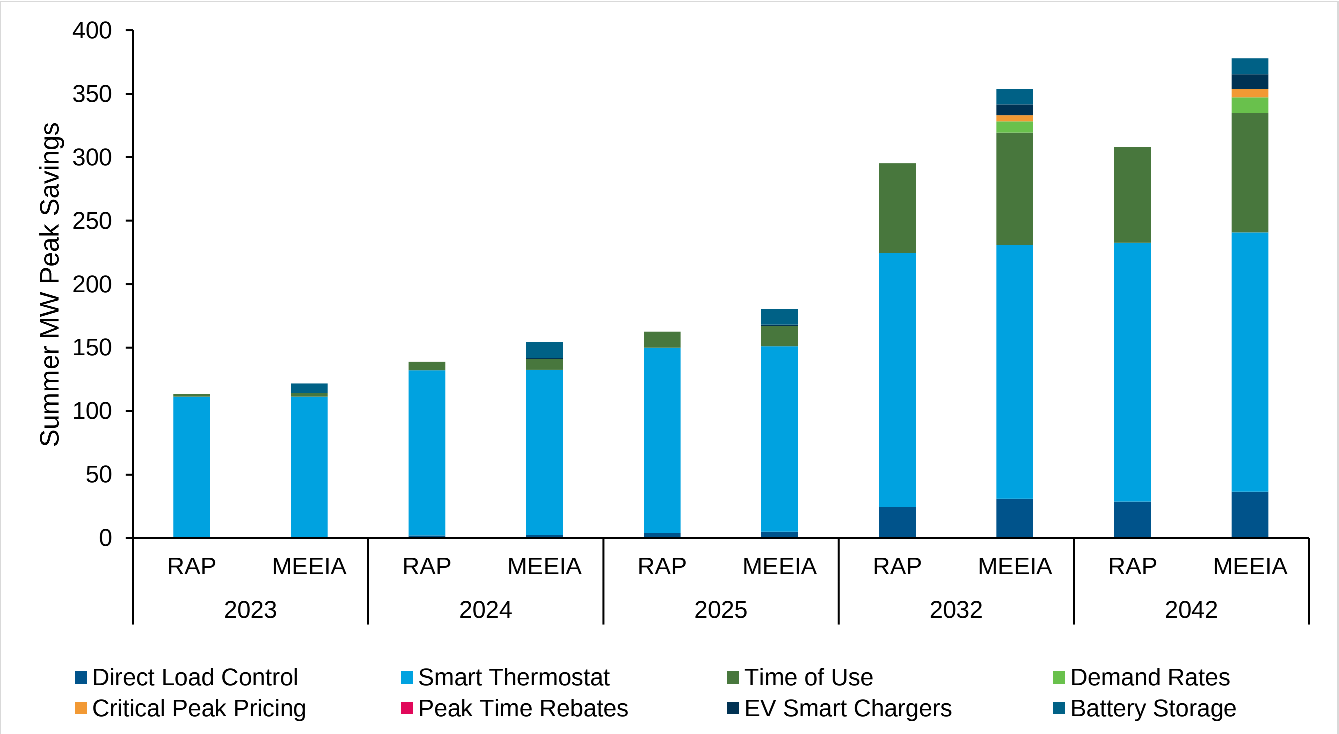


Figure II-14 Residential summer MW peak savings by program & scenario for selected years

Evergy has achieved significant participation in the Smart Thermostat program already and the program gets a head start for the initial years of the study. Since the savings each year account for peak reduction from both existing and new participants, the savings contribution of smart thermostats continues to be high. In the summer of 2032, the Smart Thermostat program is projected to account for 68% and 57% of the total demand savings in the RAP and MEEIA scenarios, respectively, even as the absolute MW savings numbers remain the same due to additional programs and more aggressive participation curves in the MEEIA scenario. Table II-10 shows the savings by program for the year 2032.

Table II-10 RAP and MEEIA Summer Residential Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Direct Load Control	24.4	8.3%	31.1	8.8%
Smart Thermostat	200.0	67.8%	199.9	56.5%
Time of Use	70.6	23.9%	88.4	25.0%
Demand Rates	0.0	0.0%	8.8	2.5%
Critical Peak Pricing	0.0	0.0%	4.9	1.4%
Peak Time Rebates	0.0	0.0%	0.0	0.0%
EV Smart Chargers	0.0	0.0%	8.7	2.4%
Battery Storage	0.0	0.0%	12.3	3.5%
Total	295.1	100.0%	354.0	100.0%

Winter residential savings for the RAP and MEEIA scenarios are shown in Figure II-15 and Table II-11, similar to the summer outputs.

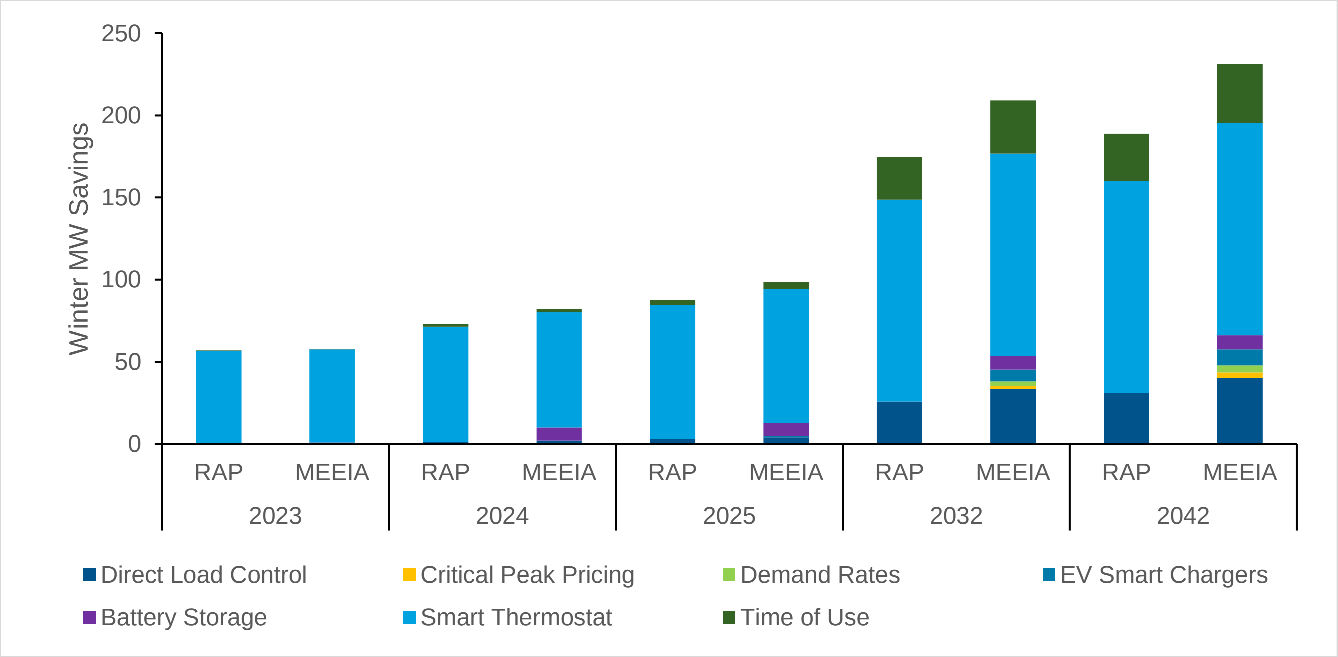


Figure II-15 Residential winter MW peak savings by program & scenario for selected years

Table II-11 RAP and MEEIA Winter Residential Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Direct Load Control	25.7	14.7%	33.3	15.9%
Critical Peak Pricing	0.0	0.0%	2.1	1.0%
Demand Rates	0.0	0.0%	2.7	1.3%
EV Smart Chargers	0.0	0.0%	7.2	3.4%
Battery Storage	0.0	0.0%	8.3	4.0%
Smart Thermostat	123.0	70.4%	123.1	58.9%
Time of Use	25.9	14.8%	32.3	15.5%
Total	174.7	100.0%	209.1	100.0%

Summer End Use Breakdown of DR and DSR Savings

Space cooling dominates the summer demand savings for residential demand response and demand side potential, followed by the water heating end use. The baseline summer peak demand has a significantly high contribution from space cooling resulting, in this skew of savings towards the cooling end-use. While DR savings are from the Smart Thermostat program for cooling and the DLC program for water heating, DSR savings are from the ToU program. The breakdown of savings by DR and DSR, separated by end-use, is shown in Figure II-16.

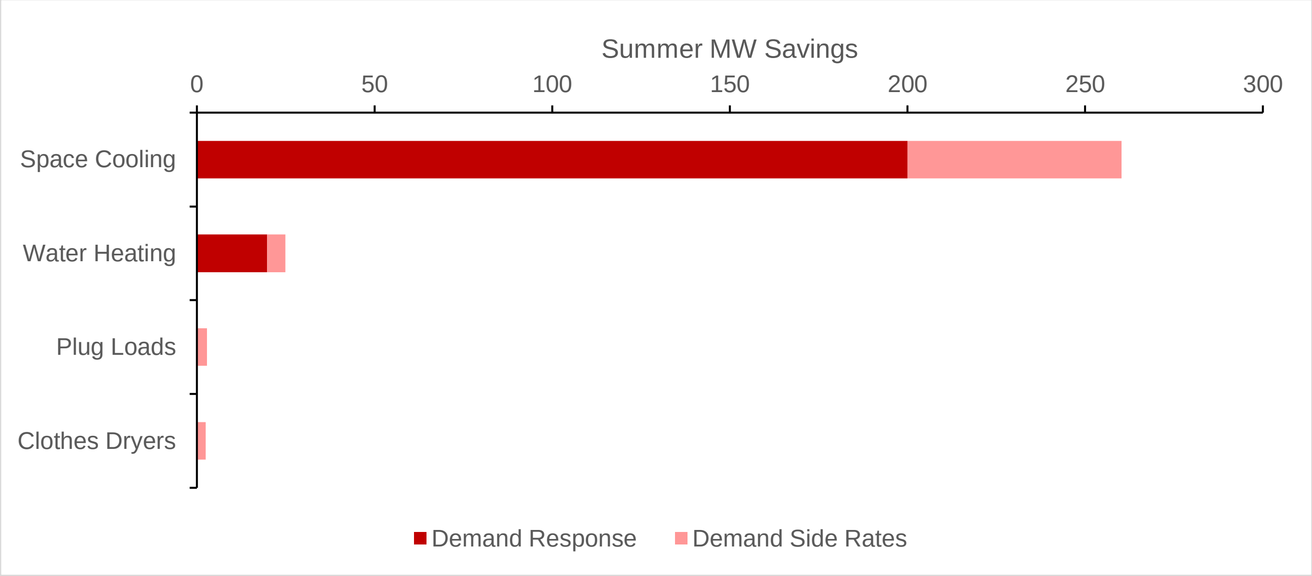


Figure II-16 Residential summer savings DR and DSR split, by end-use (2032)

5.2 Commercial

Savings by Program

Commercial demand savings are dominated by the business demand response (BDR) program, as shown in Figure II-17. Towards the end of the study period, ToU contributes significantly as well, followed by RTP and critical peak pricing programs.

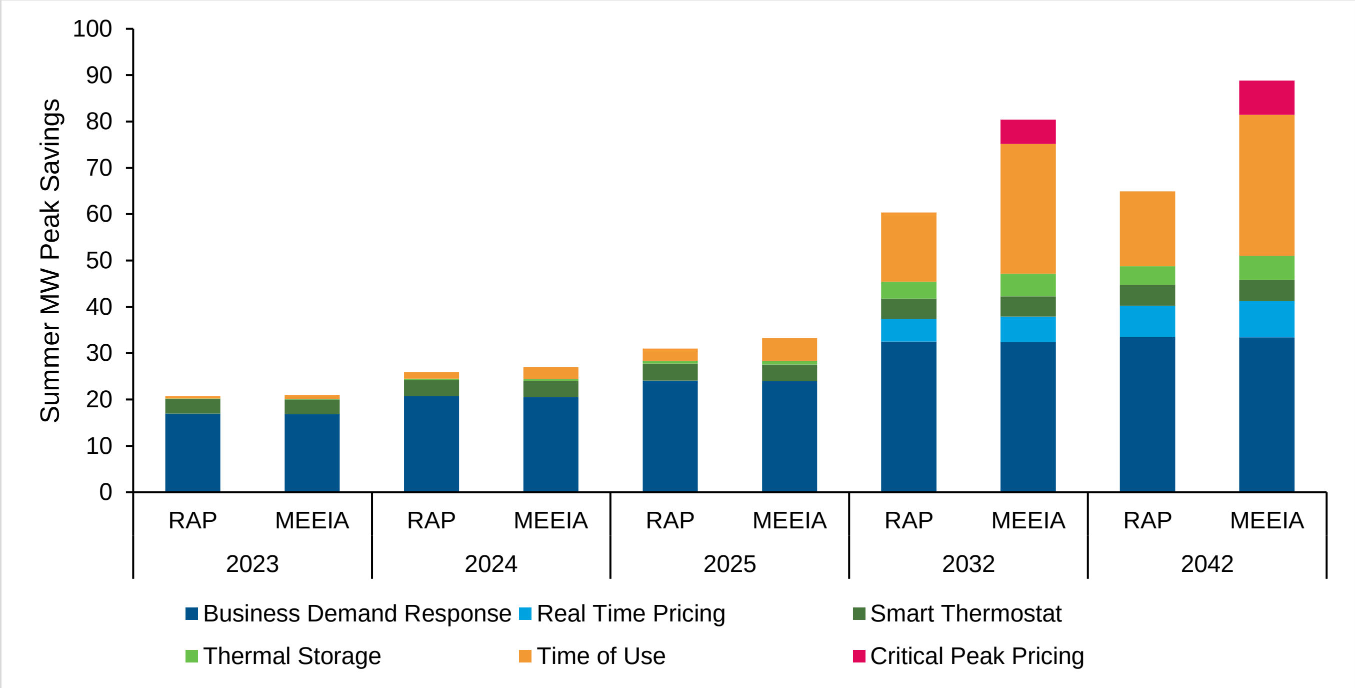


Figure II-17 Commercial summer MW peak savings by program & scenario for selected years

Similar to the Smart Thermostat program in the residential sector, business demand response (BDR) program dominates the savings in the commercial sector, mainly due the fact that there are existing participants in this program and the participation curve is ahead of the other programs. In summer 2032, as shown in Table II-12, BDR contributes 54% of the savings in the RAP scenario and 40% of the savings in the MEEIA scenario. The corresponding savings contribution from the ToU rate is 25% and 35% respectively. The BDR program saves slightly fewer MW in the MEEIA scenario than in the RAP scenario due to the cascading impact of energy efficiency savings on to the DR and DSR programs. The Smart Thermostat program has a much smaller impact in the commercial sector as compared to the residential sector due to significantly lower eligible stock and participation.

Table II-12 RAP and MEEIA Summer Commercial Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Business Demand Response	32.6	53.9%	32.4	40.3%
Real Time Pricing	4.8	8.0%	5.6	6.9%
Smart Thermostat	4.4	7.3%	4.4	5.4%
Thermal Storage	3.7	6.1%	4.9	6.0%
Time of Use	15.0	24.8%	28.0	34.9%
Critical Peak Pricing	0.0	0.0%	5.2	6.5%
Total	60.4	100.0%	80.4	100.0%

Winter commercial savings for the RAP and MEEIA scenarios are shown in Figure II-18 and Table II-13, similar to the summer outputs.

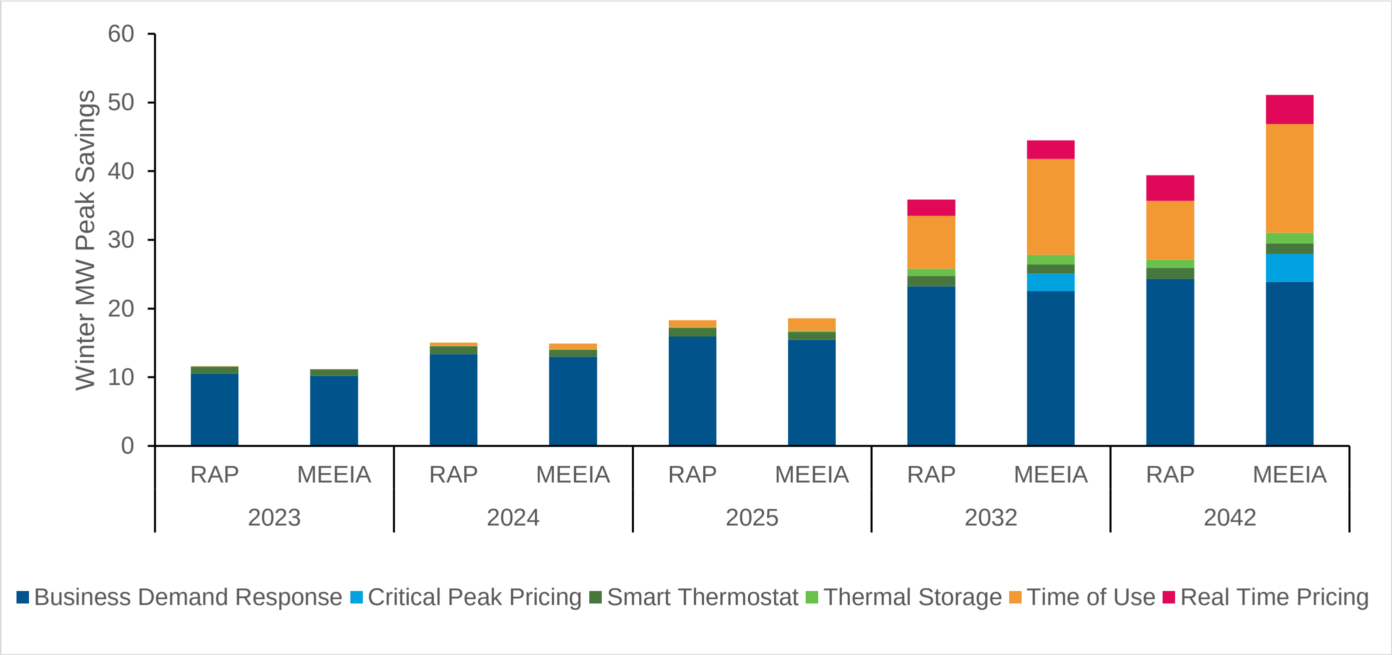


Figure II-18 Commercial winter MW peak savings by program & scenario for selected years

Table II-13 RAP and MEEIA Winter Commercial Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Business Demand Response	23.2	64.8%	22.5	50.7%
Critical Peak Pricing		0.0%	2.5	5.7%
Smart Thermostat	1.5	4.2%	1.3	3.0%
Thermal Storage	1.1	3.0%	1.4	3.2%
Time of Use	7.7	21.4%	14.0	31.4%
Real Time Pricing	2.4	6.7%	2.7	6.1%
Total	35.9	100.0%	44.5	100.0%

Summer End Use Breakdown of DR and DSR Savings

Summer demand savings potential for the commercial sector is also dominated by space cooling due to the high cooling loads in the baseline peak usage. Among the other end-uses, refrigeration and ventilation show up as significant contributors as well, since these along with cooling loads allow for shifting to backup generation, optimization of operation, and storage. While DR is still the significant contributor of savings for each end-use, the 2032 split presented in Figure II-19 shows that the rate-based programs contribute almost as much to commercial savings for each end-use. This trend is unlike residential where the DR (Smart Thermostat program) contribution dominated (corresponding chart in Figure II-16).

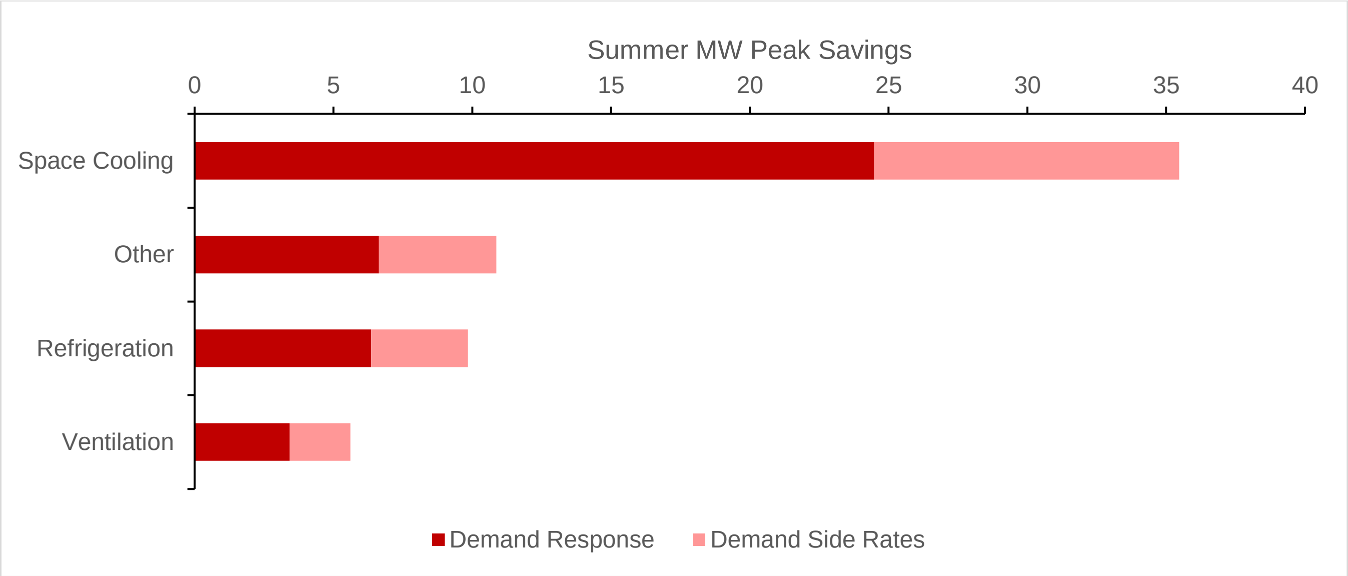


Figure II-19 Commercial summer savings DR and DSR split, by end-use (2032)

5.3 Industrial

Savings by Program

Industrial demand savings are dominated by the business demand response (BDR) program, as shown in Figure II-17. Towards the end of the study period, the rate-based programs show some contribution, but the savings are limited due to the small number of industrial customers and participants. The BDR program has seen already significant participation and load contracted compared to industry standards and is not expected to grow as much as some of the other programs.

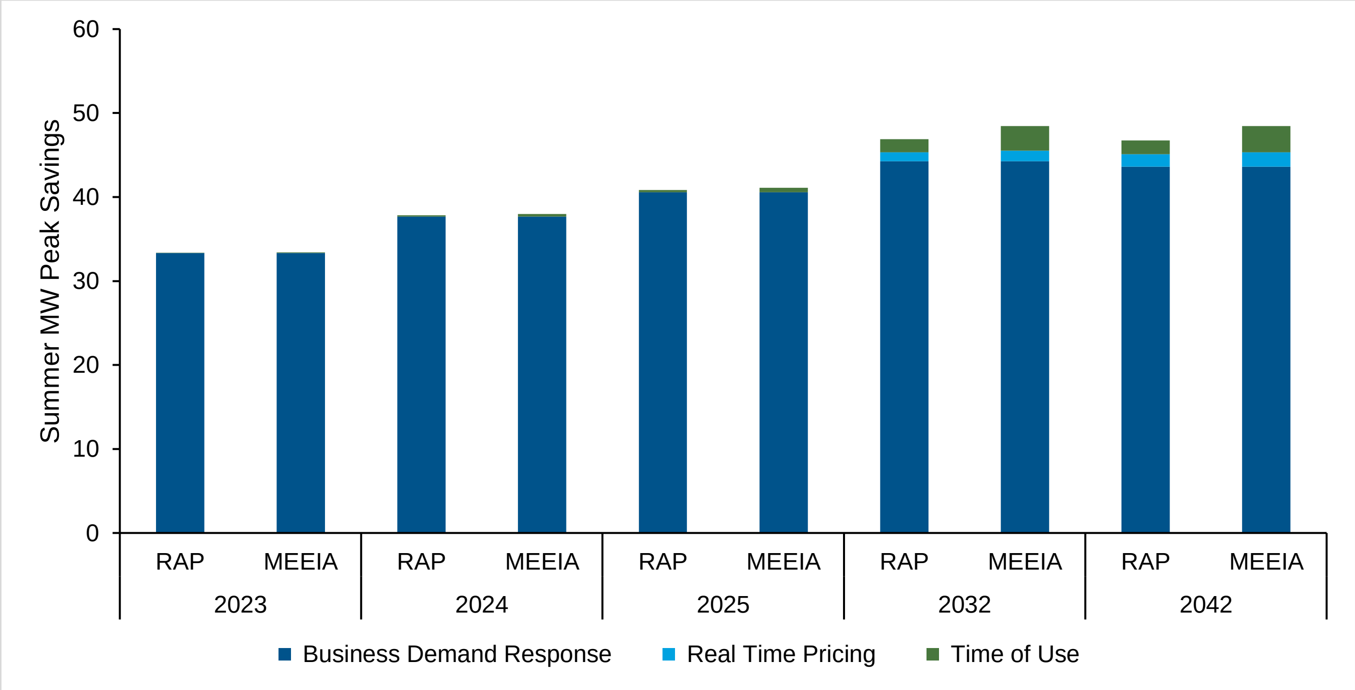


Figure II-20 Industrial summer MW peak savings by program & scenario for selected years

In the year 2032, BDR makes up 94% and 91% of the summer demand savings potential for the industrial sector in the RAP and MEEIA scenarios, respectively, with a potential of 44.3 MW (with the realization rates factored in), while the rate based programs fill the rest of the savings.

Table II-14 RAP and MEEIA Summer Industrial Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Business Demand Response	44.3	94.3%	44.3	91.3%
Real Time Pricing	1.1	2.3%	1.3	2.6%
Time of Use	1.6	3.3%	3.0	6.1%
Total	46.9	100%	48.5	100%

Winter industrial savings for the RAP and MEEIA scenarios are shown in Figure II-21 and Table II-15. These are similar since the seasonal impact on the BDR program is minimal.

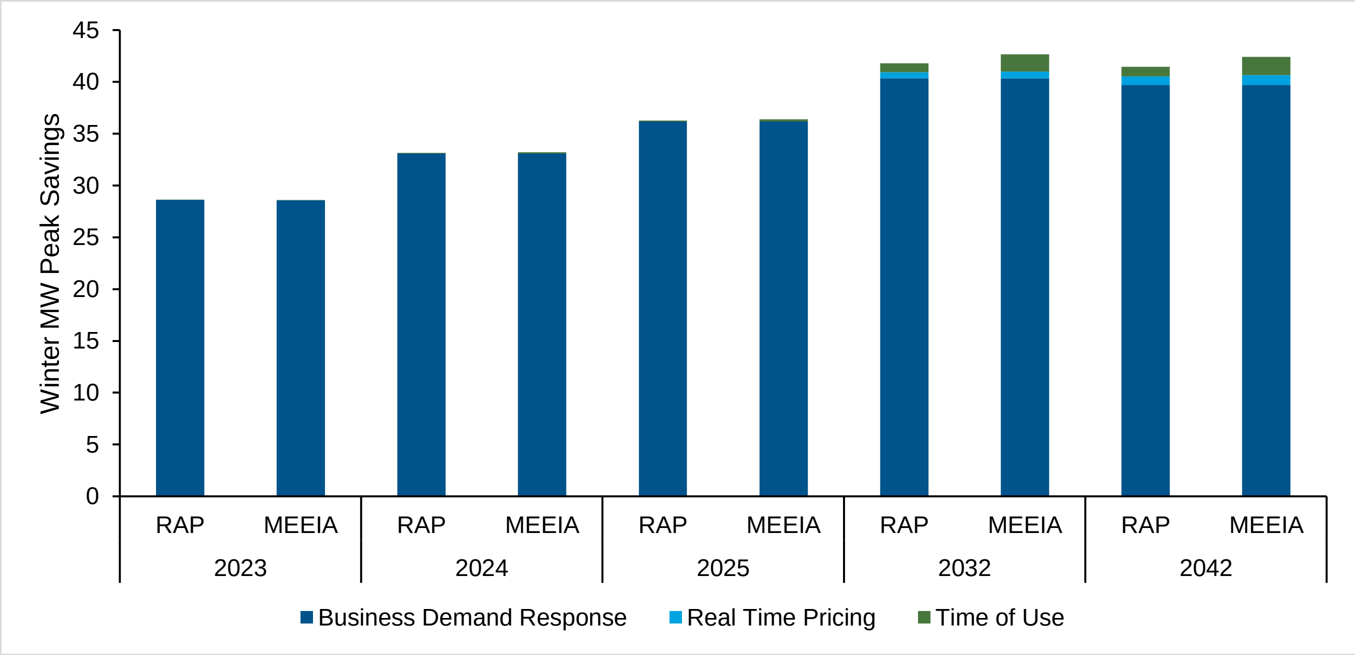


Figure II-21 Industrial winter MW peak savings by program & scenario for selected years

Table II-15 RAP and MEEIA Winter Industrial Savings by Program (2032)

Program	RAP Savings	Share RAP Savings	MEEIA Savings	Share MEEIA Savings
Business Demand Response	40.36	96.6%	40.36	94.6%
Real Time Pricing	0.56	1.3%	0.65	1.5%
Time of Use	0.88	2.1%	1.65	3.9%
Total	41.79	100.0%	42.7	100.0%

Summer End Use Breakdown of DR and DSR Savings

The savings breakdown by end-use mimics the baseline information but is limited to the industries included in the programs. Some types of industries that involve process heating loads at high temperatures and requiring huge lead times to start and stop the machines are not included in the rate-based programs, since shifting is not an option for such loads.

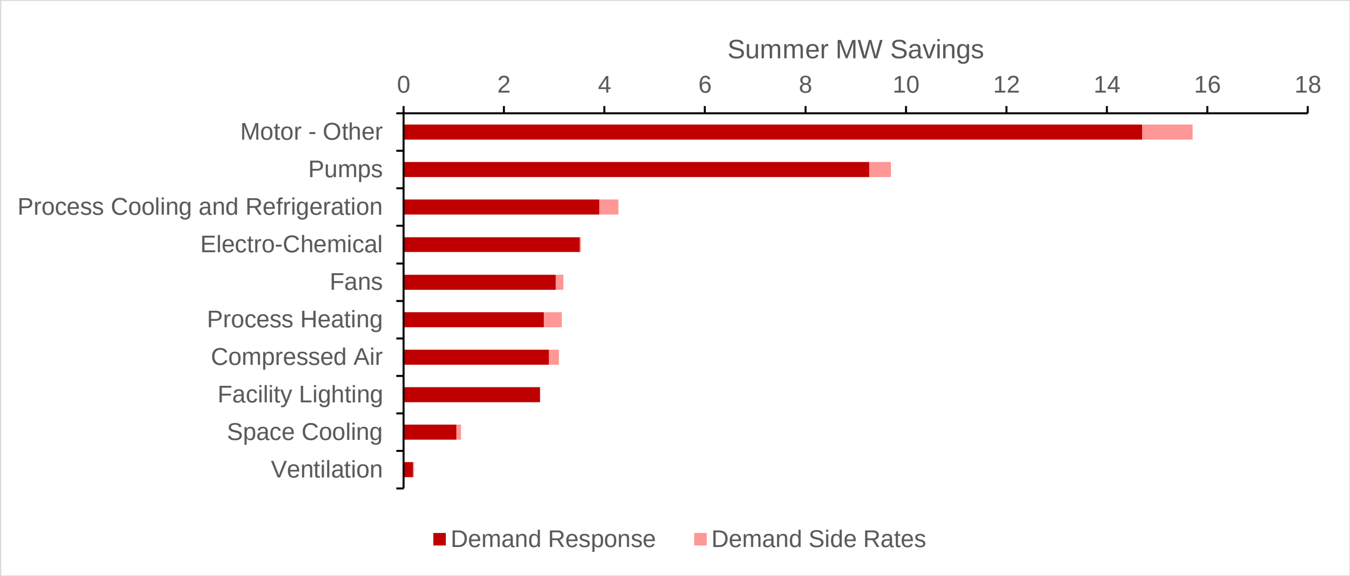


Figure II-22 Industrial summer savings DR and DSR split, by end-use (2032)

5.4 Stand-Alone Potential

The stand-alone potential results reflect the maximum achievable potential for each program if it were rolled out independently. Since these are devoid of any hierarchy implications such as cascading, the general observation is that the programs lower in the hierarchy tend to show larger difference in savings compared to the MAP scenario. The potentials for the stand-alone scenario for all programs in the residential, commercial and industrial sectors are listed in Table II-16,

Table II-17 and

Table II-18.

Table II-16 Residential Stand-Alone Demand Response and Demand Side Rates Savings Potential

Program		Cumulative Summer MW Peak Savings					Cumulative Winter MW Peak Savings				
		2023	2024	2025	2032	2042	2023	2024	2025	2032	2042
DR	Direct Load Control	1.0	3.3	6.2	38.5	45.3	0.2	2.2	5.0	41.7	50.6
	Smart Thermostat	129.7	170.5	196.5	290.5	306.4	58.6	90.6	108.1	178.2	193.6
	Critical Peak Pricing	0.0	0.0	0.0	107.5	149.1	0.0	0.0	0.0	46.7	72.8
	Peak Time Rebates	0.0	0.0	0.0	13.3	18.4	0.0	0.0	0.0	10.1	15.7
	EV Smart Chargers	0.3	0.9	1.7	12.9	17.2	0.0	0.5	1.0	10.8	14.6
	Battery Storage	7.4	12.7	12.6	12.3	12.5	0.6	8.0	8.1	8.3	8.6
DSR	Time of Use	139.2	138.6	136.8	134.9	137.1	48.5	48.7	49.0	50.7	51.6
	Demand Rates	0.0	0.0	0.0	44.2	60.5	0.0	0.0	0.0	13.7	21.0

Table II-17 Commercial Stand-Alone Demand Response and Demand Side Rates Savings Potential

Program		Cumulative Summer MW Peak Savings					Cumulative Winter MW Peak Savings				
		2023	2024	2025	2032	2042	2023	2024	2025	2032	2042
DR	Business Demand Response	16.8	20.6	24.0	32.4	33.4	8.7	11.3	13.7	20.8	21.8
	Critical Peak Pricing	0.0	0.0	0.0	45.6	64.2	0.0	0.0	0.0	22.7	35.6
	Direct Load Control	0.0	0.0	0.1	0.3	0.3	0.0	0.0	0.1	0.4	0.4
	Smart Thermostat	3.7	4.5	4.9	6.4	6.6	1.1	1.5	1.6	2.2	2.4
	Thermal Storage	0.2	0.6	1.1	6.6	7.1	0.0	0.1	0.3	1.9	2.1
DSR	Time of Use	54.3	54.5	54.7	56.2	57.6	28.2	28.3	28.5	29.3	30.5
	Real Time Pricing	0.0	0.0	0.0	20.0	28.2	0.0	0.0	0.0	10.0	15.6

Table II-18 Industrial Stand-Alone Demand Response and Demand Side Rates Savings Potential

Program		Cumulative Summer MW Peak Savings					Cumulative Winter MW Peak Savings				
		2023	2024	2025	2032	2042	2023	2024	2025	2032	2042
DR	Business Demand Response	33.3	37.7	40.6	44.3	43.6	28.6	33.1	36.2	40.4	39.7
DSR	Time of Use	6.1	6.0	6.0	6.0	6.0	3.4	3.4	3.4	3.4	3.4
	Real Time Pricing	0.0	0.0	0.0	4.6	6.2	0.0	0.0	0.0	2.4	3.5

6. Conclusions

This study shows that current demand response programs have the greatest potential to add further savings, owing to their head starts in participation and customer education. While the residential Smart Thermostat program has seen considerable participation, there is opportunity to increase the savings potential as additional customers are enrolled into the program. The Business Demand Response program has already seen a high participation level and retaining the customers while trying to recruit further will ensure assured savings in the C&I sector.

The demand side rates, especially the time of use programs, also show significant potential in the long run. While the program is only starting out and thus ramps up slowly, the results show that it could contribute substantially to peak demand savings in the residential and commercial sectors, and to a lesser extent in the industrial sector.

III. Sensitivity and Uncertainty Analysis

The uncertainty analysis was conducted on the RAP scenarios as an attempt to assess the impact of COVID-19 on the Evergy programs. This analysis was based on limited program performance data from March to mid-June of 2020 and does not constitute a full economic analysis of the expected impacts of the global pandemic. In addition to the participation impacts from the pandemic, avoided costs and the discount rates were also varied in the analysis. The results of this analysis are not a full scenario but instead a select set of indicators: energy savings, demand savings, and portfolio cost-effectiveness.

1. Method

The process started with the selection of the variables that would be changed in the uncertainty analysis. For this study, the variables selected were avoided energy cost, avoided capacity cost, discount rate, and participation. Once the values were selected, the boundaries for each of these variable as well as the distribution for sampling within those boundaries was defined. The boundaries and distributions will be discussed further in section III.2. Once these were defined a sampling algorithm was used to generate a full set of program inputs. For this analysis, 250 iterations were done to populate the full set of samples. The model was then run using each sample of the variables, with the results for the key program indicators recorded. Once all iterations were complete, the results from across the full set of samples were plotted and evaluated. These are shown and discussed in section III.3.

2. Inputs

Table III-1 Sensitivity Analysis Participation Reduction Parameters

Sector	Measure Type	First Year Reduction Magnitude
Residential	• Home Energy Reports • DIY (e.g. Lighting) • Large Appliances (e.g. HVAC)	Low Reduction
	• Shell Measures • Energy Savings Kits • Smart Thermostats (inc. DR)	Medium Reduction
	• DI Multi-family Low-Income • Direct Load Control	High Reduction
Commercial and Industrial	• Behavioral/SEM	Low Reduction
	• All Others • Smart Thermostats (inc. DR)	Medium Reduction
	• DI • Direct Load Control	High Reduction

The inputs selected for this analysis were the avoided energy cost, avoided capacity cost, discount rate, and participation. Each variable has a description of the boundaries defined for it as well as the distribution used for the sampling algorithm.

For the avoided energy cost, the bounds were based on scenarios used in the latest Evergy MO IRP with a uniform distribution for sampling. For the avoided capacity cost, the bounds were varied over time. The bound started at 50% to 100% of the baseline for the first three years, followed by 75% to 100% of the baseline for the next three years, and finally at 75% to 125% for all the rest of the years.

During all boundary periods a uniform distribution was used for sampling. For the discount rate, the bounds were between 3.5% and 4.5% with a uniform distribution for sampling.

For participation, the boundaries were set independently for each program, with the maximum reduction in the first year. The maximum reduction in the first year was set according to the table on the left for each program. Large reductions were close to complete reductions, while medium and low reductions in participation were equal to three quarters and half of the participation of the RAP scenario, respectively. The sampling used a distribution skewed towards the status. The boundaries were developed based on data and insight from the program implementation teams. After the first year, the participation increased, gradually returning to the RAP baseline by the fifth year.

3. Results

While the variation in the avoided costs and the discount rate result in a wide variation in the Total Resource Cost (TRC) test and the Program Administrator Cost (PAC) test, the portfolio remains cost effective in most cases when measures use the TRC and all cases when measures use the PAC. In the long, the portfolio is expected to perform quite similarly to the RAP scenario. Participation reductions used to estimate the impacts of COVID-19 are more significant for the commercial and industrial sectors than the residential sector, but the impacts estimated through 2028 are only modest. In addition, energy savings and cost-effectiveness vary independently of each other indicating that the main drivers behind the cost-effectiveness are the avoided costs and discount rate, and not the energy savings. All distribution charts showing the impacts on energy and demand savings as well as cost-effectiveness by sector by jurisdiction are provided in Appendix E of Volume 5.

3.1 Residential

The impact of the participation reductions on energy savings in the residential sector are minimal because most savings come from programs that only had small reductions. The impact of the participation reductions is more substantial for demand savings since DR measures are more significantly impacted. These demand savings impacts persist much more than other savings reductions due to the nature of the Smart Thermostat program and the expected participation trajectory.

The variation in the incremental savings in the first year is relatively substantial, with a range of roughly 15% of the baseline savings, but shrinks quickly, with a range of roughly 5% by the third year.

Despite the wide range of avoided costs, the residential portfolio remains very cost effective, varying between 2.0 and 3.5. While this represents a large variation in the benefit-cost ratio, it does not represent significant risk since it does not come close to approaching the threshold of 1.0.

3.2 Commercial

The impact of the participation reductions on the energy savings in the commercial sector are more significant than for the residential sector, since most of the programs, including the customer program, see at least a medium reduction. The impact of the participation reductions on the demand savings is initially similar to that of the residential sector but savings are able to rebound in the later years of the study.

The variation in the incremental savings in the first year is very substantial, with a range of roughly 50% of the baseline savings, but it shrinks quickly as participation picks back up again, similar to the residential variation.

With the wide range of avoided costs between samplings, the cost effectiveness of the commercial portfolio is quite variable, though not as variable as the residential sector. The TRC cost effectiveness of the commercial portfolio also comes very close to dropping below 1.0, the cutoff for cost-effectiveness, but remains in the range of 1.0 to 1.7.

3.3 Industrial

Because all the industrial sector programs also serve the commercial sector, the results are very similar between the two sectors. The effects of reduced participation are more significant for energy savings than demand savings and the variation in the incremental savings are large, though not quite as large as for commercial portfolio. The largest difference is that the TRC cost-effectiveness of the industrial portfolio clearly drops below the threshold of 1.0 in some cases, with a general variation between 0.9 and 1.5.

IV. Combined Heat and Power Potential

As a final consideration for demand-side programs, ICF conducted a market potential assessment for combined heat and power (CHP) in Evergy's Missouri territories.

The state of Missouri has been exploring the potential benefits of CHP in terms of both resilience and energy efficiency. The Missouri Department of Natural Resources, Division of Energy has been actively involved in multiple Department of Energy (DOE) Accelerators related to CHP and has held summits focused on CHP for resilience in the healthcare and education sectors throughout the state. Officials have also participated in regulatory proceedings and provided testimony to the Missouri Public Service Commission (PSC) to highlight CHP energy savings and resilience benefits for future growth and deployment.

ICF evaluated the potential for CHP among commercial, institutional, and industrial customers in Evergy's Missouri territories, both from the customer's perspective in the form of payback period calculations and from the utility's perspective in the form of resource cost tests. This chapter presents the results of ICF's CHP analysis in the following sections:

- Approach
- Data Development
- Market Characterization and Baseline Projection
- Potential Results
- Conclusions

1. Approach

CHP is unlike most energy efficiency measures for several reasons, including:

- CHP systems generate electricity, rather than conserving it. The increase in efficiency occurs as a result of heat recovery and avoided T&D line losses.
- CHP systems are sized to cover baseload electric and thermal requirements throughout the year, so a single installation can produce a large amount of energy savings.
- CHP systems are complex machines that require specialized maintenance.
- A CHP system represents a substantial capital investment. Installed costs for a 100-kW system (on the smaller end of the size range) are close to $300,000, while installed costs for a 1 MW system are close to $2 million.

CHP saves energy through 1) avoided line loss from electricity delivery, and 2) avoided boiler fuel for heating loads displaced by recovered CHP heat. The energy efficiency benefits of CHP are summarized in Figure IV-1.

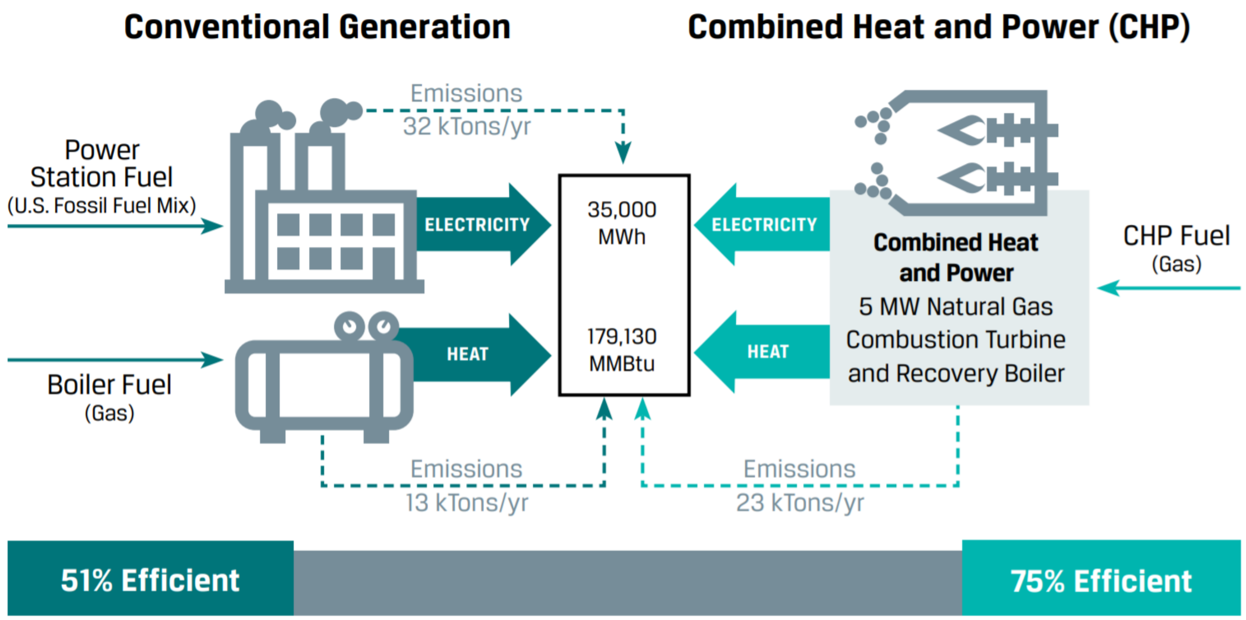


Figure IV-1 CHP efficiency benefits

Compared to other energy efficiency or demand response measures CHP packs a large amount of potential energy savings into a relatively small number of potential projects. Only large commercial, institutional, or industrial facilities can support economic CHP installations, and not all these facilities have consistent thermal and electric load requirements. Furthermore, the customer decision-making process for CHP is different than other efficiency measures because it is a large investment that is in many ways transformative to facility operations.

In order to estimate the technical potential for CHP in Evergy's Missouri territories, ICF matched customer data from Evergy with our CHP Technical Potential and CHP Installation databases. The analysis used electricity consumption data, combined with thermal-to-electric load ratios, to determine the potential size of a baseload CHP installation for each customer. It then compared expected cost, performance, and energy bill savings for CHPs in that size range to separate heat and utility power purchases.

ICF evaluated CHP economics at the customer level, in the form of payback period on the CHP investment, as this determines the expected market penetration for both the base case and incentivized cases in ICF's CHPower modeling. The data inputs, process, and outputs/applications for the CHPower model are shown in Figure IV-2.

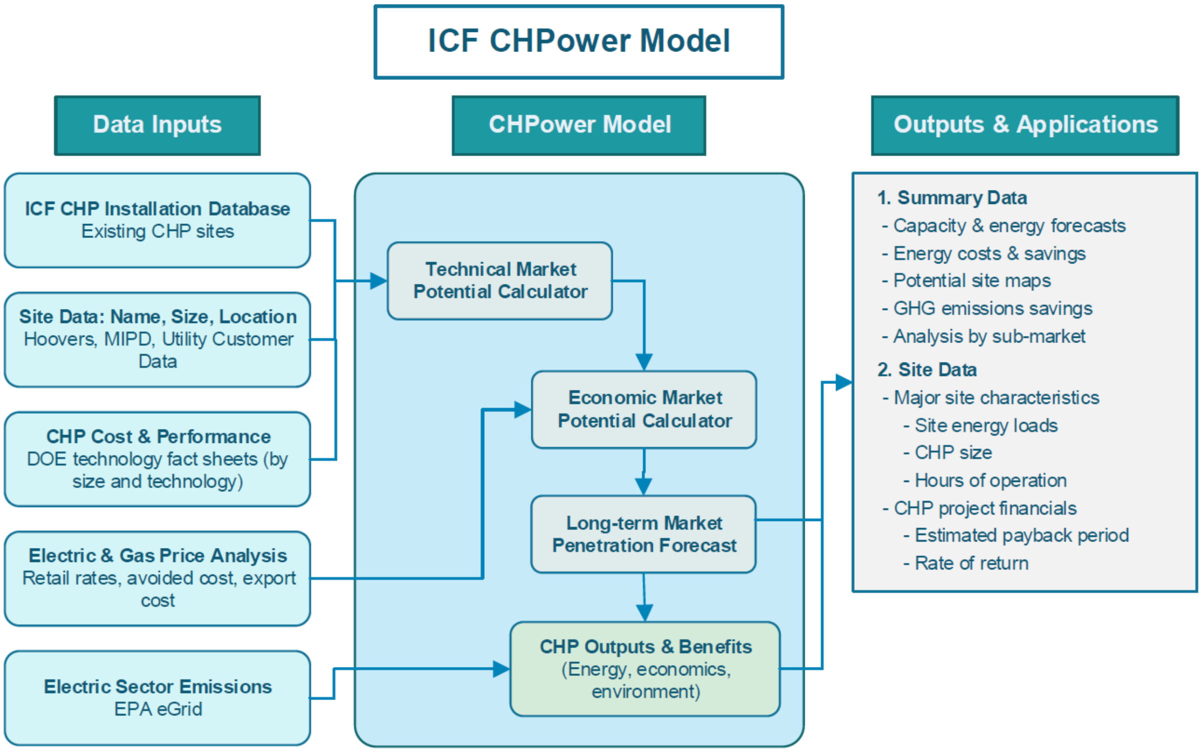


Figure IV-2 ICF's CHPower Model to evaluate technical, economic, and market potential for CHP

After characterizing technical potential, economic potential, and expected market adoption of CHP in Evergy's Missouri territories, ICF applied the Total Resource Cost (TRC) test to evaluate the benefit/cost ratio, and the corresponding economic and achievable potential at the program level.

$$TRC\ \ B/C\ \ Ratio = \frac{CHP\ Electricity\ Benefits + Displaced\ Boiler\ Benefit + Federal\ Tax\ Credits}{CHP\ System\ Costs + CHP\ Fuel\ Consumption + Utility\ Administration\ Costs}$$

Overall, economics for CHP in Missouri do not appear to be favorable. From the customer perspective, payback periods for CHP are currently over 15 years in most cases. From the total resource perspective, the TRC benefit/cost ratio did not exceed one for any Evergy customers, resulting in zero economic or achievable potential.

2. Data Development

In order to estimate the full technical and market potential for CHP, ICF first cleaned and prepared customer data to estimate individual site thermal loads and CHP sizes. This process is detailed in the steps below:

1. Obtained data for all Evergy Missouri commercial and industrial customers, which included basic site and rate code information (such as site name, address, rate code, and premise & meter ID) and monthly energy consumption and capacity values.
2. Consolidated individual meters based on premise ID, address, and rate code to construct a full list of all potential sites.
3. Assigned rate categories to sites based on the rate codes provided by Evergy size (SGS, MGS, LGS) and voltage (secondary, primary, substation, and transmission).

4. Identified data anomalies (such as highly seasonal data and missing month data) and used data cleaning procedures and checks to align or remove sites with data anomalies.
5. Finalized industrial classification (SIC) for customer sites based on Evergy-assigned SIC codes and matching with ICF's technical potential database.
    a. Also assigned industry classification SIC or NAICS codes for unknown customers based on web scraping and web search procedures.
    b. Removed customers with applications determined not suitable for CHP.
6. Applied CHP sizing strategies for customers with applications conducive to CHP.

3. CHP Sizing Strategies

ICF applied the following site electric load and CHP sizing strategies for all sites determined to be conducive to CHP in the steps above.

Electric Load Estimation

1. Determined customer load factors based on assembled data for monthly energy consumption (kWh) and monthly peak loads (kW) for each site.
2. Identified Power-to-Heat Ratio (P/H) and estimated hours of operation for each site based on industrial classification (SIC) and predetermined classification metrics.
3. Calculated individual site electric load, the maximum size for onsite or behind-the-meter CHP, which is defined as the lesser of:
    a. Minimum monthly peak load (kW), or
    b. Annual energy consumption (kWh) divided by assumed operational hours (based on application type).

CHP Size Estimation

1. Applied a thermal factor based on the P/H ratio and typical CHP system efficiencies.
2. Calculated CHP sizes (kW) for individual sites by combining the estimated site electric load and calculated thermal factor, not to exceed the site electric load.
3. Assigned sites a CHP size bin for representative equipment based on calculated CHP size. The size bins are highlighted in Table IV-1, which details the CHP cost and performance values from the Department of Energy (DOE) CHP Fact Sheet Series. ICF applied these values to sites with technical potential for CHP.

Table IV-1 CHP Cost & Performance Values from the DOE CHP Technology Fact Sheet Series[20]

CHP Size Range	50 – 500 kW	500 kW – 1 MW	1 – 5 MW	5 – 20 MW	> 20 MW
CHP Size Bin	1	2	3	4	5
Prime Mover	Engine	Engine	Engine	Turbine	Turbine
Installed Cost ($/kW)	2,900	2,200	1,800	1,800	1,470
Maintenance Cost ($/kWh)	0.024	0.017	0.016	0.012	0.009
Heat Rate, Btu/kWh	11,530	9,950	8,340	12,190	10,310
Net Electrical Efficiency, %	30%	34%	41%	28%	33%
Thermal Output, Btu/kWh	6,100	5,164	3,215	4,893	3,787
Thermal Output, MMBtu/hr	0.61	2.84	10.69	52.2	77.4
Total Efficiency, %	80%	78%	78%	70%	71%

The data development and CHP sizing procedures highlighted above resulted in final CHP sizes for all sites, which were then used to estimate cumulative technical potential in the Evergy Missouri territory.

4. Energy Rates

ICF also modeled electricity rates for each customer class and applied them to individual sites to estimate economic potential. Facilities, demand, and energy charges for select rate classes are highlighted in Table IV-2 below, with energy and demand charges broken down by season and energy charges by site operational hours. State average industrial and commercial natural gas prices from the Energy Information Administration (EIA) were also used to model gas rates depending on CHP size (Industrial >5 MW, Commercial <500 kW).[21]

Table IV-2 Modeled Facilities, Demand and Energy Charges for Evergy Missouri Used in the CHP Analysis

Flat Charges (Facilities & Demand, $/kW)				Energy Charges ($/kWh)					
Rate Category	Facilities ($/kW)	Demand ($/kW, (Sumr.))	Demand ($/kW, (Wntr.))	Summer (180 hrs)	Summer (180-360 hrs)	Summer (>360 hrs)	Winter (180 hrs)	Winter (180-360 hrs)	Winter (>360 hrs)
GMO_SGS_SV	$1.40	$1.23	$1.20	$0.0949	$0.0714	$0.0714	$0.0690	$0.0622	$0.0662
GMO_SGS_PV	$1.40	$1.19	$1.16	$0.0891	$0.0670	$0.0670	$0.0677	$0.0611	$0.0611
GMO_SGS_SV 1	$0.00	$0.00	$0.00	$0.1354	$0.1354	$0.1354	$0.0851	$0.0851	$0.0851
GMO_SGS_PV 1	$0.00	$0.00	$0.00	$0.1354	$0.1354	$0.1354	$0.0634	$0.0634	$0.0634
GMO_LGS_SV	$2.21	$0.88	$0.59	$0.0874	$0.0661	$0.0463	$0.0666	$0.0610	$0.0418
GMO_LGS_PV	$1.43	$0.85	$0.57	$0.0847	$0.0641	$0.0448	$0.0641	$0.0588	$0.0402
GMO_LPS_SV	$3.15	$10.54	$5.49	$0.0536	$0.0422	$0.0370	$0.0500	$0.0394	$0.0345
GMO_LPS_PV	$2.75	$10.23	$5.33	$0.0520	$0.0409	$0.0358	$0.0485	$0.0382	$0.0335
GMO_LPS_SUV	$0.00	$10.01	$5.21	$0.0505	$0.0398	$0.0348	$0.0477	$0.0376	$0.0329

[20] Department of Energy (DOE) CHP Technology Fact Sheet Series, 2016. Available at: https://www.energy.gov/sites/prod/files/2017/12/f46/CHP%20Overview-120817_compliant_0.pdf
[21] U.S. Energy Information Administration (EIA). Natural Gas. Available at: https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

GMO_LPS_TV	$0.00	$9.93	$5.17	$0.0515	$0.0405	$0.0355	$0.0465	$0.0366	$0.0321

5. Market Characterization and Baseline Projection

5.1 Technical Potential

ICF combined Evergy customer data with our CHP Technical Potential Database and CHPower Model to estimate the technical, economic, and achievable potential for CHP under baseline conditions. The analysis used a bottom-up approach by quantifying the potential for CHP at each customer site based on electric load data and estimated thermal energy requirements. Through this analysis, ICF estimated 270 MW of technical potential in the Missouri territories, broken down by size range and territory in Figure IV-3.

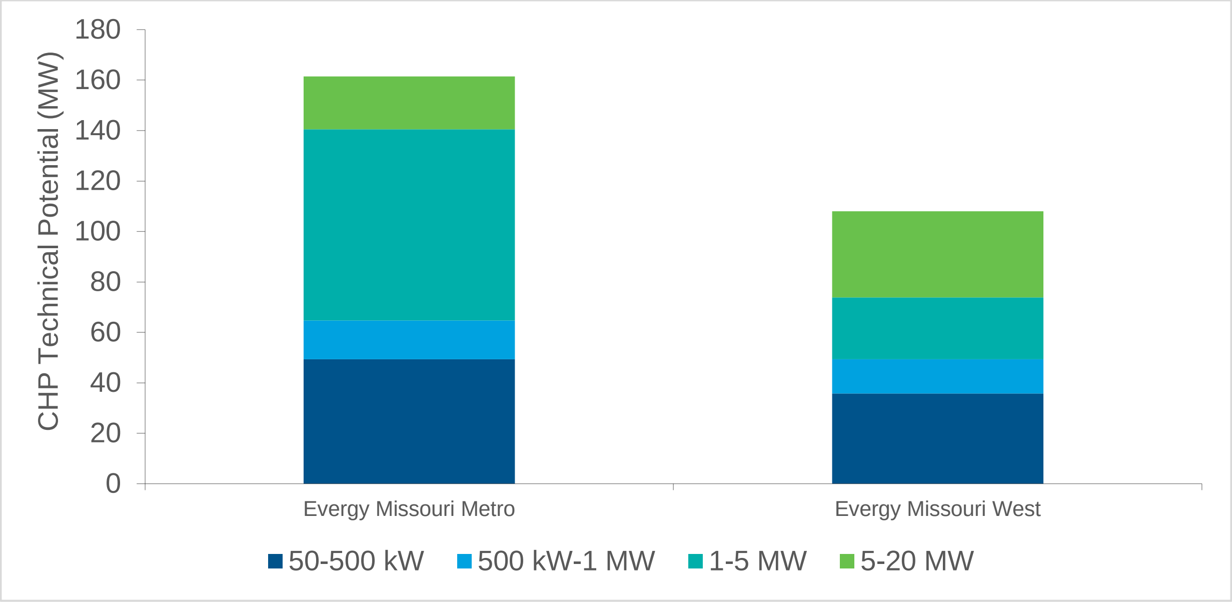


Figure IV-3 Technical potential for CHP in Missouri West and Metro territories

Throughout both of Evergy's Missouri territories, there were no facilities estimated to have potential to install a CHP system over 20 MW in size. Typically, these installations occur at large industrial facilities, and they can be some of the most economical CHP systems. A breakdown of technical potential by building or customer type is shown in Figure IV-4.

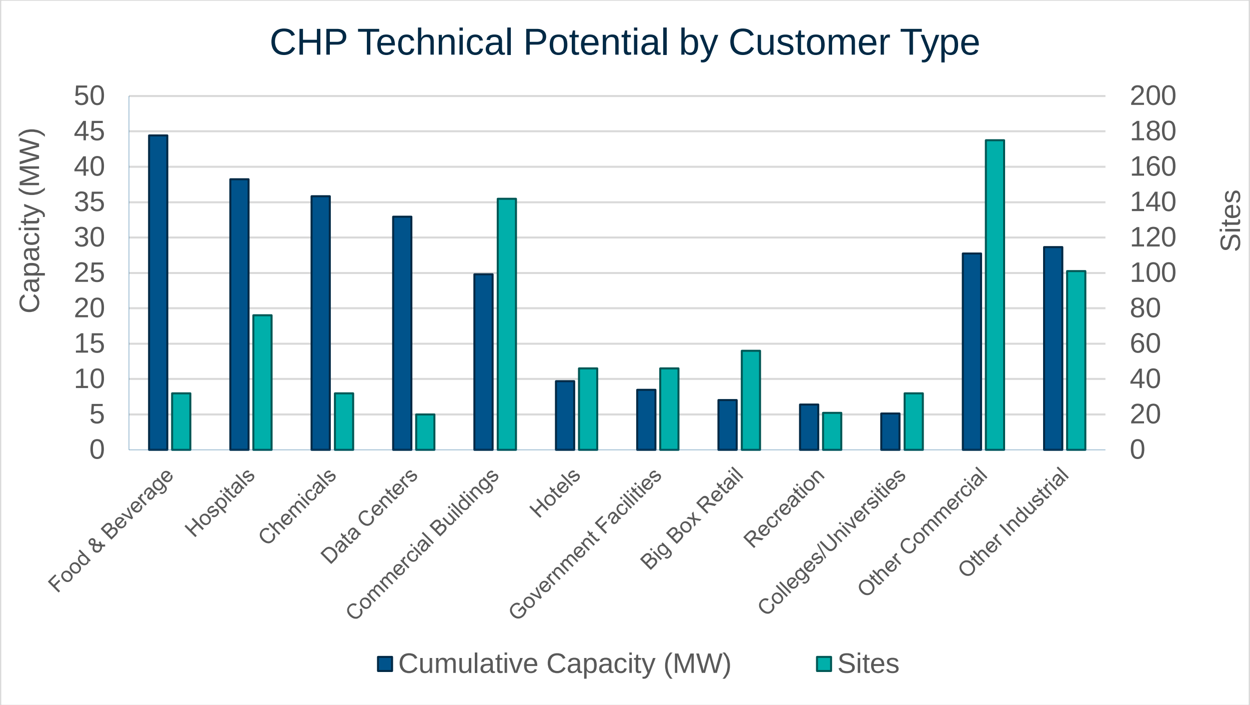


Figure IV-4 Number of sites and total CHP potential by customer type, Evergy Missouri territories

The food and beverage sector has the highest technical potential for CHP within Evergy's service area, with 44 MW of capacity across 32 sites. The next top four applications for CHP include hospitals (38 MW across 76 sites), chemicals (36 MW across 32 sites), data centers (33 MW across 20 sites), and commercial buildings, which has the most potential sites out of all application areas (25 MW across 142 sites). No other sector outside of the top five measured by capacity has a technical potential over 10 MW.

Looking at Evergy's CHP potential by size range, most potential projects lie within the range of 50-500 kW. There are 680 potential sites in this range, totaling a capacity just over 85 MW. In comparison, there are only 40 sites which can use CHP systems from 500 kW to one megawatt in size. The most capacity lies in sites that can utilize one to five megawatt CHP systems, with 100 MW from 51 sites. There are also eight larger potential CHP sites within Evergy's territory, totaling an estimated potential of 55 MW. This is illustrated in Figure IV-5.

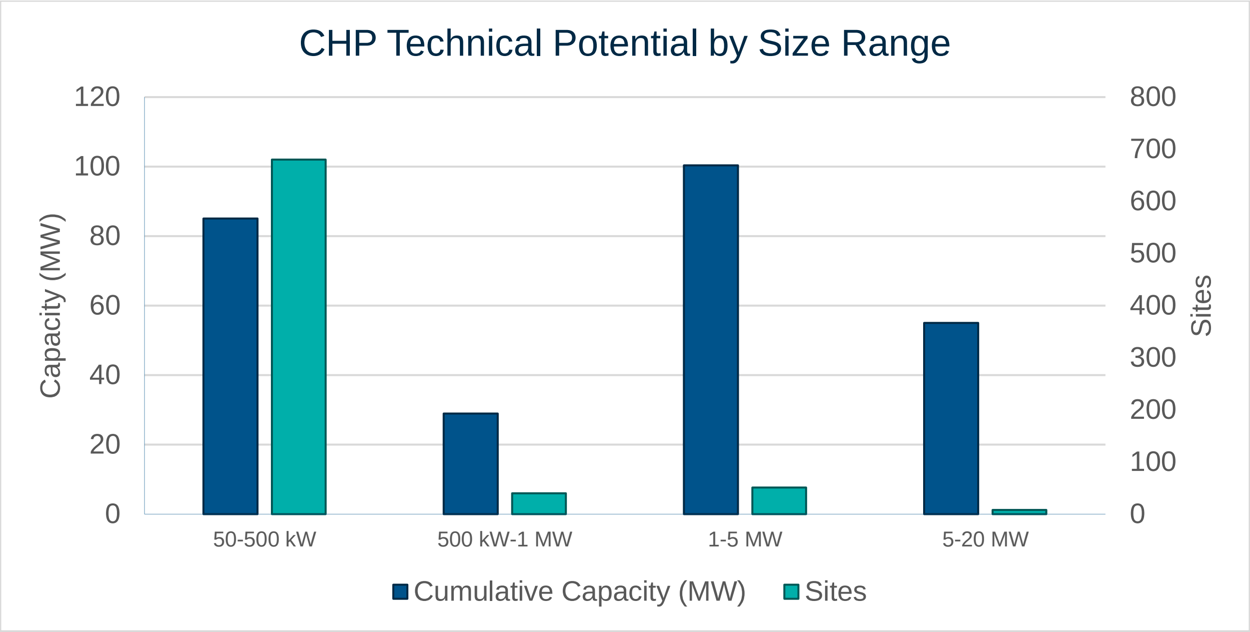


Figure IV-5 Evergy Missouri CHP potential by size range

5.2 Economic Modeling

To model the economic feasibility of CHP within Evergy's service area, ICF applied CHP cost and performance values from the 2016 DOE CHP Fact Sheet series to sites with technical potential for CHP (previously shown in Table IV-1).

Based on this modeling, CHP economics for Evergy customers were not found to be favorable. Electricity prices for large customers in Evergy's Missouri territories are relatively low, with an average of 6.7 to 8.9 cents per kWh for Evergy Missouri West C&I customers, and 8.0 to 10.7 cents per kWh for Evergy Missouri Metro C&I customers.[22] Normally, larger CHP installations have more favorable economics due to lower capital and maintenance costs on a per-kW basis. However, a combination of higher electricity rates and lower standby charges led to smaller CHP installations being more economical in this analysis.

ICF found two customers that could achieve a payback period under 10 years, and eight additional customers estimated to be able to achieve a 10 to 15-year payback. All the CHP systems for these ten customers are under one megawatt in size (3.2 MW total), and most are high load factor applications at industrial facilities.

5.3 Baseline Projection

Due to challenging economics for CHP in the absence of incentives, there is no adoption expected for the baseline scenario. This aligns with what has been seen in the Missouri CHP market recently, with only one CHP system installed in Evergy territories over the past ten years: a 5 MW boiler/steam turbine

[22] U.S. Department of Energy, Energy Information Administration, Average Electricity Prices by Sector and Utility, 2018 data.

at a district energy plant.[23] Generally, industrial facilities require payback periods of five years or less to move forward with a CHP investment, and that is not currently found in Evergy's Missouri territories.

TRC tests for CHP within Evergy's territory were similarly unfavorable. ICF applied TRC tests to the lowest cost options, incorporating CHP electricity benefits, displaced boiler benefits, CHP system costs, CHP fuel consumption, utility administration costs, and federal tax credits, as applicable.

$$TRC\ \ B/C\ \ Ratio = \frac{CHP\ Electricity\ Benefits + Displaced\ Boiler\ Benefit + Federal\ Tax\ Credits}{CHP\ System\ Costs + CHP\ Fuel\ Consumption + Utility\ Administration\ Costs}$$

Note that no Federal Tax Credits were applied in this case, as the Federal ITC is being phased down and set to expire for CHP in 2021. The analysis assumed line losses of 4.7% for energy and 5.7% for capacity, and 7,500 full load equivalent hours of operation for the CHP system, with full thermal utilization. The results from this test (see Table IV-3) show that only gas turbines larger than 20 MW are estimated to have a TRC ratio greater than one for projects starting in 2023.

Table IV-3 Evergy TRC Results for CHP

CHP Size Range	Representative System	Life (years)	TRC Ratio (2023)
<500 kW	100 kW Recip Engine	15	0.77
500-999 kW	633 kW Recip Engine	15	0.91
1-5 MW	3.3 MW Recip Engine	15	0.94
5-20 MW	10.7 MW Gas Turbine	20	0.98
>20 MW	20.4 MW Gas Turbine	20	1.11

As noted earlier, there are no buildings within Evergy Missouri's service area that can host a 20 MW CHP system when sized to on-site power requirements. Therefore, there is no achievable potential for CHP in either of Evergy's Missouri territories.

When UTC tests were applied assuming a generous CHP incentive (up to 50% of project costs, capped at $2 million), CHP systems over 500 kW in size were able to achieve a UTC Ratio higher than one. However, since no systems were able to pass the TRC test, no achievable potential was modeled.

6. Potential Results

In this study, no economic or achievable potential was found for customer-sited CHP in Evergy's Missouri territories, and economics for CHP are not expected to improve over time, with electricity prices projected to escalate at a faster rate than gas prices. Therefore, results are not presented over the study period.

[23] U.S. Department of Energy, CHP Installation Database, maintained by ICF, https://doe.icfwebservices.com/chpdb/

In a previous DSM potential study for Evergy (then Kansas City Power & Light), some economic and achievable potential was found in the form of steam turbines that could be applied to industrial facilities. However, ICF found some faults with this analysis.

The consultant team from the previous study assumed that steam turbine generators could be installed with no additional costs for boilers, piping, or balance of plant, as the steam source from existing industrial boilers could be sufficient for installing steam turbine generators. In reality, more boiler capacity will likely be required, the system will need to be engineered for extraction at specific steam pressures, and the steam turbine may not be located adjacent to the steam source, requiring additional piping and engineering. When these factors are considered, the cost for a fully engineered boiler-steam turbine system are higher than the reciprocating engines and gas turbines modeled in this analysis.

Outside of the steam turbine assumptions from the previous study, both studies agree that the economics for CHP in Evergy's Missouri territories are not favorable, and none of the technical potential for CHP is achievable.

7. Conclusions

Across Evergy Missouri's service area, there is 270 MW of technical potential for CHP. This potential is primarily centered in food processing, hospitals, chemicals, data centers, and commercial buildings. Despite the potential, economics for CHP in Evergy Missouri's service area were not found to be favorable, and they are not expected to improve in the near term. Only 10 facilities, or 1.2% of all potential sites, are estimated to have payback periods under 15 years. These facilities total 3.2 MW of potential. In addition, no potential CHP site within Evergy's territory passes a TRC test when estimated costs and benefits are applied. Despite there being a high number of potential CHP sites within Evergy's Missouri service areas, CHP is not currently a recommended resource for energy efficiency.