VOLUME 5

DEMAND-SIDE RESOURCE ANALYSIS

THE EMPIRE DISTRICT ELECTRIC COMPANY – A LIBERTY UTILITIES COMPANY (LIBERTY-EMPIRE)

4 CSR 240-22.050

FILE NO. EO-2019-0049

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****Denotes Confidential****

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DEMAND-SIDE RESOURCE ANALYSIS

4 CSR 240-22.050

PURPOSE: This rule specifies the principles by which potential demand-side resource options shall be developed and analyzed for cost effectiveness, with the goal of achieving all cost effective demand-side savings. It also requires the selection of demand-side candidate resource options that are passed on to integrated resource analysis in 4 CSR 240-22.060 and an assessment of their maximum achievable potentials, technical potentials, and realistic achievable potentials.

SECTION 1 POTENTIAL DEMAND-SIDE RESOURCES

(1) The utility shall identify a set of potential demand-side resources from which demand-side candidate resource options will be identified for the purposes of developing the alternative resource plans required by 4 CSR 240-22.060(3). A potential demand-side resource consists of a demand-side program designed to deliver one (1) or more energy efficiency and energy management measures or a demand-side rate. The utility shall select the set of potential demand-side resources and describe and document its selection—

1.1 Describe and Document Selections

(A) To provide broad coverage of–

1. Appropriate market segments within each major class;

Liberty-Empire engaged Applied Energy Group ("AEG") to conduct a Demand-Side Management ("DSM") Potential Study to assess the future potential for savings through its programs and to identify refinements that will enhance savings.

The first step in the analysis was to assess Liberty-Empire's service territory. The market assessment defined the market segments (building types, end uses, and other dimensions) that are relevant in the Liberty-Empire service territory. The segmentation scheme for this project is presented in Table 5-1.

Table 5-1 – Overview of Liberty-Empire Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
1	Sector	Residential, Nonresidential
2	Segment	Residential: Single Family, Multifamily, Single Family Low Income, and Multifamily Low Income Nonresidential: Small and Large
3	Vintage	Existing and new construction
4	End use	Cooling, lighting, water heat, motors, etc. (as appropriate)
5	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
6	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

With the segmentation scheme defined, AEG performed a high-level market characterization of electricity sales in the base year, 2017. AEG used detailed billing and customer data with minimal augmentation from secondary sources to allocate energy use and customers to the various sectors and segments, such that the total customer count and energy consumption aligned with the Liberty-Empire system totals provided by Itron, detailed in Volume 3. This information provided control totals at a sector level for calibrating the LoadMAP™ model to known data for the base-year. For the purposes of this analysis, impacts from solar PV were removed from the analysis in order to model the full unadjusted market energy consumption.

The total number of households and electricity sales for the service territory were obtained from Liberty-Empire's customer database. In 2017, there were 144,718 households in the Liberty-Empire service territory. These households used a total of 1,903 GWh with peak demand of 634 MW. Characterization of the residential electric market is shown in Figure 5-1 and Table 5-2.

Figure 5-1 – Residential Electricity Use by Segment (2017)

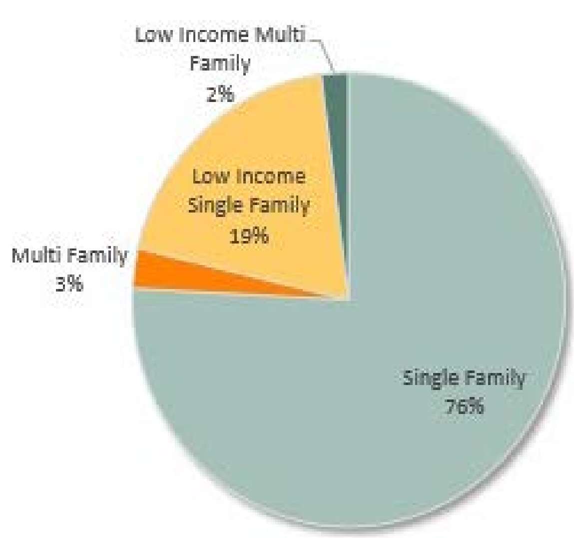

Table 5-2 – Residential Market Characterization (2017)

Segment	Households	Electric Use (GWh)	Annual Use/ Customer (kWh/HH)
Single Family	100,603	1,443	14,341
Multi Family	6,940	55	7,870
Low Income Single Family	31,311	366	11,701
Low Income Multi Family	5,864	39	6,633
Total	**144,718**	**1,903**	**13,147**

AEG utilized commercial and industrial customer billing data and secondary sources to develop the commercial and industrial market segments, shown in Figure 5-2 and Table 5-3. The nonresidential sector excludes customers that opt-out of Liberty-Empire's DSM tariff (as of December 2017) and is segmented into small and large nonresidential segments based upon a 1,000 MWh annual use threshold. Customers with usage greater than or equal to the 1,000 MWh threshold were characterized as large nonresidential; all other customers were considered small nonresidential.

Figure 5-2 – Commercial Electricity Use by Segment (2017)

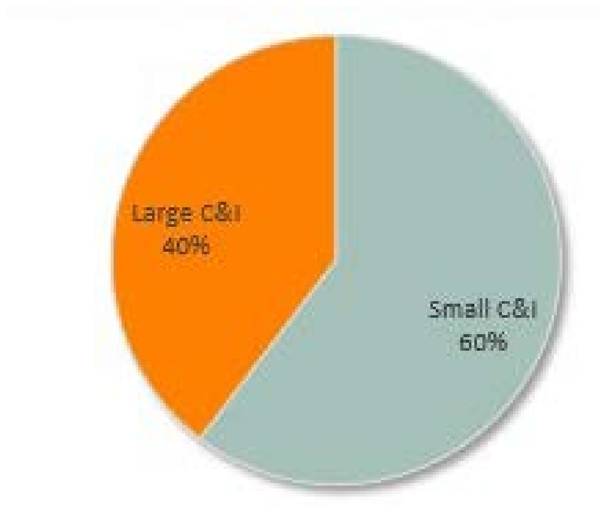

Table 5-3 – Nonresidential Market Characterization (2014)

Segment	Floorspace (sq ft)	Electric Use (GWh)	Annual Use/ Customer (kWh/sq ft)
Small C&I	107,197,896	1,180	11.0
Large C&I	18,395,410	774	42.1
Total	**125,593,307**	**1,954**	**15.6**

2. All significant decision makers – including those who choose building design features and thermal integrity levels, equipment and appliance efficiency levels, and utilization levels of the energy-using capital stock – and

Liberty-Empire's energy efficiency personnel regularly interface and communicate with a variety of trade allies, Community Action Program ("CAP") agencies, implementation contractors, consulting, evaluation, marketers, regulatory stakeholders, and customers from all classes. Decision makers are involved in all matters related to Liberty-Empire's active portfolios of residential, commercial and industrial energy efficiency programs in Arkansas and Missouri. The table below represents an exhaustive list of entities with which Liberty-Empire interacts regarding demand-side issues. Representatives from these entities are potential decision makers as defined by the IRP Regulatory Stakeholder Group

Table 5-4 – List of Liberty-Empire Demand-Side Decision Makers

Category	Group
Customers	Current and Prospective Residential Electric Customers
	Current and Prospective Commercial Electric Customers
	Current and Prospective Industrial Electric Customers
	Current and Prospective Residential Gas Customers
	Current and Prospective Commercial Gas Customers
	Current and Prospective Industrial Gas Customers
	Current and Prospective Residential Solar Customers
	Current and Prospective Commercial Solar Customers
	Current and Prospective Industrial Solar Customers
	Current and Prospective Residential Landlords/Property Owners
	Current and Prospective Commercial Landlords/Property Owners
	Large Commercial and Industrial Customers Requesting "Opt-Out"
	Large Commercial and Industrial Customers with Curtailment Contracts
	Large Commercial and Industrial Customers For Voluntary Curtailments
Regulatory and/or Governmental Stakeholders	Missouri Public Service Commission Staff
	Missouri Office of the Public Counsel
	Missouri Department of Economic Development-Division of Energy
	Missouri-based Environmental Advocates
	Missouri-based Customer Advocates
	Arkansas Public Service Commission Staff
	The Arkansas Energy Office
	Arkansas Community Action Agency Association
	The office of the Arkansas Attorney General
	Arkansas-based Environmental Advocates
	Kansas Public Service Commission Staff
	Oklahoma Public Service Commission Staff
	Municipal Governments advocating for Liberty-Empire Retail Customers
	Municipal Governments advocating for Liberty-Empire Wholesale Customers
	Contracted Consultants of any of the above agencies
	Outside/Contracted Legal Counsel of any of the above agencies
	Peer Investor-Owned Electric and Gas Utilities

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Category	Group
	Peer Rural Electric Cooperatives
	Peer Rural Electric Cooperative Associations
	Peer Municipal Utility Companies
Contractors	Implementation Contractors
	Evaluation, Measurement, & Verification Contractors
	Energy Efficiency Program Design Contractors
	Consulting Contractors for Energy Efficiency
	Marketing Contractors
	Product Vendors for DSM and Solar Programs
	Outside/Contracted Legal Counsel for Regulatory Support
Trade Allies	Residential and Commercial Building Contractors
	Residential and Commercial Energy Raters
	Residential and Commercial Energy Auditors
	Non-Profit/Public Commercial and Industrial Energy Auditors
	Residential and Commercial HVAC Contractors
	Residential and Commercial Plumbing Contractors (Gas)
	Commercial Lighting Vendors
	Residential and Commercial Solar Contractors
	Local/Regional Homeowner's Associations
	Local/Regional Real Estate Agents
Community Action Agencies	Economic Security Corporation (of SW Missouri)
	Ozarks Area Community Action Corporation
	West Central Community Action Agency
	Community Services, Inc. of Northwest Missouri
	Green Hills Community Action Agency
	Missouri Valley Community Action Agency
	The Office of Human Concern (of NW Arkansas)
	Central Arkansas Development Council

3. All major end uses, including at least the end uses which are to be considered in the utility's load analysis as listed in 4 CSR 240-22.030(4)(A)1.;

Liberty-Empire engaged AEG to conduct a DSM Potential Study. AEG analyzed potential demand-side resources for all major end uses as identified by the Residential Customer Energy Survey and secondary sources. The major end uses considered include:

- Residential sector: cooling, space heating, water heating, interior lighting, exterior lighting, appliances, electronics, and miscellaneous.
- Non-Residential sector: space heat, space cooling, ventilation, water heating, refrigeration, interior and exterior lighting, office equipment, food preparation, motors, process, and miscellaneous.[1]

1.2 Designing Effective Potential Demand-Side Programs

(B) To fulfill the goal of achieving all cost effective demand-side savings, the utility shall design highly effective potential demand-side programs consistent with subsection (1)(A) that broadly cover the full spectrum of cost effective end-use measures for all customer market segments;

Liberty-Empire engaged AEG to conduct a Demand-Side Management Potential Study and a Program Design Study. AEG developed eight program design scenarios to assess the optimal demand-side programs for potential further consideration. Programs were designed for the 20-year time period from 2020 to 2039, with 2020 representing a half-year to allow for implementation planning and contractor procurement. The recommended near-term demand-side management programs for 2020-2022 include:

- Residential Lighting
- Residential Behavioral
- Residential Whole House Efficiency
- Low Income Weatherization

[1] CHP is analyzed as a supply-side resource.

- Low Income Behavioral
- Low Income Whole House Efficiency
- Commercial & Industrial Rebate

These programs are detailed below (also see Appendices 5A and 5B).

Additional programs are added to the portfolio after 2022 as measures and programs become cost effective. Many of these demand-side programs are dependent on advanced metering infrastructure necessary to support new DSM rate structures. There are also other business cases that were outside of the scope of the study that apply to the wider Liberty-Empire company. While resources were identified as cost effective and included in the modeling, Liberty-Empire anticipates following up with additional scoping studies and/or pilots to further study implementation designs.

Demand Side Rates

- **Residential Time of Use ("TOU") (2029-2038)** – This rate provides a higher price during the designated peak period and lower prices during off-peak periods.
- **Residential Critical Peak Pricing ("CPP") (2026-2038**) – This rate provides a higher rate for a particular block of hours that occurs on a critical peak event day.
- **Residential Inclining Block Rates ("IBR") (2026-2038)** – An inclining block rate applies a rate(s) to a customer's bill if the customer exceeds certain thresholds.
- **Non-Residential Time of Use Rate (2029-2038**) - This rate provides a higher price during the designated peak period and lower prices during off-peak periods.
- **Non-Residential Critical Peak Pricing Rate (2026-2038)** – This rate provides a higher rate for a particular block of hours that occurs on a critical peak event day.

- **Non-Residential Real Time Pricing ("RTP") (2026-2038)** – This rate is a varied rate that is linked to the hourly market price for electricity. Typically targeted at large C&I customers.

With regard to the overall implementation strategy of the DSM portfolio, Liberty-Empire is currently exploring an on-bill financing option for residential customers. Liberty-Empire commissioned a feasibility study[2] in 2018 to determine if *Pay As You Save* ("PAYS") is a viable program design to offer residential electric customers as part of its energy efficiency portfolio of programs. Through the PAYS program, the utility pays all or part of the up-front cost for energy efficiency upgrades, and it recovers those funds through an on-bill tariff. The PAYS feasibility study is included in Appendix 5C. If implemented, the whole house programs described below could include the PAYS option.

[2] Appendix 5c - The Empire District Electric Company PAYS Feasibility Study; May 31, 2018; The Cadmus Group LLC.

Residential Lighting Program

Objective	Increase the penetration of efficient lighting and secure energy savings by incentivizing the purchase of efficient lighting.
Target Market	Residential customers as well as lighting manufacturers and local retailers.
Description	Customers will receive an instant incentive at the point-of-purchase for the purchase of qualified LEDs. Incentives will vary depending upon the type of lighting, manufacturer and the associated retail cost.
Implementation	Liberty-Empire will engage a third-party contractor to implement the program. The contractor will provide the necessary services to effectively implement the program and obtain the energy savings goals while adhering to the budget. The implementation contractor will: • Establish and maintain relationships with lighting manufacturers and retailers throughout Liberty-Empire's service territory. • Provide in-store promotional materials and retail sales staff training. • Track program performance, audit sales data, and process payments to retailers/manufacturers. • Periodically report program activities, progress towards goals and opportunities for improvement. Liberty-Empire will work with the implementation contractor to market the program to customers and educate retail sales staff. Marketing to increase customer awareness may include, but is not limited to bill inserts, newspaper advertisements, internet placement and point-of-purchase materials (e.g., hang tags, posters, etc.). The program will be implemented upstream from retailers, which means incentives will be provided at the manufacturer and distributor level. Upstream programs simplify the participation process, eliminating the need for customers to complete and

	submit a rebate application. However, upstream programs typically have higher free ridership and leakage outside of the service territory. A number of steps will be taken to reduce free ridership and leakage while increasing spillover, including the following: • Liberty-Empire will work with the implementation contractor to select retailers located well within the service territory to reduce leakage. • Incentives will be modified as needed to respond to the market price of qualifying light bulbs, with a goal of the incentive being no higher than 50% of the incremental cost. • Liberty-Empire will cross-market the program with Liberty-Empire's other DSM programs to increase spillover.
Eligible Measures and Incentives	Residential customers will be eligible for instant, point-of-purchase rebates on LEDs and Specialty LEDs. Incentives may be modified to respond to the market.

Measure	Unit	Incentive per Unit 2020-2022
LED	per Bulb	$1.60
Specialty LED	per Bulb	$2.50

Estimated Participation	The table below presents the number of bulbs purchased in each year. The analysis assumed that each customer would purchase 6 bulbs per transaction, on average.

Measure	2020	2021	2022
LED 2020	24,000	43,000	45,000
LED 2025 +	-	-	-
Specialty LED	700	2,500	2,200

Estimated Savings

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
118	225	231	0.19	0.37	0.37

Estimated Budget		2020	2021	2022
	Incentives	$40,150	$75,050	$77,500
	Delivery	$24,700	$45,500	$47,200
	Administration	$1,297	$2,411	$2,494
	Education & Marketing	$3,243	$6,028	$6,235
	Evaluation	$3,470	$6,449	$6,671
	Tracking and Reporting	$8,586	$8,747	$6,556
	Total	**$81,446**	**$144,185**	**$146,656**
Cost-Effectiveness[3]		2020	2021	2022
	TRC	1.65	1.82	1.92
	UCT	2.01	2.27	2.39
	PCT	6.50	6.62	6.78
	RIM	0.52	0.55	0.56
	SCT	1.89	2.08	2.20

[3] These acronyms refer to standard evaluations of the cost-effectiveness of energy efficiency and other demand side programs. Each is unique and considers a unique range of costs and benefits. Each provides additional perspective on the merits of the programs from a cost/benefit point of view. No single measure is dispositive. See Section 3 for further discussion.

Whole House Efficiency

Objective	Encourage whole-house improvements to existing homes by enhancing home energy audits and promoting comprehensive retrofit services.
Target Market	Residential customers that own or rent a residence, including owners of rental properties and new construction, as well as HVAC contractors.
Description	The program will consist of two tiers: **Tier 1: Direct Install**. Customers will receive an in-home energy audit and installation of low-cost measures at no cost. The energy audit will identify potential efficiency improvements. The measures to be installed may include an LED, faucet aerator, low-flow showerhead, and water heater tank wrap. **Tier 2: Rebates**. Customers are eligible for incentives for the purchase and installation of qualifying measures. Customers are not required to participate in Tier 1. Qualifying measures include: • Attic Insulation • Foundation Insulation • Floor Insulation • Wall Insulation • Duct Sealing and Insulation • Advanced Thermostat • Furnace Blower Motor • Heat Pump Water Heater (2030+) • ENERGY STAR Appliances Customers that rent a residence must receive the written approval of the homeowner/landlord to participate in the program.
Implementation	Liberty-Empire will engage a third-party contractor to implement the program. An implementation contractor will: • Hire staff/engage local contractors to conduct audits and direct measure installation.

	• Engage customers and schedule home energy audit appointments. • Provide customer service support. • Establish relationships with local HVAC contractors to work with the program installing energy efficient HVAC equipment and insulation measures. • Process rebate applications, including review and verification of applications and payment of customer rebates. • Track program performance, including customer and contractor participation as well as quality assurance/quality control (QA/QC). • Periodically report program progress. Liberty-Empire will work with the implementation contractor to market the program to residential customers and contractors. The implementation contractor will develop partnerships with contractors through education and training seminars, presentations at Chamber of Commerce meetings, and other informational events. Customer marketing activities may include, but are not limited to bill inserts, newspaper advertisements, email blasts, bill messaging and community events. It is important that the measures are properly installed, and customer satisfaction is high. Liberty-Empire and/or the implementation contractor should conduct QA/QC of a random group of completed projects by project type and contractor. The QA/QC process should include verification of the equipment installed and customer satisfaction with the contractor and the program.
Eligible Measures and Incentives	The direct install portion (Tier 1) will be provided at no cost to the customer. Incentives may be modified to respond to the market.

Measure	Incentive (per unit)
Attic Insulation R-38	$0.30 per sq. ft., up to $500
Wall Insulation R-11	$0.30 per sq. ft., up to $150
Foundation Insulation R-13	$0.30 per sq. ft., up to $150
Floor Insulation R-30	$0.30 per sq. ft., up to $150
Duct Insulation & Sealing	$0.10 per sq. ft., up to $150
Advanced Thermostat	$50
Furnace Blower Motor	$45
ENERGY STAR Dehumidifier	$20

ENERGY STAR Air Purifier	$30

Estimated Participation

Measure	2020	2021	2022
Home Audit & Direct Install	200	400	500
Attic Insulation R-38	80	160	200
Wall Insulation R-11	20	30	40
Foundation Insulation R-13	20	50	60
Floor Insulation R-30	20	50	60
Duct Installation & Sealing	30	60	80
Advanced Thermostat	150	375	375
Furnace Blower Motor	20	21	22
ENERGY STAR Dehumidifier	10	20	25
ENERGY STAR Air Purifier	20	40	50

Estimated Savings

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
375	754	947	0.13	0.27	0.33

Estimated Budget

	2020	2021	2022
Incentives	$45,640	$92,025	$115,140
Delivery	$29,250	$58,275	$72,800
Administration	$13,480	$27,054	$33,829
Education & Marketing	$11,234	$22,545	$28,191
Evaluation	$4,980	$9,995	$12,498
Tracking and Reporting	$12,324	$13,556	$12,283
Total	**$116,908**	**$223,450**	**$274,741**

Cost-Effectiveness[3]

	2020	2021	2022
TRC	1.06	1.16	1.21
UCT	1.73	1.88	1.99
PCT	7.07	7.46	7.56
RIM	0.24	0.24	0.25
SCT	1.47	1.61	1.69

Residential Behavioral

Objective	Reduce consumption via socially- and information-driven behavioral change and raise general awareness of energy efficiency.
Target Market	Residential single-family homes.
Description	Provide individualized energy use information to customers while simultaneously offering recommendations on how to save energy and money by making small changes to energy consuming behaviors. Energy reports will be periodically mailed/emailed to customer households to increase self-awareness and provide peer comparison of their energy usage. Social competitiveness increases behaviors to reduce energy consumption.
Implementation	Liberty-Empire will select an implementation contractor that specializes in developing and issuing residential energy reports. The implementation contractor will utilize experimental design to select report recipients and a control group, design the reports and develop customized energy reduction tips with input from Liberty-Empire. The program will cross-promote and market Liberty-Empire's DSM portfolio.
Eligible Measures and Incentives	Customers receive personalized energy reports, but there is no monetary incentive.
Estimated Participation	(see table below)
Estimated Savings	The average savings per household is a planning estimate. The implementation contractor will aim to achieve the total net savings provided in the table below.

Estimated Participation:

2020	2021	2022
15,000	30,000	30,000

Estimated Savings:

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
1,800	3,600	3,600	0.36	0.72	0.72

Estimated Budget	Customers do not receive a monetary incentive. The delivery budget includes the administration as well as the education and marketing budgets.

	2020	2021	2022
Delivery	$75,000	$150,000	$150,000
Administration	$6,000	$12,000	$12,000
Evaluation	$4,050	$8,100	$8,100
Tracking and Reporting	$10,022	$10,986	$7,960
Total	**$95,072**	**$181,086**	**$178,060**

Cost-Effectiveness[3]

	2020	2021	2022
TRC	1.03	1.16	1.24
UCT	1.03	1.16	1.24
PCT	N/A	N/A	N/A
RIM	0.18	0.19	0.20
SCT	1.44	1.61	1.72

Low-Income Whole House Efficiency

Objective	Deliver long-term energy savings and bill reductions to low-income customers.
Target Market	Residential low-income homeowners and renters.
Description	The program will consist of two tiers: **Tier 1: Direct Install**. Customers will receive an in-home energy audit and installation of low-cost measures at no cost. The energy audit will identify potential efficiency improvements. The measures to be installed may include an LED, faucet aerator, low-flow showerhead, water heater tank wrap, and hot water pipe insulation. **Tier 2: Rebates**. Customers are eligible for incentives for the purchase and installation of qualifying measures. Customers are not required to participate in Tier 1. Qualifying measures include: • Attic Insulation • Foundation Insulation • Floor Insulation • Wall Insulation • Duct Sealing and Insulation • Advanced Thermostat • Furnace Blower Motor • ENERGY STAR Appliances Customers that rent a residence must receive the written approval of the homeowner/landlord to participate in the program.
Implementation	Liberty-Empire will engage a third-party contractor to implement the program that will: • Hire staff/engage local contractors to conduct audits and direct measure installation. • Engage customers and schedule home energy audit appointments. • Provide customer service support. • Establish relationships with local HVAC contractors to work with the program installing energy efficient HVAC equipment

	and insulation measures. • Process rebate applications, including review and verification of applications and payment of customer rebates. • Track program performance, including customer and contractor participation as well as quality assurance/quality control (QA/QC). • Periodically report program progress. Liberty-Empire will work with the implementation contractor to market the program to residential customers and contractors. The implementation contractor will develop partnerships with contractors through education and training seminars, presentations at Chamber of Commerce meetings, and other informational events. Customer marketing activities may include, but not be limited to bill inserts, newspaper advertisements, email blasts, bill messaging and community events. It is important that the measures are properly installed and customer satisfaction is high. Liberty-Empire and/or the implementation contractor should conduct QA/QC of a random group of completed projects by project type and contractor. The QA/QC process should include verification of the equipment installed and customer satisfaction with the contractor and the program.
Eligible Measures and Incentives	The direct install portion (Tier 1) will be provided at no cost to the customer. Incentives may be modified to respond to the market.

Measure	Incentive per Unit
Attic Insulation R-38	$0.60 per sq. ft., up to $800
Wall Insulation R-11	$0.60 per sq. ft., up to $300
Foundation Insulation R-13	$0.60 per sq. ft., up to $300
Floor Insulation R-30	$0.60 per sq. ft., up to $300
Duct Installation & Sealing	$0.20 per sq. ft., up to $300
Advanced Thermostat	$100
Furnace Blower Motor	$90
ENERGY STAR Dehumidifier	$40
ENERGY STAR Air Purifier	$60

Estimated Participation	see table below

Measure	2020	2021	2022
Home Audit & Direct Install	60	120	160
Attic Insulation R-38	6	12	16
Wall Insulation R-11	1	2	3
Foundation Insulation R-13	2	4	5
Floor Insulation R-30	2	4	5
Duct Installation & Sealing	5	11	14
Advanced Thermostat	11	23	30
Furnace Blower Motor	6	6	7
ENERGY STAR Dehumidifier	1	2	2
ENERGY STAR Air Purifier	2	3	4

Estimated Savings

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
36	71	93	0.01	0.02	0.03

Estimated Budget

	2020	2021	2022
Incentives	$8,282	$16,164	$21,202
Delivery	$2,400	$4,675	$6,150
Administration	$1,923	$3,751	$4,923
Education & Marketing	$1,602	$3,126	$4,103
Evaluation	$710	$1,386	$1,819
Tracking and Reporting	$1,758	$1,880	$1,788
Total	**$16,675**	**$30,982**	**$39,985**

Cost-Effectiveness[3]

	2020	2021	2022
TRC	1.10	1.14	1.02
UCT	1.24	1.30	1.12
PCT	8.49	8.52	8.54
RIM	0.22	0.22	0.21
SCT	1.55	1.61	1.42

Low Income Weatherization

Objective	Deliver long-term energy savings and bill reductions to low-income customers.
Target Market	Low-income residential homeowners and renters.
Description	The program reduces energy costs for eligible low-income homeowners and renters through increased home efficiency, at no cost to the participant. Home efficiency is improved through the installation of energy saving measures, such as insulation, caulking, weather stripping and heating system repair or replacement. The program supplements the federal Low-Income Weatherization Assistance Program.
Implementation	Liberty-Empire customers work with one of the Missouri Weatherization Agencies to participate: • Economic Security Corporation of Southwest Area • Ozarks Area Community Action Corporation • West Central Missouri Community Action Agency The Missouri Weatherization Agencies offer cost-effective implementation, which allows most of the program budget to go directly to the purchase and installation of efficient equipment. The Missouri Weatherization Agencies have primary responsibility for promoting the program. Liberty-Empire will supplement statewide marketing efforts, promoting the program through community events and organizations, including schools, churches and nonprofit organizations within the service territory.
Eligible Measures and Incentives	The program supplements the federal Low-Income Weatherization Assistance Program.
Estimated Participation	2020: 150; 2021: 300; 2022: 300

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<table>
<tr><td>Estimated Savings</td><td>
<table>
<tr><th colspan="3">Net MWh Savings</th><th colspan="3">Net MW Savings</th></tr>
<tr><th>2020</th><th>2021</th><th>2022</th><th>2020</th><th>2021</th><th>2022</th></tr>
<tr><td>425</td><td>851</td><td>851</td><td>0.15</td><td>0.30</td><td>0.30</td></tr>
</table>
</td></tr>
<tr><td>Estimated Budget</td><td>The program budget is accounted for separately from the DSM programs. The DSM program expenditures are recovered via Liberty-Empire’s DSIM charge. However, the Low-Income Weatherization program expenditures are amortized and recovered through general rates.</td></tr>
<tr><td>Cost-Effectiveness</td><td>N/A</td></tr>
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Low Income Behavioral

Objective	Reduce consumption via socially- and information-driven behavioral change and raise general awareness of energy efficiency.
Target Market	Residential low-income homeowners and renters.
Description	Provide individualized energy use information to customers while simultaneously offering recommendations on how to save energy and money by making small changes to energy consuming behaviors. Energy reports will be periodically sent to customer households to increase self-awareness and provide peer comparison of their energy usage. Social competitiveness increases behaviors to reduce energy consumption.
Implementation	Liberty-Empire will select an implementation contractor that specializes in developing and issuing residential energy reports. The implementation contractor will utilize experimental design to select report recipients and a control group, design the reports and develop customized energy reduction tips with input from Liberty-Empire. The program will cross-promote and market Liberty-Empire's DSM portfolio.
Eligible Measures and Incentives	Customers receive personalized energy reports, but there is no monetary incentive.
Estimated Participation	(see table below)
Estimated Savings	The average savings per household is a planning estimate. The implementation contractor will aim to achieve the total net savings provided in the table.

Estimated Participation:

2020	2021	2022
6,000	12,000	12,000

Estimated Savings:

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
720	1,440	1,440	0.14	0.29	0.29

Estimated Budget	Customers do not receive a monetary incentive. The delivery budget includes administration as well as the education and marketing budgets.

	2020	2021	2022
Delivery	$30,000	$60,000	$60,000
Administration	$2,400	$4,800	$4,800
Evaluation	$1,620	$3,240	$3,240
Tracking and Reporting	$4,009	$4,394	$3,184
Total	**$38,029**	**$72,434**	**$71,224**

Cost-Effectiveness[3]

	2020	2021	2022
TRC	1.03	1.16	1.24
UCT	1.03	1.16	1.24
PCT	N/A	N/A	N/A
RIM	0.18	0.19	0.20
SCT	1.44	1.61	1.72

Commercial and Industrial Rebate

Objective	Encourage purchase and installation of energy efficient equipment by providing incentives to lower the cost of purchasing efficient equipment for commercial and industrial facilities.
Target Market	Commercial and industrial customers.
Description	The program provides incentives to lower the cost of purchasing energy efficient equipment for commercial and industrial facilities. The program consists of prescriptive and custom rebates. **Prescriptive**. Pre-qualified prescriptive rebates are available for new construction and retrofit projects. **Custom**. Equipment that does not qualify for a prescriptive rebate will be eligible for a custom rebate. Applications must be pre-approved by Liberty-Empire before equipment is purchased and installed and must produce a Total Resource Cost Test benefit-cost ratio of at least 1.0. A $50,000 incentive cap is imposed per facility per program year. However, if funds are still available in the last three months of the program year, the cap may be exceeded.
Implementation	Liberty-Empire will engage a third-party implementation contractor. The contractor will be responsible for: • Process customer applications and verify customer and project eligibility (including pre-approval of custom projects), and process customer rebates. • Conduct QA/QC to verify equipment installation. • Provide customer service support. • Track program performance. • Periodically report progress towards program goals and opportunities for improvement. The program will be marketed through partnerships, bill inserts, and advertising in HVAC trade publications. One key barrier to participation is ensuring that enough vendors are properly educated

to allow them to actively engage customers. Therefore, Liberty-Empire will work closely with trade allies to ensure they understand and promote the program.

The measure list and incentive levels may be updated annually to reflect changes to the market. Incentives will be modified as needed to respond to market prices, with a goal of the incentive being no higher than 50% of the incremental cost. Proper incentives can reduce free ridership while still encouraging customers to participate in the program.

Eligible Measures and Incentives

Custom rebates will be $0.10 per first-year kWh savings. Prescriptive rebates are presented in the table below. Incentives may be modified to respond to the market.

Measure	Unit	Incentive per Unit
Air Cooled Chiller	per unit	$2,500
Water Cooled Chiller	per unit	$2,250
Room Air Conditioner (12 EER)	per unit	$40
CAC <65 kBtu (SEER 14)	per unit	$146
CAC 65<135 kBtu (EER 11.7)	per unit	$350
CAC 135<240 kBtu (EER 11.7)	per unit	$700
CAC 240<760 kBtu (EER 10.5)	per unit	$875
Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	per unit	$350
Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	per unit	$700
Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	per unit	$875
Packaged Terminal Air Conditioner	per unit	$40
Packaged Terminal Heat Pump	per unit	$40
Guest Room Energy Management	per unit	$125
Variable Speed Drive - Chilled Water Pump	per unit	$500
Variable Speed Drive - Hot Water Pump	per unit	$500
Demand Controlled Ventilation	per unit	$600
ENERGY STAR Steamer	per unit	$750

ENERGY STAR Dishwasher	per unit	$400
ENERGY STAR Hot Food Holding Cabinets	per unit	$500
ENERGY STAR Electric Convention Oven	per unit	$400
ENERGY STAR Electric Fryer	per unit	$100
Evaporator Fan Control	per unit	$125
Strip Curtain for Walk-In Cooler/Freezer	per unit	$125
Night Covers for Open Refrigerated Display Cases	per unit	$175
Door Heater Controls	per unit	$125
Refrigeration Economizer	per unit	$800
Directional LED Bulb (<15W)	per bulb	$15
Directional LED Bulb (≥15W)	per bulb	$15
High Bay Fluorescent Fixture (HP T8 >4 lamps)	per fixture	$75
High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	per fixture	$75
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 >4 lamps)	per fixture	$30
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 ≤4 lamps)	per fixture	$30
LED Direct Linear Ambient fixtures <=35W	per fixture	$10
LED Direct Linear Ambient fixtures 36W-60W	per fixture	$10
LED Direct Linear Ambient fixtures 61W-100W	per fixture	$10
LED linear replacement lamps (Type A or AB) 2 foot	per lamp	$2
LED linear replacement lamps (Type A or AB) 4 foot	per lamp	$2
LED Exit Sign	per unit	$15
LED Flood Light (<15W)	per fixture	$15
LED Flood Light (≥15W)	per fixture	$15
LED Recessed Fixture (1x4)	per fixture	$15
LED Recessed Fixture (2x2)	per fixture	$15
LED Recessed Fixture (2x4)	per fixture	$15

	Lighting Optimization - Remove 4ft Lamp from T8 System	per lamp	$6
	Lighting Optimization - Remove 8ft Lamp from T8 System	per lamp	$8
	Omnidirectional LED Bulb (<10W)	per bulb	$15
	Omnidirectional LED Bulb (≥10W)	per bulb	$15
	LED Parking Garage/Canopy (<30W)	per fixture	$60
	LED Parking Garage/Canopy (30-75W)	per fixture	$80
	LED Parking Garage/Canopy (≥75W)	per fixture	$100
	LED Wall Mounted Area Lights (<30W)	per fixture	$60
	LED Wall Mounted Area Lights (30-75W)	per fixture	$80
	LED Wall Mounted Area Lights (≥75W)	per fixture	$100
	Wall-Mount Occupancy Sensor	per unit	$20
	VFD Fans and Blowers	per unit	$0
	Compressed Air Nozzle	per unit	$0

Estimated Participation

	2020	2021	2022
Prescriptive/Custom	374	799	777

Estimated Savings

Net MWh Savings			Net MW Savings		
2020	2021	2022	2020	2021	2022
2,061	3,999	3,977	1.43	2.03	2.00

Estimated Budget

	2020	2021	2022
Incentives	$370,232	$622,807	$616,546
Delivery	$56,100	$119,850	$116,565
Administration	$42,633	$74,266	$73,311
Education & Marketing	$42,633	$74,266	$73,311
Evaluation	$25,580	$44,559	$43,987

Tracking and Reporting	$63,301	$60,436	$43,229
Total	**$600,479**	**$996,184**	**$966,948**

Cost-Effectiveness[3]

	2020	2021	2022
TRC	1.28	1.38	1.45
UCT	2.32	2.32	2.47
PCT	3.09	3.83	3.90
RIM	0.51	0.45	0.46
SCT	1.57	1.75	1.84

1.3 Demand-Side Rates

(C) To include demand-side rates for all customer market segments;

The three most common types of demand-side rates are as follows:

- **Time-of-Use**. Customers pay a higher price during the designated peak period and lower prices during off-peak periods. The designated peak and off-peak periods are typically defined by the season, day and time of day. Requires an interval meter.
- **Critical Peak Price**. Customers pay higher peak period prices during a critical peak event day and pay a discounted off-peak price for the remainder of the year. A critical peak event day occurs multiple times a year and is typically called a day in advanced when it wholesale prices are forecasted to be highest. Requires an interval meter.
- **Real Time Pricing**. Customers pay for energy at a rate that is linked to the hourly market price for electricity. Depending on their size, participants are typically made aware of the hourly prices on either a day-ahead or hour-ahead basis. Typically, only the largest customers — above one megawatt of load — face hour-ahead prices. Requires an interval meter.

AEG assessed these three most common demand side rate options for the Liberty-Empire service territory for a multitude of different customer segments.

AEG also considered a residential Inclining Block Rate (“IBR”). IBR is considered a conservation rate that applies a differentiated rate based on customer usage. The rate increases as the amount of electricity consumed increases. Typically, the rate is separated into two blocks or tiers by a kWh threshold, with the first block below the threshold charged a specific rate and the second block above the threshold charged a higher rate. Unlike other demand response and rate-based options, this option has low to zero operation, maintenance and incentive costs. However, introducing this rate option requires a significant amount of rate-making and regulatory changes, all of which present challenges for implementing the rate and capturing the costs associated with doing so within the modeling.

Table 5-5 presents the eligible customer classes for the demand-side rates analyzed, briefly indicates the load control mechanism, and lists the associated reliability. These options are not currently offered by Liberty-Empire.

Table 5-5 – Demand-Side Rate Options

Option	Eligibility	Mechanism	Reliability[4]
Time of Use	All segments	Higher price during the designated peak period and lower prices during off-peak periods	Non-firm
Real Time Pricing	Non-Residential	Varied rate that is linked to the hourly market price for electricity	Non-firm
Critical Peak Pricing	All segments	Higher rate for a particular block of hours that occurs on a critical peak event day	Non-firm
Inclining Block Rate	Residential	Applies a rate(s) to a customer's bill if they exceed certain thresholds.	Non-firm

1.4 Multiple Designs

(D) To consider and assess multiple designs for demand-side programs and demand-side rates, selecting the optimal designs for implementation, and modifying them as necessary to enhance their performance; and

[4] Reliability refers to the customer's commitment to the specific program, it is not related to the technology that calls the events.

Liberty-Empire engaged AEG to conduct a Demand-Side Management Potential Study in Liberty-Empire's Missouri service territory. AEG developed five energy efficiency portfolios based on cost-effective measures. Each of these portfolios, described below, was considered during the integration phase of Liberty-Empire's IRP process to determine which DSM portfolio was the optimal decision based upon Liberty-Empire's supply options.

- **RAP Program Design Portfolio**. The Realistic Achievable Potential ("RAP") candidates from the DSM Potential Study that Liberty-Empire proposes to pass to the integration phase. This portfolio reflects expected program participation given barriers to customer acceptance and non-ideal implementation conditions. These measures are delivered under less than ideal market conditions.
- **MAP Program Design Portfolio**. The Maximum Achievable Potential ("MAP") candidates from the DSM Potential Study that Liberty-Empire proposes passing into the integration phase. This portfolio reflects expected program participation given favorable market implementation and few barriers to customer adoption. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with dealers and delivery partners. Under this scenario, incentives represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **RAP- Portfolio**. Alternative demand-side portfolio designed to represent one-half of the RAP Program Design portfolio participation.
- **RAP+ Portfolio**. Alternative demand-side portfolio designed to represent the midpoint between the RAP Program Design and MAP Program Design portfolios.
- **Aggressive Capacity Portfolio**. Alternative demand-side portfolio designed to utilize demand-side resources to meet additional future capacity.

Liberty-Empire provided several different commodity cost scenarios, each described in Section 5. For the purposes of this Demand Side Management analysis, the base avoided energy cost scenario and the "base + carbon" scenario, which incorporated a cost for avoided CO_2 emissions, were used to screen measures. The energy efficiency portfolios described above were screened using the base scenario. The RAP Program Design Portfolio was also screened utilizing the "base + carbon" scenario.

1.5 Effects of Improved Technologies

(E) To include the effects of improved technologies expected over the planning horizon to—

Reduce or manage energy use; or improve the delivery of demand-side programs or demand-side rates.

AEG assessed several different "improved" or "emerging" technologies that are either available in the market, but restricted by current market barriers (e.g. due to high cost or low supply), or are not currently available, but come on-market at various times throughout the planning period. The intent for including these technologies was to capture the effects of advancements in technology and potential reduction in technology costs. The assumptions for these technologies were based on currently available secondary research. Table 5-6 below contains the measures that AEG classified as emerging technology options.

Table 5-6 – Improved or Emerging Technologies

Sector	End Use	Technology	Measure Label
Residential	Cooling	Central AC	SEER 21.0
Residential	Cooling	Central AC	SEER 24.0 Ductless, Var.Ref.Flow
Residential	Cooling / Heating	Air-Source Heat Pump	SEER 23.0
Residential	Cooling / Heating	Geothermal Heat Pump	EER 30.0 / COP 5.0
Residential	Cooling / Heating	Geothermal Heat Pump	EER 36.0 / COP 4.9
Residential	Water Heating	Water Heater (<= 55 Gal)	NEEA Tier 1 EF 2.35
Residential	Water Heating	Water Heater (<= 55 Gal)	NEEA Tier 2 EF 2.50
Residential	Water Heating	Water Heater (> 55 Gal)	NEEA Tier 3 EF 2.35
Residential	Water Heating	Water Heater (> 55 Gal)	NEEA Tier 4 EF 2.50
Residential	Interior Lighting	General Service Screw-In	LED 2019/2020 (97 lm/W)
Residential	Interior Lighting	General Service Screw-In	LED 2025 (111 lm/W)
Residential	Interior Lighting	General Service Screw-In	LED 2030 (123 lm/W)
Residential	Interior Lighting	Linear Lighting	LED 2019/2020 (123 lm/W system)
Residential	Interior Lighting	Linear Lighting	LED 2025 (142 lm/W system)
Residential	Interior Lighting	Linear Lighting	LED 2030 (158 lm/W system)
Residential	Interior Lighting	Exempted Screw-In	LED 2019/2020 (89 lm/W)
Residential	Interior Lighting	Exempted Screw-In	LED 2025 (108 lm/W)
Residential	Interior Lighting	Exempted Screw-In	LED 2030 (122 lm/W)
Residential	Exterior Lighting	Screw-in	LED 2019/2020 (89 lm/W)
Residential	Exterior Lighting	Screw-in	LED 2025 (104 lm/W)
Residential	Exterior Lighting	Screw-in	LED 2030 (117 lm/W)
Residential	Appliances	Refrigerator	Advanced Refrigerator with Vacuum Insulation
Residential	Appliances	Clothes Washer	High Efficiency (MEF 2.89)
Residential	Appliances	Clothes Dryer	High 2020 (EF 4.51)
Residential	Appliances	Clothes Dryer	Heat Pump Dryer (CEF 4.35)
Residential	Appliances	Clothes Dryer	Heat Pump Dryer (CEF 6.65)
Residential	Appliances	Dishwasher	Proposed ENERGY STAR (270 kWh)
Residential	Water Heating	Water Heater	Drainwater Heat Recovery

Sector	End Use	Technology	Measure Label
Residential	Water Heating	Water Heater	Water Heater - Desuperheater
Residential	All	All	ENERGY STAR Home Design
Residential	All	All	Connected Home Energy Management System
Non-Residential	Cooling	Air-Cooled Chiller	COP 4.45 (EER 15.2)
Non-Residential	Cooling	Water-Cooled Chiller	COP 11.72 (0.30 kW/ton)
Non-Residential	Cooling	Water-Cooled Chiller	COP 12.13 (0.29 kW/ton)
Non-Residential	Cooling	Water-Cooled Chiller	COP 13.03 (0.27 kW/ton)
Non-Residential	Cooling/Heating	Geothermal Heat Pump	EER 35.5 (COP 4.76)
Non-Residential	Interior Lighting	Exempted Lighting	LED 2019/2020 (97 lm/W)
Non-Residential	Interior Lighting	Exempted Lighting	LED 2025 (111 lm/W)
Non-Residential	Interior Lighting	Exempted Lighting	LED 2030 (123 lm/W)
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2019/2020 (121 lm/W)
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2025 (138 lm/W)
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2030 (152 lm/W)
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2019/2020 (121 lm/W) w/ Controls
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2025 (138 lm/W) w/ Controls
Non-Residential	Interior Lighting	High-Bay Lighting	LED 2030 (152 lm/W) w/ Controls
Non-Residential	Interior Lighting	Linear Lighting	LED 2019/2020 (123 lm/W system)
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2025 (142 lm/W system)
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2030 (158 lm/W system)
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2019/2020 (123 lm/W system) w/ Controls

Sector	End Use	Technology	Measure Label
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2025 (142 lm/W system) w/ Controls
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2030 (158 lm/W system) w/ Controls
Non-Residential	Int./Ext. Lighting	Linear Lighting	LED 2019/2020 (123 lm/W system)
Non-Residential	Exterior Lighting	General Service Lighting	LED 2019/2020 (97 lm/W)
Non-Residential	Exterior Lighting	General Service Lighting	LED 2025 (111 lm/W)
Non-Residential	Exterior Lighting	General Service Lighting	LED 2030 (123 lm/W)
Non-Residential	Exterior Lighting	Area Lighting	LED 2019/2020 (105 lm/W)
Non-Residential	Exterior Lighting	Area Lighting	LED 2025 (120 lm/W)
Non-Residential	Exterior Lighting	Area Lighting	LED 2030 (132 lm/W)
Non-Residential	Exterior Lighting	Area Lighting	LED 2019/2020 (105 lm/W) w/ Controls
Non-Residential	Exterior Lighting	Area Lighting	LED 2025 (120 lm/W) w/ Controls
Non-Residential	Exterior Lighting	Area Lighting	LED 2030 (132 lm/W) w/ Controls
Non-Residential	Heating	All	Space Heating - Heat Recovery Ventilator
Non-Residential	Cooling	RTU	RTU - Advanced Controls
Non-Residential	Water Heating	Water Heater	Water Heater - Drainwater Heat Recovery
Non-Residential	Water Heating	Water Heater	Water Heater - Solar System
Non-Residential	Water Heating	Water Heater	Commercial Laundry - Ozone Treatment
Non-Residential	Ventilation	Ventilation	Ventilation - Demand Controlled
Non-Residential	Cooling	All	Data Center - Server Virtualization

SECTION 2 DEMAND-SIDE RESEARCH

(2) The utility shall conduct, describe, and document market research studies, customer surveys, pilot demand-side programs, pilot demand-side rates, test marketing programs, and other activities as necessary to estimate the maximum achievable potential, technical potential, and realistic achievable potential of potential demand-side resource options for the utility and to develop the information necessary to design and implement cost-effective demand-side programs and demand-side rates. These research activities shall be designed to provide a solid foundation of information applicable to the utility about how and by whom energy-related decisions are made and about the most appropriate and cost-effective methods of influencing these decisions in favor of greater long-run energy efficiency and energy management impacts. The utility may compile existing data or adopt data developed by other entities, including government agencies and other utilities, as long as the utility verifies the applicability of the adopted data to its service territory. The utility shall provide copies of completed market research studies, pilot programs, pilot rates, test marketing programs, and other studies as required by this rule and descriptions of those studies that are planned or in progress and the scheduled completion dates.

Liberty-Empire obtained a variance from 4 CSR 240-20.094(3)(A), which required that Liberty-Empire collect primary data in 2015/2016 for the residential sector to inform the 2016 market potential study. This data was also utilized for the 2019 market potential study. The prior study data is still applicable and relevant to the Liberty-Empire service territory. New primary data is not necessary because (1) the previous data is supplemented with information from secondary sources to account for changes in particular technologies, (2) new primary data collection is costly, and (3) no significant market transformation or standard changes have occurred that would significantly impact the validity of the 2016 study. Liberty-Empire commissioned a Residential Customer Energy Survey in 2015 and supplemented the potential study with secondary data sources as needed. Details on the results of the Residential Customer Energy Survey can be found in the 2016 IRP triennial compliance filing.

For the DSM Potential Study, AEG used its Load Management Analysis and Planning tool (LoadMAP^{TM}) version 5.0 to develop the baseline projection and potential estimates. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for more than 50 studies in the past five years. Built in Microsoft Excel, the LoadMAP framework is both accessible and transparent.[5]

LoadMAP^{TM} Data Sources

Below is a discussion of the data sources for the study. In general, data was adapted to local conditions. For example, local sources are utilized for measure data and local weather data is used for building simulations.

Liberty-Empire Data

The highest priority data sources for this study were those that were specific to Liberty-Empire:

- *Liberty-Empire 2014 and 2017 customer billing data*
- *Load forecasts*: most recent load and peak forecasts, economic growth forecast by sector, and retail electricity price history and forecasts.
- *Economic information:* avoided cost forecasts, discount rate, and line loss factor.
- *Residential saturation survey*: 2015 Residential Customer Energy Survey completed by Opinion Research Specialists, LLC.
- *Secondary saturation information from EIA's Annual Energy Outlook. Other primary market research from regional studies were used to benchmark values.*
- *Liberty-Empire current and historical DSM program data*

[5] See the Empire District Electric Company DSM Market Potential Study for the full report.

AEG Data

AEG maintains several databases and modeling tools for potential studies. Relevant data from these tools are listed below and have been incorporated into the analysis and deliverables for this study.

- *AEG Energy Market Profiles:* For more than 10 years, AEG staff has maintained profiles of end-use consumption for the residential and nonresidential sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use, customer segment and end use for 10 regions in the U.S. Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- *Building Energy Simulation Tool ("BEST")*: a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs[6] as well as HVAC-related measure savings.
- *AEG's EnergyShape™*: Database of residential and nonresidential end-use load shapes.
- *AEG's Database of Energy Efficiency Measures ("DEEM")*: AEG maintains an extensive database of measure data from national, state and utility technical reference manuals and evaluations from around the country.

Energy Efficiency Measure Data

Several sources of data were used to characterize the energy efficiency measures. AEG used recent studies performed for the Midwest, supplemented by data (described above) and the following national and well-vetted regional data sources:

[6] UEC: Annual electricity use in homes and buildings that have the technology
EUI: Annual electricity use per square foot for a technology in floor space that has the technology

- Appliance and Equipment Standards. The market potential study utilized data from the U.S. Department of Energy,[7] Energy Star[8] and the Consortium for Energy Efficiency[9] to determine baseline savings as well as efficient savings for Energy Star and Consortium for Energy Efficiency qualifying measures.
- Missouri Dept. of Economic Development, Division of Energy. Missouri Technical Reference Manual – 2017.
- Illinois Statewide Technical Reference Manual for Energy Efficiency. Draft Version 7.0 Effective January 1, 2019.
- Arkansas Public Service Commission. Arkansas Technical Reference Manual. Version 7.0 (August 31, 2017).
- State of Minnesota. Technical Reference Manual for Energy Conservation Improvement Programs. Version 2.1. Effective January 1, 2017 – December 31, 2018.
- Iowa Utilities Commission Board. Iowa Energy Efficiency Statewide Technical Reference Manual Version 2.0. Effective January 1, 2018
- Michigan Public Service Commission (2018). Michigan Energy Measures Database. Prepared by Morgan Marketing Partners.
- Ameren Missouri 2017 Integrated Resource Plan. Appendix A – Technical Resource Manual.
- ComEd. ComEd Programs NTG Approach for EPY10.[10]

Table 5-7 through Table 5-9 below note how the data above was applied to the market profiles, measure characteristics, and baseline projection and potential estimates.

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[7] U.S. Department of Energy. Current Rulemakings and Notices. http://energy.gov/eere/buildings/current-rulemakings-and-notices
[8] Energy Star. Product Specifications and Partner Commitments Search. http://www.energystar.gov/products/spec/
[9] Consortium for Energy Efficiency. Program Resources. https://www.cee1.org/
[10] http://ilsagfiles.org/SAG_files/NTG/2017_NTG_Meetings/Final/ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.pdf

Table 5-7 – Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings and nonresidential floor space	Liberty-Empire billing data Liberty-Empire RASS survey AEO 2017
Annual intensity	Residential: Annual use per household Nonresidential: Annual use per square foot	Liberty-Empire billing data Liberty-Empire RASS survey AEG's Energy Market Profiles AEO 2017 Other recent potential studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of commercial floor space with equipment/technology	Liberty-Empire RASS survey AEG's Energy Market Profiles Other recent potential studies
UEC/EUI for each end-use technology	UEC: Annual electricity use in homes and buildings that have the technology EUI: Annual electricity use per square foot for a technology in floor space that has the technology	Recent Midwest studies HVAC uses: BEST simulations using prototypes developed for Missouri Engineering analysis
Appliance/equipment age distribution	Age distribution for each technology	Liberty-Empire RASS survey EIA Data (CBECs, RECs) Recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	AEG DEEM AEO 2017 DEER NWPCC workbooks, RTF Previous studies
Peak factors	Share of technology energy use that occurs during the peak hour	Liberty-Empire system peak data EnergyShape database

Table 5-8 – Data Needs for the Baseline Projection and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and nonresidential sectors	Liberty-Empire load forecast Liberty-Empire customer growth forecast AEO 2017 economic growth forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	AEO 2017 regional technology forecast assumptions[11] Appliance/efficiency standards analysis Liberty-Empire program results
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	Liberty-Empire forecast data

Table 5-9 – Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	AEG DEEM AEG BEST (HVAC only) AEO 2017 Missouri TRM Illinois TRM Arkansas TRM Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	AEG DEEM AEG BEST (HVAC only) Missouri TRM
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-household or per-square-foot basis for the residential and nonresidential sectors, respectively. Non-equipment measures: 1. Existing buildings – full installed cost.	AEG DEEM AEO 2017 Missouri TRM Illinois TRM Michigan Database RS Means Other secondary sources

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

Model Inputs	Description	Key Sources
	2. New Construction – the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	AEG DEEM AEO 2017 Missouri TRM Other secondary sources
Applicability	Estimate of the percentage of dwellings in the residential sector or square feet in the nonresidential sector where the measure is applicable and where it is technically feasible to implement.	AEG DEEM Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	AEG appliance standards and building codes analysis

SECTION 3 DEVELOPMENT OF POTENTIAL DEMAND-SIDE PROGRAMS

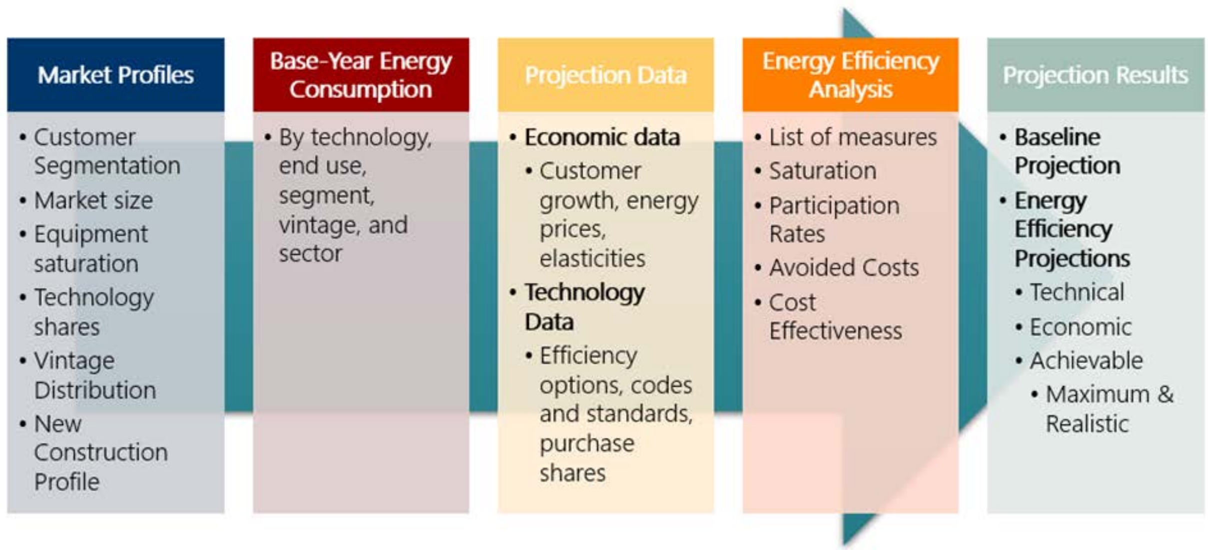
(3) The utility shall develop potential demand-side programs that are designed to deliver an appropriate selection of end-use measures to each market segment. The utility shall describe and document its potential demand-side program planning and design process which shall include at least the following activities and elements:

Liberty-Empire engaged AEG to conduct a DSM Market Potential Study ("study") to assess the future potential for savings through its programs and to identify refinements that will enhance savings. The study is part of a larger effort to support Liberty-Empire's Demand-Side Resource Analysis under 4 CSR 240-22.050 for the 2019 IRP filing. AEG worked closely with the other IRP contractors to ensure consistency across different aspects of load forecasting, supply resources, and final IRP resource modeling. Key objectives for the study include:

1) Provide credible and transparent estimation of the technical, economic, and achievable energy efficiency potential by year over the next 20 years within Liberty-Empire's Missouri service territory.
2) Evaluate energy efficiency measures, as well as demand response options and behavior change programs.
3) Develop several DSM program designs based upon cost-effective measures and equipment.
4) Support Liberty-Empire's Demand-Side Resource Analysis under 4 CSR 240-22.050 for the 2019 IRP filing.
5) Develop a final report including summary data tables and graphs reporting incremental and cumulative potential by year from 2019 through 2039.

For the measure-level energy efficiency potential analysis, AEG used its Load Management Analysis and Planning tool (LoadMAP^{TM}) version 5.0 to develop both the baseline projection and the estimates of potential. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for more than 50 studies in the past five years. The analysis framework of the study is illustrated below in Figure 5-3.

Figure 5-3 – Potential Analysis Framework



Market Characterization

In order to estimate the savings potential from energy-efficient measures, it is necessary to understand how much energy is used today and what equipment is currently being used. The characterization begins with a segmentation of Liberty-Empire's electricity footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies used. AEG began with the previous potential study's base year of 2014 and the original characterization assumptions as a starting point for this study. Using data provided Liberty-Empire and Itron, as well as secondary sources such as the EIA AEO, AEG updated specific assumptions in order to calibrate 2014 through 2017 to Liberty-Empire's actual sales. This step was done in order to ensure that the updated base year of 2017 and the baseline projection beyond aligned specifically with the load forecast that is being used in Liberty-Empire's 2019 IRP load forecast. The final segmentation scheme is presented in Table 5-1.

With the segmentation scheme defined, AEG performed a high-level market characterization of electricity sales in the base year, 2017. AEG used detailed Liberty-Empire billing and customer data with minimal augmentation from secondary sources to allocate energy use and customers to the various sectors and segments such that the total customer count and energy consumption aligns with Liberty-Empire system totals provided by Itron, detailed in Technical Volume 3. This data provided control totals at a sector level for calibrating the LoadMAP™ model to known data for the base-year. For the purposes of this analysis, impacts from solar PV were removed from the analysis in order to model the full unadjusted market energy consumption.

Total electricity consumption for Liberty-Empire in 2017 was 3,856 GWh. As shown in Table 5-10, the residential sector accounts for approximately 49% of annual energy use, followed by nonresidential with 51%. In terms of summer peak demand, the total system peak in 2017 was 1,082 MW. The residential sector contributes the most to peak demand, contributing to 59% of the peak, mainly due to the saturation of air conditioning equipment.

Table 5-10 – Liberty-Empire Sector Control Totals (2017)

Sector	Annual Electricity Use (GWh)	% of Annual Use	Summer Peak Demand (MW)	% of Summer Peak
Residential	1,903	49%	634	59%
Nonresidential	1,954	51%	448	41%
Total	**3,856**	**100%**	**1,082**	**100%**

Residential Sector

The total number of households and electricity sales for the service territory were obtained from Liberty-Empire's customer database. In 2017, there were 144,718 households in the Liberty-Empire service territory that consumed a total of 1,903 GWh, with a peak demand of 634 MW. These totals were allocated into four residential segments. Additionally, impacts from the solar PV installations were removed from our baseline projection in order to model the full unadjusted market unit consumption.

Table 5-11 – Residential Sector Control Totals (2017)

Segment	Number of Customers	Electricity Sales (GWh)	% of Total Usage	Avg. Use/ Customer (kWh)	Peak Demand Summer (MW)
Single Family, Non Low Income	100,603	1,443	76%	14,341	481
Multi Family, Non Low Income	6,940	55	3%	7,870	15
Single Family, Low Income	31,311	366	19%	11,701	125
Multi Family, Low Income	5,864	39	2%	6,633	12
Total	**144,718**	**1,903**	**100%**	**13,147**	**634**

Figure 5-4 shows the distribution of annual electricity use and summer peak demand by end use for all residential customers. Three end uses — space heating, appliances and cooling — account for 61% of total electricity use. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the electronics, lighting, heating, water heating, and the miscellaneous categories, which is comprised of furnace fans, pool pumps, and other "plug" loads (i.e. all other usage, such as hair dryers, power tools, and coffee makers). As expected, air conditioning is the largest contributor to summer peak demand, followed by appliances. Lighting has low peak coincidence and makes a small contribution.

Figure 5-4 – Residential Electricity Use and Summer Peak Demand by End Use (2017)

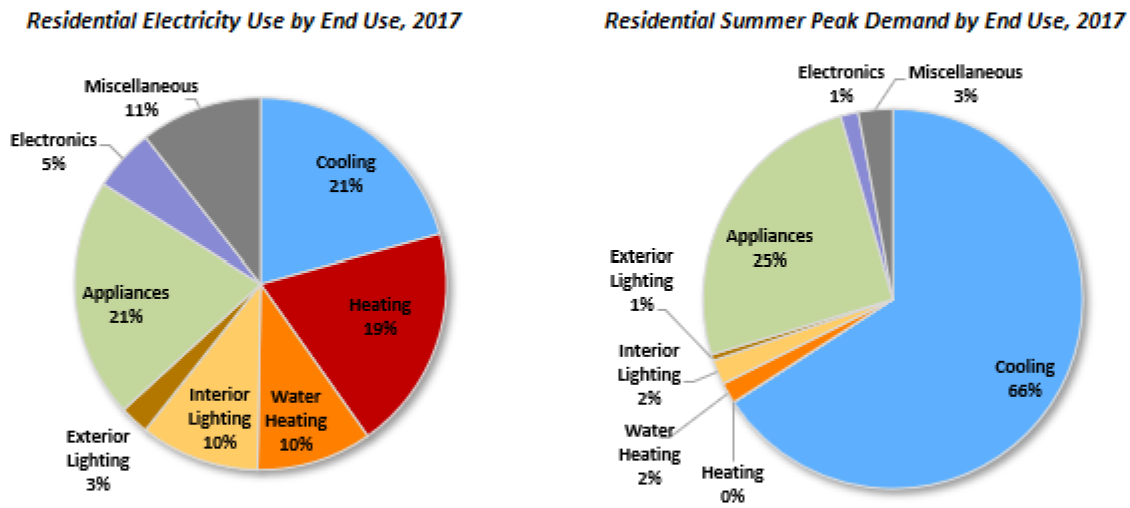
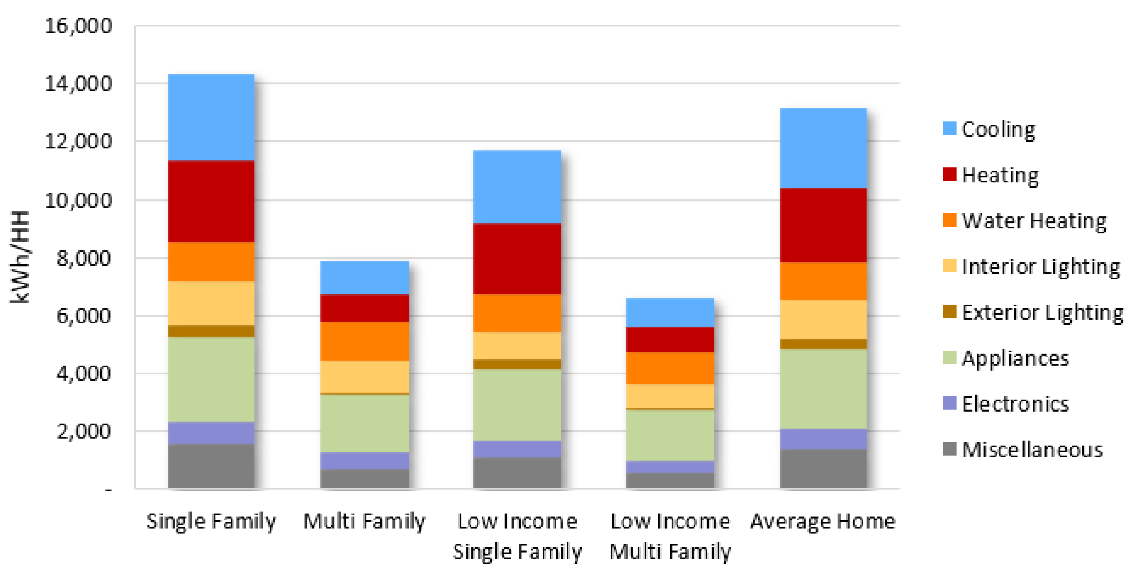


Figure 5-5 presents the electricity intensities (kWh per household) by end use. Single family homes have higher use across all end uses primarily due to larger home size.

Figure 5-5 – Residential Intensity by End Use and Segment (2017) (Annual kWh/HH)



Nonresidential Sector

In 2017, nonresidential customers consumed 1,954 GWh in Liberty-Empire's service territory. Liberty-Empire billing data and secondary data were used to allocate this energy usage into two segments and to develop estimates of energy intensity (annual kWh/square foot). AEG analyzed Liberty-Empire's nonresidential customer billing data and determined that there would be two segments, small and large nonresidential customers. The threshold for differentiating the segments is 1,000 MWh annual use in 2017. Customers with usage equal to and above the threshold were characterized as large nonresidential, and all other customers were considered small nonresidential. These segments and sector totals are shown below in Table 5-12.

Table 5-12 – Nonresidential Sector Control Totals (2017)

Segment	Floorspace (sq ft)	Electric Use (GWh)	Annual Use/ Customer (kWh/sq ft)	Summer Peak Demand (MW)
Small C&I	107,197,896	1,180	11.0	240
Large C&I	18,395,410	774	42.1	209
Total	**125,593,307**	**1,954**	**15.6**	**448**

As previously noted, the nonresidential sector excludes customers that opt out of Liberty-Empire's DSIM charge (as of December 2017). These opt-out customers have elected not to participate in energy efficiency programs and are thus not applicable to the analysis. For the purposes of this study, the number of opt-out customers and the amount of opt-out electricity load was assumed to be constant throughout the forecast and removed for each year. Additionally, specific municipalities that are projected to discontinue service from Liberty-Empire were removed. Impacts from solar PV installations were also removed from the baseline projection in order to model the full unadjusted market unit consumption.

Figure 5-6 presents the distribution of annual electricity consumption by end use for the small and large nonresidential segments. The lighting and cooling end uses account for a significant portion of electric usage in the small nonresidential segment. By contrast, large nonresidential usage is dominated by motors and process end uses. Figure 5-7 shows the nonresidential peak summer demand by end use for both the small and large nonresidential segments. Cooling dominates both segments.

Figure 5-6 – Nonresidential Sector Electricity Consumption by End Use (2017)

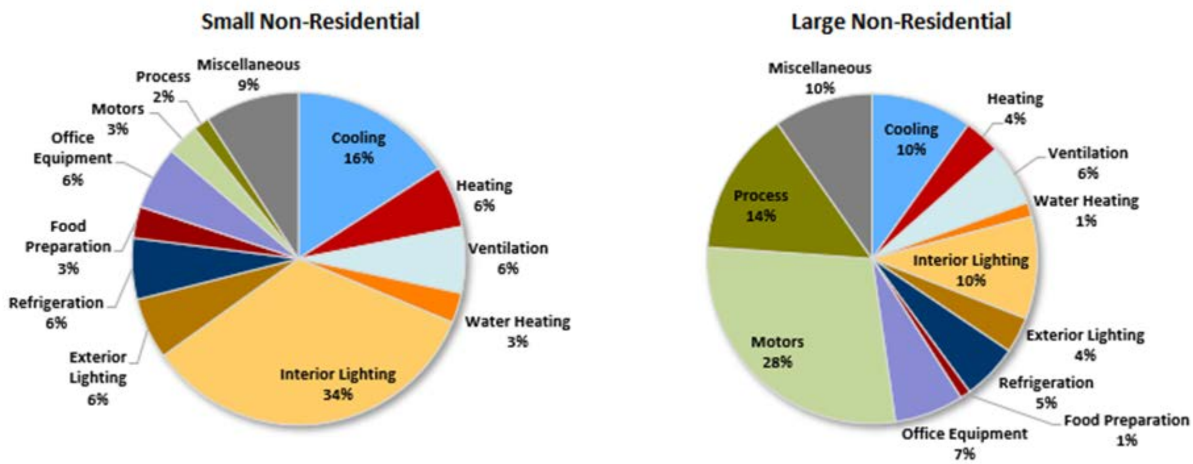
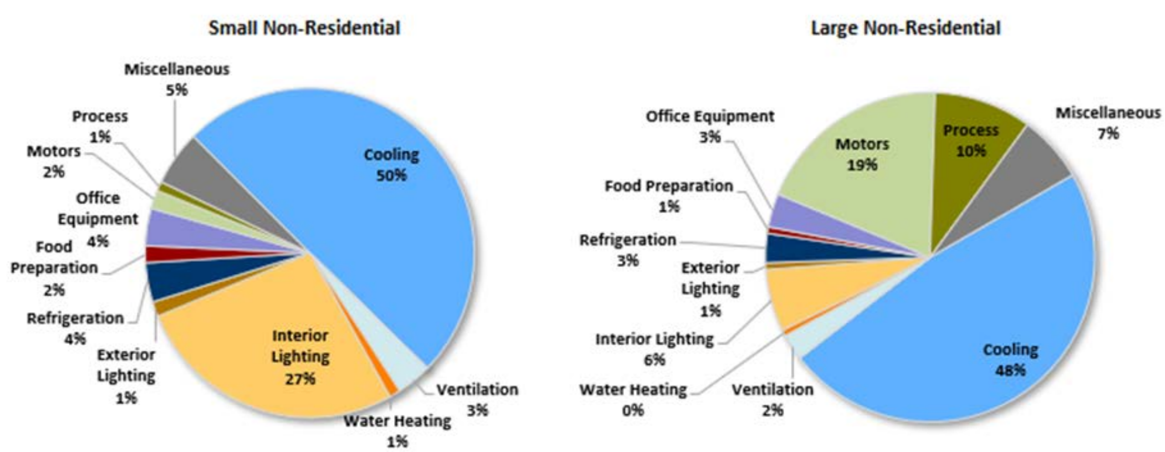


Figure 5-7 – Nonresidential Sector Electricity Peak Summer Demand by End Use (2017)



Baseline End-Use Projection

Prior to developing estimates of energy efficiency potential, AEG developed a baseline end-use projection to quantify what the consumption is likely to be in the future in the absence of any energy efficiency programs. The savings from past programs are embedded in the forecast, but the baseline projection assumes that those past programs cease to exist in the future. Thus, the potential analysis captures all possible savings from future programs.

The baseline projection incorporates assumptions regarding:

- Customer population and economic growth
- Appliance/equipment standards and building codes already mandated
- Forecasts of future electricity prices and other drivers of consumption
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous electricity growth
- Naturally occurring energy efficiency, which reflects the manufacturing of more efficient options in response to new appliance standards and purchases of high-efficiency appliances and equipment by early adopters outside of utility programs
- Liberty-Empire’s 2019 IRP Load Forecast
- Current demand side management program and solar PV impacts
- Future consumption of specific customer groups, such as nonresidential opt-out customers and contracted municipalities

AEG took the following steps to align the baseline projection with the Liberty-Empire 2019 IRP forecast developed by Itron:

- Updated market size forecast with actual number of customers provided by Liberty-Empire for 2014-2017

- Added actual 2014 HDD/CDD and weather normalized 2015+ used in the development of the 2019 IRP load forecast
- Updated forecasts of other utilization variables, indices for electricity price, income and HH size used in the development of the 2019 IRP load forecast
- Reviewed and updated equipment saturation growth forecasts in light of actuals provided by Liberty-Empire and Itron
- Analyzed program accomplishments to identify where savings are coming from by end use and measure

Although it aligns closely, the baseline projection is not identical to Liberty-Empire's official load forecast or the projection provided by Itron that is detailed in Volume 3. Rather, it was developed to serve as the metric against which DSM potentials are measured. This section presents the baseline projections AEG developed for this study.

Baseline projections for each sector are presented below, which include projections of annual use in GWh and summer peak demand in MW. A summary across all sectors is also presented.

Residential Sector Baseline Projection

Table 5-13 and Figure 5-8 present AEG's net baseline projection for electricity at the end-use level for the residential sector as a whole. Overall, residential usage remains relatively flat, increasing only slightly from 1,903 GWh in 2017 to 2,004 GWh in 2039, representing an increase of 5.3%. The unevenness of the projection is due to federal codes and standards coming into effect. Table 5-13 includes an estimate of naturally occurring energy efficiency, which has the greatest impact in the lighting end uses due to early adoption of LED lamps. Three high-level factors affect growth:

- A moderate increase in number of households (9% between 2017 and 2039).

- A decrease in lighting equipment consumption due to future standards and naturally occurring efficiency improvements. Lighting use decreases throughout the time period as the lighting standards from EISA[12] come into effect.
- An increase in household income. AEG applied a factor that represents Liberty-Empire's econometric relationship between income and energy consumption. Overall, there is an expected annual increase of 1.45% in household income. This has an upward pressure on electricity consumption.

Table 5-13 – Residential Sector Baseline Projection by End Use (Net GWh)

End Use	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
Cooling	394	395	400	406	416	431	9.4%
Heating	372	379	395	417	439	463	24.5%
Water Heating	191	193	198	204	210	219	14.5%
Interior Lighting	197	180	114	93	85	80	-59.5%
Exterior Lighting	49	44	24	20	18	17	-64.7%
Appliances	396	394	395	402	413	426	7.7%
Electronics	103	102	104	112	123	137	33.1%
Miscellaneous	202	205	211	218	225	231	14.6%
Total	**1,903**	**1,893**	**1,841**	**1,873**	**1,929**	**2,004**	5.3%

[12] Energy Independence and Security Act. Passed in 2007, the law improved fuel economy, created standards for appliances, industrial motors, lighting, and more. The efficiency standards for lighting became effective in 2012 and have begun to transform the market. http://www2.epa.gov/laws-regulations/summary-energy-independence-and-security-act

Figure 5-8 – Residential Baseline Projection by End Use (Net GWh)

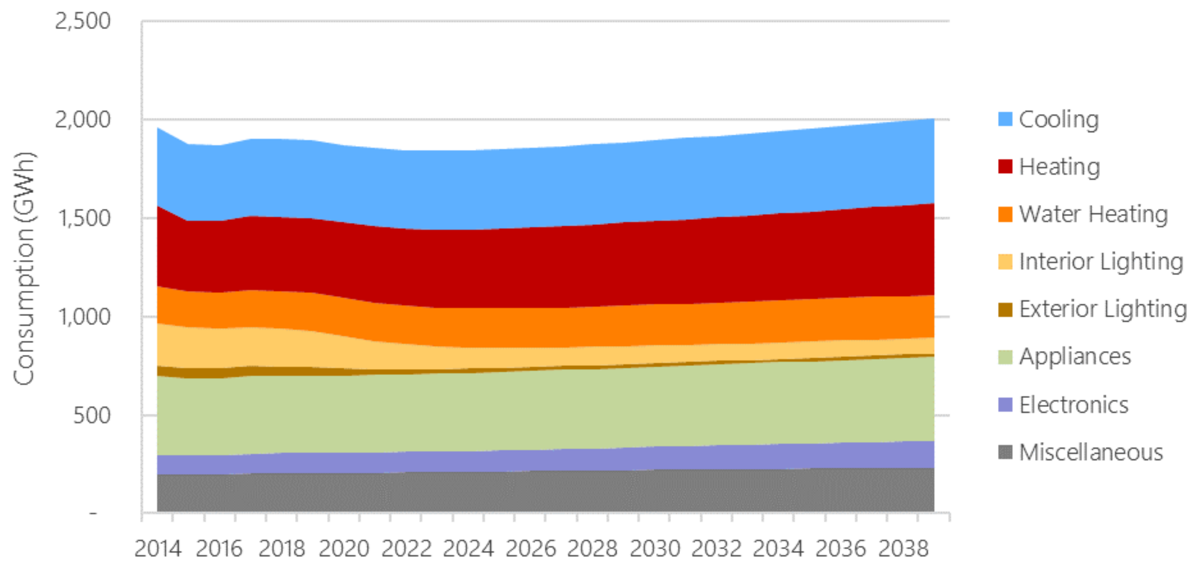


Table 5-14 shows the end-use projection at the technology level for select years. This projection is in general alignment with Liberty-Empire's residential load forecast. Specific observations include:

1) Lighting use continues to decline in the early years of the projection, reflecting the first phase of the EISA lighting standard. Lighting energy use declines more dramatically starting in 2020 as a result of the second phase of the EISA lighting standard.
2) Modest growth in the heating end use reflects a wider deployment of electric heating within the service territory.
3) Growth in electronics is substantial and reflects an increase in the saturation of electronics and the trend toward higher-powered computers. Growth in other miscellaneous use is also substantial. This end use has also grown consistently in the past. Future growth assumptions that are consistent with the Annual Energy Outlook are incorporated.

Table 5-14 – Residential Baseline Projection by End Use and Technology (Net GWh)

End Use	Technology	2017	2019	2023	2028	2033	2038	% Change ('19-'38)
Cooling	Central AC	311	311	313	315	318	325	4.5%
	Room AC	14	14	14	14	14	15	7.3%
	Air-Source Heat Pump	65	66	68	72	77	84	30.7%
	Geothermal Heat Pump	5	5	5	6	6	7	48.6%
Heating	Air-Source Heat Pump	107	111	119	131	143	160	49.6%
	Geothermal Heat Pump	4	4	4	5	5	6	56.4%
	Electric Furnace	241	244	251	260	267	274	13.5%
	Electric Room Heat	20	20	21	22	22	23	17.6%
Water Heating	Water Heater (<= 55 Gal)	180	183	188	195	202	211	17.2%
	Water Heater (> 55 Gal)	11	10	10	9	8	8	-29.3%
Interior Lighting	General Service Screw-In	137	123	63	49	45	44	-68.2%
	Exempted Screw-In	48	45	38	33	30	27	-44.9%
	Linear Lighting	12	12	12	12	10	10	-18.6%
Ext. Lighting	Screw-in	49	44	24	20	18	17	-64.7%
Appliances	Refrigerator	100	98	96	96	98	101	0.4%
	Second Refrigerator	27	27	26	26	27	28	2.8%
	Freezer	35	33	29	26	25	25	-29.6%
	Clothes Washer	11	10	9	9	8	8	-24.9%
	Clothes Dryer	97	99	102	105	109	113	16.6%
	Dishwasher	43	44	46	50	53	56	29.3%

End Use	Technology	2017	2019	2023	2028	2033	2038	% Change ('19-'38)
	Microwave	17	17	18	19	19	20	15.0%
	Stove	51	52	53	56	58	60	17.7%
	Dehumidifier	9	10	10	10	11	11	14.8%
	Air Purifier	5	5	5	6	6	6	14.8%
Electronics	Personal Computers	10	10	11	11	11	11	9.6%
	Monitor	4	4	4	4	4	4	0.2%
	Laptops	6	6	7	8	9	11	95.4%
	Printer/Fax/Copier	6	6	6	7	8	9	57.8%
	TVs	57	58	60	64	70	77	35.1%
	Set top Boxes/DVRs	13	11	8	9	11	13	-0.9%
	Devices and Gadgets	8	8	9	10	11	12	61.0%
Misc.	Pool Pump	16	16	16	17	18	18	14.8%
	Pool Heater	1	1	1	1	1	0	-65.3%
	Furnace Fan	77	78	80	83	86	88	14.8%
	Well Pump	8	8	9	9	9	9	14.8%
	Miscellaneous	100	101	104	108	112	115	15.5%
Total		**1,903**	**1,893**	**1,841**	**1,873**	**1,929**	**2,004**	**5.3%**

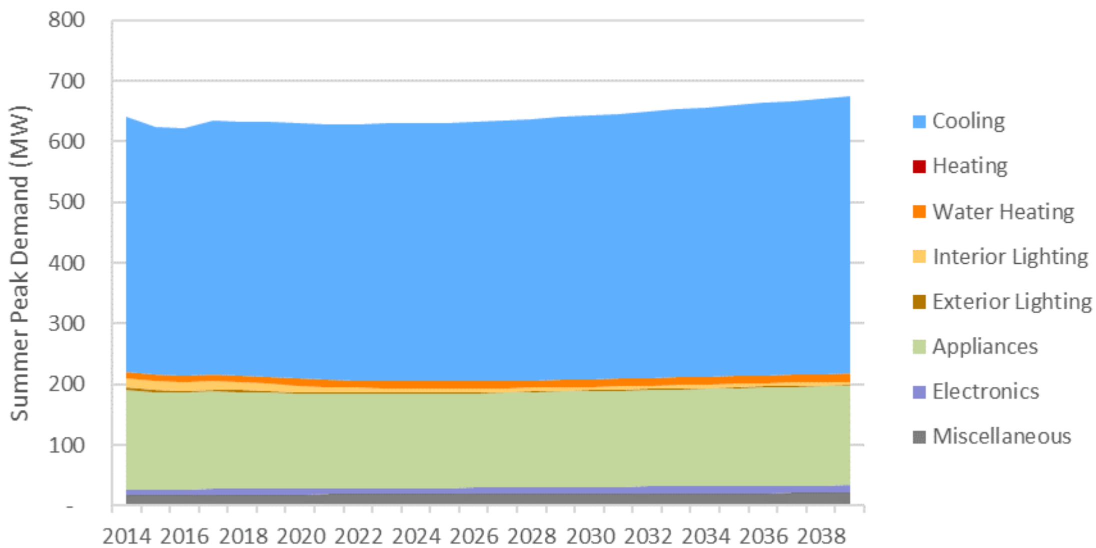
Table 5-15 and Figure 5-9 present the residential baseline projection for summer peak demand at the end-use level. Overall, residential summer peak increases slightly from 634 MW in 2017 to 675 MW in 2039. The summer peak associated with electronics and miscellaneous uses increases substantially, corresponding to growth in annual energy use.

Table 5-15 – Residential Summer Peak Baseline Projection by End Use (Net MW)

End Use	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
Cooling	417	419	424	431	441	457	9.5%

Heating	-	-	-	-	-	-	0.0%
Water Heating	11	11	12	12	12	13	14.5%
Interior Lighting	13	12	8	6	6	5	-59.5%
Exterior Lighting	3	3	2	1	1	1	-64.7%
Appliances	160	158	155	157	160	164	2.5%
Electronics	9	9	10	10	11	13	33.1%
Miscellaneous	19	19	19	20	21	21	14.6%
Total	**634**	**632**	**630**	**637**	**653**	**675**	**6.4%**

Figure 5-9 – Residential Summer Peak Baseline Projection by End Use (Net MW)



Nonresidential Sector Baseline Projection

Annual electricity use in the nonresidential sector grows 21.3% during the overall planning period, starting at 1,954 GWh in 2017 and increasing to 2,371 in 2039. Similar to the residential model, three factors contribute to this growth. Large market growth is expected in the non-manufacturing sector. Utilizing the econometric assumptions, this results in a substantial increase in consumption. Rather than increasing consumption per square foot when GRP increases, AEG assumed that new spaces would develop or that underutilized/vacant spaces would be repurposed. This is reflected in larger market growth rather than in an increase in kWh per square foot. The miscellaneous end use comprises a growing portion of energy consumption in commercial buildings that is not captured in the other defined end uses. The annual growth rate of 4% is similar to those seen in other studies in the region to account for new technologies that enter the market.

Table 5-16 – Nonresidential Baseline Projection by End Use (Net GWh)

End Use	2017	2019	2023	2028	2033	2039	% Change ('17-'38)
Cooling	264	277	279	277	275	278	5.3%
Heating	98	104	105	108	110	114	15.6%
Ventilation	123	128	129	130	131	133	8.5%
Water Heating	45	48	49	51	53	55	21.0%
Interior Lighting	476	493	478	466	450	424	-11.1%
Exterior Lighting	98	100	96	92	88	83	-15.0%
Refrigeration	113	115	106	99	94	93	-17.6%
Food Preparation	44	46	47	49	50	52	17.2%
Office Equipment	125	137	150	169	189	218	74.6%
Motors	256	272	279	288	297	307	19.9%
Process	128	136	139	144	148	153	19.9%
Miscellaneous	183	217	262	317	377	461	151.7%
Total	**1,954**	**2,073**	**2,120**	**2,189**	**2,263**	**2,371**	**21.3%**

Figure 5-10 – Nonresidential Baseline Projection by End Use (GWh)

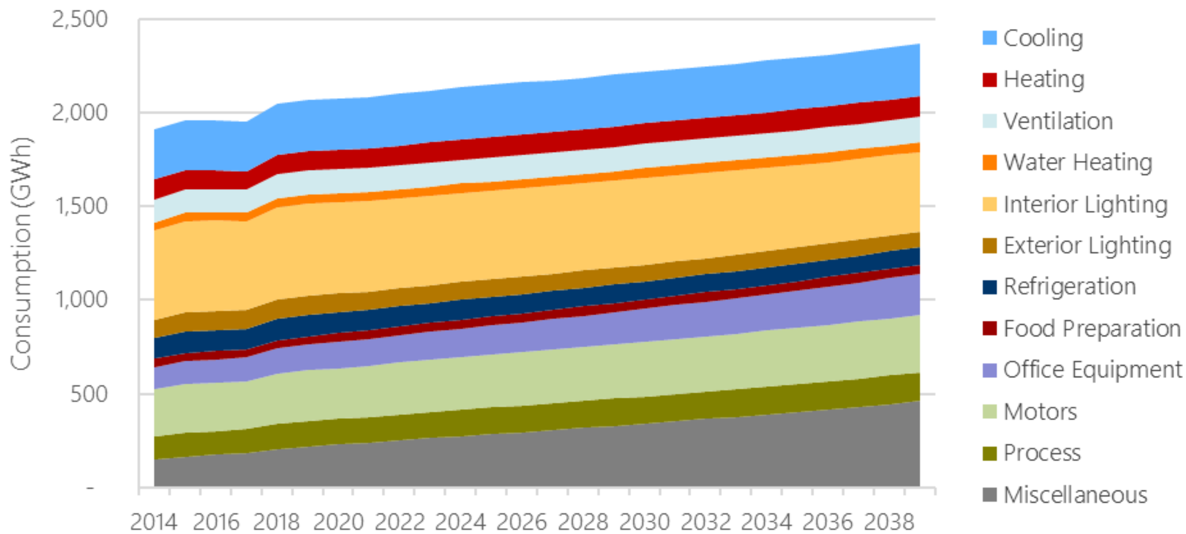


Table 5-17 presents the nonresidential sector annual projection by technology for select years. Screw-in lighting and refrigeration technologies decrease significantly over the timeline as a result of efficiency standards. Roof top unit ("RTU") technologies also decline slightly due to efficiency standards. Large growth is seen within the office equipment technologies due to large projected growth in the non-manufacturing sector.

Table 5-17 – Nonresidential Baseline Projection by End Use and Technology (Net GWh)

End Use	Technology	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
Cooling	Air-Cooled Chiller	16	17	18	19	19	20	22%
	Air-Source Heat Pump	6	6	6	6	6	6	4%
	Geothermal Heat Pump	1	1	1	1	2	2	9%
	PTAC	10	10	10	10	10	11	9%
	PTHP	14	14	14	14	15	15	11%

End Use	Technology	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
	RTU	163	171	171	165	161	159	-3%
	Water-Cooled Chiller	54	57	59	61	63	66	22%
Heating	Air-Source Heat Pump	5	5	5	5	6	6	11%
	Electric Furnace	62	66	67	69	71	73	17%
	Electric Room Heat	18	19	20	20	21	21	17%
	Geothermal Heat Pump	1	2	2	2	2	2	20%
	PTHP	11	12	11	12	12	12	9%
Ventilation	Ventilation	123	128	129	130	131	133	8%
Water Heating	Water Heater	45	48	49	51	53	55	21%
Interior Lighting	Exempted Lighting	11	10	9	8	7	7	-35%
	General Service Lighting	44	42	30	27	25	24	-45%
	High-Bay Lighting	126	132	134	136	136	136	8%
	Linear Lighting	296	308	305	296	283	257	-13%
Exterior Lighting	Area Lighting	76	79	78	76	72	69	-9%
	General Service Lighting	8	8	5	4	4	4	-50%
	Linear Lighting	13	14	13	12	11	10	-26%
Refrigeration	Glass Door Display	13	13	12	11	11	10	-19%
	Icemaker	21	22	21	21	21	21	-2%
	Open Display Case	20	21	21	21	21	22	8%
	Reach-in Refrig. /Freezer	6	5	5	5	4	4	-20%
	Vending Machine	6	6	6	6	6	7	17%
	Walk-in Refrig./Freezer	47	48	42	35	31	29	-39%
Food Preparation	Broiler	2	3	3	3	3	3	17%
	Dishwasher	13	13	14	14	15	15	18%

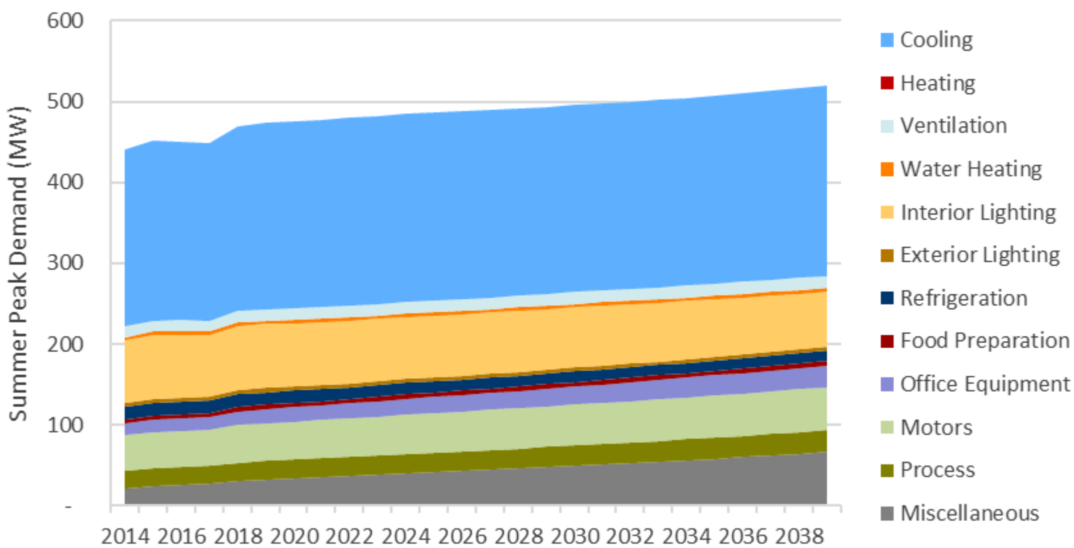
End Use	Technology	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
	Fryer	2	2	2	2	2	2	14%
	Griddle	11	12	12	13	13	13	17%
	Hot Food Container	1	1	1	1	1	1	17%
	Oven	5	6	6	6	6	6	17%
	Range	6	6	7	7	7	7	17%
	Steamer	4	4	4	4	4	4	18%
Office Equipment	Desktop Computer	55	60	66	75	84	97	76%
	Laptop	17	18	20	22	25	28	70%
	Monitor	10	11	12	13	15	17	77%
	POS Terminal	8	8	9	10	12	13	77%
	Printer/Copier/ Fax	13	15	16	18	20	23	71%
	Server	23	25	27	31	35	40	76%
Motors	Compressed Air	34	36	37	38	39	40	20%
	Conveyors	119	126	129	134	138	143	20%
	Fans & Blowers	42	45	46	47	49	51	20%
	Other Motors	15	16	16	17	17	18	20%
	Pumps	46	49	50	52	54	56	20%
Process	Process Cooling	44	47	48	50	51	53	20%
	Process Electrochemical	0	1	1	1	1	1	19%
	Process Heating	36	38	39	41	42	43	20%
	Process Other	3	3	3	3	3	3	20%
	Process Refrigeration	44	47	48	50	51	53	20%
Miscellaneous	Clothes Dryer	0	0	0	0	0	0	17%
	Clothes Washer	0	0	0	0	0	0	17%
	Non-HVAC Motors	4	5	5	5	5	5	17%
	Pool Heater	0	0	0	0	0	0	15%
	Pool Pump	0	0	0	0	0	0	15%
	Miscellaneous	178	212	257	312	371	455	156%
Total		**1,954**	**2,073**	**2,120**	**2,189**	**2,263**	**2,371**	**21%**

Table 5-18 and Figure 5-11 present the net summer peak baseline projection at the end-use level for the nonresidential sector as a whole. Summer peak demand increases over the planning period, starting at 448 MW in 2017 and increasing to 520 MW in 2039. The peak increases primarily due to customer growth within the sector.

Table 5-18 – Nonresidential Summer Peak Baseline Projection by End Use (Net MW)

End Use	2017	2019	2023	2028	2033	2038	% Change ('17-'38)
Cooling	219	231	233	232	232	235	7.2%
Heating	-	-	-	-	-	-	0.0%
Ventilation	14	14	14	14	15	15	8.5%
Water Heating	4	4	4	4	4	5	21.0%
Interior Lighting	77	80	77	75	73	68	-11.0%
Exterior Lighting	5	5	5	5	4	4	-15.0%
Refrigeration	15	16	14	13	13	13	-17.7%
Food Preparation	5	6	6	6	6	6	17.2%
Office Equipment	16	17	19	21	24	27	74.6%
Motors	44	47	48	50	51	53	19.9%
Process	22	24	24	25	26	27	19.9%
Miscellaneous	27	32	38	46	54	66	149.1%
Total	448	474	483	492	502	520	15.9%

Figure 5-11 – Nonresidential Summer Peak Baseline Projection by End Use (Net MW)



Summary of Baseline Projection across Sectors

Table 5-19 provides a summary of the baseline projection for net annual use by sector for the entire Liberty-Empire service territory. Overall, the projection shows a small increase in electricity use, driven primarily by customer growth projections. The average annual growth rate across both sectors over the planning period is 0.6%.

Table 5-19 – Baseline Projection Summary (Net GWh)

Sector	2017	2019	2023	2028	2033	2039	% Change ('17-'39)	Avg. Growth
Residential	1,903	1,893	1,841	1,873	1,929	2,004	5.3%	0.2%
Nonresidential	1,954	2,073	2,120	2,189	2,263	2,371	21.3%	0.9%
Total	3,856	3,966	3,961	4,062	4,192	4,374	13.4%	0.6%

Table 5-20 provides a summary of the baseline projection for net summer peak demand. Overall, the projection increases primarily due to customer growth.

Table 5-20 – Baseline Summer Peak Projection Summary (Net MW)

Sector	2017	2019	2023	2028	2033	2039	% Change ('17-'39)	Avg. Growth
Residential	634	632	630	637	653	675	6.4%	0.3%
Nonresidential	448	474	483	492	502	520	15.9%	0.7%
Total	1,082	1,106	1,112	1,129	1,155	1,194	10.4%	0.5%

Energy Efficiency Potential

In this study, the energy efficiency potential estimates represent net savings[13] developed into several levels of potential. At the measure-level, before delivery mechanisms and program costs are considered, there are four levels: technical potential, economic potential, maximum achievable potential, and realistic achievable potential. Technical and economic potential are both theoretical limits to efficiency savings and would not be realizable in actual programs. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. These levels are described in more detail below.

- **Technical Potential** is the theoretical upper limit of energy efficiency potential, assuming that customers adopt all feasible measures regardless of cost or customer preference. When existing equipment fails, customers replace their equipment with the most efficient

[13] Savings in "net" terms instead of "gross" terms mean that the baseline forecast does include naturally occurring efficiency. In other words, the baseline assumes that energy efficiency levels reflect that some customers are already purchasing the more efficient option.

option available. In new construction, customers and developers also choose the most efficient equipment option.

- **Economic Potential** represents the adoption of all *cost-effective* energy efficiency measures. Cost-effectiveness is measured by the total resource cost ("TRC") test, which compares lifetime energy and capacity benefits to the costs of the delivering the measure. If the benefits outweigh the costs (i.e. the TRC ratio is equal to or greater than 1.0), a given measure is included in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture. Economic potential is still a hypothetical upper-boundary of savings potential as it represents only measures that are economic but does not yet consider customer acceptance and other factors.
- **Maximum Achievable Potential ("MAP")** estimates customer adoption of economic measures when delivered through DSM programs under favorable market, implementation, and customer preference conditions and an appropriate regulatory framework. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. MAP establishes a maximum target for the savings that an administrator can hope to achieve through its DSM programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **Realistic Achievable Potential ("RAP")** reflects expected program participation given barriers to customer acceptance, implementation conditions, and limited program budgets.

Table 5-20 and Figure 5-12 summarize the energy efficiency savings in terms of annual energy use for all measures for four levels of potential relative to the Liberty-Empire load forecast. Figure 5-13 displays the EE projections versus the baseline. Note that only selected years of the projection are shown (2019, 2021, 2023, 2028, 2033 and 2039).

Technical potential savings reach 30% by the end of the planning period, suggesting that ample savings continue to be available. Economic potential savings, however, are about half of the technical potential, reflecting relatively low avoided costs that result in low measure cost-effectiveness. Achievable potential – RAP and MAP – are about half to two-thirds of economic potential throughout the study horizon.

Table 5-21 – Summary of Energy Efficiency Potential (Annual Energy, GWh)

	2019	2021	2023	2028	2033	2039
Baseline Projection						
Liberty-Empire Baseline Projection (GWh)	3,966	3,940	3,961	4,062	4,192	4,374
Cumulative Savings (GWh)						
Realistic Achievable Potential	28	69	105	178	243	313
Maximum Achievable Potential	41	99	149	247	334	426
Economic Potential	71	169	245	386	515	633
Technical Potential	116	303	468	814	1,092	1,299
Cumulative Savings as a Percent of Baseline						
Realistic Achievable Potential	0.7%	1.7%	2.6%	4.4%	5.8%	7.2%
Maximum Achievable Potential	1.0%	2.5%	3.8%	6.1%	8.0%	9.7%
Economic Potential	1.8%	4.3%	6.2%	9.5%	12.3%	14.5%
Technical Potential	2.9%	7.7%	11.8%	20.0%	26.0%	29.7%

Figure 5-12 – Energy Efficiency Potential as a Percent of Liberty-Empire Baseline Projection (Annual Energy)

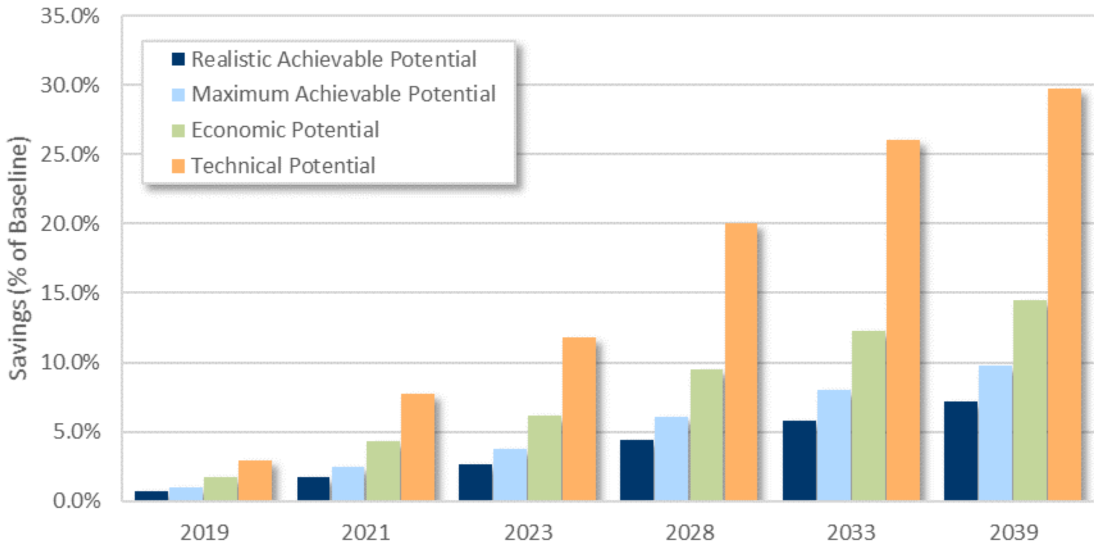


Figure 5-13 – Liberty-Empire Baseline Projection and Energy Efficiency Potential Cases (Annual Energy, GWh)

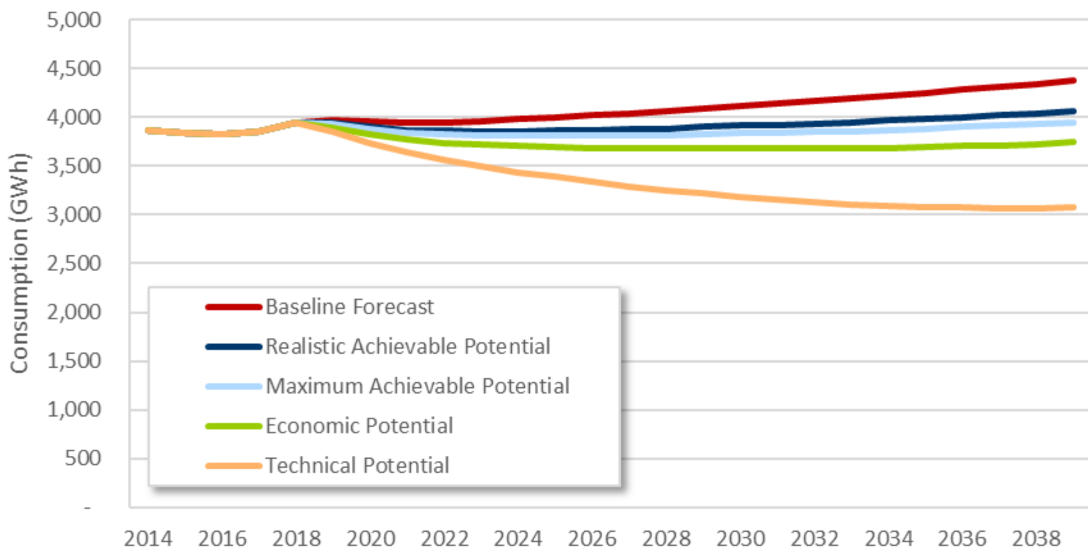


Table 5-22 and Figure 5-14 summarize the summer peak demand savings from all energy efficiency measures for four levels of potential *relative to the baseline projection.*

Table 5-22 – Summary of Energy Efficiency Potential (Summer Peak, MW)

	2019	2021	2023	2028	2033	2039
Baseline Projection						
Liberty-Empire Baseline Projection (MW)	1,106	1,105	1,112	1,129	1,155	1,194
Cumulative Savings (MW)						
Realistic Achievable Potential	6	17	28	54	71	87
Maximum Achievable Potential	9	25	40	75	97	118
Economic Potential	16	44	69	122	152	176
Technical Potential	33	94	153	280	374	440
Cumulative Savings as a % of Baseline						
Realistic Achievable Potential	0.6%	1.6%	2.6%	4.8%	6.1%	7.3%
Maximum Achievable Potential	0.8%	2.3%	3.6%	6.6%	8.4%	9.8%
Economic Potential	1.5%	4.0%	6.2%	10.8%	13.2%	14.8%
Technical Potential	3.0%	8.5%	13.8%	24.8%	32.4%	36.8%

Figure 5-14 – Summary of Peak Demand Savings

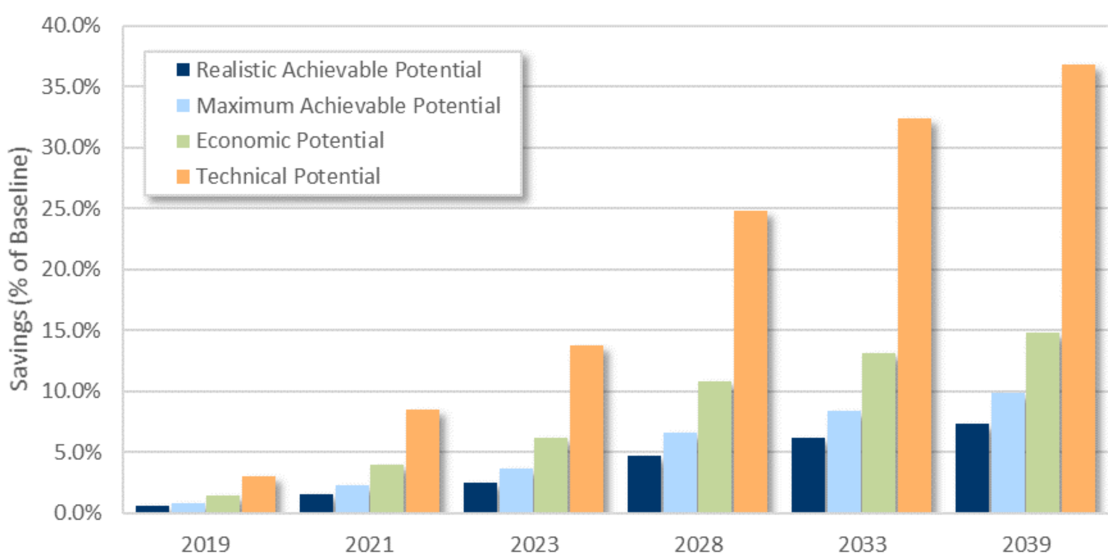


Table 5-23 and Figure 5-15 present estimates for measure-level energy efficiency potential for the residential sector in terms of annual energy savings. Realistic achievable potential in the first year in 2019 is 13 GWh, or 0.7% of the baseline projection. By 2039, cumulative realistic achievable savings are 104 GWh, or 5.2% of the baseline projection. Table 5-24 details the summer peak demand savings for the residential sector.

Table 5-23 – Residential Energy Efficiency Potential (Annual Energy, GWh)

	2019	2021	2023	2028	2033	2039
Baseline Projection						
Liberty-Empire Baseline Projection (GWh)	1,893	1,853	1,841	1,873	1,929	2,004
Cumulative Savings (GWh)						
Realistic Achievable Potential	13	29	40	59	77	104
Maximum Achievable Potential	18	41	55	77	101	135
Economic Potential	36	80	104	136	179	232
Technical Potential	63	163	243	422	571	706
Cumulative Savings as a % of Baseline						
Realistic Achievable Potential	0.7%	1.6%	2.2%	3.1%	4.0%	5.2%
Maximum Achievable Potential	1.0%	2.2%	3.0%	4.1%	5.2%	6.8%
Economic Potential	1.9%	4.3%	5.6%	7.3%	9.3%	11.6%
Technical Potential	3.4%	8.8%	13.2%	22.5%	29.6%	35.2%

Figure 5-15 – Residential Energy Efficiency Savings as a Percent of Baseline (Annual Energy)

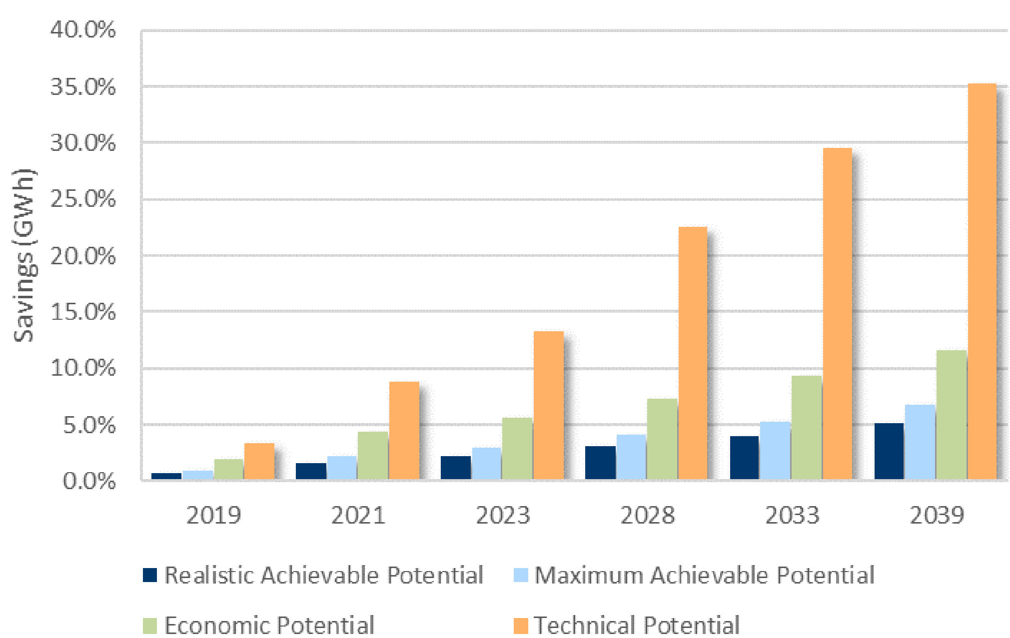


Table 5-24 – Residential Energy Efficiency Potential (Summer Peak, MW)

	2019	2021	2023	2028	2033	2039
Baseline Projection						
Liberty-Empire Baseline Projection (MW)	632	628	630	637	653	675
Cumulative Savings (MW)						
Realistic Achievable Potential	2	7	11	21	25	31
Maximum Achievable Potential	3	10	15	28	34	40
Economic Potential	7	19	30	52	60	70
Technical Potential	19	56	92	174	234	283
Cumulative Savings as a Percent of Baseline						
Realistic Achievable Potential	0.4%	1.1%	1.7%	3.3%	3.9%	4.6%
Maximum Achievable Potential	0.5%	1.5%	2.4%	4.4%	5.1%	6.0%
Economic Potential	1.1%	3.0%	4.7%	8.2%	9.3%	10.4%
Technical Potential	3.0%	8.8%	14.6%	27.3%	35.9%	42.0%

Figure 5-16 and Figure 5-17 present projections of energy savings by end use in terms of cumulative savings and as a percent of total annual savings. Interior lighting savings account for a substantial portion of savings in early years, but levels off after 2025. Newer generations of LEDs come on market later within the forecast, which help to maintain the portion of interior lighting savings. The overall share of non-lighting end uses increases over the planning period. Specifically, high efficiency tiers for heat pump water heaters become cost-effective after 2030 that substantially increase the water heating proportion of potential savings.

Figure 5-16 – Residential Realistic Achievable Savings Forecast (Annual Energy, % of Total)

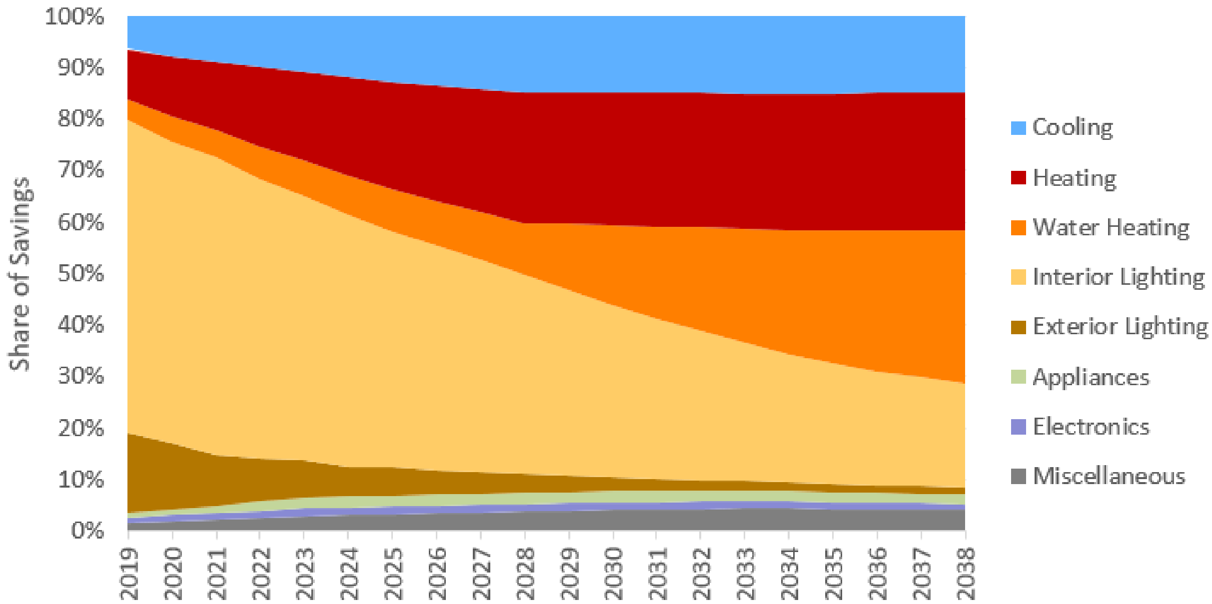


Figure 5-17 – Residential Realistic Achievable Savings Forecast (Annual Energy, GWh)

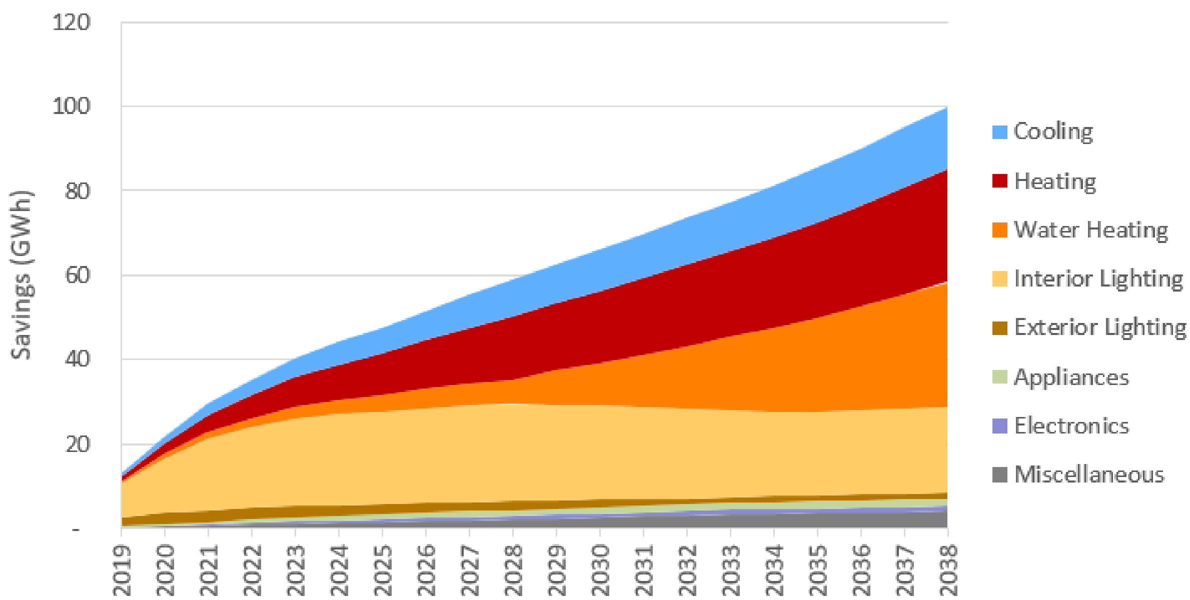


Table 5-25 and Figure 5-19 present estimates of annual energy savings for the four levels of energy efficiency potential for the nonresidential sector. In 2019, the first year of the projection, realistic achievable potential is 15 GWh, or 0.7% of the Liberty-Empire load forecast. By 2038, realistic achievable savings are 209 GWh, or 8.8% of the forecast. Table 5-26 details the summer peak demand savings for the nonresidential sector.

Table 5-25 – Non-Residential Energy Efficiency Potential (Energy Savings)

	2019	2021	2023	2028	2033	2039
Baseline Projection						
Liberty-Empire Baseline Projection (GWh)	2,073	2,087	2,120	2,189	2,263	2,371
Cumulative Savings (GWh)						
Realistic Achievable Potential	15	39	64	119	166	209
Maximum Achievable Potential	22	58	93	169	234	291
Economic Potential	35	89	141	250	335	401
Technical Potential	53	141	225	392	521	593
Energy Savings as a % of Baseline						
Realistic Achievable Potential	0.7%	1.9%	3.0%	5.4%	7.3%	8.8%
Maximum Achievable Potential	1.1%	2.8%	4.4%	7.7%	10.3%	12.3%
Economic Potential	1.7%	4.2%	6.7%	11.4%	14.8%	16.9%
Technical Potential	2.6%	6.7%	10.6%	17.9%	23.0%	25.0%

Figure 5-18 – Nonresidential Energy Efficiency Savings as a Percent of Baseline

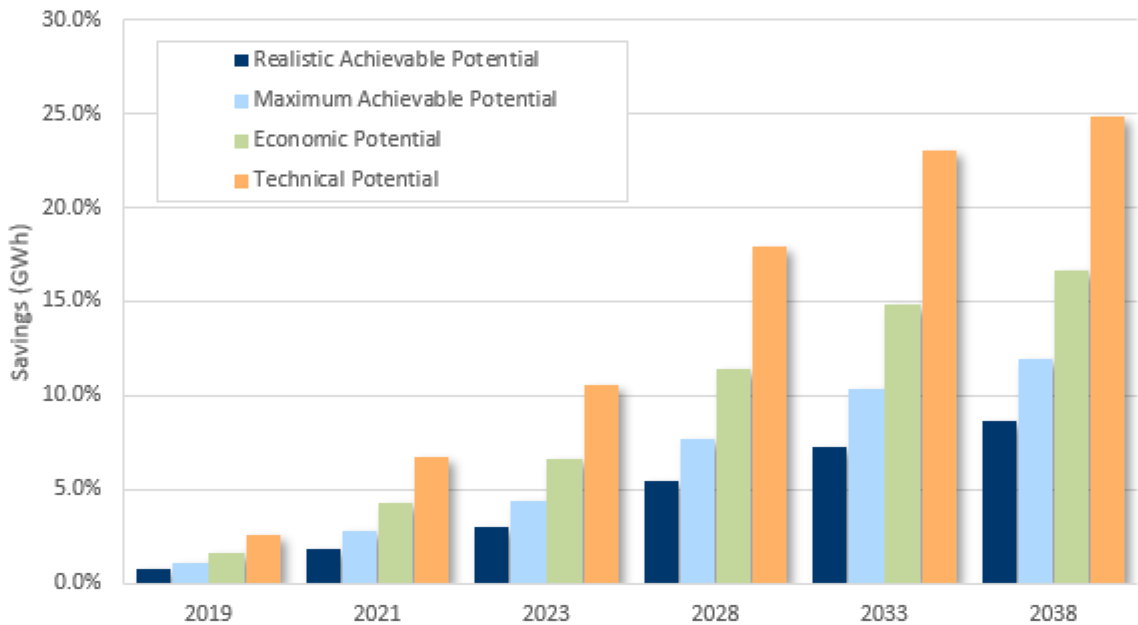


Table 5-26 – Nonresidential Energy Efficiency Potential (Summer Peak Savings)

	2019	2021	2023	2028	2033	2038
Baseline Projection						
Liberty-Empire Baseline Projection (MW)	474	476	483	492	502	520
Cumulative Savings (MW)						
Realistic Achievable Potential	3.8	11	17	33	46	57
Maximum Achievable Potential	5.6	16	25	47	64	77
Economic Potential	9.1	25	39	70	92	107
Technical Potential	14.1	39	61	106	140	157
Energy Savings as a % of Baseline						
Realistic Achievable Potential	0.8%	2.2%	3.6%	6.7%	9.1%	10.9%
Maximum Achievable Potential	1.2%	3.3%	5.2%	9.5%	12.7%	14.8%
Economic Potential	1.9%	5.2%	8.2%	14.2%	18.3%	20.5%
Technical Potential	3.0%	8.1%	12.7%	21.6%	27.8%	30.1%

Figure 5-19 and Figure 5-20 present projections of nonresidential energy savings by end use in terms of cumulative savings and as a percent of total annual savings. Interior lighting makes up the majority of annual energy savings throughout the projection, followed by cooling, motors, and exterior lighting. The HVAC measures (VSDs, Water cooled chiller, etc.) become a substantial portion of the peak demand savings by the end of the projection.

Figure 5-19 – Nonresidential Achievable Savings Forecast (Annual Energy, % of Total)

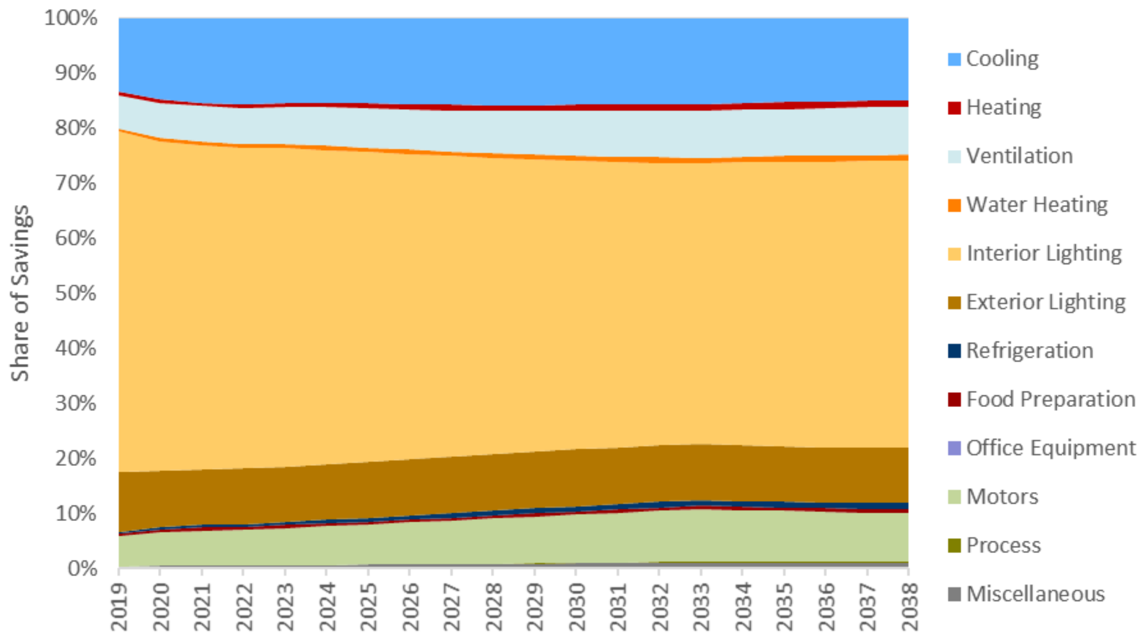


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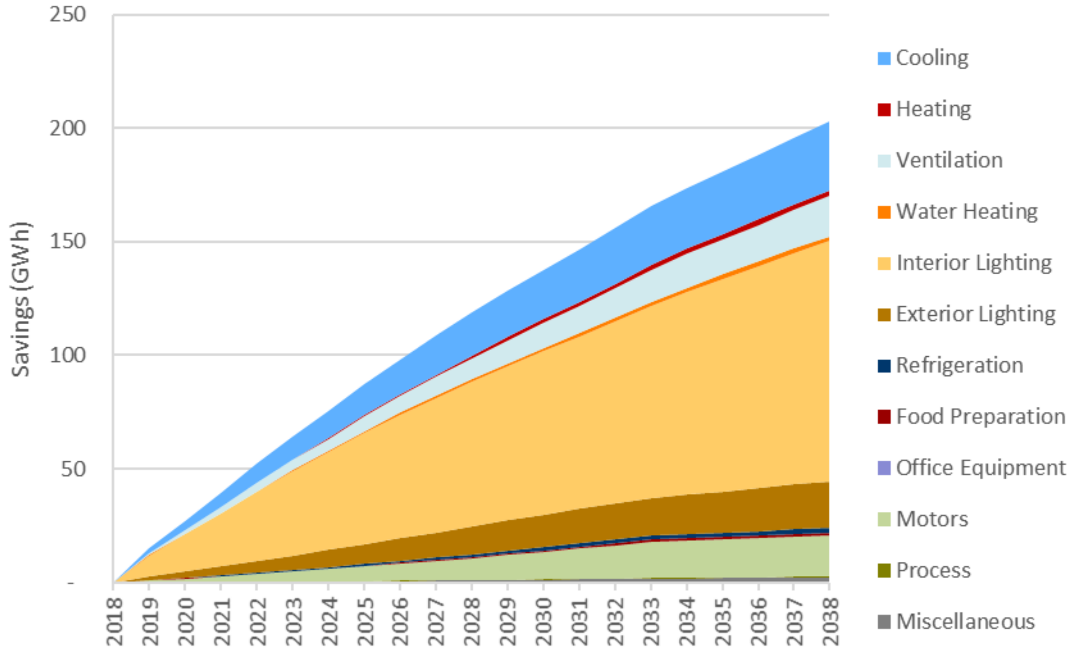
Figure 5-20 – Nonresidential Achievable Savings Forecast (Annual Energy, GWh)



3.1 Previously Implemented Demand-Side Programs from Other Utilities

(A) Review demand-side programs that have been implemented by other utilities with similar characteristics and identify programs that would be applicable for the utility;

In order to further fulfill this requirement of the IRP Rule, Liberty-Empire analyzed the demand-side portfolios of KCP&L and Ameren Missouri. These utilities were chosen due to their proximity to Liberty-Empire's service territory, although Liberty-Empire is smaller and more rural than other IOUs in Missouri.

In previous filings, Liberty-Empire also analyzed the energy efficiency portfolios of comparably-sized utilities in other states or regions. However, this did not prove to be a useful exercise. The rule cited above specifies that the purpose of the exercise is to "identify programs that would be applicable for the utility." Comparably-sized investor-owned utilities in different states and regions encounter many differences in relevant, but difficult-to-analyze variables. These variables — which could include rate structures, energy efficiency rules, recovery mechanisms, regulatory environments, customer ideologies, and utility practices — would inevitably vary significantly from state to state or region to region. Liberty-Empire has based its analysis of other Missouri investor-owned utilities on the assertion that, regardless of size, the only utility that could possess enough "similar characteristics" to serve as a useful reference point would have to be a Missouri investor-owned utility.

Liberty-Empire designed the proposed programs based upon the potential study results and potential program designs. The programs are designed to enhance Liberty-Empire's current DSM portfolio and to expand the available program offerings to allow customers greater access to energy efficiency rebates and information while considering Liberty-Empire's historical program performance and the demographics of Liberty-Empire's customers.

While many commonalities exist between Liberty-Empire's proposed programs and KCP&L or Ameren Missouri's programs, there are some programs that were deemed not cost-effective or beneficial to Liberty-Empire's service territory. For example, Residential Appliance Recycling measures were found not to be cost-effective within the potential study and therefore were excluded from the proposed programs.

Table 5-27 – Demand-Side Program Review

Program	KCP&L[14]	Ameren MO[15]	Liberty-Empire IRP
Residential			
Lighting	Instant incentives for LEDs	– Instant incentives – Online lighting and smart thermostats	X
Appliances	N/A	– Rebates for Energy Star pol pump, RAC, air purifier, heat pump water heater	X
Appliance Recycling	\$50 refrigerator or freezer RAC/dehumidifier pick-up	\$50 refrigerator or freezer RAC/dehumidifier pick-up	Not cost-effective
HVAC	Rebates for replace on failure and early retirement – CAC, HP, HP ductless mini splits. Air sealing (\$0.04 /sqft), ceiling insulation (\$0.15/sqft) + bonus combo incentives	- Rebates available for space heating/ cooling, ECM motors, space heating/ cooling tune-up -Online rebate for smart thermostat	CAC and ASHP not cost-effective. Included ECM motors and smart thermostats
Whole House	Audit & Direct Install Kit Rebates for insulation/air sealing and HVAC equipment	No longer offering	X
Low Income	– Direct Install kits – Weatherization – Multi-Family common area	Multi-family whole home – free assessment, free tenant upgrades, kits	X
New Construction	N/A	Incentives for HVAC measures	No historic participation

14 https://www.kcpl.com/save-energy-and-money
15 https://www.ameren.com/missouri/energy-efficiency

Program	KCP&L[14]	Ameren MO[15]	Liberty-Empire IRP
Home Energy Report	Program with a low-income component	N/A	X
School Kits	N/A	Participating schools receive Energy efficiency kits include LEDs, showerhead, aerators, WH pipe insulation, flow test bag etc.	Included kits as a part of the whole house programs
Non-Residential Programs			
Business Prescriptive	Varying rebates for prescriptive measures	Varying rebates for prescriptive measures	X
Business Custom	Incentive \$/kWh, capped at 75% of incremental costs, \$500,000 per year. • Interior Lighting \$0.10 /kWh • Lighting Controls \$0.27/kWh • Non-Lighting \$0.06 \$0.37 depending on end-use	Incentive \$/kWh, 50% of total project cost or 100% of incremental cost, capped at \$3,000,000. • Lighting \$0.075/kWh • Non-Lighting \$0.050-0.150 depending on end-use	X
Small Business Direct Install	No longer offering	Free assessment and up to \$2,500 incentives for lighting equipment and installation costs	No historic participation
Strategic Energy Management	No longer offering	N/A	Not cost-effective
Block Bidding	Customers purchase blocks of energy	N/A	Not beneficial to Liberty-Empire's territory
RCx	N/A	Financial assistance for studies, purchase and implementation of upgrades and re-commissioning efforts. \$0.01-\$0.03 per kWh incentive	Not cost-effective
New Construction	N/A	Whole building performance; \$/kWh incentives based on savings \$0.02 kWh – \$0.04 kWh	No historic participation
Demand Response			

Program	KCP&L[14]	Ameren MO[15]	Liberty-Empire IRP
Advanced Thermostat	*Residential & Small Business* Free communicating thermostat and $25 per year	N/A	Not cost-effective
DR Incentive	Companies volunteer if they can reduce load by a minimum of 25 kW	N/A	Not Cost-effective

3.2 Market Segment Identification

(B) Identify, describe, and document market segments that are numerous and diverse enough to provide relatively complete coverage of the major classes and decision-makers identified in subsection (1)(A) and that are specifically defined to reflect the primary market imperfections that are common to the members of the market segment;

Liberty-Empire engaged AEG to conduct a Demand-Side Management Potential Study to assess the future potential for savings through its programs and to identify refinements that will enhance savings. The first step in the analysis was to assess Liberty-Empire's market. The market assessment defines the market segments (building types, end uses, and other dimensions) that are relevant in the Liberty-Empire service territory. The segmentation scheme for this project is presented in Table 5-1.

The residential market segments were determined from the 2015 Residential Customer Energy Survey that Liberty-Empire commissioned in 2015.[16] The data gathered during the 2015 Residential Customer Energy Survey is still pertinent to the Liberty-Empire service territory. This data was used as the basis for the 2019 market potential study and was modified using the most up-to-date and accessible secondary data available. The survey identified five home types which were condensed to two segments: single family (81% detached, 4% attached, 6% mobile/manufactured homes) and multi-family (4% with 2 to 4 units, 4% with 5 or more units).

AEG reviewed the survey data and determined that there was sufficient data to identify low-income customers in single- and multi-family segments. Based on the US DOE WAP, the low-income definition for Missouri is $48,500 for a family of four and $31,860 for a family of two.

[16] A total of 2,750 residential customers within Liberty-Empire's Missouri, Arkansas, Kansas and Oklahoma service territory completed the six-page questionnaire. The survey included questions on general household characteristics, space and water heating equipment, cooling equipment, appliances, electronics, and energy efficiency actions.

Given an average of 2.6 people per home based on the survey responses, “low-income” was defined as an annual household income of less than $30,000 per year due to the ranges offered in the survey (the closest option was $30,000-$49,999). This definition of “low-income” customers was reviewed with stakeholders. Despite some concern that the percentage of customers was underestimated, given that Liberty-Empire’s median household income is approximately $38,000, coupled with the survey data and THE DOE WAP definition of low-income customers in Missouri, AEG and Liberty-Empire kept the household income threshold at $30,000.

With the segmentation scheme defined, AEG then performed a high-level market characterization of electricity sales in the base year, 2017. AEG used detailed Liberty-Empire billing and customer data with minimal augmentation from secondary sources to allocate energy use and customers to the various sectors and segments such that the total customer count and energy consumption aligned with the Liberty-Empire system totals provided by Itron, detailed in Volume 3. This information provided control totals at a sector level for calibrating the LoadMAP™ model to known data for the base year. For the purposes of this analysis, impacts from solar PV were removed from the analysis in order to model the full unadjusted market energy consumption.

The total number of households and electricity sales for the service territory were obtained from Liberty-Empire data. In 2017, there were 144,718 households in the Liberty-Empire service territory that used a total of 1,903 GWh. AEG allocated these totals into four residential segments, identified from the Residential Customer Energy Survey that Liberty-Empire commissioned in 2015 (shown in Table 5-28).

Table 5-28 – Residential Control Totals (2017)

Segment	Number of Customers	Electricity Sales (GWh)	% of Total Usage	Avg. Use/ Customer (kWh)
Single Family	100,603	1,443	76%	14,331
Multi Family	6,940	55	3%	7,870

Segment	Number of Customers	Electricity Sales (GWh)	% of Total Usage	Avg. Use/ Customer (kWh)
Low Income Single Family	31,311	366	19%	11,701
Low Income Multi Family	5,864	39	2%	6,633
Total	144,718	1,903	100%	13,147

AEG utilized commercial and industrial customer billing data and secondary sources to develop the commercial and industrial market segments, shown in Table 5-29. The nonresidential sector excludes customers that opt-out of Liberty-Empire's DSM tariff (as of December 2017) and is segmented into small and large nonresidential segments based upon a 1,000 MWh annual use threshold.[17] Opt-out customers have elected not to participate in energy efficiency programs and are thus not applicable to the analysis. For the purposes of this study, the number of opt-out customers and the amount of opt-out electricity load was assumed to be constant throughout the forecast and removed for each year. Additionally, specific municipalities that are projected to discontinue service from Liberty-Empire were removed. Impacts from solar PV installations were also removed from the baseline projection in order to model the full unadjusted market unit consumption.

Table 5-29 – Nonresidential Control Totals (2017)

Segment	Electricity Sales (GWh)	% of Total Usage	Avg. Use / Square Foot (kWh)
Small Nonresidential	1,180	60%	11.0
Large Nonresidential	774	40%	42.0
Total	1,954	100%	15.6

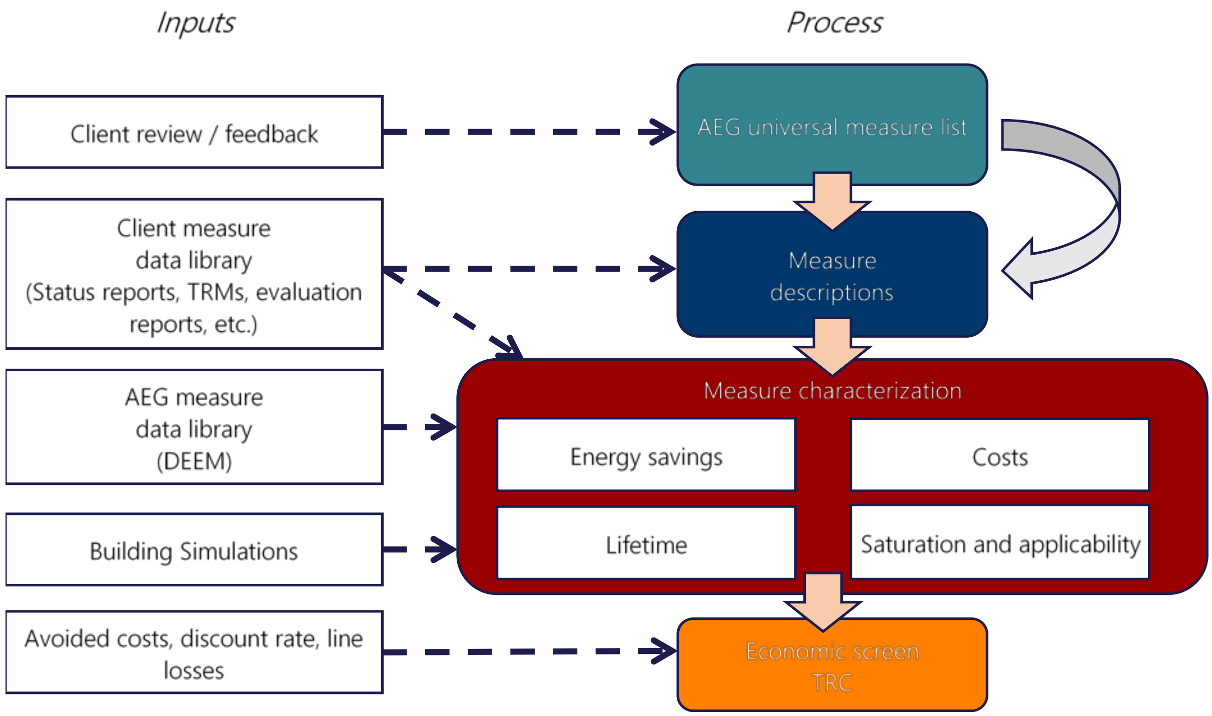
[17] Liberty-Empire's commercial and industrial market does not have significant variability that would require segmentation by business type (e.g. there are a number of small retail facilities). For this reason, the potential study examined two nonresidential segments, small and large).

3.3 Development of End Use Measures

(C) Identify a comprehensive list of end-use measures and demand-side programs considered by the utility and develop menus of end-use measures for each demand-side program. The demand-side programs shall be appropriate to the shared characteristics of each market segment. The end-use measures shall reflect technological changes in end-uses that may be reasonably anticipated to occur during the planning horizon;

AEG compiled a comprehensive list of energy efficiency and demand response measures for each customer sector, drawing upon Liberty-Empire's current programs, AEG's measure database, and measure lists developed from previous studies. The list of energy efficiency measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit or early replacement of equipment, improvements to the building envelope, the application of controls to optimize energy use, and other actions resulting in improved energy efficiency. If considered today, some of these measures would not pass the economic screens initially, but may pass in future years as a result of lower projected equipment costs or higher avoided costs. AEG developed a preliminary list of measures, which was distributed to Liberty-Empire for review.

Figure 5-21 – Approach for Energy-Efficiency Measure Assessment



Each measure was characterized with energy and demand savings, incremental cost, service life, and other performance factors, drawing upon data from well-vetted national and regional sources. Energy and demand impacts were calculated using generally accepted engineering algorithms based on a set of reasonable assumptions.

Only cost-effective measures are included in economic and achievable potential. Therefore, each individual measure is screened for cost-effectiveness. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above, along with Liberty-Empire's avoided cost data, to determine economically feasible measures. LoadMAP utilized the TRC test for measure screening (i.e. a TRC benefit-cost ratio of at least 1.0).

The TRC test is the primary method for assessing the cost-effectiveness of energy efficiency measures and programs. The TRC test is a widely-accepted methodology that has been used across the United States for over twenty-five years. TRC measures the net costs and benefits of an energy efficiency program as a resource option based on the total costs of the program, including both the participant's and the utility's costs. This test represents the combination of the effects of a program on both participating and non-participating customers.

The LoadMAP model performs this screening dynamically, taking into account changing savings and costs over time. Thus, some measures pass the economic screen for some, but not all, of the years in the projection. Table 5-30 and Table 5-31 present the measures screened in LoadMAP.

Table 5-30 – Residential Measures

End Use	Efficient Technology	Baseline
HVAC	Central AC SEER 14.0	SEER 13.0
HVAC	Central AC SEER 15.0	SEER 13.0
HVAC	Central AC SEER 16.0	SEER 13.0
HVAC	Central AC SEER 18.0	SEER 13.0
HVAC	Central AC SEER 21.0	SEER 13.0
HVAC	SEER 24.0 Ductless, Var.Ref.Flow	SEER 13.0
HVAC	Room AC EER 11.2	EER 11.0
HVAC	Room AC EER 12.1	EER 11.0
HVAC	Room AC EER 13.0	EER 11.0
HVAC	Air-Source Heat Pump SEER 15.0 / HSPF 8.5	SEER 14.0 / HSPF 8.2
HVAC	Air-Source Heat Pump SEER 16.0 / HSPF 9.0	SEER 14.0 / HSPF 8.2
HVAC	Air-Source Heat Pump SEER 18.0 / HSPF 10.0	SEER 14.0 / HSPF 8.2
HVAC	Air-Source Heat Pump SEER 18.0 / HSPF 10.0	SEER 14.0 / HSPF 8.2
HVAC	Geothermal Heat Pump EER 16.1 / COP 3.5	EER 13.4 / COP 3.1
HVAC	Geothermal Heat Pump EER 23.0 / COP 4.3	EER 13.4 / COP 3.1
HVAC	Geothermal Heat Pump EER 30.0 / COP 5.0	EER 13.4 / COP 3.1
HVAC	ECM Fan Motor	Standard
HVAC	Ductless Mini Split Heat Pump	Standard
HVAC	Advanced Thermostat	Standard

End Use	Efficient Technology	Baseline
HVAC	Central AC - Maintenance	N/A
HVAC	Central Heat Pump - Maintenance	N/A
Water Heating	NEEA Tier 1 Heat Pump (UEF 2.0)	EF 0.95, >0.55 Gal = .885
Water Heating	NEEA Tier 2 Heat Pump (UEF 2.3)	EF 0.95, >0.55 Gal = .885
Water Heating	NEEA Tier 3 Heat Pump (UEF 2.6)	EF 0.95, >0.55 Gal = .885
Water Heating	NEEA Tier 4 Heat Pump (UEF 3.0)	EF 0.95, >0.55 Gal = .885
Water Heating	Drainwater Heat Recovery	Standard
Water Heating	Faucet Aerators	Standard
Water Heating	Low-Flow Showerheads	Standard
Water Heating	Tank Blanket/Insulation	Standard
Water Heating	Pipe Insulation	Standard
Water Heating	Desuperheater	Standard
Water Heating	Temperature Setback	Standard
Water Heating	Thermostatic Shower Restriction Valve	Standard
Lighting	LED 2019/2020 (97 lm/W)	EISA Compliant
Lighting	LED 2025 (111 lm/W)	EISA Compliant
Lighting	LED 2030 (123 lm/W)	EISA Compliant
Lighting	T8 - F28HE (82.5 lm/W system)	EISA Compliant
Lighting	LED 2019/2020 (123 lm/W system)	EISA Compliant
Lighting	LED 2025 (142 lm/W system)	EISA Compliant
Lighting	LED 2030 (158 lm/W system)	EISA Compliant
Lighting	T8 - F28HE (82.5 lm/W system)	EISA Compliant
Lighting	Halogen Exempted Screw-In	Incandescent
Lighting	CFL Exempted Screw-In	Incandescent
Lighting	LED 2019/2020 (89 lm/W)	Incandescent
Lighting	LED 2025 (108 lm/W)	Incandescent
Lighting	LED 2030 (122 lm/W)	Incandescent

End Use	Efficient Technology	Baseline
Appliances	ENERGY STAR Refrigerator	Standard
Appliances	CEE 2 & 3 Refrigerator	Standard
Appliances	ENERGY STAR Freezer	Standard
Appliances	CEE Clothes Washer	Standard (2015/8)
Appliances	ENERGY STAR Clothes Washer	Standard (2015/8)
Appliances	ENERGY STAR Clothes Dryer	Standard
Appliances	UCEF 3.3 - Heat Pump	Standard
Appliances	UCEF 4.0 - Heat Pump	Standard
Appliances	UCEF 6.65 - Heat Pump	Standard
Appliances	ENERGY STAR Dishwasher	Standard
Appliances	Convection Stove	Standard
Appliances	Halogen Burner Stove	Standard
Appliances	ENERGY STAR Dehumidifier	Standard
Appliances	ENERGY STAR Air Purifier	Standard
Appliances	ENERGY STAR Ceiling Fan	Standard
Recycle	Room AC Recycling	N/A
Recycle	Refrigerator Recycling	N/A
Recycle	Freezer Recycling	N/A
Electronics	ENERGY STAR Personal Computers	Standard
Electronics	ENERGY STAR Monitor	Standard
Electronics	ENERGY STAR Laptops	Standard
Electronics	ENERGY STAR Printer/Fax/Copier	Standard
Electronics	ENERGY STAR TVs	Standard
Electronics	Smart Power Strips	Standard
Shell	Insulation - Ceiling	Standard
Shell	Insulation - Ducting	Standard
Shell	Insulation - Foundation	Standard
Shell	Insulation - Floor	Standard
Shell	Air Sealing	Standard
Shell	Insulation - Radiant Barrier	Standard
Shell	Insulation - Wall Cavity	Standard
Shell	Insulation - Wall Sheathing	Standard
Shell	Ducting - Repair and Sealing	Standard
Shell	Windows - High Efficiency	Standard
Shell	Windows - Install Reflective Film	Standard
Shell	Doors - Storm and Thermal	Standard
Shell	Cool Roofs	Standard

End Use	Efficient Technology	Baseline
Miscellaneous	ENERGY STAR Two-Speed Pool Pump	Standard
Miscellaneous	ENERGY STAR Variable Speed Pool Pump	Standard
Miscellaneous	Heat Pump Pool Heater	Standard
Other	ENERGY STAR Home Design	N/A
Other	Behavioral Programs	N/A
Other	Connected Home Energy Management System	N/A

Table 5-31 – Nonresidential Measures

End Use	Efficient Technology	Baseline
HVAC	Air-Cooled Chiller COP 3.91 (EER 13.3)	COP 3.06 (EER 10.4)
HVAC	Air-Cooled Chiller COP 4.40 (EER 15.0)	COP 3.06 (EER 10.4)
HVAC	Air-Cooled Chiller COP 4.45 (EER 15.2)	COP 3.06 (EER 10.4)
HVAC	Water-Cooled Chiller COP 7.82 (0.45 kW/TR)	COP 6.39 (0.56 kW/TR)
HVAC	Water-Cooled Chiller COP 9.02 (0.38 kW/TR)	COP 6.39 (0.56 kW/TR)
HVAC	Water-Cooled Chiller COP 9.77 (0.36 kW/TR)	COP 6.39 (0.56 kW/TR)
HVAC	Water-Cooled Chiller COP 11.72 (0.30 kW/ton)	COP 6.39 (0.56 kW/TR)
HVAC	Water-Cooled Chiller COP 12.13 (0.29 kW/ton)	COP 6.39 (0.56 kW/TR)
HVAC	Water-Cooled Chiller COP 13.03 (0.27 kW/ton)	COP 6.39 (0.56 kW/TR)
HVAC	RTU EER 11.5	EER 11.2
HVAC	RTU EER 12	EER 11.2
HVAC	RTU EER 12.4	EER 11.2
HVAC	RTU EER 13.9	EER 11.2
HVAC	Room AC EER 11.2	EER 11.0
HVAC	Room AC EER 11.5	EER 11.0
HVAC	Room AC EER 13.0	EER 11.0
HVAC	Air-Source Heat Pump EER 12 (COP 3.4)	EER 11.0 (COP 3.3)
HVAC	Air-Source Heat Pump EER 12.7 / COP 3.40, VRF	EER 11.0 (COP 3.3)
HVAC	Ductless Multi-Split VRF	EER 11.0 (COP 3.3)
HVAC	Geothermal Heat Pump EER 15.5 (COP 3.98)	EER 13.8 (COP 3.4)
HVAC	Geothermal Heat Pump EER 25.5 (COP 4.40)	EER 13.8 (COP 3.4)

End Use	Efficient Technology	Baseline
HVAC	Geothermal Heat Pump EER 35.5 (COP 4.76)	EER 13.8 (COP 3.4)
HVAC	Chiller - VSD on Fans	Standard
HVAC	Chiller - Chilled Water Reset	Standard
HVAC	Chiller - Chilled Water Variable-Flow System	Standard
HVAC	Chiller - Heat Recovery	Standard
HVAC	HVAC - Economizer	Standard
HVAC	Cool Roofs	Standard
HVAC	Space Heating - Heat Recovery Ventilator	Standard
HVAC	Advanced Thermostats	Standard
HVAC	Lodging - Guest Room Controls	Standard
HVAC	Destratification Fans (HVLS)	Standard
HVAC	RTU - Maintenance	N/A
HVAC	RTU - Advanced Controls	Standard
Ventilation	Ventilation Variable Air Volume	Constant Volume
Ventilation	Ventilation - ECM on VAV Boxes	Standard
Ventilation	Ventilation - Variable Speed Control	Standard
Ventilation	Ventilation - Demand Controlled	Standard
Ventilation	Ventilation - Fan Drive Improvements	Standard
Ventilation	Ventilation - Synchronous Belts	Standard
Ventilation	Cooking - Exhaust Hoods with Sensor Control	Standard
Water Heating	Heat Pump Water Heater	EF 0.97
Water Heating	Tankless Water Heater	EF 0.97
Water Heating	Drainwater Heat Recovery	Standard
Water Heating	Faucet Aerators/Low Flow Nozzles	Standard
Water Heating	Pipe Insulation	Standard
Lighting	LED Screw-in	EISA Compliant
Lighting	High-Bay HPS Fixtures	Metal Halide
Lighting	High-Bay T8 Fixtures	Metal Halide
Lighting	High-Bay T5 Fixtures	Metal Halide
Lighting	High-Bay LED Fixtures	Metal Halide
Lighting	HPS Lighting	Metal Halide Lighting
Lighting	LED Linear Lighting	T8 Linear Lighting
Lighting	Advanced Connected Lighting	Standard
Lighting	Lighting Controls	Standard
Refrigeration	Walk-in Refrigerator/Freezer	Standard
Refrigeration	Reach-in Refrigerator/Freezer	Standard
Refrigeration	ENERGY STAR Icemaker	Standard

End Use	Efficient Technology	Baseline
Refrigeration	ENERGY STAR Vending Machine	Standard
Refrigeration	Anti-Sweat Heater	Standard
Refrigeration	Door Gasket Replacement	Standard
Refrigeration	Evaporator Fan Controls	Standard
Refrigeration	Floating Head Pressure	Standard
Refrigeration	Strip Curtain	Standard
Refrigeration	High Efficiency Compressor	Standard
Refrigeration	Variable Speed Compressor	Standard
Refrigeration	Adaptive Controls	Standard
Refrigeration	Automatic Door Closer	Standard
Refrigeration	Permanent Magnet Fan Motor	Standard
Refrigeration	Low-Heat/No-Heat Doors	Standard
Refrigeration	Demand Defrost	Standard
Refrigeration	Grocery - Display Case - LED Lighting	Standard
Refrigeration	Grocery - Display Case Motion Sensors	Standard
Food Preparation	ENERGY STAR Oven	Standard
Food Preparation	ENERGY STAR Fryer	Standard
Food Preparation	ENERGY STAR Dishwasher	Standard
Food Preparation	ENERGY STAR Steamer	Standard
Food Preparation	ENERGY STAR Hot Food Container	Standard
Office Equipment	ENERGY STAR Desktop Computer	Standard
Office Equipment	ENERGY STAR Laptop	Standard
Office Equipment	ENERGY STAR Server	Standard
Office Equipment	ENERGY STAR Monitor	Standard
Office Equipment	ENERGY STAR Printer/Copier/Fax	Standard
Office Equipment	ENERGY STAR POS Terminal	Standard
Office Equipment	Office Equipment - Smart Power Strips	Standard

End Use	Efficient Technology	Baseline
Office Equipment	Data Center - Air Flow Optimization and Commissioning	Standard
Office Equipment	Data Center - Server Virtualization	Standard
Shell	Insulation - Ceiling	Standard
Shell	Insulation - Ducting	Standard
Shell	Insulation - Foundation	Standard
Shell	Insulation - Radiant Barrier	Standard
Shell	Insulation - Wall Cavity	Standard
Shell	HVAC - Duct Repair and Sealing	Standard
Shell	Windows - High Efficiency	Standard
Shell	Cool Roofs	Standard
Motors	Compressed Air (various measures)	Standard
Motors	Pumping System	Standard
Motors	Fan System	Standard
Motors	Motors - Variable Frequency Drive	Standard
Motors	Motors - Efficient Rewind	Standard
Miscellaneous	Two-Speed Pool Pump	Standard
Miscellaneous	Variable Speed Pool Pump	Standard
Miscellaneous	Heat Pump Pool Heater	Standard
Motors	Compressed Air	Standard
Other	Strategic Energy Management	N/A
Other	Commissioning	N/A
Other	Retrocommissioning	N/A
Other	Advanced New Construction Designs	N/A

3.4 Advanced, Metering, and Distribution Assessment

(D) Assess how advancements in metering and distribution technologies that may be reasonably anticipated to occur during the planning horizon affect the ability to implement or deliver potential demand-side programs;

Advancements in metering and distribution technologies, such as two-way communicating meters and programmable thermostats, allow utilities to communicate in real-time with the customer and provide customers with a better understanding of their energy consumption.

These advanced technologies, and those that can reasonably be anticipated to surface during the planning period, are costly, and if utilized, could impact customer rates and the cost-effectiveness of the demand-side program. These technologies are not currently prevalent throughout Liberty-Empire's territory but could improve demand-side programs, particularly customer behavior programs. The demand response programs were modeled to start in 2022 to give Liberty-Empire time to roll out the AMI meters to participating customers.

3.5 End-Use Measures Marketing Plan

(E) Design a marketing plan and delivery process to present the menu of end-use measures to the members of each market segment and to persuade decision-makers to implement as many of these measures as may be appropriate to their situation. When appropriate, consider multiple approaches such as rebates, financing, and direct installations for the same menu of end-use measures;

The marketing plan and delivery process will be designed to inform each market segment of the DSM programs. The plans will include a combination of strategies and approaches to reach all market segments and decision makers (as described in 1.1(A)).

Preliminary program-specific marketing (included in the program descriptions in 1.2(B)). The program-specific marketing tactics will be discussed and finalized during implementation. The marketing plan will include, but not be limited to:

- The Smart Energy Solutions portal of Liberty-Empire's website
- Direct customer outreach (via Liberty-Empire and/or an implementation contractor)
- Bill inserts, on-bill messaging and email blasts
- Newspaper, radio and billboard advertisements
- Community newsletters and events
- Trade publication advertisements

- Partnerships with local businesses/contractors developed through education and training seminars as well as presentations/presence at Chamber of Commerce meetings, trade association events and business organization events.

The Missouri Weatherization Agencies have primary responsibility for promoting Low-Income Weatherization Program. Liberty-Empire will supplement statewide marketing efforts, promoting the program through community events and organizations, including churches and nonprofit organizations within the service territory.

3.6 State-Wide Marketing and Outreach Program Evaluation

(F) Evaluate, describe, and document the feasibility, cost-reduction potential and potential benefits of statewide marketing and outreach programs, joint programs with natural gas utilities, upstream market transformation programs, and other activities. In the event that statewide marketing and outreach programs are preferred, the utilities shall develop joint programs in consultation with the stakeholder group;

Liberty-Empire will cooperatively market programs jointly run with outside organizations, such as non-profit organizations and other Missouri electric and natural gas utilities. Liberty-Empire is currently cooperatively marketing the Low-Income Weatherization, Low-Income New Homes, Building Operating Certificate and whole-home programs with partnering organizations. Liberty-Empire will assess the benefits and economies to be had from cooperating with neighboring municipalities, rural electric cooperatives and investor owned utilities.

3.7 Cost-Effectiveness

(G) Estimate the characteristics needed for the twenty (20)-year planning horizon to assess the cost effectiveness of each potential demand-side program, including:

1. An assessment of the demand and energy reduction impacts of each stand-alone end-use *measure contained in each potential demand-side program;*

Measures that were found to be cost-effective at some point during the 20-year period analyzed for the DSM Potential Study were vetted for inclusion in the DSM program design. The measures shown in the following two tables are included in the proposed DSM programs.

Table 5-32 – Residential Measures, Potential DSM Program Design

Measure Name	Measure Life (Years)	Gross kWh Savings @ Meter	Gross Coincident kW Savings @ Meter	Per Unit Incremental Measure Cost ($)
LED	19	22.1	0.04	$3.26
LED 2020	19	6.6	0.01	$3.26
LED 2025 +	19	8.6	0.01	$2.40
Specialty LED	19	16.3	0.03	$8.21
ENERGY STAR Dehumidifier	12	141.9	0.09	$50
ENERGY STAR Air Purifier	9	293.0	0.03	$70
Air Sealing	15	237.5	0.08	$224
Attic Insulation R-38	25	1,175.0	0.26	$515
Wall Insulation R-11	25	1,800.3	0.45	$1,219
Foundation Insulation R-13	25	1,116.9	0.23	$62
Floor Insulation R-30	25	1,654.1	0.32	$515
Duct Installation & Sealing	20	2,017.6	0.13	$449
Faucet Aerator	10	69.4	0.01	$11
Low Flow Showerhead	10	77.9	0.01	$15
Hot Water Pipe Insulation	12	35.4	0.00	$18
Water Heater Wrap	12	103.4	0.01	$29
CAC SEER 15, EER 12.5	18	265.5	0.37	$714
CAC SEER 16, EER 13	18	373.3	0.48	$1,071
CAC SEER 17, EER 13	18	468.5	0.48	$1,428
ASHP SEER 15, HSPF 8.5	18	426.5	0.17	$510
ASHP SEER 16, HSPF 9	18	994.8	0.28	$1,020
ASHP SEER 18, HSPF 10	18	1,957.4	0.28	$1,587
Advanced Thermostat	10	780.7	0.74	$175
Furnace Blower Motor	20	651.0	0.14	$97

Measure Name	Measure Life (Years)	Gross kWh Savings @ Meter	Gross Coincident kW Savings @ Meter	Per Unit Incremental Measure Cost ($)
Heat Pump Water Heater ≤55 gallons	13	1,867.2	0.17	$757
Heat Pump Water Heater >55 gallons	13	477.6	0.04	$818
Behavioral Reports	2	120.0	0.02	$0
Low Income Weatherization	15	2,835.0	1.01	$0
Water Heater - Desuperheater	10	1,540.0	0.18	$239
Water Heater - Temperature Set Back	2	81.6	0.01	$5
Connected Home Management System	5	456.0	0.01	$354
Time of Use Rate	1	96	0.18	$0
Critical Peak Pricing	1	57	0.95	$0
Inclining Block Rate	1	92	0.06	$0

Table 5-33 – Nonresidential Measures, Potential DSM Program Design

Measure Name	Measure Life (Years)	Gross kWh Savings @ Meter	Gross Coincident kW Savings @ Meter	Per Unit Incremental Measure Cost ($)
Air Cooled Chiller	20	6,520.1	9.46	$6,350
Water Cooled Chiller	20	11,082.5	16.07	$6,350
Room Air Conditioner (12 EER)	9	32.5	0.03	$50
CAC <65 kBtu (SEER 14)	15	620.4	0.90	$417
CAC 65<135 kBtu (EER 11.7)	15	1,298.1	1.88	$1,000
CAC 135<240 kBtu (EER 11.7)	15	3,084.9	4.47	$2,000
CAC 240<760 kBtu (EER 10.5)	15	2,468.8	3.58	$2,500
CAC ≥760 kBtu (EER 9.9)	15	4,013.2	5.82	$6,500
Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	15	519.6	0.59	$417
Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	15	1,476.4	1.69	$1,000
Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	15	1,997.3	2.29	$2,000

Measure Name	Measure Life (Years)	Gross kWh Savings @ Meter	Gross Coincident kW Savings @ Meter	Per Unit Incremental Measure Cost ($)
Heat Pump ≥240 kBtu (EER 10.3, COP 3.2)	15	4,684.6	5.36	$2,500
Packaged Terminal Air Conditioner	15	343.9	0.50	$84
Packaged Terminal Heat Pump	15	420.3	0.61	$84
Variable Speed Drive - Chilled Water Pump	15	3,903.8	1.04	$1,330
Variable Speed Drive - Hot Water Pump	15	6,888.5	-	$1,330
Demand Controlled Ventilation	10	6,735.0	-	$1,500
ENERGY STAR Steamer	12	3,052.7	0.61	$630
ENERGY STAR Dishwasher	10	3,171.6	0.22	$770
ENERGY STAR Hot Food Holding Cabinets	12	1,731.3	0.35	$0
ENERGY STAR Electric Convention Oven	12	4,296.6	0.86	$0
ENERGY STAR Electric Fryer	12	951.7	1.90	$210
Evaporator Fan Control	15	408.0	0.05	$177
Strip Curtain for Walk-In Cooler/Freezer	4	3,780.0	0.51	$358
Night Covers for Open Refrigerated Display Cases	5	2,470.0	-	$420
Door Heater Controls	12	717.9	0.10	$1,266
Refrigeration Economizer	15	5,150.0	4.21	$2,558
Kitchen Demand Ventilation Controls	15	4,966.0	0.68	$994
Directional LED Bulb (<15W)	10	118.7	0.02	$8
Directional LED Bulb (≥15W)	10	227.6	0.04	$8
High Bay Fluorescent Fixture (HP T8 >4 lamps)	15	858.4	0.16	$75
High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	15	539.9	0.10	$75
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 >4 lamps)	15	376.2	0.07	$100
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 ≤4 lamps)	15	186.3	0.03	$100
LED Exit Sign	16	43.8	0.00	$42
LED Flood Light (<15W)	10	210.8	0.04	$35
LED Flood Light (≥15W)	10	236.3	0.04	$45
LED Recessed Fixture (1x4)	14	87.7	0.02	$76

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Measure Name	Measure Life (Years)	Gross kWh Savings @ Meter	Gross Coincident kW Savings @ Meter	Per Unit Incremental Measure Cost ($)
LED Recessed Fixture (2x2)	14	83.6	0.02	$48
LED Recessed Fixture (2x4)	14	125.6	0.02	$56
Lighting Optimization - Remove 4ft Lamp from T8 System	11	70.9	0.01	$12
Lighting Optimization - Remove 8ft Lamp from T8 System	11	141.0	0.03	$16
Omnidirectional LED Bulb (<10W)	8	81.5	0.02	$3
Omnidirectional LED Bulb (≥10W)	8	146.8	0.03	$3
LED Parking Garage/Canopy (<30W)	10	389.8	0.07	$80
LED Parking Garage/Canopy (30-75W)	10	640.8	0.12	$250
LED Parking Garage/Canopy (≥75W)	10	863.4	0.16	$375
LED Wall Mounted Area Lights (<30W)	10	518.2	0.10	$80
LED Wall Mounted Area Lights (30-75W)	10	762.4	0.14	$250
LED Wall Mounted Area Lights (≥75W)	10	873.7	0.16	$375
LED Refrigerator Case Light	10	157.1	0.03	$133
Photocell Occupancy Sensor	8	288.2	0.05	$50
Wall-Mount Occupancy Sensor	8	257.4	0.05	$54
VFD Fans and Blowers	10	9,452.7	1.30	$1,439
Zero-Loss Condensate Drain	13	1,546.4	0.21	$700
Compressed Air Nozzle	15	747.4	0.10	$57
VSD Ventilation	10	5,830.6	0.80	$520
C&I Custom Rebate	15	7,500	1.50	$2,500
Small C&I Retrocommissioning	5	2,878	3.07	$705
Large C&I Retrocommissioning	5	51,209	6.34	$5,872
Time of Use Rate (Non Res)	1	1,242	2.35	$0
Critical Peak Pricing (Non Res)	1	130	2.16	$0
Real Time Pricing	1	19,926	37.74	$0

2. An assessment of how the interactions between end-use measures, when bundled with other end-use measures in the potential demand-side program, would affect the stand-alone end-use measure impact estimates;

Measures that were cost-effective within LoadMAP were included in the economic and achievable potential study. The DSM Potential Study measure-level MAP and RAP results were vetted for inclusion in a DSM program and measures were bundled into programs and re-screened for cost-effectiveness. Measures were added to bundles as they became cost-effective throughout the timeframe. Additionally, AEG looked at the technical potential for measures that did not pass cost-effectiveness but would be beneficial to Liberty-Empire and could be bundled with other measures to achieve a cost-effective program.

With the exception of the low-income weatherization and low-income new homes programs, all programs were designed to be cost-effective. Measures were bundled based on the end-use, sector and implementation strategy into programs. Incentive costs and program costs were assigned to programs. Finally, the programs were bundled into three levels of first year $/kWh (low, medium, and high), and DR/DSR bundle.

3. An estimate of the incremental and cumulative number of program participants and end-use measure installations due to the potential demand-side program;

An estimate of the RAP Program Design incremental and cumulative end-use measure installations and participants is shown in the tables below.

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Table 5-34 – Incremental Residential End-Use Measure Installations

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Residential Lighting	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Lighting	LED 2020	24,000	43,000	45,000	34,000	26,000	15,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Lighting	LED 2025 +	-	-	-	-	-	-	13,000	10,300	10,000	9,400	9,400	9,400	9,400	9,400	9,400	9,400	9,400	9,400	9,400	9,400
Residential Lighting	Specialty LED	700	2,500	2,200	1,800	1,500	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,000	1,000	1,300	1,300	1,200	1,000	900	900
Whole House Efficiency	Audit	200	400	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Whole House Efficiency	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whole House Efficiency	LED 2020	800	1,600	2,000	2,000	2,000	2,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whole House Efficiency	LED 2025 +	-	-	-	-	-	-	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Whole House Efficiency	Faucet Aerator	150	300	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380
Whole House Efficiency	Low Flow Showerhead	110	230	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
Whole House Efficiency	Water Heater Wrap	110	230	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
Whole House Efficiency	Attic Insulation R-38	80	160	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Whole House Efficiency	Wall Insulation R-11	20	30	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Whole House Efficiency	Foundation Insulation R-13	20	50	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Whole House Efficiency	Floor Insulation R-30	20	50	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Whole House Efficiency	Duct Installation & Sealing	30	60	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Whole House Efficiency	Advanced Thermostat	150	300	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375
Whole House Efficiency	Furnace Blower Motor	20	21	22	23	24	30	31	32	33	34	35	36	37	38	39	40	40	40	40	40
Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	-	-	-	-	-	-	-	-	-	-	200	210	210	210	220	220	220	220	220	220
Whole House Efficiency	ENERGY STAR Dehumidifier	10	20	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Whole House Efficiency	ENERGY STAR Air Purifier	20	40	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Whole House Efficiency	Water Heater - Temperature Set Bacl	110	230	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
Residential Behavioral	Behavioral Reports	15,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Low Income Whole House Efficiency	Audit	15	30	40	40	40	40	40	40	60	60	60	60	60	60	60	60	60	60	60	60
Low Income Whole House Efficiency	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income Whole House Efficiency	LED 2020	60	120	160	160	160	160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income Whole House Efficiency	LED 2025 +	-	-	-	-	-	-	160	160	240	240	240	240	240	240	240	240	240	240	240	240
Low Income Whole House Efficiency	Faucet Aerator	9	19	25	25	25	25	25	25	38	38	38	38	38	38	38	38	38	38	38	38
Low Income Whole House Efficiency	Low Flow Showerhead	7	14	19	19	19	19	19	19	28	28	28	28	28	28	28	28	28	28	28	28
Low Income Whole House Efficiency	Water Heater Wrap	7	14	19	19	19	19	19	19	28	28	28	28	28	28	28	28	28	28	28	28
Low Income Whole House Efficiency	Attic Insulation R-38	6	12	16	16	16	16	16	16	24	24	24	24	24	24	24	24	24	24	24	24
Low Income Whole House Efficiency	Wall Insulation R-11	1	2	3	3	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5
Low Income Whole House Efficiency	Foundation Insulation R-13	2	4	5	5	5	5	5	5	7	7	7	7	7	7	7	7	7	7	7	7
Low Income Whole House Efficiency	Floor Insulation R-30	2	4	5	5	5	5	5	5	7	7	7	7	7	7	7	7	7	7	7	7
Low Income Whole House Efficiency	Duct Installation & Sealing	5	11	14	14	14	14	14	14	21	21	21	21	21	21	21	21	21	21	21	21
Low Income Whole House Efficiency	Advanced Thermostat	11	23	30	30	30	30	30	30	45	45	45	45	45	45	45	45	45	45	45	45
Low Income Whole House Efficiency	Furnace Blower Motor	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	11	12	12	12	12
Low Income Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	-	-	-	-	-	-	-	-	-	-	30	30	30	30	30	30	30	30	30	30
Low Income Whole House Efficiency	ENERGY STAR Dehumidifier	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Low Income Whole House Efficiency	ENERGY STAR Air Purifier	2	3	4	4	4	4	4	4	6	6	6	6	6	6	6	6	6	6	6	6
Low Income Whole House Efficiency	Water Heater - Temperature Set Bacl	10	10	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30
Low Income Behavioral	Behavioral Reports	6,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Low Income Weatherization	Low Income Weatherization	150	300	300	300	300	300	300	300	350	350	350	350	350	350	350	350	350	350	350	350
Time of Use Rate	Time of Use Rate	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,191
Critical Peak Pricing	Critical Peak Pricing	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,094
Inclining Block Rates	Inclining Block Rate	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000

Table 5-35 – Incremental Non-Residential End-Use Measure Installations

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
C&I Program	Air Cooled Chiller	23	28	28	30	30	32	32	32	32	32	34	34	34	34	34	36	36	36	36	36
C&I Program	Water Cooled Chiller	30	36	34	38	38	40	40	40	38	40	40	40	42	42	44	42	42	44	44	44
C&I Program	CAC <65 kBtu (SEER 14)	137	170	170	191	191	191	191	191	191	191	191	191	191	191	191	191	191	191	191	191
C&I Program	CAC 65<135 kBtu (EER 11.7)	82	102	102	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
C&I Program	CAC 135<240 kBtu (EER 11.7)	55	68	68	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
C&I Program	Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	6	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7
C&I Program	Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
C&I Program	Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
C&I Program	Packaged Terminal Air Conditioner	20	24	24	26	26	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34
C&I Program	Variable Speed Drive - Chilled Water Pump	54	74	76	82	86	86	90	92	98	100	20	20	20	20	20	22	22	22	22	22
C&I Program	Variable Speed Drive - Hot Water Pump	3	4	4	4	5	5	5	5	5	5	5	6	6	6	6	2	2	2	2	2
C&I Program	ENERGY STAR Dishwasher	22	42	40	46	44	44	46	44	44	46	48	46	46	46	48	48	48	50	50	50
C&I Program	ENERGY STAR Hot Food Holding Cabinets	10	18	20	20	20	20	22	22	22	22	22	22	22	22	20	20	24	24	24	24
C&I Program	ENERGY STAR Electric Convention Oven	20	40	38	40	40	40	42	40	40	42	42	40	40	48	48	48	54	50	50	50
C&I Program	ENERGY STAR Electric Fryer	7	14	14	14	14	14	14	14	14	14	14	14	14	16	16	16	18	16	16	16
C&I Program	Evaporator Fan Control	8	15	15	15	15	15	15	15	15	15	18	18	18	18	18	3	3	3	3	3
C&I Program	Refrigeration Economizer	3	6	6	6	6	6	6	6	6	6	6	4	4	4	4	2	2	2	2	2
C&I Program	Directional LED Bulb (<15W)	49	148	148	170	170	172	172	170	170	174	174	176	176	174	176	182	184	188	210	210
C&I Program	Directional LED Bulb (≥15W)	33	59	59	68	68	69	69	68	68	70	70	70	70	70	70	73	74	75	84	84
C&I Program	High Bay Fluorescent Fixture (HP T8 >4 lamps)	90	842	846	948	958	962	968	956	958	972	1,048	1,058	1,052	1,054	1,070	1,090	1,102	1,110	1,362	1,362
C&I Program	High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	135	253	254	284	287	289	290	287	287	292	314	317	316	316	321	327	331	333	409	409
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Balla	45	84	85	95	96	96	97	96	96	97	105	106	105	105	107	109	110	111	136	136
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Balla	180	337	338	379	383	385	387	382	383	389	419	423	421	422	428	436	441	444	545	545
C&I Program	LED Direct Linear Ambient fixtures <=35W	90	169	169	190	192	193	194	178	165	156	147	138	159	177	192	233	240	281	276	276
C&I Program	LED Direct Linear Ambient fixtures 36W-60W	158	296	296	333	337	338	339	312	289	272	258	242	279	310	337	407	420	491	483	483
C&I Program	LED Direct Linear Ambient fixtures 61W-100W	90	169	169	190	192	193	194	178	165	156	147	138	159	177	192	233	240	281	276	276
C&I Program	LED linear replacement lamps (Type A or AB) 2 foo	68	127	127	143	144	145	145	134	124	117	110	104	119	133	144	175	180	211	207	207
C&I Program	LED linear replacement lamps (Type A or AB) 4 foo	45	85	85	95	96	97	97	89	83	78	74	69	80	89	96	116	120	140	138	138
C&I Program	LED Flood Light (<15W)	13	38	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
C&I Program	LED Flood Light (≥15W)	15	40	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
C&I Program	Lighting Optimization - Remove 4ft Lamp from T8 S	36	74	76	80	82	91	91	91	91	91	91	91	91	91	91	92	92	92	92	92
C&I Program	Lighting Optimization - Remove 8ft Lamp from T8 S	36	74	76	80	82	91	91	91	91	91	91	91	91	91	91	92	92	92	92	92
C&I Program	Omnidirectional LED Bulb (<10W)	811	1,396	1,264	1,069	716	554	358	416	470	517	544	550	759	688	650	627	586	567	554	554
C&I Program	Omnidirectional LED Bulb (≥10W)	811	1,396	1,264	1,069	716	554	358	416	470	517	544	550	759	688	650	627	586	567	554	554
C&I Program	LED Parking Garage/Canopy (<30W)	90	842	846	948	958	962	968	956	958	972	1,048	1,058	1,052	1,054	1,070	1,090	1,102	1,110	1,362	1,362
C&I Program	LED Parking Garage/Canopy (30-75W)	135	253	254	284	287	289	290	287	287	292	314	317	316	316	321	327	331	333	409	409
C&I Program	LED Parking Garage/Canopy (≥75W)	225	421	423	474	479	481	484	478	479	486	524	529	526	527	535	545	551	555	681	681
C&I Program	LED Wall Mounted Area Lights (<30W)	7	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
C&I Program	Wall-Mount Occupancy Sensor	76	193	230	291	341	123	121	119	118	120	123	124	123	122	124	127	128	129	130	130
C&I Program	VFD Fans and Blowers	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	2	2	2	2	2
C&I Program	Compressed Air Nozzle	7	13	13	14	14	15	14	15	16	16	17	17	18	18	19	5	5	5	5	5
C&I Program	C&I Custom Rebate	5	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Time of Use Rat	Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pri	Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricin	Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

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Table 5-36 – Cumulative Residential End-Use Measure Installations

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Residential Lighting	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residential Lighting	LED 2020	24,000	67,000	112,000	146,000	172,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000	187,000
Residential Lighting	LED 2025 +	-	-	-	-	-	-	13,000	23,300	33,300	42,700	52,100	61,500	70,900	80,300	89,700	99,100	108,500	117,900	127,300	136,700
Residential Lighting	Specialty LED	700	3,200	5,400	7,200	8,700	9,800	10,900	12,000	13,100	14,200	15,300	16,400	17,400	18,400	19,700	21,000	22,200	23,200	24,100	25,000
Whole House Efficiency	Audit	200	600	1,100	1,600	2,100	2,600	3,100	3,600	4,100	4,600	5,100	5,600	6,100	6,600	7,100	7,600	8,100	8,600	9,100	9,600
Whole House Efficiency	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whole House Efficiency	LED 2020	800	2,400	4,400	6,400	8,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400	10,400
Whole House Efficiency	LED 2025 +	-	-	-	-	-	-	2,000	4,000	6,000	8,000	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000	26,000	28,000
Whole House Efficiency	Faucet Aerator	150	450	830	1,210	1,590	1,970	2,350	2,730	3,110	3,490	3,870	4,250	4,630	5,010	5,390	5,770	6,150	6,530	6,910	7,290
Whole House Efficiency	Low Flow Showerhead	110	340	620	900	1,180	1,460	1,740	2,020	2,300	2,580	2,860	3,140	3,420	3,700	3,980	4,260	4,540	4,820	5,100	5,380
Whole House Efficiency	Water Heater Wrap	110	340	620	900	1,180	1,460	1,740	2,020	2,300	2,580	2,860	3,140	3,420	3,700	3,980	4,260	4,540	4,820	5,100	5,380
Whole House Efficiency	Attic Insulation R-38	80	240	440	640	840	1,040	1,240	1,440	1,640	1,840	2,040	2,240	2,440	2,640	2,840	3,040	3,240	3,440	3,640	3,840
Whole House Efficiency	Wall Insulation R-11	20	50	90	130	170	210	250	290	330	370	410	450	490	530	570	610	650	690	730	770
Whole House Efficiency	Foundation Insulation R-13	20	70	130	190	250	310	370	430	490	550	610	670	730	790	850	910	970	1,030	1,090	1,150
Whole House Efficiency	Floor Insulation R-30	20	70	130	190	250	310	370	430	490	550	610	670	730	790	850	910	970	1,030	1,090	1,150
Whole House Efficiency	Duct Installation & Sealing	30	90	170	250	330	410	490	570	650	730	810	890	970	1,050	1,130	1,210	1,290	1,370	1,450	1,530
Whole House Efficiency	Advanced Thermostat	150	450	825	1,200	1,575	1,950	2,325	2,700	3,075	3,450	3,825	4,200	4,575	4,950	5,325	5,700	6,075	6,450	6,825	7,200
Whole House Efficiency	Furnace Blower Motor	20	41	63	86	110	140	171	203	236	270	305	341	378	416	455	495	535	575	615	655
Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	-	-	-	-	-	-	-	-	-	-	200	410	620	830	1,050	1,270	1,490	1,710	1,930	2,150
Whole House Efficiency	ENERGY STAR Dehumidifier	10	30	55	80	105	130	155	180	205	230	255	280	305	330	355	380	405	430	455	480
Whole House Efficiency	ENERGY STAR Air Purifier	20	60	110	160	210	260	310	360	410	460	510	560	610	660	710	760	810	860	910	960
Whole House Efficiency	Water Heater - Temperature Set Bacl	110	340	620	900	1,180	1,460	1,740	2,020	2,300	2,580	2,860	3,140	3,420	3,700	3,980	4,260	4,540	4,820	5,100	5,380
Residential Behavioral	Behavioral Reports	15,000	45,000	75,000	105,000	135,000	165,000	195,000	225,000	255,000	285,000	315,000	345,000	375,000	405,000	435,000	465,000	495,000	525,000	555,000	585,000
Low Income Whole House Efficiency	Audit	15	45	85	125	165	205	245	285	345	405	465	525	585	645	705	765	825	885	945	1,005
Low Income Whole House Efficiency	LED	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Income Whole House Efficiency	LED 2020	60	180	340	500	660	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820
Low Income Whole House Efficiency	LED 2025 +	-	-	-	-	-	-	160	320	560	800	1,040	1,280	1,520	1,760	2,000	2,240	2,480	2,720	2,960	3,200
Low Income Whole House Efficiency	Faucet Aerator	9	28	53	78	103	128	153	178	216	254	292	330	368	406	444	482	520	558	596	634
Low Income Whole House Efficiency	Low Flow Showerhead	7	21	40	59	78	97	116	135	163	191	219	247	275	303	331	359	387	415	443	471
Low Income Whole House Efficiency	Water Heater Wrap	7	21	40	59	78	97	116	135	163	191	219	247	275	303	331	359	387	415	443	471
Low Income Whole House Efficiency	Attic Insulation R-38	6	18	34	50	66	82	98	114	138	162	186	210	234	258	282	306	330	354	378	402
Low Income Whole House Efficiency	Wall Insulation R-11	1	3	6	9	12	15	18	21	26	31	36	41	46	51	56	61	66	71	76	81
Low Income Whole House Efficiency	Foundation Insulation R-13	2	6	11	16	21	26	31	36	43	50	57	64	71	78	85	92	99	106	113	120
Low Income Whole House Efficiency	Floor Insulation R-30	2	6	11	16	21	26	31	36	43	50	57	64	71	78	85	92	99	106	113	120
Low Income Whole House Efficiency	Duct Installation & Sealing	5	16	30	44	58	72	86	100	121	142	163	184	205	226	247	268	289	310	331	352
Low Income Whole House Efficiency	Advanced Thermostat	11	34	64	94	124	154	184	214	259	304	349	394	439	484	529	574	619	664	709	754
Low Income Whole House Efficiency	Furnace Blower Motor	6	12	19	26	33	41	49	57	66	75	85	95	105	116	127	138	150	162	174	186
Low Income Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	-	-	-	-	-	-	-	-	-	-	30	60	90	120	150	180	210	240	270	300
Low Income Whole House Efficiency	ENERGY STAR Dehumidifier	1	3	5	7	9	11	13	15	18	21	24	27	30	33	36	39	42	45	48	51
Low Income Whole House Efficiency	ENERGY STAR Air Purifier	2	5	9	13	17	21	25	29	35	41	47	53	59	65	71	77	83	89	95	101
Low Income Whole House Efficiency	Water Heater - Temperature Set Bacl	10	20	40	60	80	100	120	140	170	200	230	260	290	320	350	380	410	440	470	500
Low Income Behavioral	Behavioral Reports	6,000	18,000	30,000	42,000	54,000	66,000	78,000	90,000	102,000	114,000	126,000	138,000	150,000	162,000	174,000	186,000	198,000	210,000	222,000	234,000
Low Income Weatherization	Low Income Weatherization	150	450	750	1,050	1,350	1,650	1,950	2,250	2,600	2,950	3,300	3,650	4,000	4,350	4,700	5,050	5,400	5,750	6,100	6,450
Time of Use Rate	Time of Use Rate	-	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191
Critical Peak Pricing	Critical Peak Pricing	-	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094
Inclining Block Rates	Inclining Block Rate	-	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000

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Table 5-37 – Cumulative Non-Residential End-Use Measure Installations

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
C&I Program	Air Cooled Chiller	23	51	79	109	139	171	203	235	267	299	333	367	401	435	469	505	541	577	613	649
C&I Program	Water Cooled Chiller	30	66	100	138	176	216	256	296	334	374	414	454	496	538	582	624	666	710	754	798
C&I Program	CAC <65 kBtu (SEER 14)	137	307	477	668	859	1,050	1,241	1,432	1,623	1,814	2,005	2,196	2,387	2,578	2,769	2,960	3,151	3,342	3,533	3,724
C&I Program	CAC 65<135 kBtu (EER 11.7)	82	184	286	401	516	631	746	861	976	1,091	1,206	1,321	1,436	1,551	1,666	1,781	1,896	2,011	2,126	2,241
C&I Program	CAC 135<240 kBtu (EER 11.7)	55	123	191	267	343	419	495	571	647	723	799	875	951	1,027	1,103	1,179	1,255	1,331	1,407	1,483
C&I Program	Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	6	11	16	22	28	34	40	46	52	58	64	70	76	82	88	94	100	106	113	120
C&I Program	Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	4	7	10	14	18	22	26	30	34	38	42	46	50	54	58	62	66	70	74	78
C&I Program	Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	39	42
C&I Program	Packaged Terminal Air Conditioner	20	44	68	94	120	148	176	204	234	264	294	324	356	388	420	452	486	520	554	588
C&I Program	Variable Speed Drive - Chilled Water Pump	54	128	204	286	372	458	548	640	738	838	858	878	898	918	938	960	982	1,004	1,026	1,048
C&I Program	Variable Speed Drive - Hot Water Pump	3	7	11	15	20	25	30	35	40	45	50	56	62	68	74	76	78	80	82	84
C&I Program	ENERGY STAR Dishwasher	22	64	104	150	194	238	284	328	372	418	466	512	558	604	652	700	748	798	848	898
C&I Program	ENERGY STAR Hot Food Holding Cabinets	10	28	48	68	88	108	130	152	174	196	218	240	262	284	304	324	348	372	396	420
C&I Program	ENERGY STAR Electric Convention Oven	20	60	98	138	178	218	260	300	340	382	424	464	504	552	600	648	702	752	802	852
C&I Program	ENERGY STAR Electric Fryer	7	21	35	49	63	77	91	105	119	133	147	161	175	191	207	223	241	257	273	289
C&I Program	Evaporator Fan Control	8	23	38	53	68	83	98	113	128	143	161	179	197	215	233	236	239	242	245	248
C&I Program	Refrigeration Economizer	3	9	15	21	27	33	39	45	51	57	63	67	71	75	79	81	83	85	87	89
C&I Program	Directional LED Bulb (<15W)	49	197	345	515	685	857	1,029	1,199	1,369	1,543	1,717	1,893	2,069	2,243	2,419	2,601	2,785	2,973	3,183	3,393
C&I Program	Directional LED Bulb (≥15W)	33	92	151	219	287	356	425	493	561	631	701	771	841	911	981	1,054	1,128	1,203	1,287	1,371
C&I Program	High Bay Fluorescent Fixture (HP T8 >4 lamps)	90	932	1,778	2,726	3,684	4,646	5,614	6,570	7,528	8,500	9,548	10,606	11,658	12,712	13,782	14,872	15,974	17,084	18,446	19,808
C&I Program	High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	135	388	642	926	1,213	1,502	1,792	2,079	2,366	2,658	2,972	3,289	3,605	3,921	4,242	4,569	4,900	5,233	5,642	6,051
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Balla	45	129	214	309	405	501	598	694	790	887	992	1,098	1,203	1,308	1,415	1,524	1,634	1,745	1,881	2,017
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Balla	180	517	855	1,234	1,617	2,002	2,389	2,771	3,154	3,543	3,962	4,385	4,806	5,228	5,656	6,092	6,533	6,977	7,522	8,067
C&I Program	LED Direct Linear Ambient fixtures <=35W	90	259	428	618	810	1,003	1,197	1,375	1,540	1,696	1,843	1,981	2,140	2,317	2,509	2,742	2,982	3,263	3,539	3,815
C&I Program	LED Direct Linear Ambient fixtures 36W-60W	158	454	750	1,083	1,420	1,758	2,097	2,409	2,698	2,970	3,228	3,470	3,749	4,059	4,396	4,803	5,223	5,714	6,197	6,680
C&I Program	LED Direct Linear Ambient fixtures 61W-100W	90	259	428	618	810	1,003	1,197	1,375	1,540	1,696	1,843	1,981	2,140	2,317	2,509	2,742	2,982	3,263	3,539	3,815
C&I Program	LED linear replacement lamps (Type A or AB) 2 foo	68	195	322	465	609	754	899	1,033	1,157	1,274	1,384	1,488	1,607	1,740	1,884	2,059	2,239	2,450	2,657	2,864
C&I Program	LED linear replacement lamps (Type A or AB) 4 foo	45	130	215	310	406	503	600	689	772	850	924	993	1,073	1,162	1,258	1,374	1,494	1,634	1,772	1,910
C&I Program	LED Flood Light (<15W)	13	51	76	101	126	151	176	201	226	251	276	301	326	351	376	401	426	451	476	501
C&I Program	LED Flood Light (≥15W)	15	55	93	131	169	207	245	283	321	359	397	435	473	511	549	587	625	663	701	739
C&I Program	Lighting Optimization - Remove 4ft Lamp from T8 S	36	110	186	266	348	439	530	621	712	803	894	985	1,076	1,167	1,258	1,350	1,442	1,534	1,626	1,718
C&I Program	Lighting Optimization - Remove 8ft Lamp from T8 S	36	110	186	266	348	439	530	621	712	803	894	985	1,076	1,167	1,258	1,350	1,442	1,534	1,626	1,718
C&I Program	Omnidirectional LED Bulb (<10W)	811	2,207	3,471	4,540	5,256	5,810	6,168	6,584	7,054	7,571	8,115	8,665	9,424	10,112	10,762	11,389	11,975	12,542	13,096	13,650
C&I Program	Omnidirectional LED Bulb (≥10W)	811	2,207	3,471	4,540	5,256	5,810	6,168	6,584	7,054	7,571	8,115	8,665	9,424	10,112	10,762	11,389	11,975	12,542	13,096	13,650
C&I Program	LED Parking Garage/Canopy (<30W)	90	932	1,778	2,726	3,684	4,646	5,614	6,570	7,528	8,500	9,548	10,606	11,658	12,712	13,782	14,872	15,974	17,084	18,446	19,808
C&I Program	LED Parking Garage/Canopy (30-75W)	135	388	642	926	1,213	1,502	1,792	2,079	2,366	2,658	2,972	3,289	3,605	3,921	4,242	4,569	4,900	5,233	5,642	6,051
C&I Program	LED Parking Garage/Canopy (≥75W)	225	646	1,069	1,543	2,022	2,503	2,987	3,465	3,944	4,430	4,954	5,483	6,009	6,536	7,071	7,616	8,167	8,722	9,403	10,084
C&I Program	LED Wall Mounted Area Lights (<30W)	7	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342	362	382
C&I Program	Wall-Mount Occupancy Sensor	76	269	499	790	1,131	1,254	1,375	1,494	1,612	1,732	1,855	1,979	2,102	2,224	2,348	2,475	2,603	2,732	2,862	2,992
C&I Program	VFD Fans and Blowers	4	8	12	16	21	26	31	36	41	46	51	57	63	69	75	77	79	81	83	85
C&I Program	Compressed Air Nozzle	7	20	33	47	61	76	90	105	121	137	154	171	189	207	226	231	236	241	246	251
C&I Program	C&I Custom Rebate	5	16	29	42	55	68	81	94	107	120	133	146	159	172	185	198	211	224	237	250
Time of Use Rat	Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pri	Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricin	Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

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Table 5-38 – Incremental Participation by Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**25,471**	**50,429**	**50,859**	**49,256**	**48,011**	**150,537**	**158,502**	**174,062**	**181,846**	**185,632**	**185,903**	**186,036**	**186,194**	**186,301**	**186,457**	**186,572**	**186,645**	**186,718**	**186,865**	**186,865**
Total Residential	**18,914**	**37,266**	**37,699**	**36,071**	**34,886**	**33,260**	**32,975**	**32,590**	**32,548**	**32,462**	**32,563**	**32,568**	**32,555**	**32,555**	**32,604**	**32,604**	**32,589**	**32,561**	**32,546**	**32,546**
Residential Lighting	3,529	6,500	6,743	5,114	3,929	2,300	2,014	1,629	1,586	1,500	1,500	1,500	1,486	1,486	1,529	1,529	1,514	1,486	1,471	1,471
Whole House Efficiency	385	766	956	957	957	960	961	961	962	962	1,063	1,068	1,069	1,069	1,075	1,075	1,075	1,075	1,075	1,075
Residential Behavioral	15,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Total Residential Low Income	**6,183**	**12,364**	**12,383**	**12,383**	**12,383**	**12,384**	**12,384**	**12,384**	**12,474**	**12,474**	**12,489**	**12,489**	**12,489**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**
Low Income Whole House Efficiency	33	64	83	83	83	84	84	84	124	124	139	139	139	140	140	140	140	140	140	140
Low Income Behavioral	6,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Low Income Weatherization	150	300	300	300	300	300	300	300	350	350	350	350	350	350	350	350	350	350	350	350
Total Business	**374**	**799**	**777**	**802**	**742**	**692**	**656**	**655**	**661**	**672**	**694**	**694**	**745**	**741**	**747**	**768**	**769**	**789**	**878**	**878**
C&I Program	374	799	777	802	742	692	656	655	661	672	694	694	745	741	747	768	769	789	878	878
Demand Response	**-**	**-**	**-**	**-**	**-**	**104,201**	**112,487**	**128,433**	**136,163**	**140,024**	**140,157**	**140,285**	**140,405**	**140,515**	**140,616**	**140,710**	**140,797**	**140,878**	**140,951**	**140,951**
Time of Use Rate	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,191
Critical Peak Pricing	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,094
Inclining Block Rates	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

Table 5-39 – Cumulative Participation by Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**25,471**	**54,900**	**63,759**	**71,015**	**77,026**	**185,563**	**197,864**	**217,439**	**228,852**	**236,321**	**240,200**	**244,079**	**247,988**	**251,884**	**255,826**	**259,782**	**263,717**	**267,638**	**271,625**	**275,539**
Total Residential	**18,914**	**41,180**	**48,879**	**54,950**	**59,836**	**63,096**	**66,071**	**68,661**	**71,209**	**73,671**	**76,234**	**78,802**	**81,357**	**83,912**	**86,516**	**89,120**	**91,709**	**94,270**	**96,816**	**99,362**
Residential Lighting	3,529	10,029	16,772	21,886	25,815	28,115	30,129	31,758	33,344	34,844	36,344	37,844	39,330	40,816	42,345	43,874	45,388	46,874	48,345	49,816
Whole House Efficiency	385	1,151	2,107	3,064	4,021	4,981	5,942	6,903	7,865	8,827	9,890	10,958	12,027	13,096	14,171	15,246	16,321	17,396	18,471	19,546
Residential Behavioral	15,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Total Residential Low Income	**6,183**	**12,547**	**12,930**	**13,313**	**13,696**	**14,080**	**14,464**	**14,848**	**15,322**	**15,796**	**16,285**	**16,774**	**17,263**	**17,753**	**18,243**	**18,733**	**19,223**	**19,713**	**20,203**	**20,693**
Low Income Whole House Efficiency	33	97	180	263	346	430	514	598	722	846	985	1,124	1,263	1,403	1,543	1,683	1,823	1,963	2,103	2,243
Low Income Behavioral	6,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Low Income Weatherization	150	450	750	1,050	1,350	1,650	1,950	2,250	2,600	2,950	3,300	3,650	4,000	4,350	4,700	5,050	5,400	5,750	6,100	6,450
Total Business	**374**	**1,173**	**1,950**	**2,752**	**3,494**	**4,186**	**4,842**	**5,497**	**6,158**	**6,830**	**7,524**	**8,218**	**8,963**	**9,704**	**10,451**	**11,219**	**11,988**	**12,777**	**13,655**	**14,533**
C&I Program	374	1,173	1,950	2,752	3,494	4,186	4,842	5,497	6,158	6,830	7,524	8,218	8,963	9,704	10,451	11,219	11,988	12,777	13,655	14,533
Demand Response	**-**	**-**	**-**	**-**	**-**	**104,201**	**112,487**	**128,433**	**136,163**	**140,024**	**140,157**	**140,285**	**140,405**	**140,515**	**140,616**	**140,710**	**140,797**	**140,878**	**140,951**	**140,951**
Time of Use Rate	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,191
Critical Peak Pricing	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,094
Inclining Block Rates	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

4. For each year of the planning horizon, an estimate of the incremental and cumulative demand reduction and energy savings due to the potential demand-side program; and

An estimate of the realistic achievable potential incremental and cumulative demand reductions and energy savings due to the DSM Programs is shown in the tables below.

Table 5-40 – Incremental Net Demand Reductions by Program (kW)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2,422**	**3,996**	**4,050**	**4,162**	**4,094**	**13,091**	**18,333**	**28,035**	**32,631**	**34,888**	**34,965**	**35,038**	**35,150**	**35,227**	**35,333**	**35,378**	**35,445**	**35,524**	**35,666**	**35,666**
Total Residential	**684**	**1,351**	**1,427**	**1,338**	**1,273**	**1,185**	**1,202**	**1,177**	**1,174**	**1,168**	**1,193**	**1,194**	**1,192**	**1,192**	**1,199**	**1,199**	**1,197**	**1,194**	**1,192**	**1,192**
Residential Lighting	191	365	374	285	221	132	145	119	116	110	110	110	108	108	114	114	112	108	107	107
Whole House Efficiency	133	266	332	332	332	333	338	338	338	338	362	364	364	364	365	365	365	365	365	365
Residential Behavioral	360	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
Total Residential Low Income	**307**	**613**	**620**	**620**	**620**	**620**	**620**	**620**	**685**	**685**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**
Low Income Whole House Efficiency	11	21	28	28	28	28	28	28	42	42	46	46	46	46	46	46	46	46	46	46
Low Income Behavioral	144	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288
Low Income Weatherization	152	304	304	304	304	304	304	304	354	354	354	354	354	354	354	354	354	354	354	354
Total Business	**1,431**	**2,032**	**2,003**	**2,204**	**2,201**	**2,236**	**2,237**	**2,233**	**2,211**	**2,251**	**2,219**	**2,214**	**2,254**	**2,264**	**2,301**	**2,288**	**2,302**	**2,334**	**2,431**	**2,431**
C&I Program	1,431	2,032	2,003	2,204	2,201	2,236	2,237	2,233	2,211	2,251	2,219	2,214	2,254	2,264	2,301	2,288	2,302	2,334	2,431	2,431
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,050**	**14,273**	**24,006**	**28,561**	**30,784**	**30,864**	**30,941**	**31,015**	**31,082**	**31,144**	**31,202**	**31,257**	**31,307**	**31,354**	**31,354**
Time of Use Rate	-	-	-	-	-	352	1,061	2,485	3,207	3,575	3,587	3,598	3,609	3,619	3,628	3,636	3,644	3,651	3,657	3,657
Critical Peak Pricing	-	-	-	-	-	2,086	6,121	13,575	17,022	18,702	18,764	18,823	18,879	18,930	18,976	19,019	19,059	19,096	19,129	19,129
Inclining Block Rates	-	-	-	-	-	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355
Time of Use Rate (Non Res)	-	-	-	-	-	71	216	506	654	729	734	737	741	744	748	751	755	758	762	762
Critical Peak Pricing (Non Res)	-	-	-	-	-	73	218	482	607	667	669	674	676	680	682	687	689	693	695	695
Real Time Pricing	-	-	-	-	-	113	302	604	717	755	755	755	755	755	755	755	755	755	755	755

Table 5-41 – Cumulative Net Demand Reductions by Program (kW)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2,422**	**6,418**	**9,963**	**13,115**	**16,200**	**28,280**	**36,554**	**49,306**	**56,885**	**62,136**	**65,093**	**67,855**	**70,586**	**73,283**	**76,024**	**77,968**	**79,475**	**81,002**	**82,504**	**83,755**
Total Residential	**684**	**2,035**	**3,101**	**3,718**	**4,269**	**4,732**	**5,212**	**5,667**	**6,119**	**6,565**	**6,957**	**7,272**	**7,545**	**7,817**	**8,094**	**8,372**	**8,648**	**8,920**	**9,190**	**9,264**
Residential Lighting	191	556	931	1,216	1,437	1,568	1,713	1,832	1,948	2,058	2,169	2,279	2,387	2,496	2,610	2,724	2,836	2,944	3,051	2,967
Whole House Efficiency	133	399	731	1,062	1,392	1,724	2,059	2,395	2,731	3,067	3,348	3,553	3,718	3,881	4,044	4,208	4,372	4,536	4,699	4,857
Residential Behavioral	360	1,080	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440
Total Residential Low Income	**307**	**920**	**1,396**	**1,727**	**2,059**	**2,391**	**2,723**	**3,055**	**3,452**	**3,848**	**4,243**	**4,631**	**5,016**	**5,400**	**5,785**	**6,017**	**6,098**	**6,179**	**6,252**	**6,325**
Low Income Whole House Efficiency	11	32	60	88	116	144	172	201	243	285	325	359	390	420	450	480	510	541	563	585
Low Income Behavioral	144	432	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576
Low Income Weatherization	152	456	759	1,063	1,367	1,671	1,974	2,278	2,633	2,987	3,341	3,696	4,050	4,404	4,759	4,961	5,012	5,063	5,113	5,164
Total Business	**1,431**	**3,463**	**5,466**	**7,670**	**9,872**	**12,108**	**14,345**	**16,578**	**18,753**	**20,940**	**23,029**	**25,010**	**27,010**	**28,984**	**31,001**	**32,377**	**33,473**	**34,595**	**35,707**	**36,812**
C&I Program	1,431	3,463	5,466	7,670	9,872	12,108	14,345	16,578	18,753	20,940	23,029	25,010	27,010	28,984	31,001	32,377	33,473	34,595	35,707	36,812
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,050**	**14,273**	**24,006**	**28,561**	**30,784**	**30,864**	**30,941**	**31,015**	**31,082**	**31,144**	**31,202**	**31,257**	**31,307**	**31,354**	**31,354**
Time of Use Rate	-	-	-	-	-	352	1,061	2,485	3,207	3,575	3,587	3,598	3,609	3,619	3,628	3,636	3,644	3,651	3,657	3,657
Critical Peak Pricing	-	-	-	-	-	2,086	6,121	13,575	17,022	18,702	18,764	18,823	18,879	18,930	18,976	19,019	19,059	19,096	19,129	19,129
Inclining Block Rates	-	-	-	-	-	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355
Time of Use Rate (Non Res)	-	-	-	-	-	71	216	506	654	729	734	737	741	744	748	751	755	758	762	762
Critical Peak Pricing (Non Res)	-	-	-	-	-	73	218	482	607	667	669	674	676	680	682	687	689	693	695	695
Real Time Pricing	-	-	-	-	-	113	302	604	717	755	755	755	755	755	755	755	755	755	755	755

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Table 5-42 – Incremental Net Energy Savings by Program (MWh)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**5,535**	**10,940**	**11,138**	**11,438**	**11,381**	**20,938**	**21,752**	**23,235**	**24,162**	**24,594**	**24,804**	**24,837**	**24,918**	**24,963**	**25,050**	**25,037**	**25,100**	**25,155**	**25,672**	**25,672**
Total Residential	**2,293**	**4,579**	**4,778**	**4,723**	**4,684**	**4,631**	**4,643**	**4,627**	**4,626**	**4,623**	**4,900**	**4,914**	**4,913**	**4,914**	**4,931**	**4,932**	**4,931**	**4,928**	**4,927**	**4,927**
Residential Lighting	118	225	231	176	136	81	89	73	72	68	68	68	67	67	70	70	69	67	66	66
Whole House Efficiency	375	754	947	947	948	950	954	954	954	955	1,232	1,246	1,246	1,247	1,261	1,262	1,262	1,262	1,262	1,262
Residential Behavioral	1,800	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Total Residential Low Income	**1,181**	**2,362**	**2,383**	**2,383**	**2,383**	**2,384**	**2,384**	**2,384**	**2,570**	**2,570**	**2,612**	**2,612**	**2,612**	**2,613**	**2,613**	**2,613**	**2,613**	**2,613**	**2,613**	**2,613**
Low Income Whole House Efficiency	36	71	93	93	93	93	93	93	138	138	180	180	180	181	181	181	181	181	181	181
Low Income Behavioral	720	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440
Low Income Weatherization	425	851	851	851	851	851	851	851	992	992	992	992	992	992	992	992	992	992	992	992
Total Business	**2,061**	**3,999**	**3,977**	**4,332**	**4,314**	**4,273**	**4,273**	**4,244**	**4,253**	**4,329**	**4,208**	**4,216**	**4,286**	**4,320**	**4,380**	**4,358**	**4,413**	**4,462**	**4,972**	**4,972**
C&I Program	2,061	3,999	3,977	4,332	4,314	4,273	4,273	4,244	4,253	4,329	4,208	4,216	4,286	4,320	4,380	4,358	4,413	4,462	4,972	4,972
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,650**	**10,452**	**11,979**	**12,713**	**13,071**	**13,084**	**13,095**	**13,107**	**13,116**	**13,126**	**13,135**	**13,144**	**13,151**	**13,159**	**13,159**
Time of Use Rate	-	-	-	-	-	186	560	1,312	1,693	1,888	1,894	1,900	1,906	1,911	1,915	1,920	1,924	1,928	1,931	1,931
Critical Peak Pricing	-	-	-	-	-	125	367	814	1,021	1,122	1,126	1,129	1,133	1,136	1,139	1,141	1,144	1,146	1,148	1,148
Inclining Block Rates	-	-	-	-	-	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238
Time of Use Rate (Non Res)	-	-	-	-	-	37	114	267	345	385	388	389	391	393	395	396	399	400	403	403
Critical Peak Pricing (Non Res)	-	-	-	-	-	4	13	29	36	40	40	40	41	41	41	41	41	42	42	42
Real Time Pricing	-	-	-	-	-	60	159	319	379	399	399	399	399	399	399	399	399	399	399	399

Table 5-43 – Cumulative Net Energy Savings by Program (MWh)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**5,535**	**16,475**	**25,087**	**31,472**	**37,796**	**53,677**	**60,722**	**68,448**	**75,381**	**81,854**	**87,667**	**92,809**	**97,911**	**102,901**	**107,998**	**111,798**	**114,271**	**116,772**	**119,569**	**122,192**
Total Residential	**2,293**	**6,872**	**9,844**	**10,954**	**12,022**	**13,037**	**14,065**	**15,076**	**16,086**	**17,089**	**18,268**	**19,363**	**20,399**	**21,424**	**22,463**	**23,501**	**24,539**	**25,574**	**26,608**	**27,521**
Residential Lighting	118	343	574	750	886	967	1,056	1,129	1,201	1,269	1,337	1,405	1,472	1,539	1,609	1,679	1,748	1,815	1,881	1,829
Whole House Efficiency	375	1,129	2,070	3,004	3,936	4,871	5,809	6,747	7,685	8,620	9,731	10,758	11,727	12,686	13,654	14,622	15,591	16,559	17,527	18,492
Residential Behavioral	1,800	5,400	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200
Total Residential Low Income	**1,181**	**3,543**	**5,206**	**6,148**	**7,090**	**8,033**	**8,976**	**9,918**	**11,048**	**12,176**	**13,340**	**14,495**	**15,645**	**16,796**	**17,945**	**18,670**	**18,969**	**19,269**	**19,558**	**19,848**
Low Income Whole House Efficiency	36	107	199	291	383	475	567	659	797	933	1,104	1,267	1,425	1,583	1,741	1,898	2,056	2,213	2,361	2,509
Low Income Behavioral	720	2,160	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880	2,880
Low Income Weatherization	425	1,276	2,126	2,977	3,827	4,678	5,528	6,379	7,371	8,363	9,356	10,348	11,340	12,332	13,325	13,892	14,033	14,175	14,317	14,459
Total Business	**2,061**	**6,060**	**10,038**	**14,369**	**18,684**	**22,956**	**27,230**	**31,474**	**35,534**	**39,517**	**42,975**	**45,856**	**48,760**	**51,565**	**54,464**	**56,492**	**57,619**	**58,778**	**60,243**	**61,663**
C&I Program	2,061	6,060	10,038	14,369	18,684	22,956	27,230	31,474	35,534	39,517	42,975	45,856	48,760	51,565	54,464	56,492	57,619	58,778	60,243	61,663
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,650**	**10,452**	**11,979**	**12,713**	**13,071**	**13,084**	**13,095**	**13,107**	**13,116**	**13,126**	**13,135**	**13,144**	**13,151**	**13,159**	**13,159**
Time of Use Rate	-	-	-	-	-	186	560	1,312	1,693	1,888	1,894	1,900	1,906	1,911	1,915	1,920	1,924	1,928	1,931	1,931
Critical Peak Pricing	-	-	-	-	-	125	367	814	1,021	1,122	1,126	1,129	1,133	1,136	1,139	1,141	1,144	1,146	1,148	1,148
Inclining Block Rates	-	-	-	-	-	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238	9,238
Time of Use Rate (Non Res)	-	-	-	-	-	37	114	267	345	385	388	389	391	393	395	396	399	400	403	403
Critical Peak Pricing (Non Res)	-	-	-	-	-	4	13	29	36	40	40	40	41	41	41	41	41	42	42	42
Real Time Pricing	-	-	-	-	-	60	159	319	379	399	399	399	399	399	399	399	399	399	399	399

5. For each year of the planning horizon, an estimate of the costs, including:

A. The incremental cost of each stand-alone end-use measure;

The incremental cost of each end-use measure is shown in the table below.

Table 5-44 – Measure Incremental Costs

Measure Name	Per Unit Incremental Measure Cost ($)
LED	$3.26
LED 2020	$3.26
LED 2025 +	$2.40
Specialty LED	$8.21
ENERGY STAR Dehumidifier	$50
ENERGY STAR Air Purifier	$70
Air Sealing	$224
Attic Insulation R-38	$515
Wall Insulation R-11	$1,219
Foundation Insulation R-13	$62
Floor Insulation R-30	$515
Duct Installation & Sealing	$449
Faucet Aerator	$11
Low Flow Showerhead	$15
Hot Water Pipe Insulation	$18
Water Heater Wrap	$29
CAC SEER 15, EER 12.5	$714
CAC SEER 16, EER 13	$1,071
CAC SEER 17, EER 13	$1,428
ASHP SEER 15, HSPF 8.5	$510
ASHP SEER 16, HSPF 9	$1,020
ASHP SEER 18, HSPF 10	$1,587
Advanced Thermostat	$175
Furnace Blower Motor	$97
Heat Pump Water Heater ≤55 gallons	$757
Heat Pump Water Heater >55 gallons	$818

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Measure Name	Per Unit Incremental Measure Cost ($)
Behavioral Reports	$0
Low Income Weatherization	$0
Water Heater - Desuperheater	$239
Water Heater - Temperature Set Back	$5
Connected Home Management System	$354
Time of Use Rate	$0
Critical Peak Pricing	$0
Inclining Block Rate	$0
Air Cooled Chiller	$6,350
Water Cooled Chiller	$6,350
Room Air Conditioner (12 EER)	$50
CAC <65 kBtu (SEER 14)	$417
CAC 65<135 kBtu (EER 11.7)	$1,000
CAC 135<240 kBtu (EER 11.7)	$2,000
CAC 240<760 kBtu (EER 10.5)	$2,500
CAC ≥760 kBtu (EER 9.9)	$6,500
Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	$417
Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	$1,000
Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	$2,000
Heat Pump ≥240 kBtu (EER 10.3, COP 3.2)	$2,500
Packaged Terminal Air Conditioner	$84
Packaged Terminal Heat Pump	$84
Variable Speed Drive - Chilled Water Pump	$1,330
Variable Speed Drive - Hot Water Pump	$1,330
Demand Controlled Ventilation	$1,500
ENERGY STAR Steamer	$630
ENERGY STAR Dishwasher	$770

Measure Name	Per Unit Incremental Measure Cost ($)
ENERGY STAR Hot Food Holding Cabinets	$0
ENERGY STAR Electric Convention Oven	$0
ENERGY STAR Electric Fryer	$210
Evaporator Fan Control	$177
Strip Curtain for Walk-In Cooler/Freezer	$358
Night Covers for Open Refrigerated Display Cases	$420
Door Heater Controls	$1,266
Refrigeration Economizer	$2,558
Kitchen Demand Ventilation Controls	$994
Directional LED Bulb (<15W)	$8
Directional LED Bulb (≥15W)	$8
High Bay Fluorescent Fixture (HP T8 >4 lamps)	$75
High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	$75
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 >4 lamps)	$100
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 ≤4 lamps)	$100
LED Exit Sign	$42
LED Flood Light (<15W)	$35
LED Flood Light (≥15W)	$45
LED Recessed Fixture (1x4)	$76
LED Recessed Fixture (2x2)	$48
LED Recessed Fixture (2x4)	$56
Lighting Optimization - Remove 4ft Lamp from T8 System	$12
Lighting Optimization - Remove 8ft Lamp from T8 System	$16
Omnidirectional LED Bulb (<10W)	$3

Measure Name	Per Unit Incremental Measure Cost ($)
Omnidirectional LED Bulb (≥10W)	$3
LED Parking Garage/Canopy (<30W)	$80
LED Parking Garage/Canopy (30-75W)	$250
LED Parking Garage/Canopy (≥75W)	$375
LED Wall Mounted Area Lights (<30W)	$80
LED Wall Mounted Area Lights (30-75W)	$250
LED Wall Mounted Area Lights (≥75W)	$375
LED Refrigerator Case Light	$133
Photocell Occupancy Sensor	$50
Wall-Mount Occupancy Sensor	$54
VFD Fans and Blowers	$1,439
Zero-Loss Condensate Drain	$700
Compressed Air Nozzle	$57
VSD Ventilation	$520
C&I Custom Rebate	$2,500
Small C&I Retrocommissioning	$705
Large C&I Retrocommissioning	$5,872
Time of Use Rate (Non Res)	$0
Critical Peak Pricing (Non Res)	$0
Real Time Pricing	$0

B. The cost of incentives paid by the utility to customers or utility financing to encourage participation in the potential demand-side program. The utility shall consider multiple levels of incentives paid by the utility for each end-use measure within a potential demand-side program, with corresponding adjustments to the maximum achievable potential and the realistic achievable potential of that potential demand-side program;

The RAP Program Design cost of incentives or financing to encourage participation in the DSM Programs is shown in the table below. The incentives varied depending on the scenario analyzed (e.g. the RAP scenario versus the MAP scenario). This table only includes measures that were included in the program bundles.

Table 5-45 – Measure Incentives

Program	Measure Name	Incentive
Residential Lighting	LED 2020	$1.60
Residential Lighting	LED 2025 +	$1
Residential Lighting	Specialty LED	$3
Whole House Efficiency	Attic Insulation R-38	$0.30 per sq. ft., up to $500
Whole House Efficiency	Wall Insulation R-11	$0.30 per sq. ft., up to $150
Whole House Efficiency	Foundation Insulation R-13	$0.30 per sq. ft., up to $150
Whole House Efficiency	Floor Insulation R-30	$0.30 per sq. ft., up to $150
Whole House Efficiency	Duct Installation & Sealing	$0.10 per sq. ft., up to $150
Whole House Efficiency	Advanced Thermostat	$50
Whole House Efficiency	Furnace Blower Motor	$45
Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	$200
Whole House Efficiency	ENERGY STAR Dehumidifier	$20
Whole House Efficiency	ENERGY STAR Air Purifier	$30
Low Income Whole House Efficiency	Attic Insulation R-38	$0.60 per sq. ft., up to $800
Low Income Whole House Efficiency	Wall Insulation R-11	$0.60 per sq. ft., up to $300
Low Income Whole House Efficiency	Foundation Insulation R-13	$0.60 per sq. ft., up to $300
Low Income Whole House Efficiency	Floor Insulation R-30	$0.60 per sq. ft., up to $300
Low Income Whole House Efficiency	Duct Installation & Sealing	$0.20 per sq. ft., up to $300
Low Income Whole House Efficiency	Advanced Thermostat	$100
Low Income Whole House Efficiency	Furnace Blower Motor	$90
Low Income Whole House Efficiency	Heat Pump Water Heater ≤55 gallons	$400

Program	Measure Name	Incentive
Low Income Whole House Efficiency	Heat Pump Water Heater >55 gallons	$500
Low Income Whole House Efficiency	ENERGY STAR Dehumidifier	$40
Low Income Whole House Efficiency	ENERGY STAR Air Purifier	$60
C&I Program	Air Cooled Chiller	$2,500
C&I Program	Water Cooled Chiller	$2,250
C&I Program	CAC <65 kBtu (SEER 14)	$146
C&I Program	CAC 65<135 kBtu (EER 11.7)	$350
C&I Program	CAC 135<240 kBtu (EER 11.7)	$700
C&I Program	CAC 240<760 kBtu (EER 10.5)	$875
C&I Program	CAC ≥760 kBtu (EER 9.9)	$2,275
C&I Program	Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	$350
C&I Program	Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	$700
C&I Program	Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	$875
C&I Program	Heat Pump ≥240 kBtu (EER 10.3, COP 3.2)	$2,275
C&I Program	Packaged Terminal Air Conditioner	$40
C&I Program	Packaged Terminal Heat Pump	$40
C&I Program	Guest Room Energy Management	$125
C&I Program	Variable Speed Drive - Chilled Water Pump	$500
C&I Program	Variable Speed Drive - Hot Water Pump	$500
C&I Program	Demand Controlled Ventilation	$600
C&I Program	ENERGY STAR Steamer	$750
C&I Program	ENERGY STAR Dishwasher	$400
C&I Program	ENERGY STAR Hot Food Holding Cabinets	$500
C&I Program	ENERGY STAR Electric Convention Oven	$400
C&I Program	ENERGY STAR Electric Fryer	$100

Program	Measure Name	Incentive
C&I Program	Evaporator Fan Control	$125
C&I Program	Strip Curtain for Walk-In Cooler/Freezer	$125
C&I Program	Night Covers for Open Refrigerated Display Cases	$175
C&I Program	Door Heater Controls	$125
C&I Program	Refrigeration Economizer	$800
C&I Program	Directional LED Bulb (<15W)	$15
C&I Program	Directional LED Bulb (≥15W)	$15
C&I Program	High Bay Fluorescent Fixture (HP T8 >4 lamps)	$75
C&I Program	High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	$75
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 >4 lamps)	$30
C&I Program	High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 ≤4 lamps)	$30
C&I Program	LED Direct Linear Ambient fixtures <=35W	$10
C&I Program	LED Direct Linear Ambient fixtures 36W-60W	$10
C&I Program	LED Direct Linear Ambient fixtures 61W-100W	$10
C&I Program	LED linear replacement lamps (Type A or AB) 2 foot	$2
C&I Program	LED linear replacement lamps (Type A or AB) 4 foot	$2
C&I Program	LED Exit Sign	$15
C&I Program	LED Flood Light (<15W)	$15
C&I Program	LED Flood Light (≥15W)	$15
C&I Program	LED Recessed Fixture (1x4)	$15
C&I Program	LED Recessed Fixture (2x2)	$15
C&I Program	LED Recessed Fixture (2x4)	$15
C&I Program	Lighting Optimization - Remove 4ft Lamp from T8 System	$6

Program	Measure Name	Incentive
C&I Program	Lighting Optimization - Remove 8ft Lamp from T8 System	$8
C&I Program	Omnidirectional LED Bulb (<10W)	$15
C&I Program	Omnidirectional LED Bulb (≥10W)	$15
C&I Program	LED Parking Garage/Canopy (<30W)	$60
C&I Program	LED Parking Garage/Canopy (30-75W)	$80
C&I Program	LED Parking Garage/Canopy (≥75W)	$100
C&I Program	LED Wall Mounted Area Lights (<30W)	$60
C&I Program	LED Wall Mounted Area Lights (30-75W)	$80
C&I Program	LED Wall Mounted Area Lights (≥75W)	$100
C&I Program	Wall-Mount Occupancy Sensor	$20
C&I Program	VFD Fans and Blowers	$432
C&I Program	Compressed Air Nozzle	$17
C&I Program	C&I Custom Rebate	$0.10

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C. The cost of incentives to customers to participate in the potential demand-side program paid by the entities other than the utility;

The RAP Program Design cost of incentives to customers to participate in the DSM Programs is shown in the table below.

Table 5-46 – Total Incentives per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$464,304**	**$806,046**	**$830,388**	**$868,175**	**$849,789**	**$833,241**	**$822,334**	**$817,258**	**$827,304**	**$838,590**	**$876,055**	**$878,165**	**$888,294**	**$890,765**	**$901,388**	**$901,563**	**$908,226**	**$914,293**	**$977,351**	**$977,351**
Total Residential	**$85,790**	**$167,075**	**$192,640**	**$174,085**	**$160,580**	**$142,250**	**$131,295**	**$128,640**	**$128,385**	**$127,830**	**$167,875**	**$169,920**	**$169,715**	**$169,760**	**$172,555**	**$172,600**	**$172,350**	**$171,850**	**$171,600**	**$171,600**
Residential Lighting	$40,150	$75,050	$77,500	$58,900	$45,350	$26,750	$15,750	$13,050	$12,750	$12,150	$12,150	$12,150	$11,900	$11,900	$12,650	$12,650	$12,400	$11,900	$11,650	$11,650
Whole House Efficiency	$45,640	$92,025	$115,140	$115,185	$115,230	$115,500	$115,545	$115,590	$115,635	$115,680	$155,725	$157,770	$157,815	$157,860	$159,905	$159,950	$159,950	$159,950	$159,950	$159,950
Residential Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Residential Low Income	**$8,282**	**$16,164**	**$21,202**	**$21,202**	**$21,202**	**$21,292**	**$21,292**	**$21,292**	**$31,518**	**$31,518**	**$43,608**	**$43,608**	**$43,608**	**$43,698**	**$43,698**	**$43,698**	**$43,788**	**$43,788**	**$43,788**	**$43,788**
Low Income Whole House Efficiency	$8,282	$16,164	$21,202	$21,202	$21,202	$21,292	$21,292	$21,292	$31,518	$31,518	$43,608	$43,608	$43,608	$43,698	$43,698	$43,698	$43,788	$43,788	$43,788	$43,788
Low Income Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$370,232**	**$622,807**	**$616,546**	**$672,888**	**$668,007**	**$669,699**	**$669,747**	**$667,326**	**$667,401**	**$679,242**	**$664,572**	**$664,637**	**$674,971**	**$677,307**	**$685,135**	**$685,265**	**$692,088**	**$698,655**	**$761,963**	**$761,963**
C&I Program	$370,232	$622,807	$616,546	$672,888	$668,007	$669,699	$669,747	$667,326	$667,401	$679,242	$664,572	$664,637	$674,971	$677,307	$685,135	$685,265	$692,088	$698,655	$761,963	$761,963
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Time of Use Rate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Inclining Block Rates	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Real Time Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

D. The cost to the customer and to the utility of technology to implement a potential demand-side program;

The RAP Program Design cost to the customer and utility to implement the DSM Programs is shown in the tables below. Budget categories for the total utility costs include program delivery, administration, education/marketing, tracking/reporting, and evaluation. Incentives are not included in this total.

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Table 5-47 – Total Utility Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	$484,305	$842,276	$847,227	$851,512	$827,919	$2,060,264	$1,739,256	$2,236,020	$1,798,349	$1,593,226	$1,407,423	$1,408,856	$1,421,011	$1,420,832	$1,425,551	$1,429,472	$1,431,392	$1,436,506	$1,469,486	$1,469,486
Total Residential	$207,636	$381,647	$406,818	$389,549	$378,102	$352,045	$349,766	$343,975	$345,584	$345,961	$371,976	$373,253	$372,973	$373,012	$374,663	$374,688	$374,465	$374,066	$373,205	$373,205
Residential Lighting	$41,296	$69,135	$69,156	$52,347	$40,328	$22,674	$18,799	$15,112	$14,834	$14,108	$14,162	$14,161	$13,995	$13,994	$14,458	$14,456	$14,297	$13,980	$13,791	$13,791
Whole House Efficiency	$71,268	$131,425	$159,601	$159,345	$159,714	$154,745	$155,737	$154,480	$155,648	$156,340	$181,937	$183,224	$183,168	$183,214	$184,441	$184,477	$184,435	$184,381	$183,936	$183,936
Residential Behavioral	$95,072	$181,086	$178,060	$177,857	$178,060	$174,626	$175,231	$174,384	$175,102	$175,513	$175,877	$175,867	$175,810	$175,804	$175,765	$175,755	$175,733	$175,706	$175,479	$175,479
Total Residential Low Income	$46,422	$87,252	$90,007	$89,880	$90,006	$87,937	$88,315	$87,785	$97,022	$97,324	$104,077	$104,069	$104,021	$104,091	$104,058	$104,050	$104,108	$104,085	$103,894	$103,894
Low Income Whole House Efficiency	$8,393	$14,818	$18,783	$18,737	$18,782	$18,087	$18,223	$18,032	$26,981	$27,118	$33,726	$33,722	$33,697	$33,769	$33,752	$33,748	$33,815	$33,802	$33,702	$33,702
Low Income Behavioral	$38,029	$72,434	$71,224	$71,143	$71,224	$69,851	$70,092	$69,753	$70,041	$70,205	$70,351	$70,347	$70,324	$70,322	$70,306	$70,302	$70,293	$70,282	$70,191	$70,191
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	$230,247	$373,377	$350,402	$372,084	$359,810	$330,922	$327,350	$321,630	$326,795	$334,927	$336,768	$336,774	$349,474	$349,384	$352,771	$356,772	$359,016	$364,696	$399,697	$399,697
C&I Program	$230,247	$373,377	$350,402	$372,084	$359,810	$330,922	$327,350	$321,630	$326,795	$334,927	$336,768	$336,774	$349,474	$349,384	$352,771	$356,772	$359,016	$364,696	$399,697	$399,697
Demand Response	$0	$0	$0	$0	$0	$1,289,360	$973,825	$1,482,629	$1,028,948	$815,014	$594,602	$594,760	$594,543	$594,345	$594,058	$593,962	$593,802	$593,659	$592,690	$592,690
Time of Use Rate	$0	$0	$0	$0	$0	$240,652	$294,135	$543,560	$323,814	$212,788	$95,738	$95,751	$95,547	$95,423	$95,210	$95,125	$94,965	$94,856	$94,571	$94,571
Critical Peak Pricing	$0	$0	$0	$0	$0	$262,974	$335,637	$588,696	$360,531	$260,344	$159,727	$159,877	$159,965	$159,890	$159,881	$159,877	$159,907	$159,914	$159,659	$159,659
Inclining Block Rates	$0	$0	$0	$0	$0	$619,816	$270,417	$269,110	$270,219	$270,853	$271,415	$271,400	$271,311	$271,302	$271,242	$271,227	$271,194	$271,151	$270,801	$270,801
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$15,318	$9,296	$13,127	$9,751	$7,996	$6,225	$6,167	$6,229	$6,171	$6,234	$6,177	$6,240	$6,181	$6,237	$6,237
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$15,673	$9,941	$13,805	$10,371	$8,759	$7,171	$7,241	$7,184	$7,254	$7,199	$7,269	$7,214	$7,283	$7,219	$7,219
Real Time Pricing	$0	$0	$0	$0	$0	$134,927	$54,399	$54,331	$54,263	$54,274	$54,326	$54,323	$54,306	$54,304	$54,292	$54,289	$54,282	$54,274	$54,203	$54,203

Table 5-48 – Total Customer Incremental Costs per Program (NPV)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	$951,383	$1,447,449	$1,437,835	$1,460,310	$1,388,384	$1,317,145	$1,253,888	$1,190,381	$1,141,800	$1,102,884	$1,097,417	$1,050,984	$1,010,683	$966,847	$937,811	$895,239	$857,791	$828,024	$837,465	$799,756
Total Residential	$161,214	$297,178	$336,780	$300,217	$271,811	$240,299	$220,257	$207,430	$197,818	$188,353	$244,400	$236,511	$225,599	$215,475	$209,299	$199,905	$190,657	$181,600	$173,197	$165,399
Residential Lighting	$52,850	$96,572	$94,552	$68,842	$50,804	$28,953	$19,201	$15,383	$14,377	$13,131	$12,540	$11,975	$11,139	$10,637	$10,972	$10,478	$9,759	$8,847	$8,223	$7,853
Whole House Efficiency	$108,365	$200,606	$242,228	$231,375	$221,007	$211,346	$201,055	$192,046	$183,441	$175,221	$231,860	$224,536	$214,460	$204,837	$198,328	$189,428	$180,898	$172,753	$164,974	$157,546
Residential Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Residential Low Income	$9,187	$17,625	$22,253	$21,251	$20,294	$19,429	$18,488	$17,656	$25,359	$24,217	$32,838	$31,360	$29,948	$28,633	$27,343	$26,112	$24,966	$23,841	$22,768	$21,743
Low Income Whole House Efficiency	$9,187	$17,625	$22,253	$21,251	$20,294	$19,429	$18,488	$17,656	$25,359	$24,217	$32,838	$31,360	$29,948	$28,633	$27,343	$26,112	$24,966	$23,841	$22,768	$21,743
Low Income Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	$780,982	$1,132,646	$1,078,802	$1,138,843	$1,096,279	$1,057,417	$1,015,143	$965,295	$918,623	$890,314	$820,179	$783,113	$755,137	$722,740	$701,168	$669,222	$642,168	$622,583	$641,500	$612,614
C&I Program	$780,982	$1,132,646	$1,078,802	$1,138,843	$1,096,279	$1,057,417	$1,015,143	$965,295	$918,623	$890,314	$820,179	$783,113	$755,137	$722,740	$701,168	$669,222	$642,168	$622,583	$641,500	$612,614
Demand Response	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Inclining Block Rates	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Real Time Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

E. The utility's cost to administer the potential demand-side program; and

The RAP Program Design utility's cost to administer the DSM Programs by administrative budget category is shown in the tables below.

Table 5-49 – Total Utility Delivery Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$217,450**	**$438,300**	**$452,715**	**$445,060**	**$427,755**	**$624,212**	**$646,297**	**$699,217**	**$729,264**	**$743,515**	**$752,989**	**$753,742**	**$761,692**	**$761,542**	**$763,429**	**$766,873**	**$767,341**	**$770,396**	**$783,930**	**$783,930**
Total Residential	**$128,950**	**$253,775**	**$270,000**	**$258,625**	**$250,350**	**$239,100**	**$237,125**	**$234,450**	**$234,175**	**$233,600**	**$238,625**	**$238,900**	**$238,825**	**$238,850**	**$239,425**	**$239,450**	**$239,350**	**$239,150**	**$239,050**	**$239,050**
Residential Lighting	$24,700	$45,500	$47,200	$35,800	$27,500	$16,100	$14,100	$11,400	$11,100	$10,500	$10,500	$10,500	$10,400	$10,400	$10,700	$10,700	$10,600	$10,400	$10,300	$10,300
Whole House Efficiency	$29,250	$58,275	$72,800	$72,825	$72,850	$73,000	$73,025	$73,050	$73,075	$73,100	$78,125	$78,400	$78,425	$78,450	$78,725	$78,750	$78,750	$78,750	$78,750	$78,750
Residential Behavioral	$75,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000
Total Residential Low Income	**$32,400**	**$64,675**	**$66,150**	**$66,150**	**$66,150**	**$66,175**	**$66,175**	**$66,175**	**$69,175**	**$69,175**	**$69,950**	**$69,950**	**$69,950**	**$69,975**	**$69,975**	**$69,975**	**$70,000**	**$70,000**	**$70,000**	**$70,000**
Low Income Whole House Efficiency	$2,400	$4,675	$6,150	$6,150	$6,150	$6,175	$6,175	$6,175	$9,175	$9,175	$9,950	$9,950	$9,950	$9,975	$9,975	$9,975	$10,000	$10,000	$10,000	$10,000
Low Income Behavioral	$30,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$56,100**	**$119,850**	**$116,565**	**$120,285**	**$111,255**	**$103,860**	**$98,430**	**$98,280**	**$99,105**	**$100,830**	**$104,040**	**$104,070**	**$111,675**	**$111,090**	**$112,050**	**$115,140**	**$115,380**	**$118,350**	**$131,730**	**$131,730**
C&I Program	$56,100	$119,850	$116,565	$120,285	$111,255	$103,860	$98,430	$98,280	$99,105	$100,830	$104,040	$104,070	$111,675	$111,090	$112,050	$115,140	$115,380	$118,350	$131,730	$131,730
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$215,077**	**$244,567**	**$300,312**	**$326,809**	**$339,910**	**$340,374**	**$340,822**	**$341,242**	**$341,627**	**$341,979**	**$342,308**	**$342,611**	**$342,896**	**$343,150**	**$343,150**
Time of Use Rate	$0	$0	$0	$0	$0	$3,886	$11,712	$27,440	$35,410	$39,480	$39,610	$39,736	$39,852	$39,960	$40,058	$40,150	$40,234	$40,312	$40,382	$40,382
Critical Peak Pricing	$0	$0	$0	$0	$0	$10,955	$32,150	$71,295	$89,400	$98,225	$98,550	$98,860	$99,155	$99,420	$99,665	$99,890	$100,100	$100,295	$100,470	$100,470
Inclining Block Rates	$0	$0	$0	$0	$0	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$60	$184	$430	$556	$620	$624	$626	$630	$632	$636	$638	$642	$644	$648	$648
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$170	$505	$1,115	$1,405	$1,545	$1,550	$1,560	$1,565	$1,575	$1,580	$1,590	$1,595	$1,605	$1,610	$1,610
Real Time Pricing	$0	$0	$0	$0	$0	$6	$16	$32	$38	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40

Table 5-50 – Total Utility Administrative Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$67,733**	**$124,282**	**$131,357**	**$136,776**	**$134,960**	**$633,887**	**$333,102**	**$332,749**	**$335,221**	**$336,565**	**$345,847**	**$346,275**	**$348,074**	**$348,283**	**$349,600**	**$349,934**	**$350,655**	**$351,594**	**$359,256**	**$359,256**
Total Residential	**$20,777**	**$41,465**	**$48,323**	**$47,736**	**$47,311**	**$46,787**	**$46,540**	**$46,444**	**$46,445**	**$46,433**	**$54,546**	**$54,964**	**$54,969**	**$54,982**	**$55,420**	**$55,433**	**$55,426**	**$55,412**	**$55,405**	**$55,405**
Residential Lighting	$1,297	$2,411	$2,494	$1,894	$1,457	$857	$597	$489	$477	$453	$453	$453	$446	$446	$467	$467	$460	$446	$439	$439
Whole House Efficiency	$13,480	$27,054	$33,829	$33,842	$33,854	$33,930	$33,943	$33,955	$33,968	$33,980	$42,093	$42,511	$42,523	$42,536	$42,953	$42,966	$42,966	$42,966	$42,966	$42,966
Residential Behavioral	$6,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Total Residential Low Income	**$4,323**	**$8,551**	**$9,723**	**$9,723**	**$9,723**	**$9,744**	**$9,744**	**$9,744**	**$12,125**	**$12,125**	**$14,440**	**$14,440**	**$14,440**	**$14,461**	**$14,461**	**$14,461**	**$14,482**	**$14,482**	**$14,482**	**$14,482**
Low Income Whole House Efficiency	$1,923	$3,751	$4,923	$4,923	$4,923	$4,944	$4,944	$4,944	$7,325	$7,325	$9,640	$9,640	$9,640	$9,661	$9,661	$9,661	$9,682	$9,682	$9,682	$9,682
Low Income Behavioral	$2,400	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800	$4,800
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$42,633**	**$74,266**	**$73,311**	**$79,317**	**$77,926**	**$77,356**	**$76,818**	**$76,561**	**$76,651**	**$78,007**	**$76,861**	**$76,871**	**$78,665**	**$78,840**	**$79,719**	**$80,040**	**$80,747**	**$81,700**	**$89,369**	**$89,369**
C&I Program	$42,633	$74,266	$73,311	$79,317	$77,926	$77,356	$76,818	$76,561	$76,651	$78,007	$76,861	$76,871	$78,665	$78,840	$79,719	$80,040	$80,747	$81,700	$89,369	$89,369
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$500,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**	**$200,000**
Time of Use Rate	$0	$0	$0	$0	$0	$112,500	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Critical Peak Pricing	$0	$0	$0	$0	$0	$112,500	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Inclining Block Rates	$0	$0	$0	$0	$0	$125,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$12,500	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$12,500	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Real Time Pricing	$0	$0	$0	$0	$0	$125,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000

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Table 5-51 – Total Utility Education/Marketing Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$58,712**	**$105,965**	**$111,840**	**$116,357**	**$113,884**	**$592,949**	**$566,447**	**$987,230**	**$537,405**	**$325,916**	**$128,421**	**$128,504**	**$129,850**	**$129,503**	**$130,288**	**$130,234**	**$130,555**	**$131,143**	**$138,355**	**$138,355**
Total Residential	**$14,477**	**$28,573**	**$34,426**	**$32,937**	**$31,855**	**$30,418**	**$29,779**	**$29,519**	**$29,500**	**$29,450**	**$36,211**	**$36,559**	**$36,551**	**$36,562**	**$36,963**	**$36,973**	**$36,955**	**$36,920**	**$36,903**	**$36,903**
Residential Lighting	$3,243	$6,028	$6,235	$4,735	$3,643	$2,143	$1,493	$1,223	$1,193	$1,133	$1,133	$1,133	$1,115	$1,115	$1,168	$1,168	$1,150	$1,115	$1,098	$1,098
Whole House Efficiency	$11,234	$22,545	$28,191	$28,202	$28,212	$28,275	$28,286	$28,296	$28,307	$28,317	$35,078	$35,426	$35,436	$35,447	$35,795	$35,805	$35,805	$35,805	$35,805	$35,805
Residential Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Residential Low Income	**$1,602**	**$3,126**	**$4,103**	**$4,103**	**$4,103**	**$4,120**	**$4,120**	**$4,120**	**$6,104**	**$6,104**	**$8,034**	**$8,034**	**$8,034**	**$8,051**	**$8,051**	**$8,051**	**$8,068**	**$8,068**	**$8,068**	**$8,068**
Low Income Whole House Efficiency	$1,602	$3,126	$4,103	$4,103	$4,103	$4,120	$4,120	$4,120	$6,104	$6,104	$8,034	$8,034	$8,034	$8,051	$8,051	$8,051	$8,068	$8,068	$8,068	$8,068
Low Income Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$42,633**	**$74,266**	**$73,311**	**$79,317**	**$77,926**	**$77,356**	**$76,818**	**$76,561**	**$76,651**	**$78,007**	**$76,861**	**$76,871**	**$78,665**	**$78,840**	**$79,719**	**$80,040**	**$80,747**	**$81,700**	**$89,369**	**$89,369**
C&I Program	$42,633	$74,266	$73,311	$79,317	$77,926	$77,356	$76,818	$76,561	$76,651	$78,007	$76,861	$76,871	$78,665	$78,840	$79,719	$80,040	$80,747	$81,700	$89,369	$89,369
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$481,055**	**$455,730**	**$877,030**	**$425,150**	**$212,355**	**$7,315**	**$7,040**	**$6,600**	**$6,050**	**$5,555**	**$5,170**	**$4,785**	**$4,455**	**$4,015**	**$4,015**
Time of Use Rate	$0	$0	$0	$0	$0	$106,865	$215,215	$432,520	$219,175	$111,925	$3,575	$3,465	$3,190	$2,970	$2,695	$2,530	$2,310	$2,145	$1,925	$1,925
Critical Peak Pricing	$0	$0	$0	$0	$0	$120,505	$233,145	$430,595	$199,155	$97,075	$3,575	$3,410	$3,245	$2,915	$2,695	$2,475	$2,310	$2,145	$1,925	$1,925
Inclining Block Rates	$0	$0	$0	$0	$0	$250,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$1,650	$3,410	$6,765	$3,465	$1,760	$110	$55	$110	$55	$110	$55	$110	$55	$110	$110
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$1,870	$3,685	$6,710	$3,190	$1,540	$55	$110	$55	$110	$55	$110	$55	$110	$55	$55
Real Time Pricing	$0	$0	$0	$0	$0	$165	$275	$440	$165	$55	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table 5-52 – Total Utility Tracking/Reporting Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$100,000**	**$100,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**	**$75,000**
Total Residential	**$30,932**	**$33,290**	**$26,800**	**$24,582**	**$24,081**	**$12,812**	**$14,085**	**$11,609**	**$13,539**	**$14,612**	**$17,731**	**$17,813**	**$17,625**	**$17,610**	**$17,637**	**$17,609**	**$17,529**	**$17,417**	**$16,699**	**$16,699**
Residential Lighting	$8,586	$8,747	$6,556	$4,852	$3,830	$1,281	$1,012	$692	$788	$810	$864	$863	$841	$840	$874	$872	$856	$826	$780	$780
Whole House Efficiency	$12,324	$13,556	$12,283	$11,973	$12,291	$7,005	$7,943	$6,634	$7,749	$8,389	$11,090	$11,182	$11,074	$11,066	$11,099	$11,082	$11,040	$10,986	$10,541	$10,541
Residential Behavioral	$10,022	$10,986	$7,960	$7,757	$7,960	$4,526	$5,131	$4,284	$5,002	$5,413	$5,777	$5,767	$5,710	$5,704	$5,665	$5,655	$5,633	$5,606	$5,379	$5,379
Total Residential Low Income	**$5,767**	**$6,274**	**$4,972**	**$4,845**	**$4,971**	**$2,831**	**$3,209**	**$2,679**	**$3,672**	**$3,974**	**$4,851**	**$4,843**	**$4,795**	**$4,795**	**$4,762**	**$4,754**	**$4,741**	**$4,718**	**$4,527**	**$4,527**
Low Income Whole House Efficiency	$1,758	$1,880	$1,788	$1,742	$1,787	$1,021	$1,157	$966	$1,671	$1,808	$2,540	$2,536	$2,511	$2,513	$2,496	$2,492	$2,488	$2,475	$2,375	$2,375
Low Income Behavioral	$4,009	$4,394	$3,184	$3,103	$3,184	$1,811	$2,052	$1,713	$2,001	$2,165	$2,311	$2,307	$2,284	$2,282	$2,266	$2,262	$2,253	$2,242	$2,151	$2,151
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$63,301**	**$60,436**	**$43,229**	**$45,574**	**$45,947**	**$25,936**	**$29,194**	**$24,292**	**$28,399**	**$31,278**	**$32,889**	**$32,840**	**$33,271**	**$33,311**	**$33,453**	**$33,527**	**$33,695**	**$33,925**	**$35,607**	**$35,607**
C&I Program	$63,301	$60,436	$43,229	$45,574	$45,947	$25,936	$29,194	$24,292	$28,399	$31,278	$32,889	$32,840	$33,271	$33,311	$33,453	$33,527	$33,695	$33,925	$35,607	$35,607
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$33,420**	**$28,512**	**$36,419**	**$29,391**	**$25,136**	**$19,529**	**$19,504**	**$19,309**	**$19,284**	**$19,147**	**$19,110**	**$19,035**	**$18,940**	**$18,167**	**$18,167**
Time of Use Rate	$0	$0	$0	$0	$0	$6,238	$8,612	$13,352	$9,250	$6,563	$3,144	$3,140	$3,103	$3,096	$3,069	$3,061	$3,044	$3,026	$2,899	$2,899
Critical Peak Pricing	$0	$0	$0	$0	$0	$6,816	$9,827	$14,461	$10,298	$8,029	$5,246	$5,243	$5,195	$5,188	$5,153	$5,144	$5,126	$5,102	$4,894	$4,894
Inclining Block Rates	$0	$0	$0	$0	$0	$16,066	$7,917	$6,610	$7,719	$8,353	$8,915	$8,900	$8,811	$8,802	$8,742	$8,727	$8,694	$8,651	$8,301	$8,301
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$397	$272	$322	$279	$247	$204	$202	$202	$200	$201	$199	$200	$197	$191	$191
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$406	$291	$339	$296	$270	$236	$237	$233	$235	$232	$234	$231	$232	$221	$221
Real Time Pricing	$0	$0	$0	$0	$0	$3,497	$1,593	$1,335	$1,550	$1,674	$1,784	$1,781	$1,764	$1,762	$1,750	$1,747	$1,740	$1,732	$1,661	$1,661

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Table 5-53 – Total Utility Evaluation Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$40,410**	**$73,729**	**$76,315**	**$78,318**	**$76,320**	**$134,217**	**$118,411**	**$141,824**	**$121,459**	**$112,229**	**$105,166**	**$105,335**	**$106,396**	**$106,505**	**$107,235**	**$107,430**	**$107,841**	**$108,372**	**$112,945**	**$112,945**
Total Residential	**$12,500**	**$24,544**	**$27,269**	**$25,669**	**$24,505**	**$22,928**	**$22,237**	**$21,953**	**$21,925**	**$21,866**	**$24,863**	**$25,017**	**$25,003**	**$25,008**	**$25,218**	**$25,223**	**$25,205**	**$25,167**	**$25,148**	**$25,148**
Residential Lighting	$3,470	$6,449	$6,671	$5,066	$3,898	$2,293	$1,597	$1,308	$1,276	$1,212	$1,212	$1,212	$1,193	$1,193	$1,249	$1,249	$1,231	$1,193	$1,174	$1,174
Whole House Efficiency	$4,980	$9,995	$12,498	$12,503	$12,507	$12,535	$12,540	$12,545	$12,549	$12,554	$15,551	$15,705	$15,710	$15,715	$15,869	$15,874	$15,874	$15,874	$15,874	$15,874
Residential Behavioral	$4,050	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100	$8,100
Total Residential Low Income	**$2,330**	**$4,626**	**$5,059**	**$5,059**	**$5,059**	**$5,067**	**$5,067**	**$5,067**	**$5,946**	**$5,946**	**$6,802**	**$6,802**	**$6,802**	**$6,809**	**$6,809**	**$6,809**	**$6,817**	**$6,817**	**$6,817**	**$6,817**
Low Income Whole House Efficiency	$710	$1,386	$1,819	$1,819	$1,819	$1,827	$1,827	$1,827	$2,706	$2,706	$3,562	$3,562	$3,562	$3,569	$3,569	$3,569	$3,577	$3,577	$3,577	$3,577
Low Income Behavioral	$1,620	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240	$3,240
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$25,580**	**$44,559**	**$43,987**	**$47,590**	**$46,756**	**$46,414**	**$46,091**	**$45,936**	**$45,990**	**$46,804**	**$46,117**	**$46,122**	**$47,199**	**$47,304**	**$47,831**	**$48,024**	**$48,448**	**$49,020**	**$53,622**	**$53,622**
C&I Program	$25,580	$44,559	$43,987	$47,590	$46,756	$46,414	$46,091	$45,936	$45,990	$46,804	$46,117	$46,122	$47,199	$47,304	$47,831	$48,024	$48,448	$49,020	$53,622	$53,622
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$59,808**	**$45,016**	**$68,868**	**$47,598**	**$37,613**	**$27,384**	**$27,394**	**$27,392**	**$27,384**	**$27,377**	**$27,374**	**$27,371**	**$27,368**	**$27,358**	**$27,358**
Time of Use Rate	$0	$0	$0	$0	$0	$11,163	$13,596	$25,248	$14,979	$9,820	$4,409	$4,410	$4,402	$4,397	$4,388	$4,384	$4,377	$4,373	$4,365	$4,365
Critical Peak Pricing	$0	$0	$0	$0	$0	$12,198	$15,515	$27,345	$16,678	$12,015	$7,356	$7,364	$7,370	$7,367	$7,368	$7,368	$7,371	$7,372	$7,370	$7,370
Inclining Block Rates	$0	$0	$0	$0	$0	$28,750	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$711	$430	$610	$451	$369	$287	$284	$287	$284	$287	$285	$288	$285	$288	$288
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$727	$460	$641	$480	$404	$330	$334	$331	$334	$332	$335	$333	$336	$333	$333
Real Time Pricing	$0	$0	$0	$0	$0	$6,259	$2,515	$2,524	$2,510	$2,505	$2,502	$2,502	$2,502	$2,502	$2,502	$2,502	$2,502	$2,502	$2,502	$2,502

F. Other costs identified by the utility;

AEG did not identify other costs for the DSM Programs.

3.8 Participants and Impacts

(H) A tabulation of the incremental and cumulative number of participants, load impacts, utility costs, and program participant costs in each year of the planning horizon for each potential demand-side program; and

The realistic achievable potential incremental and cumulative participants, load impacts, utility costs, and program participant costs for each DSM Program can be found in the tables below.

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Table 5-54 – Incremental Participation by Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**25,471**	**50,429**	**50,859**	**49,256**	**48,011**	**150,537**	**158,502**	**174,062**	**181,846**	**185,632**	**185,903**	**186,036**	**186,194**	**186,301**	**186,457**	**186,572**	**186,645**	**186,718**	**186,865**	**186,865**
Total Residential	**18,914**	**37,266**	**37,699**	**36,071**	**34,886**	**33,260**	**32,975**	**32,590**	**32,548**	**32,462**	**32,563**	**32,568**	**32,555**	**32,555**	**32,604**	**32,604**	**32,589**	**32,561**	**32,546**	**32,546**
Residential Lighting	3,529	6,500	6,743	5,114	3,929	2,300	2,014	1,629	1,586	1,500	1,500	1,500	1,486	1,486	1,529	1,529	1,514	1,486	1,471	1,471
Whole House Efficiency	385	766	956	957	957	960	961	961	962	962	1,063	1,068	1,069	1,069	1,075	1,075	1,075	1,075	1,075	1,075
Residential Behavioral	15,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Total Residential Low Income	**6,183**	**12,364**	**12,383**	**12,383**	**12,383**	**12,384**	**12,384**	**12,384**	**12,474**	**12,474**	**12,489**	**12,489**	**12,489**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**	**12,490**
Low Income Whole House Efficiency	33	64	83	83	83	84	84	84	124	124	139	139	139	140	140	140	140	140	140	140
Low Income Behavioral	6,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Low Income Weatherization	150	300	300	300	300	300	300	300	350	350	350	350	350	350	350	350	350	350	350	350
Total Business	**374**	**799**	**777**	**802**	**742**	**692**	**656**	**655**	**661**	**672**	**694**	**694**	**745**	**741**	**747**	**768**	**769**	**789**	**878**	**878**
C&I Program	374	799	777	802	742	692	656	655	661	672	694	694	745	741	747	768	769	789	878	878
Demand Response	**-**	**-**	**-**	**-**	**-**	**104,201**	**112,487**	**128,433**	**136,163**	**140,024**	**140,157**	**140,285**	**140,405**	**140,515**	**140,616**	**140,710**	**140,797**	**140,878**	**140,951**	**140,951**
Time of Use Rate	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,191
Critical Peak Pricing	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,094
Inclining Block Rates	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

Table 5-55 – Cumulative Participation by Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**25,471**	**54,900**	**63,759**	**71,015**	**77,026**	**185,563**	**197,864**	**217,439**	**228,852**	**236,321**	**240,200**	**244,079**	**247,988**	**251,884**	**255,826**	**259,782**	**263,717**	**267,638**	**271,625**	**275,539**
Total Residential	**18,914**	**41,180**	**48,879**	**54,950**	**59,836**	**63,096**	**66,071**	**68,661**	**71,209**	**73,671**	**76,234**	**78,802**	**81,357**	**83,912**	**86,516**	**89,120**	**91,709**	**94,270**	**96,816**	**99,362**
Residential Lighting	3,529	10,029	16,772	21,886	25,815	28,115	30,129	31,758	33,344	34,844	36,344	37,844	39,330	40,816	42,345	43,874	45,388	46,874	48,345	49,816
Whole House Efficiency	385	1,151	2,107	3,064	4,021	4,981	5,942	6,903	7,865	8,827	9,890	10,958	12,027	13,096	14,171	15,246	16,321	17,396	18,471	19,546
Residential Behavioral	15,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Total Residential Low Income	**6,183**	**12,547**	**12,930**	**13,313**	**13,696**	**14,080**	**14,464**	**14,848**	**15,322**	**15,796**	**16,285**	**16,774**	**17,263**	**17,753**	**18,243**	**18,733**	**19,223**	**19,713**	**20,203**	**20,693**
Low Income Whole House Efficiency	33	97	180	263	346	430	514	598	722	846	985	1,124	1,263	1,403	1,543	1,683	1,823	1,963	2,103	2,243
Low Income Behavioral	6,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Low Income Weatherization	150	450	750	1,050	1,350	1,650	1,950	2,250	2,600	2,950	3,300	3,650	4,000	4,350	4,700	5,050	5,400	5,750	6,100	6,450
Total Business	**374**	**1,173**	**1,950**	**2,752**	**3,494**	**4,186**	**4,842**	**5,497**	**6,158**	**6,830**	**7,524**	**8,218**	**8,963**	**9,704**	**10,451**	**11,219**	**11,988**	**12,777**	**13,655**	**14,533**
C&I Program	374	1,173	1,950	2,752	3,494	4,186	4,842	5,497	6,158	6,830	7,524	8,218	8,963	9,704	10,451	11,219	11,988	12,777	13,655	14,533
Demand Response	**-**	**-**	**-**	**-**	**-**	**104,201**	**112,487**	**128,433**	**136,163**	**140,024**	**140,157**	**140,285**	**140,405**	**140,515**	**140,616**	**140,710**	**140,797**	**140,878**	**140,951**	**140,951**
Time of Use Rate	-	-	-	-	-	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,191
Critical Peak Pricing	-	-	-	-	-	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,094
Inclining Block Rates	-	-	-	-	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Time of Use Rate (Non Res)	-	-	-	-	-	30	92	215	278	310	312	313	315	316	318	319	321	322	324	324
Critical Peak Pricing (Non Res)	-	-	-	-	-	34	101	223	281	309	310	312	313	315	316	318	319	321	322	322
Real Time Pricing	-	-	-	-	-	3	8	16	19	20	20	20	20	20	20	20	20	20	20	20

Table 5-56 – Incremental Net Demand Reductions by Program (kW)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2,422**	**3,996**	**4,050**	**4,162**	**4,094**	**13,091**	**18,333**	**28,035**	**32,631**	**34,888**	**34,965**	**35,038**	**35,150**	**35,227**	**35,333**	**35,378**	**35,445**	**35,524**	**35,666**	**35,666**
Total Residential	**684**	**1,351**	**1,427**	**1,338**	**1,273**	**1,185**	**1,202**	**1,177**	**1,174**	**1,168**	**1,193**	**1,194**	**1,192**	**1,192**	**1,199**	**1,199**	**1,197**	**1,194**	**1,192**	**1,192**
Residential Lighting	191	365	374	285	221	132	145	119	116	110	110	110	108	108	114	114	112	108	107	107
Whole House Efficiency	133	266	332	332	332	333	338	338	338	338	362	364	364	364	365	365	365	365	365	365
Residential Behavioral	360	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720
Total Residential Low Income	**307**	**613**	**620**	**620**	**620**	**620**	**620**	**620**	**685**	**685**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**	**689**
Low Income Whole House Efficiency	11	21	28	28	28	28	28	28	42	42	46	46	46	46	46	46	46	46	46	46
Low Income Behavioral	144	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288
Low Income Weatherization	152	304	304	304	304	304	304	304	354	354	354	354	354	354	354	354	354	354	354	354
Total Business	**1,431**	**2,032**	**2,003**	**2,204**	**2,201**	**2,236**	**2,237**	**2,233**	**2,211**	**2,251**	**2,219**	**2,214**	**2,254**	**2,264**	**2,301**	**2,288**	**2,302**	**2,334**	**2,431**	**2,431**
C&I Program	1,431	2,032	2,003	2,204	2,201	2,236	2,237	2,233	2,211	2,251	2,219	2,214	2,254	2,264	2,301	2,288	2,302	2,334	2,431	2,431
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,050**	**14,273**	**24,006**	**28,561**	**30,784**	**30,864**	**30,941**	**31,015**	**31,082**	**31,144**	**31,202**	**31,257**	**31,307**	**31,354**	**31,354**
Time of Use Rate	-	-	-	-	-	352	1,061	2,485	3,207	3,575	3,587	3,598	3,609	3,619	3,628	3,636	3,644	3,651	3,657	3,657
Critical Peak Pricing	-	-	-	-	-	2,086	6,121	13,575	17,022	18,702	18,764	18,823	18,879	18,930	18,976	19,019	19,059	19,096	19,129	19,129
Inclining Block Rates	-	-	-	-	-	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355
Time of Use Rate (Non Res)	-	-	-	-	-	71	216	506	654	729	734	737	741	744	748	751	755	758	762	762
Critical Peak Pricing (Non Res)	-	-	-	-	-	73	218	482	607	667	669	674	676	680	682	687	689	693	695	695
Real Time Pricing	-	-	-	-	-	113	302	604	717	755	755	755	755	755	755	755	755	755	755	755

Table 5-57 – Cumulative Net Demand Reductions by Program (kW)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2,422**	**6,418**	**9,963**	**13,115**	**16,200**	**28,280**	**36,554**	**49,306**	**56,885**	**62,136**	**65,093**	**67,855**	**70,586**	**73,283**	**76,024**	**77,968**	**79,475**	**81,002**	**82,504**	**83,755**
Total Residential	**684**	**2,035**	**3,101**	**3,718**	**4,269**	**4,732**	**5,212**	**5,667**	**6,119**	**6,565**	**6,957**	**7,272**	**7,545**	**7,817**	**8,094**	**8,372**	**8,648**	**8,920**	**9,190**	**9,264**
Residential Lighting	191	556	931	1,216	1,437	1,568	1,713	1,832	1,948	2,058	2,169	2,279	2,387	2,496	2,610	2,724	2,836	2,944	3,051	2,967
Whole House Efficiency	133	399	731	1,062	1,392	1,724	2,059	2,395	2,731	3,067	3,348	3,553	3,718	3,881	4,044	4,208	4,372	4,536	4,699	4,857
Residential Behavioral	360	1,080	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440
Total Residential Low Income	**307**	**920**	**1,396**	**1,727**	**2,059**	**2,391**	**2,723**	**3,055**	**3,452**	**3,848**	**4,243**	**4,631**	**5,016**	**5,400**	**5,785**	**6,017**	**6,098**	**6,179**	**6,252**	**6,325**
Low Income Whole House Efficiency	11	32	60	88	116	144	172	201	243	285	325	359	390	420	450	480	510	541	563	585
Low Income Behavioral	144	432	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576	576
Low Income Weatherization	152	456	759	1,063	1,367	1,671	1,974	2,278	2,633	2,987	3,341	3,696	4,050	4,404	4,759	4,961	5,012	5,063	5,113	5,164
Total Business	**1,431**	**3,463**	**5,466**	**7,670**	**9,872**	**12,108**	**14,345**	**16,578**	**18,753**	**20,940**	**23,029**	**25,010**	**27,010**	**28,984**	**31,001**	**32,377**	**33,473**	**34,595**	**35,707**	**36,812**
C&I Program	1,431	3,463	5,466	7,670	9,872	12,108	14,345	16,578	18,753	20,940	23,029	25,010	27,010	28,984	31,001	32,377	33,473	34,595	35,707	36,812
Demand Response	**-**	**-**	**-**	**-**	**-**	**9,050**	**14,273**	**24,006**	**28,561**	**30,784**	**30,864**	**30,941**	**31,015**	**31,082**	**31,144**	**31,202**	**31,257**	**31,307**	**31,354**	**31,354**
Time of Use Rate	-	-	-	-	-	352	1,061	2,485	3,207	3,575	3,587	3,598	3,609	3,619	3,628	3,636	3,644	3,651	3,657	3,657
Critical Peak Pricing	-	-	-	-	-	2,086	6,121	13,575	17,022	18,702	18,764	18,823	18,879	18,930	18,976	19,019	19,059	19,096	19,129	19,129
Inclining Block Rates	-	-	-	-	-	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355	6,355
Time of Use Rate (Non Res)	-	-	-	-	-	71	216	506	654	729	734	737	741	744	748	751	755	758	762	762
Critical Peak Pricing (Non Res)	-	-	-	-	-	73	218	482	607	667	669	674	676	680	682	687	689	693	695	695
Real Time Pricing	-	-	-	-	-	113	302	604	717	755	755	755	755	755	755	755	755	755	755	755

Table 5-58 – Total Incentives per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$464,304**	**$806,046**	**$830,388**	**$868,175**	**$849,789**	**$833,241**	**$822,334**	**$817,258**	**$827,304**	**$838,590**	**$876,055**	**$878,165**	**$888,294**	**$890,765**	**$901,388**	**$901,563**	**$908,226**	**$914,293**	**$977,351**	**$977,351**
Total Residential	**$85,790**	**$167,075**	**$192,640**	**$174,085**	**$160,580**	**$142,250**	**$131,295**	**$128,640**	**$128,385**	**$127,830**	**$167,875**	**$169,920**	**$169,715**	**$169,760**	**$172,555**	**$172,600**	**$172,350**	**$171,850**	**$171,600**	**$171,600**
Residential Lighting	$40,150	$75,050	$77,500	$58,900	$45,350	$26,750	$15,750	$13,050	$12,750	$12,150	$12,150	$12,150	$11,900	$11,900	$12,650	$12,650	$12,400	$11,900	$11,650	$11,650
Whole House Efficiency	$45,640	$92,025	$115,140	$115,185	$115,230	$115,500	$115,545	$115,590	$115,635	$115,680	$155,725	$157,770	$157,815	$157,860	$159,905	$159,950	$159,950	$159,950	$159,950	$159,950
Residential Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Residential Low Income	**$8,282**	**$16,164**	**$21,202**	**$21,202**	**$21,202**	**$21,292**	**$21,292**	**$21,292**	**$31,518**	**$31,518**	**$43,608**	**$43,608**	**$43,608**	**$43,698**	**$43,698**	**$43,698**	**$43,788**	**$43,788**	**$43,788**	**$43,788**
Low Income Whole House Efficiency	$8,282	$16,164	$21,202	$21,202	$21,202	$21,292	$21,292	$21,292	$31,518	$31,518	$43,608	$43,608	$43,608	$43,698	$43,698	$43,698	$43,788	$43,788	$43,788	$43,788
Low Income Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$370,232**	**$622,807**	**$616,546**	**$672,888**	**$668,007**	**$669,699**	**$669,747**	**$667,326**	**$667,401**	**$679,242**	**$664,572**	**$664,637**	**$674,971**	**$677,307**	**$685,135**	**$685,265**	**$692,088**	**$698,655**	**$761,963**	**$761,963**
C&I Program	$370,232	$622,807	$616,546	$672,888	$668,007	$669,699	$669,747	$667,326	$667,401	$679,242	$664,572	$664,637	$674,971	$677,307	$685,135	$685,265	$692,088	$698,655	$761,963	$761,963
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Time of Use Rate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Inclining Block Rates	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Real Time Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table 5-59 – Total Utility Administrative Costs per Program

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$484,305**	**$842,276**	**$847,227**	**$851,512**	**$827,919**	**$2,060,264**	**$1,739,256**	**$2,236,020**	**$1,798,349**	**$1,593,226**	**$1,407,423**	**$1,408,856**	**$1,421,011**	**$1,420,832**	**$1,425,551**	**$1,429,472**	**$1,431,392**	**$1,436,506**	**$1,469,486**	**$1,469,486**
Total Residential	**$207,636**	**$381,647**	**$406,818**	**$389,549**	**$378,102**	**$352,045**	**$349,766**	**$343,975**	**$345,584**	**$345,961**	**$371,976**	**$373,253**	**$372,973**	**$373,012**	**$374,663**	**$374,688**	**$374,465**	**$374,066**	**$373,205**	**$373,205**
Residential Lighting	$41,296	$69,135	$69,156	$52,347	$40,328	$22,674	$18,799	$15,112	$14,834	$14,108	$14,162	$14,161	$13,995	$13,994	$14,458	$14,456	$14,297	$13,980	$13,791	$13,791
Whole House Efficiency	$71,268	$131,425	$159,601	$159,345	$159,714	$154,745	$155,737	$154,480	$155,648	$156,340	$181,937	$183,224	$183,168	$183,214	$184,441	$184,477	$184,435	$184,381	$183,936	$183,936
Residential Behavioral	$95,072	$181,086	$178,060	$177,857	$178,060	$174,626	$175,231	$174,384	$175,102	$175,513	$175,877	$175,867	$175,810	$175,804	$175,765	$175,755	$175,733	$175,706	$175,479	$175,479
Total Residential Low Income	**$46,422**	**$87,252**	**$90,007**	**$89,880**	**$90,006**	**$87,937**	**$88,315**	**$87,785**	**$97,022**	**$97,324**	**$104,077**	**$104,069**	**$104,021**	**$104,091**	**$104,058**	**$104,050**	**$104,108**	**$104,085**	**$103,894**	**$103,894**
Low Income Whole House Efficiency	$8,393	$14,818	$18,783	$18,737	$18,782	$18,087	$18,223	$18,032	$26,981	$27,118	$33,726	$33,722	$33,697	$33,769	$33,752	$33,748	$33,815	$33,802	$33,702	$33,702
Low Income Behavioral	$38,029	$72,434	$71,224	$71,143	$71,224	$69,851	$70,092	$69,753	$70,041	$70,205	$70,351	$70,347	$70,324	$70,322	$70,306	$70,302	$70,293	$70,282	$70,191	$70,191
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$230,247**	**$373,377**	**$350,402**	**$372,084**	**$359,810**	**$330,922**	**$327,350**	**$321,630**	**$326,795**	**$334,927**	**$336,768**	**$336,774**	**$349,474**	**$349,384**	**$352,771**	**$356,772**	**$359,016**	**$364,696**	**$399,697**	**$399,697**
C&I Program	$230,247	$373,377	$350,402	$372,084	$359,810	$330,922	$327,350	$321,630	$326,795	$334,927	$336,768	$336,774	$349,474	$349,384	$352,771	$356,772	$359,016	$364,696	$399,697	$399,697
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,289,360**	**$973,825**	**$1,482,629**	**$1,028,948**	**$815,014**	**$594,602**	**$594,760**	**$594,543**	**$594,345**	**$594,058**	**$593,962**	**$593,802**	**$593,659**	**$592,690**	**$592,690**
Time of Use Rate	$0	$0	$0	$0	$0	$240,652	$294,135	$543,560	$323,814	$212,788	$95,738	$95,751	$95,547	$95,423	$95,210	$95,125	$94,965	$94,856	$94,571	$94,571
Critical Peak Pricing	$0	$0	$0	$0	$0	$262,974	$335,637	$588,696	$360,531	$260,344	$159,727	$159,877	$159,965	$159,890	$159,881	$159,877	$159,907	$159,914	$159,659	$159,659
Inclining Block Rates	$0	$0	$0	$0	$0	$619,816	$270,417	$269,110	$270,219	$270,853	$271,415	$271,400	$271,311	$271,302	$271,242	$271,227	$271,194	$271,151	$270,801	$270,801
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$15,318	$9,296	$13,127	$9,751	$7,996	$6,225	$6,167	$6,229	$6,171	$6,234	$6,177	$6,240	$6,181	$6,237	$6,237
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$15,673	$9,941	$13,805	$10,371	$8,759	$7,171	$7,241	$7,184	$7,254	$7,199	$7,269	$7,214	$7,283	$7,219	$7,219
Real Time Pricing	$0	$0	$0	$0	$0	$134,927	$54,399	$54,331	$54,263	$54,274	$54,326	$54,323	$54,306	$54,304	$54,292	$54,289	$54,282	$54,274	$54,203	$54,203

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Table 5-60 – Customer Incremental Costs (NPV)

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**$951,383**	**$1,447,449**	**$1,437,835**	**$1,460,310**	**$1,388,384**	**$1,317,145**	**$1,253,888**	**$1,190,381**	**$1,141,800**	**$1,102,884**	**$1,097,417**	**$1,050,984**	**$1,010,683**	**$966,847**	**$937,811**	**$895,239**	**$857,791**	**$828,024**	**$837,465**	**$799,756**
Total Residential	**$161,214**	**$297,178**	**$336,780**	**$300,217**	**$271,811**	**$240,299**	**$220,257**	**$207,430**	**$197,818**	**$188,353**	**$244,400**	**$236,511**	**$225,599**	**$215,475**	**$209,299**	**$199,905**	**$190,657**	**$181,600**	**$173,197**	**$165,399**
Residential Lighting	$52,850	$96,572	$94,552	$68,842	$50,804	$28,953	$19,201	$15,383	$14,377	$13,131	$12,540	$11,975	$11,139	$10,637	$10,972	$10,478	$9,759	$8,847	$8,223	$7,853
Whole House Efficiency	$108,365	$200,606	$242,228	$231,375	$221,007	$211,346	$201,055	$192,046	$183,441	$175,221	$231,860	$224,536	$214,460	$204,837	$198,328	$189,428	$180,898	$172,753	$164,974	$157,546
Residential Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Residential Low Income	**$9,187**	**$17,625**	**$22,253**	**$21,251**	**$20,294**	**$19,429**	**$18,488**	**$17,656**	**$25,359**	**$24,217**	**$32,838**	**$31,360**	**$29,948**	**$28,633**	**$27,343**	**$26,112**	**$24,966**	**$23,841**	**$22,768**	**$21,743**
Low Income Whole House Efficiency	$9,187	$17,625	$22,253	$21,251	$20,294	$19,429	$18,488	$17,656	$25,359	$24,217	$32,838	$31,360	$29,948	$28,633	$27,343	$26,112	$24,966	$23,841	$22,768	$21,743
Low Income Behavioral	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Low Income Weatherization	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Business	**$780,982**	**$1,132,646**	**$1,078,802**	**$1,138,843**	**$1,096,279**	**$1,057,417**	**$1,015,143**	**$965,295**	**$918,623**	**$890,314**	**$820,179**	**$783,113**	**$755,137**	**$722,740**	**$701,168**	**$669,222**	**$642,168**	**$622,583**	**$641,500**	**$612,614**
C&I Program	$780,982	$1,132,646	$1,078,802	$1,138,843	$1,096,279	$1,057,417	$1,015,143	$965,295	$918,623	$890,314	$820,179	$783,113	$755,137	$722,740	$701,168	$669,222	$642,168	$622,583	$641,500	$612,614
Demand Response	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Time of Use Rate	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Inclining Block Rates	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Time of Use Rate (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Critical Peak Pricing (Non Res)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Real Time Pricing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

3.9 Sources and Quality of Information

(I) The utility shall describe and document how it performed the assessments and developed the estimates pursuant to subsection (3)(G) and shall provide documentation of its sources and quality of information.

The measure lifetime, gross energy, demand savings per unit, and incremental cost per unit are detailed in Section 3.7.

As required by 4 CSR 240-22.050, Liberty-Empire must achieve all cost-effective demand-side savings. AEG utilized measure and participation data from the comprehensive DSM Potential Study to inform and develop the DSM Program Design. Figure 5-21 outlines the framework for energy-efficiency measure analysis.

A comprehensive list of EE/DR measures was developed and screened for cost-effectiveness (i.e. a TRC benefit-cost ratio of at least 1.0). Each measure was characterized with energy and demand savings, incremental cost, service life, and other performance factors, drawing upon data from well-vetted national and regional sources. Energy-efficient measure energy and demand impacts were calculated using generally accepted engineering algorithms based on a set of reasonable assumptions.

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

Measures that were cost-effective within LoadMAP were included in the economic and achievable potential. The DSM Potential Study measure-level MAP and RAP were vetted for inclusion in a DSM program. Measures were bundled into programs and re-screened for cost-effectiveness. Except for the low-income weatherization and low-income new homes programs, the programs were designed to be cost-effective. Measures were bundled based on the end-use, sector and implementation.

The TRC test is the primary method of assessing the cost-effectiveness of energy efficient measures and programs. The TRC test is a widely-accepted methodology that has been used across the United States for over twenty-five years. TRC measures the net costs and benefits of an energy efficiency program as a resource option based on the total costs of the program, including both the participant's and the utility's costs. This test represents the combination of the effects of a program on both participating and non-participating customers.

Several sources of data were used to characterize the energy efficiency measures. AEG used recent studies performed for the Midwest, AEG data (e.g., DEEM database), and national and well-vetted regional data sources:

- AEG's Database of Energy Efficiency Measures.
- Consortium for Energy Efficiency. Program Resources.[18]
- ENERGY STAR. Energy Efficiency Product Specifications.[19]
- U.S. Department of Energy. Current Rulemakings and Notices.[20]
- Missouri Dept. of Economic Development, Division of Energy. Missouri Technical Reference Manual – 2017.
- Illinois Statewide Technical Reference Manual for Energy Efficiency. Draft Version 7.0 Effective January 1, 2019.
- Arkansas Public Service Commission. Arkansas Technical Reference Manual. Version 7.0 (August 31, 2017).
- State of Minnesota. Technical Reference Manual for Energy Conservation Improvement Programs. Version 2.1. Effective January 1, 2017 – December 31, 2018.

[18] Consortium for Energy Efficiency. Program Resources. https://www.cee1.org/
[19] Energy Star. Product Specifications and Partner Commitments Search. http://www.energystar.gov/products/spec/
[20] U.S. Department of Energy. Current Rulemakings and Notices. http://energy.gov/eere/buildings/current-rulemakings-and-notices

- Iowa Utilities Commission Broad. Iowa Energy Efficiency Statewide Technical Reference Manual Version 2.0. Effective January 1, 2018
- Michigan Public Service Commission (2018). Michigan Energy Measures Database. Prepared by Morgan Marketing Partners.
- Ameren Missouri 2017 Integrated Resource Plan. Appendix A – Technical Resource Manual.
- ComEd. ComEd Programs NTG Approach for EPY10.[21]

All measure calculations and sources are identified in the program design workbooks.

[21]http://ilsagfiles.org/SAG_files/NTG/2017_NTG_Meetings/Final/ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.pdf

(4) The utility shall develop potential demand-side rates designed for each market segment to reduce the net consumption of electricity or modify the timing of its use. The utility shall describe and document its demand-side rate planning and design process and shall include at least the following activities and elements:

4.1 Demand-Side Rate Review

(A) Review demand-side rates that have been implemented by other utilities and identify whether similar demand-side rates would be applicable for the utility taking into account factors such as similarity in electric prices and customer makeup;

AEG reviewed demand-side rates that have been implemented and/or piloted by other utilities. The table below details the different rate options in the region. Almost all of the options below require advanced metering technology.

Table 5-61 – Comparison of Demand-Side Rates

State	Utility	Rate Type	Status	Sector	Description
Missouri	KCP&L	Time of Use	Active	Residential	Varying prices for the different seasonal peaks On-Peak: 4pm-8pm, Monday through Friday Super Off-Peak: 12am-6am every day Off-Peak: All other hours[22]
Missouri	KCP&L	Real Time Pricing	Frozen	C&I	Maximum demand of at least 500 kW to participation. Daily 4:00 p.m., 24 hour hourly prices released for the following day[23]
Missouri	KCP&L	Block Rate	Active	Residential	Seasonal Volumetric Base Rate[24]

[22] https://www.kcpl.com/-/media/indexedmedia/my_bill/mo/detailed_tariffs_mo/modt_7residentialtimeofuse_2018-1210.pdf?la=en
[23] https://www.kcpl.com/-/media/indexedmedia/my_bill/mo/detailed_tariffs_mo/25realtimepricing.pdf?la=en
[24] https://www.kcpl.com/my-account/rate-information/rate-overviews/residential-rate-overview-missouri

Missouri	Ameren	Time of Day	Active	Residential	On Peak 2-7 PM M-F @ 31.5 cents/kWh Off Peak 7-2 PM M-F, All day weekend @7.87 cents/kWh
Missouri	Ameren	Time of Use	Inactive	Residential	Residential TOU 2005 Pilot[25]
Illinois	Ameren	Real Time Pricing	Active	Residential	Day ahead pricing[26]
Illinois	Ameren	Peak Time Rebate	Active	Residential	Peak Events called starting June 1. Customers earn bill credit.
Illinois	Ameren	Real Time Pricing	Active	C&I	Hourly Supply pricing[27]
Illinois	ComEd	Real Time Pricing	Active	Residential	Hourly – 10-11 AM @ 2.7 cents/kWh Day Ahead – 11-12 PM @ 2.9 cents/kWh[28] [29]
Illinois	ComEd	Peak Time Pricing	Active	Residential	Peak Events called between 11am-7am, 2-4 days a year. Customers earn bill credit.

This review provided a general sense of what kind of rates are implemented by utilities in the region. The utilities supply different rate options depending on the type of service territory, customer population, and the utilities' needs. To fully assess the applicability of a rate, a detailed rate design and pilot would have to be implemented. For the purposes of this IRP, AEG assessed potential at a high level using inputs from secondary data in regional demand-side rate impact evaluations.

(B) Identify demand-side rates applicable to the major classes and decision-makers identified in subsection (1)(A). When appropriate, consider multiple demand-side rate designs for the same major classes;

[25] ttps://www.smartgrid.gov/files/AmerenUE_Residential_TOU_Pilot_Study_Load_Research_Analysis_200605.pdf
[26] https://www.ameren.com/account/retail-energy
[27] https://www.ameren.com/illinois/electric-choice/business-real-time-pricing
[28] https://hourlypricing.comed.com/
[29] https://citizensutilityboard.org/wp-content/uploads/2017/11/FinalRealTimePricingWhitepaper.pdf

AEG assessed the three most common demand-side rate options for the Liberty-Empire service territory for a variety of different customer segments. The three most common types of demand-side rates are as follows:

- **Time-of-Use**. Customers pay a higher price during the designated peak period and lower prices during off-peak periods. The designated peak and off-peak periods are typically defined by the season, day and time of day. Requires an interval meter.
- **Critical Peak Price**. Customers pay higher peak period prices during a critical peak event day and pay a discounted off-peak price for the remainder of the year. A critical peak event day occurs multiple times a year and is typically called a day in advanced when it wholesale prices are forecasted to be highest. Requires an interval meter.
- **Real Time Pricing**. Customers pay for energy at a rate that is linked to the hourly market price for electricity. Depending on their size, participants are typically made aware of the hourly prices on either a day-ahead or hour-ahead basis. Typically, only the largest customers — above one megawatt of load — face hour-ahead prices. Requires an interval meter.

AEG also considered a residential Inclining Block Rate ("IBR"). IBR is considered a conservation rate that applies a differentiated rate based on customer usage. The rate increases as the amount of electricity consumed increases. Typically, the rate is separated into two blocks or tiers by a kWh threshold, with the first block below the threshold charged a specific rate and the second block above the threshold charged a higher rate. Unlike other demand response and rate-based options, this option has low to zero operation, maintenance and incentive costs. However, introducing this rate option requires a significant amount of rate-making and regulatory changes, all of which present challenges for implementing the rate and capturing the costs associated with doing so within the modeling. These rate options are summarized in Table 5-5.

(C) Assess how technological advancements that may be reasonably anticipated to occur during the planning horizon, including advanced metering and distribution systems, affect the ability to

implement demand-side rates;

Demand-side rates are most effective with the use of two-way communicating meters and interactive/wifi thermostats, which allow Liberty-Empire to communicate with customers in real-time. Two-way communicating meters (or smart meters) and interactive/wifi thermostats are not currently prevalent throughout Liberty-Empire's territory, making pilot programs more costly. The demand response programs were modeled to start in 2025 to give Liberty-Empire time to roll out AMI meters to participating customers.

(D) Estimate the input data and other characteristics needed for the twenty (20)-year planning horizon to assess the cost effectiveness of each potential demand-side rate, including:

1. An assessment of the demand and energy reduction impacts of each potential demand-side rate;

The demand-side rate impacts are shown in the table below.

Table 5-62 – Demand-Side Rate Impacts (Potential kW Savings)

Customer Class	Option	Peak Season	Unit	Per Unit Reduction
Residential	Battery Energy Storage	Summer Peak	% of Peak	70%
Residential	Battery Energy Storage	Winter Peak	% of Peak	70%
Residential	Behavioral	Summer Peak	% of Peak	2%
Residential	Behavioral	Winter Peak	% of Peak	1%
Residential	Critical Peak Pricing Rates	Summer Peak	% of Peak	25%
Residential	Critical Peak Pricing Rates	Winter Peak	% of Peak	13%
Residential	DLC Space Heating	Winter Peak	kW @meter	1.80
Residential	DLC Central AC	Summer Peak	kW @meter	1.26
Residential	DLC EV Charging	Summer Peak	kW @meter	0.28
Residential	DLC EV Charging	Winter Peak	kW @meter	0.28
Residential	DLC Smart Thermostats	Summer Peak	kW @meter	1.26
Residential	DLC Smart Thermostats	Winter Peak	kW @meter	0.44
Residential	DLC Water Heating	Summer Peak	kW @meter	0.58
Residential	DLC Water Heating	Winter Peak	kW @meter	0.58

Residential	Inclining Block Rates	Summer Peak	% of Peak	2%
Residential	Inclining Block Rates	Winter Peak	% of Peak	2%
Residential	Thermal Energy Storage	Summer Peak	kW @meter	1.68
Residential	Time-of-Use Rates	Summer Peak	% of Peak	6%
Residential	Time-of-Use Rates	Winter Peak	% of Peak	3%
Small Non-Residential Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Small Non-Residential Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Small Non-Residential Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Small Non-Residential Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Small Non-Residential Metered	DLC Space Heating	Winter Peak	kW @meter	1.18
Small Non-Residential Metered	DLC Central AC	Summer Peak	kW @meter	1.51
Small Non-Residential Metered	DLC Smart Thermostats	Summer Peak	kW @meter	2.52
Small Non-Residential Metered	DLC Smart Thermostats	Winter Peak	kW @meter	0.77
Small Non-Residential Metered	Thermal Energy Storage	Summer Peak	kW @meter	1.68
Small Non-Residential Metered	Time-of-Use Rates	Summer Peak	% of Peak	3%
Small Non-Residential Metered	Time-of-Use Rates	Winter Peak	% of Peak	1%
Non-Residential Non-Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Non-Residential Non-Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Non-Residential Non-Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Non-Residential Non-Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Non-Residential Non-Metered	DLC Space Heating	Winter Peak	kW @meter	1.18
Non-Residential Non-Metered	DLC Central AC	Summer Peak	kW @meter	1.51
Non-Residential Non-Metered	DLC Smart Thermostats	Summer Peak	kW @meter	1.26
Non-Residential Non-Metered	DLC Smart Thermostats	Winter Peak	kW @meter	0.32

Non-Residential Non-Metered	Thermal Energy Storage	Summer Peak	kW @meter	1.68
Large Non-Residential Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Large Non-Residential Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Large Non-Residential Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Large Non-Residential Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Large Non-Residential Metered	Curtailment - Firm	Summer Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Firm	Winter Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Non Firm	Summer Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Non Firm	Winter Peak	% of Peak	21%
Large Non-Residential Metered	Real Time Pricing	Summer Peak	% of Peak	9%
Large Non-Residential Metered	Real Time Pricing	Winter Peak	% of Peak	9%
Large Non-Residential Metered	Thermal Energy Storage	Summer Peak	kW @meter	8.40
Large Non-Residential Metered	Time-of-Use Rates	Summer Peak	% of Peak	3%
Large Non-Residential Metered	Time-of-Use Rates	Winter Peak	% of Peak	2%

2. *An assessment of how the interactions between multiple potential demand-side rates, if offered simultaneously, would affect the impact estimates;*

The demand-side rates were screened for cost-effectiveness as stand-alone pilot programs. Programs that that were determined to be cost-effective by customer class were bundled together to assess overall impacts. To avoid double-counting of load reduction impacts, program-eligibility criteria were defined to ensure that customers do not participate in mutually exclusive programs at the same time. For example, residential customers cannot participate in both a Critical Peak Pricing option and in Inclining Block Rates. A program hierarchy, or loading order, was developed to prevent double counting the potential estimates among programs. Table

5-63 shows the participation hierarchy by customer sector for applicable DR/DSR options. With the hierarchy activated, each successive resource that is run in the model stack has a newly updated pool of eligible participants where customers enrolled in previously-stacked, competing resource options have been removed. The participation rate for that resource is then applied to the new pool of eligible participants, rather than the entire, original pool.

Table 5-63 – Program Hierarchy by Segment

	Customer Class	Residential	Non-Residential Non-Metered	Small Non-Residential Metered	Large Non-Residential Metered
Loaded First	DLC Central AC	X	X	X	
	DLC Smart Thermostats	X	X	X	
	DLC Water Heating	X			
	DLC Space Heating	X	X	X	
	DLC Electric Vehicle Charging	X			
	Curtailment - Non Firm				X
	Curtailment - Firm				X
	Time-of-Use Rates	X	X	X	X
	Critical Peak Pricing Rates	X	X	X	X
	Inclining Block Rates	X			
	Real Time Pricing				X
	Behavioral	X			
Loaded Last	Thermal Energy Storage	X	X	X	X
	Battery Energy Storage	X	X	X	X

3. An assessment of how the interactions between potential demand-side rates and potential demand-side programs would affect the impact estimates of the potential demand-side programs and potential demand-side rates;

The interactions between potential demand-side rates and potential demand-side programs were assessed. To avoid double counting of load reduction impacts, program-eligibility criteria were defined to ensure that customers do not participate in mutually exclusive programs at the same time.

4. For each year of the planning horizon, an estimate of the incremental and cumulative demand reduction and energy savings due to the potential demand-side rate; and

The realistic and maximum achievable potential incremental demand and energy savings due to the potential demand-side rate pilot programs can be found in the following tables separately for the winter and summer peak forecasts. These savings are estimated using an average demand reduction per unit. A detailed rate design study would need to be performed to assess the precise impact within the Liberty-Empire service territory.

Many of these demand side rates depend on advanced metering infrastructure. There are also other business cases that were outside of the scope of the study that apply to the wider Liberty-Empire company. While resources were identified as cost-effective and included in the modeling, it is recommended that Liberty-Empire follow up with additional scoping studies and/or pilots to further study implementation designs.

While the Inclining Block Rate was cost-effective, significant rate-making needs to take place to put the rate into effect. Additionally, the savings associated with Inclining Block Rates is subjective; an average savings value was utilized for the analysis but zero savings could be seen with the implementation of such a rate. Liberty-Empire's current capacity balance and forecast do not necessitate or support taking potentially costly measures to promote additional conservation at peak times.

Liberty-Empire is currently considering a plan to incorporate advanced metering technology within the service territory as described in Section 3.4 of this volume. Due to the technical constraints of installation and connectivity, as well as the planning/regulatory phase for rate designs, Liberty-Empire does not anticipate the ability to implement rates until after 2025.

Table 5-64 – Realistic Achievable Potential Incremental Net Coincident Demand Savings (MW)

Incremental Summer Peak Reduction @Generation (MW) - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.14	0.40	0.89	1.12	1.23	1.23	1.23	1.24	1.24	1.25	1.25	1.26	1.26	1.27	1.27
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.45	1.35	3.16	4.08	4.55	4.57	4.59	4.60	4.62	4.63	4.65	4.67	4.69	4.71	4.73
Critical Peak Pricing Rates	Residential	1.87	5.48	12.14	15.23	16.74	16.80	16.86	16.90	16.96	17.02	17.09	17.17	17.24	17.32	17.39
Critical Peak Pricing Rates	Small Non-Residential Metered	0.30	0.89	1.97	2.47	2.72	2.73	2.74	2.74	2.75	2.76	2.78	2.79	2.80	2.81	2.82
Inclining Block Rates	Residential	7.02	9.50	8.46	7.99	7.77	7.80	7.82	7.85	7.87	7.90	7.94	7.97	8.00	8.04	8.07
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.08	0.19	0.24	0.27	0.27	0.27	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Time-of-Use Rates	Residential	0.38	1.14	2.66	3.44	3.83	3.85	3.86	3.87	3.89	3.90	3.92	3.93	3.95	3.97	3.98
Time-of-Use Rates	Small Non-Residential Metered	0.05	0.15	0.35	0.45	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52	0.53
Total		**10.23**	**19.00**	**29.83**	**35.03**	**37.62**	**37.75**	**37.89**	**37.99**	**38.12**	**38.25**	**38.42**	**38.59**	**38.76**	**38.93**	**39.09**

Table 5-65 – Maximum Achievable Potential Incremental Net Coincident Demand Savings (MW)

Incremental Summer Peak Reduction @Generation (MW) - Maximum Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.23	0.66	1.46	1.82	2.00	2.00	2.01	2.02	2.02	2.03	2.04	2.05	2.06	2.07	2.07
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.75	2.25	5.27	6.81	7.59	7.62	7.65	7.67	7.69	7.72	7.75	7.79	7.82	7.86	7.89
Critical Peak Pricing Rates	Residential	3.73	10.89	23.90	29.85	32.71	32.83	32.94	33.03	33.15	33.27	33.41	33.56	33.70	33.85	33.99
Critical Peak Pricing Rates	Small Non-Residential Metered	0.50	1.47	3.24	4.04	4.43	4.44	4.46	4.47	4.49	4.50	4.52	4.54	4.56	4.58	4.60
Inclining Block Rates	Residential	6.93	9.15	7.70	7.03	6.72	6.74	6.77	6.79	6.81	6.83	6.86	6.89	6.92	6.95	6.98
Real Time Pricing	Large Non-Residential Metered	0.19	0.52	1.02	1.20	1.28	1.28	1.29	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.09	0.22	0.28	0.31	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.33	0.33
Time-of-Use Rates	Residential	0.44	1.31	3.07	3.97	4.42	4.44	4.46	4.47	4.48	4.50	4.52	4.54	4.56	4.58	4.60
Time-of-Use Rates	Small Non-Residential Metered	0.06	0.17	0.41	0.52	0.59	0.59	0.59	0.59	0.59	0.60	0.60	0.60	0.60	0.61	0.61
Total		**12.86**	**26.54**	**46.29**	**55.53**	**60.05**	**60.26**	**60.48**	**60.64**	**60.85**	**61.07**	**61.33**	**61.60**	**61.87**	**62.14**	**62.40**

Table 5-66 – Realistic Achievable Potential Cumulative Net Coincident Demand Savings (MW)

Cumulative Summer Peak Reduction @Generation (MW) - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.14	0.54	1.43	2.54	3.77	5.00	6.23	7.47	8.71	9.96	11.21	12.47	13.73	15.00	16.27
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.45	1.80	4.96	9.05	13.60	18.17	22.76	27.36	31.98	36.61	41.26	45.94	50.63	55.34	60.07
Critical Peak Pricing Rates	Residential	1.87	7.35	19.49	34.72	51.45	68.25	85.10	102.00	118.96	135.98	153.08	170.24	187.49	204.81	222.20
Critical Peak Pricing Rates	Small Non-Residential Metered	0.30	1.19	3.16	5.64	8.36	11.08	13.82	16.57	19.32	22.08	24.86	27.65	30.45	33.26	36.09
Inclining Block Rates	Residential	7.02	16.52	24.98	32.97	40.74	48.54	56.37	64.21	72.08	79.98	87.92	95.89	103.89	111.93	120.01
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.11	0.30	0.54	0.81	1.09	1.36	1.64	1.91	2.19	2.47	2.75	3.03	3.31	3.60
Time-of-Use Rates	Residential	0.38	1.52	4.18	7.62	11.45	15.30	19.16	23.03	26.92	30.82	34.73	38.67	42.62	46.58	50.57
Time-of-Use Rates	Small Non-Residential Metered	0.05	0.20	0.55	1.01	1.51	2.02	2.53	3.05	3.56	4.08	4.59	5.12	5.64	6.16	6.69
Total		**10.23**	**29.23**	**59.05**	**94.09**	**131.70**	**169.46**	**207.34**	**245.33**	**283.45**	**321.70**	**360.13**	**398.72**	**437.47**	**476.40**	**515.49**

Table 5-67 – Maximum Achievable Potential Cumulative Net Coincident Demand Savings (MW)

Cumulative Summer Peak Reduction @Generation (MW) - Maximum Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.23	0.89	2.35	4.17	6.17	8.17	10.18	12.20	14.22	16.25	18.29	20.33	22.39	24.46	26.53
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.75	3.00	8.27	15.08	22.67	30.29	37.94	45.60	53.30	61.02	68.77	76.56	84.38	92.24	100.12
Critical Peak Pricing Rates	Residential	3.73	14.62	38.53	68.37	101.08	133.91	166.86	199.89	233.04	266.30	299.71	333.27	366.97	400.82	434.82
Critical Peak Pricing Rates	Small Non-Residential Metered	0.50	1.98	5.21	9.25	13.68	18.12	22.58	27.05	31.54	36.04	40.56	45.11	49.67	54.25	58.85
Inclining Block Rates	Residential	6.93	16.09	23.78	30.82	37.54	44.28	51.05	57.84	64.65	71.48	78.35	85.24	92.16	99.12	106.10
Real Time Pricing	Large Non-Residential Metered	0.19	0.71	1.74	2.94	4.22	5.50	6.79	8.08	9.37	10.67	11.98	13.29	14.61	15.93	17.26
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.12	0.34	0.62	0.94	1.26	1.57	1.89	2.21	2.53	2.85	3.17	3.50	3.82	4.15
Time-of-Use Rates	Residential	0.44	1.75	4.82	8.79	13.21	17.65	22.11	26.58	31.06	35.56	40.08	44.62	49.17	53.75	58.35
Time-of-Use Rates	Small Non-Residential Metered	0.06	0.23	0.64	1.16	1.75	2.34	2.92	3.52	4.11	4.70	5.30	5.90	6.51	7.11	7.72
Total		**12.86**	**39.40**	**85.69**	**141.22**	**201.26**	**261.53**	**322.00**	**382.64**	**443.49**	**504.56**	**565.89**	**627.49**	**689.36**	**751.49**	**813.90**

5. For each year of the planning horizon, an estimate of the costs of each potential demand-side rate, including:

A. The cost of incentives to customers to participate in the potential demand-side rate paid by the utility. The utility shall consider multiple levels of incentives to achieve customer participation in each potential demand-side rate, with corresponding adjustments to the maximum achievable potential and the realistic achievable potentials of that potential demand-side rate;

The demand ride rates that were found to be cost effective do not include a direct incentive to customers paid by the utility.

B. The cost to the customer and to the utility of technology to implement the potential demand-side rate;

AEG did not identify any costs to the customer for participating in demand-side rate programs. The total cost to the utility to implement the potential demand side rate is included below for the realistic achievable potential scenario and maximum achievable potential scenarios.

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Table 5-68 – Non-Incentive Costs for DR and DSR Options for Realistic Achievable Potential

Non-Incentive Costs - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	$2,872.27	$3,142.64	$3,630.76	$3,312.92	$3,182.96	$3,031.45	$3,050.00	$3,069.37	$3,090.04	$3,111.73	$3,133.53	$3,155.66	$3,178.58	$3,202.25	$3,226.93
Critical Peak Pricing Rates	Non-Residential Non-Metered	$45,753.79	$80,198.74	$151,160.45	$111,465.77	$91,868.41	$66,095.71	$67,484.60	$68,957.27	$70,580.52	$72,313.36	$74,030.80	$75,759.81	$77,565.66	$79,441.12	$81,421.82
Critical Peak Pricing Rates	Residential	$184,911.12	$360,965.64	$683,286.04	$482,155.16	$397,316.03	$295,841.08	$303,168.89	$310,604.23	$318,017.12	$325,667.03	$333,480.52	$341,487.29	$349,663.88	$357,965.68	$366,360.15
Critical Peak Pricing Rates	Small Non-Residential Metered	$6,894.85	$9,794.86	$15,088.31	$11,514.24	$10,004.91	$8,256.60	$8,376.89	$8,504.08	$8,643.48	$8,791.84	$8,939.25	$9,087.85	$9,242.84	$9,403.64	$9,573.10
Inclining Block Rates	Residential	$359,147.04	$170,110.73	$61,670.99	$61,962.77	$62,261.84	$63,804.41	$64,094.54	$64,377.75	$64,624.30	$64,903.80	$65,193.65	$65,499.98	$65,815.03	$66,127.24	$66,429.94
Time-of-Use Rates	Large Non-Residential Metered	$1,957.51	$2,153.52	$2,548.49	$2,198.01	$2,022.39	$1,834.05	$1,842.68	$1,851.92	$1,862.11	$1,872.90	$1,883.46	$1,894.03	$1,905.04	$1,916.41	$1,928.37
Time-of-Use Rates	Residential	$168,809.89	$288,942.13	$535,703.57	$305,745.94	$187,456.34	$61,753.30	$61,958.54	$62,119.80	$62,133.62	$62,240.54	$62,361.77	$62,518.04	$62,681.88	$62,812.69	$62,886.85
Time-of-Use Rates	Small Non-Residential Metered	$4,869.81	$6,950.12	$11,217.20	$7,282.35	$5,269.04	$3,113.65	$3,122.97	$3,136.71	$3,158.82	$3,185.28	$3,206.88	$3,226.16	$3,247.89	$3,271.21	$3,298.30
Total		**$775,216.28**	**$922,258.38**	**$1,464,305.81**	**$985,637.16**	**$759,381.92**	**$503,730.25**	**$513,099.11**	**$522,621.13**	**$532,110.01**	**$542,086.48**	**$552,229.86**	**$562,628.82**	**$573,300.80**	**$584,140.24**	**$595,125.46**

C. The utility's cost to administer the potential demand-side rate; and

Below are the cost assumptions for the different components of a utility's cost to implement potential demand-side rates and demand response program. The different categories include program administration, program development costs, customer incentive, cost of equipment/installation, and annual marketing/recruitment costs. Inputs were developed using secondary research.

Table 5-69 – Program Cost Assumptions for DR and DSR Options

Program	Cost Type	Unit	Cost, RAP ($)	Cost, MAP ($)
DLC Central AC	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75
	Program Development Cost	$/program	$75,000	$75,000
DLC Electric Vehicle Charging	Annual O&M Cost	$/participant/year	$11	$11
	Annual Program Administration Cost	$/yr	$41,667	$41,667
	Cost of Equip + Install	$/tech	$1,200	$1,200
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$90	$108
	Per Participant Annual Incentive	$/participant/year	$24	$24
	Program Development Cost	$/program	$75,000	$75,000
DLC Smart Thermostats	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75
	Program Development Cost	$/program	$75,000	$75,000
DLC Space Heating	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75

	Program Development Cost	$/program	$75,000	$75,000
DLC Water Heating	Cost of Equip + Install	$/tech	$300	$300
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$90	$108
	Per Participant Annual Incentive	$/participant/year	$24	$24
	Program Development Cost	$/program	$75,000	$75,000
Curtailment - Firm, Non-Firm	Per kW Annual Incentive	$/kW @meter/year	$50	$50
	Per kW Annual Incentive	$/kW @meter/year	$50	$50
Time-of-Use Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Critical Peak Pricing Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Cost of Equip + Install	$/tech	$150	$375
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$5	$5
Inclining Block Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Real Time Pricing	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$60	$72
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Behavioral	Annual O&M Cost	$/participant/year	$3	$3
	Program Development Cost	$/program	$40,000	$40,000
Battery Energy Storage	Annual Program Administration Cost	$/yr	$20,833	$20,833
	Cost of Equip + Install	$/tech	$111,590	$111,590
	Program Development Cost	$/program	$75,000	$75,000
	Annual Program Administration Cost	$/yr	$41,667	$41,667

Thermal Energy Storage	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000

D. Other costs identified by the utility;

AEG did not identify any other costs for the demand-side rates.

(E) A tabulation of the incremental and cumulative number of participants, load impacts, utility costs, and program participant costs in each year of the planning horizon for each potential demand-side program;

Table 5-70 through Table 5-75 detail the number of participants, load reductions, and program costs for the realistic achievable scenario. Incremental participants for DR and DSRs represent the number of new customers each year. The cumulative number of participants is used to calculate savings due to the nature of continued enrollment within the program or rate.

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Table 5-70 – Incremental Participants for DR and DSR Options

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	3	6	10	5	2	0	0	0	0	0	0	0	0	0	0
Critical Peak Pricing Rates	Non-Residential Non-Metered	350	705	1,417	722	373	18	17	16	17	18	18	18	18	18	19
Critical Peak Pricing Rates	Residential	2,191	4,239	7,828	3,621	1,765	65	62	59	53	49	45	42	39	35	31
Critical Peak Pricing Rates	Small Non-Residential Metered	31	61	112	52	26	1	1	1	1	1	1	1	1	1	2
Inclining Block Rates	Residential	102,799	36,586	0	0	0	377	360	340	308	285	262	243	224	204	179
Time-of-Use Rates	Large Non-Residential Metered	3	5	10	5	3	0	0	0	0	0	0	0	0	0	0
Time-of-Use Rates	Residential	1,943	3,913	7,864	3,985	2,035	65	62	59	53	49	45	42	39	35	31
Time-of-Use Rates	Small Non-Residential Metered	28	56	113	58	30	1	1	1	1	1	1	1	1	1	2
Total		**107,348**	**45,571**	**17,355**	**8,447**	**4,234**	**528**	**505**	**477**	**435**	**404**	**374**	**348**	**323**	**295**	**263**

Table 5-71 – Cumulative Participants for DR and DSR Options

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	3	8	19	23	26	26	26	26	26	26	26	27	27	27	27
Critical Peak Pricing Rates	Non-Residential Non-Metered	350	1,054	2,471	3,193	3,565	3,584	3,600	3,617	3,633	3,651	3,669	3,687	3,705	3,723	3,742
Critical Peak Pricing Rates	Residential	2,191	6,430	14,259	17,880	19,645	19,710	19,772	19,831	19,884	19,933	19,978	20,020	20,059	20,094	20,125
Critical Peak Pricing Rates	Small Non-Residential Metered	31	92	205	257	283	284	286	287	288	290	291	293	294	296	297
Inclining Block Rates	Residential	102,799	139,385	124,311	117,266	113,994	114,371	114,731	115,072	115,380	115,665	115,927	116,170	116,395	116,598	116,778
Time-of-Use Rates	Large Non-Residential Metered	3	8	18	23	26	26	26	26	26	26	27	27	27	27	27
Time-of-Use Rates	Residential	1,943	5,856	13,720	17,705	19,740	19,805	19,868	19,926	19,980	20,029	20,075	20,117	20,156	20,191	20,222
Time-of-Use Rates	Small Non-Residential Metered	28	84	197	255	284	286	287	288	290	291	293	294	296	297	298
Total		**107,348**	**152,919**	**155,198**	**156,601**	**157,563**	**158,092**	**158,596**	**159,073**	**159,508**	**159,912**	**160,286**	**160,634**	**160,957**	**161,253**	**161,516**

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Table 5-72 – Incremental Summer Peak Reduction @Generation (MW) for DR and DSR Options

Incremental Summer Peak Reduction @Generation (MW) - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.14	0.40	0.89	1.12	1.23	1.23	1.23	1.24	1.24	1.25	1.25	1.26	1.26	1.27	1.27
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.45	1.35	3.16	4.08	4.55	4.57	4.59	4.60	4.62	4.63	4.65	4.67	4.69	4.71	4.73
Critical Peak Pricing Rates	Residential	1.87	5.48	12.14	15.23	16.74	16.80	16.86	16.90	16.96	17.02	17.09	17.17	17.24	17.32	17.39
Critical Peak Pricing Rates	Small Non-Residential Metered	0.30	0.89	1.97	2.47	2.72	2.73	2.74	2.74	2.75	2.76	2.78	2.79	2.80	2.81	2.82
Inclining Block Rates	Residential	7.02	9.50	8.46	7.99	7.77	7.80	7.82	7.85	7.87	7.90	7.94	7.97	8.00	8.04	8.07
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.08	0.19	0.24	0.27	0.27	0.27	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Time-of-Use Rates	Residential	0.38	1.14	2.66	3.44	3.83	3.85	3.86	3.87	3.89	3.90	3.92	3.93	3.95	3.97	3.98
Time-of-Use Rates	Small Non-Residential Metered	0.05	0.15	0.35	0.45	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52	0.53
Total		**10.23**	**19.00**	**29.83**	**35.03**	**37.62**	**37.75**	**37.89**	**37.99**	**38.12**	**38.25**	**38.42**	**38.59**	**38.76**	**38.93**	**39.09**

Table 5-73 – Cumulative Summer Peak Reduction @Generation (MW) for DR and DR Options

Cumulative Summer Peak Reduction @Generation (MW) - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	0.14	0.54	1.43	2.54	3.77	5.00	6.23	7.47	8.71	9.96	11.21	12.47	13.73	15.00	16.27
Critical Peak Pricing Rates	Non-Residential Non-Metered	0.45	1.80	4.96	9.05	13.60	18.17	22.76	27.36	31.98	36.61	41.26	45.94	50.63	55.34	60.07
Critical Peak Pricing Rates	Residential	1.87	7.35	19.49	34.72	51.45	68.25	85.10	102.00	118.96	135.98	153.08	170.24	187.49	204.81	222.20
Critical Peak Pricing Rates	Small Non-Residential Metered	0.30	1.19	3.16	5.64	8.36	11.08	13.82	16.57	19.32	22.08	24.86	27.65	30.45	33.26	36.09
Inclining Block Rates	Residential	7.02	16.52	24.98	32.97	40.74	48.54	56.37	64.21	72.08	79.98	87.92	95.89	103.89	111.93	120.01
Time-of-Use Rates	Large Non-Residential Metered	0.03	0.11	0.30	0.54	0.81	1.09	1.36	1.64	1.91	2.19	2.47	2.75	3.03	3.31	3.60
Time-of-Use Rates	Residential	0.38	1.52	4.18	7.62	11.45	15.30	19.16	23.03	26.92	30.82	34.73	38.67	42.62	46.58	50.57
Time-of-Use Rates	Small Non-Residential Metered	0.05	0.20	0.55	1.01	1.51	2.02	2.53	3.05	3.56	4.08	4.59	5.12	5.64	6.16	6.69
Total		**10.23**	**29.23**	**59.05**	**94.09**	**131.70**	**169.46**	**207.34**	**245.33**	**283.45**	**321.70**	**360.13**	**398.72**	**437.47**	**476.40**	**515.49**

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Table 5-74 – Non-Incentive Utility Costs for DR and DR Options

Non-Incentive Costs - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	$2,872.27	$3,142.64	$3,630.76	$3,312.92	$3,182.96	$3,031.45	$3,050.00	$3,069.37	$3,090.04	$3,111.73	$3,133.53	$3,155.66	$3,178.58	$3,202.25	$3,226.93
Critical Peak Pricing Rates	Non-Residential Non-Metered	$45,753.79	$80,198.74	$151,160.45	$111,465.77	$91,868.41	$66,095.71	$67,484.60	$68,957.27	$70,580.52	$72,313.36	$74,030.80	$75,759.81	$77,565.66	$79,441.12	$81,421.82
Critical Peak Pricing Rates	Residential	$184,911.12	$360,965.64	$683,286.04	$482,155.16	$397,316.03	$295,841.08	$303,168.89	$310,604.23	$318,017.12	$325,667.03	$333,480.52	$341,487.29	$349,663.88	$357,965.68	$366,360.15
Critical Peak Pricing Rates	Small Non-Residential Metered	$6,894.85	$9,794.86	$15,088.31	$11,514.24	$10,004.91	$8,256.60	$8,376.89	$8,504.08	$8,643.48	$8,791.84	$8,939.25	$9,087.85	$9,242.84	$9,403.64	$9,573.10
Inclining Block Rates	Residential	$359,147.04	$170,110.73	$61,670.99	$61,962.77	$62,261.84	$63,804.41	$64,094.54	$64,377.75	$64,624.30	$64,903.80	$65,193.65	$65,499.98	$65,815.03	$66,127.24	$66,429.94
Time-of-Use Rates	Large Non-Residential Metered	$1,957.51	$2,153.52	$2,548.49	$2,198.01	$2,022.39	$1,834.05	$1,842.68	$1,851.92	$1,862.11	$1,872.90	$1,883.46	$1,894.03	$1,905.04	$1,916.41	$1,928.37
Time-of-Use Rates	Residential	$168,809.89	$288,942.13	$535,703.57	$305,745.94	$187,456.34	$61,753.30	$61,958.54	$62,119.80	$62,133.62	$62,240.54	$62,361.77	$62,518.04	$62,681.88	$62,812.69	$62,886.85
Time-of-Use Rates	Small Non-Residential Metered	$4,869.81	$6,950.12	$11,217.20	$7,282.35	$5,269.04	$3,113.65	$3,122.97	$3,136.71	$3,158.82	$3,185.28	$3,206.88	$3,226.16	$3,247.89	$3,271.21	$3,298.30
Total		**$775,216.28**	**$922,258.38**	**$1,464,305.81**	**$985,637.16**	**$759,381.92**	**$503,730.25**	**$513,099.11**	**$522,621.13**	**$532,110.01**	**$542,086.48**	**$552,229.86**	**$562,628.82**	**$573,300.80**	**$584,140.24**	**$595,125.46**

Table 5-75 – Annual DR and DSR Option Benefits (NPV)

Program Annual Benefits - Realistic Achievable Potential

Program	Customer Class	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Critical Peak Pricing Rates	Large Non-Residential Metered	$5,013	$17,605	$45,182	$64,148	$71,185	$72,145	$73,095	$73,955	$78,226	$81,628	$88,367	$88,656	$88,842	$95,876	$95,809
Critical Peak Pricing Rates	Non-Residential Non-Metered	$16,415	$59,208	$160,581	$234,663	$264,248	$267,810	$271,342	$274,532	$290,397	$303,034	$328,073	$329,134	$329,817	$355,953	$355,690
Critical Peak Pricing Rates	Residential	$68,659	$241,010	$618,350	$877,711	$974,015	$987,177	$1,000,148	$1,011,933	$1,070,318	$1,116,830	$1,208,903	$1,212,928	$1,215,532	$1,311,638	$1,310,799
Critical Peak Pricing Rates	Small Non-Residential Metered	$11,098	$38,984	$100,069	$142,098	$157,684	$159,809	$161,917	$163,821	$173,288	$180,829	$195,770	$196,403	$196,810	$212,406	$212,250
Inclining Block Rates	Residential	$896,097	$1,297,101	$1,239,005	$1,242,590	$1,223,608	$1,245,159	$1,259,184	$1,274,835	$1,327,915	$1,373,536	$1,440,763	$1,464,425	$1,486,062	$1,554,011	$1,580,366
Time-of-Use Rates	Large Non-Residential Metered	$1,563	$5,300	$13,814	$19,598	$22,088	$22,431	$22,742	$23,004	$24,162	$25,120	$26,810	$27,051	$27,279	$29,015	$29,243
Time-of-Use Rates	Residential	$22,484	$76,068	$197,943	$280,384	$316,051	$321,015	$325,369	$329,166	$345,609	$359,230	$383,128	$386,736	$390,112	$414,660	$418,090
Time-of-Use Rates	Small Non-Residential Metered	$2,858	$9,710	$25,345	$35,999	$40,566	$41,192	$41,771	$42,247	$44,386	$46,155	$49,286	$49,712	$50,121	$53,338	$53,742
Total		**$1,024,187**	**$1,744,986**	**$2,400,290**	**$2,897,191**	**$3,069,445**	**$3,116,739**	**$3,155,567**	**$3,193,493**	**$3,354,301**	**$3,486,363**	**$3,721,100**	**$3,755,044**	**$3,784,576**	**$4,026,897**	**$4,055,989**

(F) Evaluate how each demand-side rate would be considered by the utility's Regional Transmission Organization (RTO) in resource adequacy determinations, eligibility to participate as a demand response resource in RTO markets for energy, capacity, and ancillary services; and

Liberty-Empire's analysis did not include consideration of RTO treatment at this time. Liberty-Empire's RTO does not currently have a market for demand-side resources. In the absence of a market and market rules, there is no firm basis for estimating the value of these resources at the RTO level. Liberty-Empire will consider this type of treatment in the future as a market is developed.

(G) The utility shall describe and document how it performed the assessments and developed the estimates pursuant to subsection (4)(D) and shall document its sources and quality of information.

The demand response potential assessment follows a similar process to the measure-level energy efficiency potential assessment.[30] Figure 5-21 illustrates this process. Each box in the figure corresponds to a key step in the study. Each arrow points to a corresponding key study element which drives the analysis toward the final results. The steps and key elements in the process used to complete the study are described below.

- Data collection consists of regional and national secondary research. The data collection process yields many of the key analysis inputs which allow us to characterize the options.
- Market characterization establishes which customer classes will be included and determines whether there are any additional segments of interest. It incorporates the utility data provided during the data collection effort and develops a baseline forecast of demand by segment over the study horizon. This step is important because it frames the space in which the study will take place and defines the customer groups which the study will investigate.

[30] See the Empire District Electric Company DSM Market Potential Study for the full report.

- A list of DR and DSR options is developed and assessed for applicability to the Liberty-Empire market as characterized in the previous step. The result of this step is a finalized a list of DR and DSR options which will be included in the study.
- AEG characterizes each of the DR and DSR options, using the best available information to describe the program as it might be implemented and estimate program impacts, participation and costs. This step yields the inputs to the potential analysis that will result in estimates at each level of potential.
- Finally, AEG estimates the technical achievable,[31] realistic achievable, and maximum achievable potential for the set of programs AEG characterized across the entire service area.
    - In order to estimate the technical achievable potential, AEG first looked at each program on a standalone basis (and without an economic screen).
    - Secondly, AEG imposed a participation hierarchy so that customers can only participate in a maximum of one program of the same type.[32] This eliminates double counting. In this "integrated" case, AEG also applied an economic screen to remove programs that do not have a TRC benefit to cost ratio >1.0. These are achievable potential estimates.

Market Characterization

The analysis begins with segmentation of the Liberty-Empire customer base and a description of how customers use energy in the peak hour.

The market segmentation scheme for the DR analysis is presented in Table 5-76. As with the EE potential, the DR analysis is conducted for two sectors, residential and nonresidential. The

[31] For results of the technical achievable scenario, see appendix 5A

[32] The participation hierarchy applies only to programs that are similar or are targeting the same load. For example, DLC CAC participants cannot participant in the DLC Smart Thermostat program and TOU participants cannot participant in a Critical Peak Pricing Rate.

residential sector is considered a single group. The nonresidential sector is further segmented by size and whether or not they received a demand charge. The break point for differentiating the nonresidential customer size is 1,000 MWh annual use in 2017. Customers with usage equal to and above the threshold were characterized as large nonresidential; all other customers were considered small nonresidential.

Table 5-76 – Market Segmentation for DR and DSR Options

Dimension	Segmentation Variable	Description	
1	Sector	Residential Nonresidential	
2	Customer Size Classes	Residential	
		Nonresidential (segmented by demand charge and kWh)	
		Non-Residential Non-Metered Small Nonresidential Metered	No Demand Charge Demand Charge <1,000 MWh
		Large Nonresidential Metered	Demand Charge >1,000 MWh

Demand Response Options

The structure of, and process for, the DR and DSR potential assessment is similar to the EE potential analysis. The key difference is that DR and DSR are “program” concepts (not measures), meaning that customers will not take these actions without a utility offering. DR requires a program to induce savings (i.e. there is no naturally-occurring DR). Similarly, DSR requires a “rate structure” to supply a price signal to induce savings or shift demand.

While DR and DSR are quite different from the customers’ perspective, they are similar with respect to modeling requirements. As such, AEG analyzed them in the same model. Because some programs will target the same customers, AEG took steps to avoid double-counting and overstating of participation.

In general, demand response options are controllable or dispatchable programmatic options where customers agree to reduce, shift, or modify their load during a specific number of hours throughout the year. Note that Behavioral DR is voluntary and not dispatchable.

AEG considered eleven DR options for Liberty-Empire's service territory, which are broadly categorized as non-rate-based and rate-based DR. The objective of these options is to realize demand reductions from eligible customers during the highest load hours of the summer and winter season as defined by Liberty-Empire. Each program type provides demand response using different load reduction and incentive strategies designed to target different types of customers.

Table 5-77 – DR Options by Market Segment

Program Option	Eligible Customer Segments	Mechanism
Behavioral DR (BDR)	All segments	Voluntary DR reductions in response to behavioral messaging. Example programs exist in CA and other states. Requires AMI technology.
Direct Load Control (DLC) of air conditioners (A/C) and domestic hot water (DHW)	All segments	DLC switch installed on customer's equipment
DLC with two-way communicating or Smart T-stats	All segments	Internet-enabled control of thermostat set points, can be coupled with any dynamic pricing rate
DLC EV Charging	Residential	Automated, level 2 EV chargers that postpone or curtail charging during peak hours.
Curtailment Agreements	Nonresidential	Customers enact their customized, mandatory curtailment plan. May use stand-by generation. Penalties apply for non-performance.
Battery Energy Storage	All segments	Peak shifting of loads using stored electrochemical energy
Thermal Energy Storage	Non-Residential	Peak shifting of primarily space cooling loads using stored ice or cold water

Table 5-78 – DSR Options by Market Segment

Program Option	Eligible Customer Segments	Mechanism
Inclining Block Rate	Residential	An inclining block rate applies a rate(s) to a customer's bill if they exceed certain thresholds.
Time-of-use Rates	All segments	Higher rate for a particular block of hours that occurs every day. Requires either on/off peak meters or AMI technology.
Critical Peak Pricing	All	Much higher rate for a particular block of hours that occurs only on event days. Requires AMI technology.
Real-time Pricing	Nonresidential	Dynamic rate that fluctuates throughout the day based on energy market prices. Requires AMI technology.

Detailed descriptions of each of the demand response program options and demand side rates can be found in the full potential study report.[33]

After the option list is developed, the next step is to develop the key data elements for the potential calculations: customer participation levels, per-customer load reduction, and program costs.

Participation Rates

AEG developed program participation based on the performance of similar programs within states geographically and demographically comparable to Missouri.

New DR/DSR programs need time to ramp up and reach a steady state. During ramp up, customer education, marketing, and recruitment, in addition to the physical implementation and installation of any hardware, software, telemetry, or other equipment required, takes place. For Liberty-Empire, AEG assumed that programs ramp up over three to five years, typical of industry experience.

[33] See Appendix 5A.

- DLC and rate-based options. Participation ramps up following an “S-shaped” diffusion curve over a five-year timeframe.
- Curtailment Agreements are typically third-party-delivered over shorter contract periods. Participation ramps up linearly over a three-year timeframe.

The Critical Peak Pricing programs and other rates were modeled to start in 2025 to give Liberty-Empire time to roll out the AMI meters to participating customers.

Detailed assumption of the participation rates for each of the demand response program options and demand side rates can be found in the full potential study report.[34]

Load Reduction Impacts

The per-customer load reduction, multiplied by the total number of participating customers, provides the potential demand savings estimate. Load reduction impact assumptions are primarily based on secondary research.

[34] Appendix 5A

Table 5-79 – DR and DSR per Unit Load Reduction Assumptions

Customer Class	Option	Peak Season	Unit	Per Unit Reduction
Residential	Battery Energy Storage	Summer Peak	% of Peak	70%
Residential	Battery Energy Storage	Winter Peak	% of Peak	70%
Residential	Behavioral	Summer Peak	% of Peak	2%
Residential	Behavioral	Winter Peak	% of Peak	1%
Residential	Critical Peak Pricing Rates	Summer Peak	% of Peak	25%
Residential	Critical Peak Pricing Rates	Winter Peak	% of Peak	13%
Residential	DLC Space Heating	Winter Peak	kW @meter	1.80
Residential	DLC Central AC	Summer Peak	kW @meter	1.26
Residential	DLC EV Charging	Summer Peak	kW @meter	0.28
Residential	DLC EV Charging	Winter Peak	kW @meter	0.28
Residential	DLC Smart Thermostats	Summer Peak	kW @meter	1.26
Residential	DLC Smart Thermostats	Winter Peak	kW @meter	0.44
Residential	DLC Water Heating	Summer Peak	kW @meter	0.58
Residential	DLC Water Heating	Winter Peak	kW @meter	0.58
Residential	Inclining Block Rates	Summer Peak	% of Peak	2%
Residential	Inclining Block Rates	Winter Peak	% of Peak	2%
Residential	Thermal Energy Storage	Summer Peak	kW @meter	1.68
Residential	Time-of-Use Rates	Summer Peak	% of Peak	6%
Residential	Time-of-Use Rates	Winter Peak	% of Peak	3%
Small Non-Residential Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Small Non-Residential Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Small Non-Residential Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Small Non-Residential Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Small Non-Residential Metered	DLC Space Heating	Winter Peak	kW @meter	1.18
Small Non-Residential Metered	DLC Central AC	Summer Peak	kW @meter	1.51
Small Non-Residential Metered	DLC Smart Thermostats	Summer Peak	kW @meter	2.52
Small Non-Residential Metered	DLC Smart Thermostats	Winter Peak	kW @meter	0.77
Small Non-Residential Metered	Thermal Energy Storage	Summer Peak	kW @meter	1.68

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Customer Class	Option	Peak Season	Unit	Per Unit Reduction
Small Non-Residential Metered	Time-of-Use Rates	Summer Peak	% of Peak	3%
Small Non-Residential Metered	Time-of-Use Rates	Winter Peak	% of Peak	1%
Non-Residential Non-Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Non-Residential Non-Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Non-Residential Non-Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Non-Residential Non-Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Non-Residential Non-Metered	DLC Space Heating	Winter Peak	kW @meter	1.18
Non-Residential Non-Metered	DLC Central AC	Summer Peak	kW @meter	1.51
Non-Residential Non-Metered	DLC Smart Thermostats	Summer Peak	kW @meter	1.26
Non-Residential Non-Metered	DLC Smart Thermostats	Winter Peak	kW @meter	0.32
Non-Residential Non-Metered	Thermal Energy Storage	Summer Peak	kW @meter	1.68
Large Non-Residential Metered	Battery Energy Storage	Summer Peak	% of Peak	70%
Large Non-Residential Metered	Battery Energy Storage	Winter Peak	% of Peak	70%
Large Non-Residential Metered	Critical Peak Pricing Rates	Summer Peak	% of Peak	14%
Large Non-Residential Metered	Critical Peak Pricing Rates	Winter Peak	% of Peak	7%
Large Non-Residential Metered	Curtailment - Firm	Summer Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Firm	Winter Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Non Firm	Summer Peak	% of Peak	21%
Large Non-Residential Metered	Curtailment - Non Firm	Winter Peak	% of Peak	21%
Large Non-Residential Metered	Real Time Pricing	Summer Peak	% of Peak	9%
Large Non-Residential Metered	Real Time Pricing	Winter Peak	% of Peak	9%

Customer Class	Option	Peak Season	Unit	Per Unit Reduction
Large Non-Residential Metered	Thermal Energy Storage	Summer Peak	kW @meter	8.40
Large Non-Residential Metered	Time-of-Use Rates	Summer Peak	% of Peak	3%
Large Non-Residential Metered	Time-of-Use Rates	Winter Peak	% of Peak	2%

Program Costs

Program costs include fixed and variable cost elements: program development costs, annual program administration costs, marketing and recruitment costs, enabling technology costs for purchase and installation, annual O&M costs, and participant incentives. These assumptions are based on actual AEG program implementation experience and experience in developing program costs for other similar studies.

Table 5-80 – DR and DSR Program Cost Assumptions

Program	Cost Type	Unit	Cost, RAP ($)	Cost, MAP ($)
DLC Central AC	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75
	Program Development Cost	$/program	$75,000	$75,000
DLC Electric Vehicle Charging	Annual O&M Cost	$/participant/year	$11	$11
	Annual Program Administration Cost	$/yr	$41,667	$41,667
	Cost of Equip + Install	$/tech	$1,200	$1,200
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$90	$108
	Per Participant Annual Incentive	$/participant/year	$24	$24
	Program Development Cost	$/program	$75,000	$75,000
DLC Smart Thermostats	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750

Program	Cost Type	Unit	Cost, RAP ($)	Cost, MAP ($)
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75
	Program Development Cost	$/program	$75,000	$75,000
DLC Space Heating	Annual Program Administration Cost	$/yr	$83,333	$83,333
	Cost of Equip + Install	$/tech	$750	$750
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$306	$367
	Per Participant Annual Incentive	$/participant/year	$75	$75
	Program Development Cost	$/program	$75,000	$75,000
DLC Water Heating	Cost of Equip + Install	$/tech	$300	$300
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$90	$108
	Per Participant Annual Incentive	$/participant/year	$24	$24
	Program Development Cost	$/program	$75,000	$75,000
Curtailment - Firm, Non-Firm	Per kW Annual Incentive	$/kW @meter/year	$50	$50
	Per kW Annual Incentive	$/kW @meter/year	$50	$50
Time-of-Use Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Critical Peak Pricing Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Cost of Equip + Install	$/tech	$150	$375
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$5	$5
Inclining Block Rates	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Real Time Pricing	Annual Program Administration Cost	$/yr	$50,000	$50,000
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$60	$72

Program	Cost Type	Unit	Cost, RAP ($)	Cost, MAP ($)
	Program Development Cost	$/program	$75,000	$75,000
	Annual Operation and Maintenance Costs	$/participant	$2	$2
Behavioral	Annual O&M Cost	$/participant/year	$3	$3
	Program Development Cost	$/program	$40,000	$40,000
Battery Energy Storage	Annual Program Administration Cost	$/yr	$20,833	$20,833
	Cost of Equip + Install	$/tech	$111,590	$111,590
	Program Development Cost	$/program	$75,000	$75,000
Thermal Energy Storage	Annual Program Administration Cost	$/yr	$41,667	$41,667
	Per Customer Annual Marketing/Recruitment Cost	$/new participant/year	$230	$276
	Program Development Cost	$/program	$75,000	$75,000

SECTION 5 DEMAND-SIDE PROGRAM COST-EFFECTIVENESS

(5) The utility shall describe and document its evaluation of the cost effectiveness of each potential demand-side program developed pursuant to section (3) and each potential demand-side rate developed pursuant to section (4). All costs and benefits shall be expressed in nominal dollars.

(A) In each year of the planning horizon, the benefits of each potential demand-side program and each potential demand-side rate shall be calculated as the cumulative demand reduction multiplied by the avoided demand cost plus the cumulative energy savings multiplied by the avoided energy cost. These calculations shall be performed both with and without the avoided probable environmental costs. The utility shall describe and document the methods, data, and assumptions it used to develop the avoided costs.

1. The utility avoided demand cost shall include the capacity cost of generation, transmission, and distribution facilities, adjusted to reflect reliability reserve margins and capacity losses on the transmission and distribution systems, or the corresponding market-based equivalents of those costs. The utility shall describe and document how it developed its avoided demand cost, and the capacity cost chosen shall be consistent throughout the triennial compliance filing.

Liberty-Empire's avoided demand cost projections are based on a combination of sources that aim to develop a reasonable benchmark for the value of capacity. Because the SPP market does not have a formal capacity market and because Liberty-Empire's own supply-demand balance dynamics will evolve over time, it is necessary to consider a combination of fundamental SPP market drivers and Liberty-Empire-specific cost drivers in developing the estimate. The following section presents the rationale and drivers behind Liberty-Empire's avoided demand cost projections for three distinct periods.

Years 2019-2024: The avoided demand cost projection for this time period is based on the mid-point between the levelized estimate of the Asbury plant's "going-forward" costs (fixed operations and maintenance costs and amortized new capital expenditures, less projected energy margins) and the fundamentally-derived ABB SPP capacity price forecast (which is close to zero today). The rationale for this approach is that while Liberty-Empire is currently long capacity, this situation is dependent on maintaining all capacity resources in the existing fleet. The Asbury plant currently has the highest going-forward costs and is thus the "marginal" retirement candidate. Therefore, the plant's going-forward costs are representative of the costs needed for Liberty-Empire to avoid a capacity deficit.

While Liberty-Empire may have significant going-forward Asbury costs during this time period, the SPP market is generally oversupplied, suggesting little fundamental value for capacity throughout SPP. With a surplus in SPP, Liberty-Empire could, in theory, retire Asbury and find a less expensive bilateral capacity opportunity in the market. Therefore, the near-term avoided demand cost calculation splits the difference between the ABB capacity price and the Asbury going-forward cost.

Years 2025-2034: The avoided demand cost projection for this time period is based on a transition to the full Asbury going-forward costs, as ABB's fundamental analysis indicates a growing value for capacity in the broader SPP market. The rationale for this approach is that as the excess capacity situation in SPP extinguishes over time due to regional plant retirements and growing load, Liberty-Empire's avoided cost would be more closely based on the actual going-forward costs of Liberty-Empire's existing fleet without a low-cost market backstop price.

Years 2035+: The avoided demand cost projection for this time period is based on the cost of new entry ("CONE") for a new simple cycle combustion turbine ("CT"). The CT CONE includes capital costs, ongoing fixed operations and maintenance costs, and projects for transmission interconnection upgrade costs. In 2035 and beyond, Asbury will have reached its end of life and Liberty-Empire would need new capacity. The ABB fundamental forecast suggests similar dynamics in SPP, meaning that new entry pricing is a reasonable benchmark for avoided demand costs over the long-run throughout the whole market and specific to Liberty-Empire.

The avoided demand cost projection used by Liberty-Empire in the 2019 IRP is shown in Figure 5-22 in nominal dollars per kW-year.

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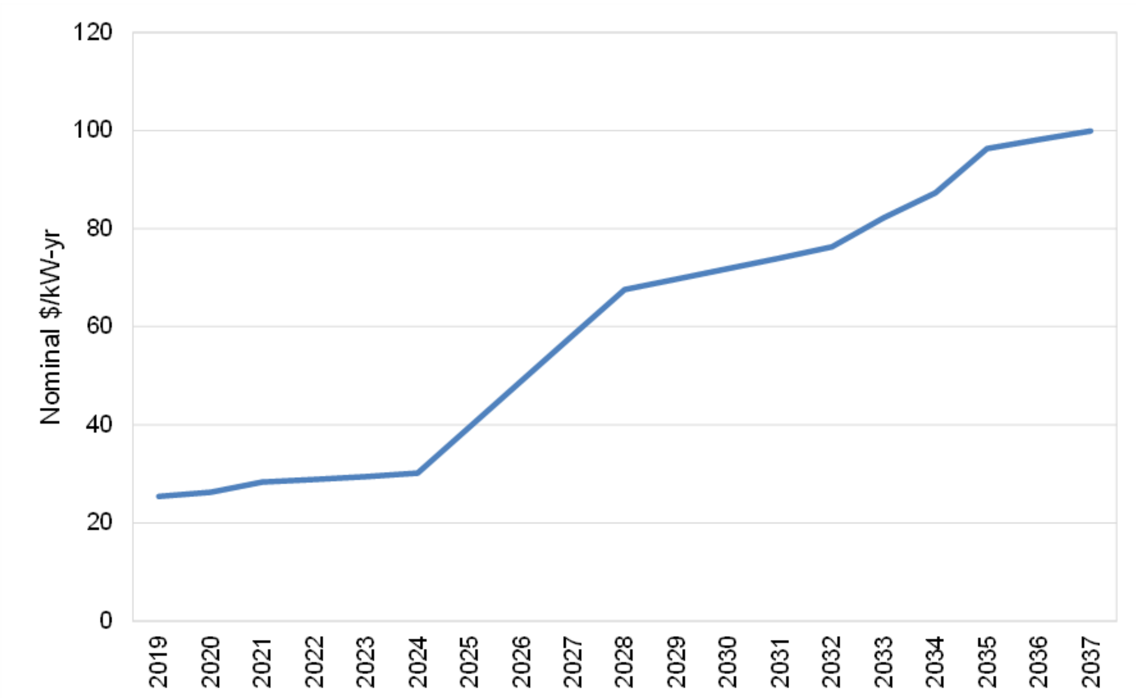
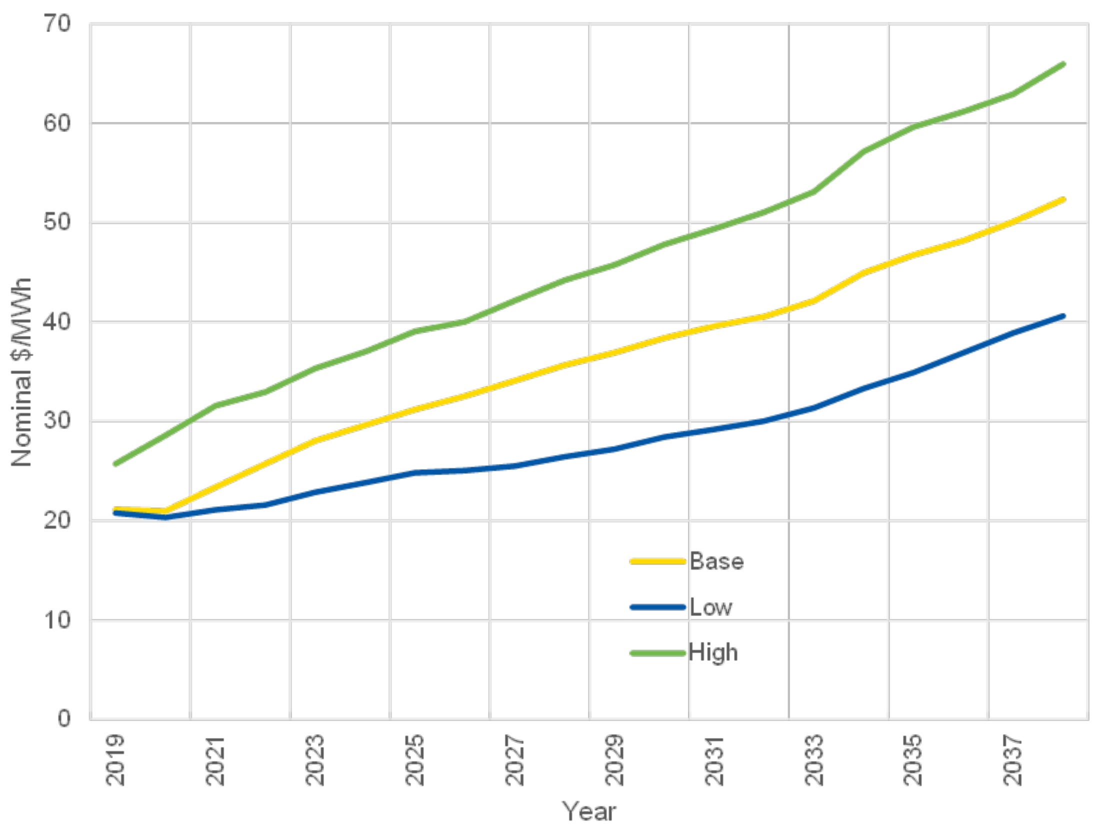
Figure 5-22 – Forecasted Electricity Market Price (Nominal $/kW-year) Over the 20-Year Planning Period



2. The utility avoided energy cost shall include the fuel costs, emission allowance costs, and other variable operation and maintenance costs of generation facilities, adjusted to reflect energy losses on the transmission and distribution systems, or the corresponding market-based equivalents of those costs. The utility shall describe and document how it developed its avoided energy cost, and the energy costs shall be consistent throughout the triennial compliance filing.

Liberty-Empire engaged ABB to develop its avoided energy costs based on a fundamental market analysis of the Southwest Power Pool ("SPP") market. Since Liberty-Empire is a member of SPP and part of the SPP Integrated Marketplace ("SPP IM"), Liberty-Empire utilized market prices as the avoided energy cost. ABB created a forward view of the SPP-KSMO regional electricity market using its Fall 2018 Reference Case data set. The Reference Case uses a combination of public data and proprietary forecasts to develop input assumptions for the key supply and demand drivers of power market outcomes. Supply includes a bottom-up analysis of generation resources, including parameters for fuel type, operations (capacity, heat rates, planned outages, and forced outages), emissions costs, and expectations for the amount of additions (and retirements) over time. Demand includes the demand for electricity by zone at an annual, monthly, and hourly level. Figure 5-23 illustrates Liberty-Empire's assumptions for the average avoided energy costs ($/MWh) for the base case and two additional fundamental costs developed by ABB: a high and low natural gas price case. These prices represent the all-hours KSMO price forecast in nominal dollars per MWh.

Figure 5-23 – Average Forecasted Energy Costs (Nominal $/MWh) for the Base, High, and Low Cases



3. The avoided probable environmental costs include the effects of the probable environmental costs calculated pursuant to 4 CSR 240-22.040(2)(B) on the utility avoided demand cost and the utility avoided energy cost. The utility shall describe and document how it developed its avoided probable environmental cost.

Given the current status of federal regulatory activity on carbon regulations, Liberty-Empire's base case avoided energy cost projections have been produced without any price on carbon, although they do include expectations for prices on NO_X and SO_2 emissions associated with current policy. To evaluate the potential risk associated with higher carbon prices in the future, Liberty-Empire developed a High CO_2 case which includes a price associated with CO_2 emissions starting in 2026. The rationale for this high case is that 2026 is a plausible starting date for a new federal regulation or policy, given the political change that would have to occur post-2020 and the time it would take to implement such regulations.

The price trajectory is based on Synapse's latest public analysis on CO_2 emission reductions from the power sector under various CO_2 tax trajectories. The Synapse analysis found that an 80% reduction in CO_2 emissions by 2050 (consistent with the Paris Agreement goals) could be achieved with a price trajectory that moves towards \$60/ton (real 2018 \$) by 2050. This price trajectory has a CO_2 price of about \$15/ton in real dollars (or \$17/ton in nominal dollars) in 2026, growing to around \$40/ton in real dollars (or \$70/ton in nominal dollars) by 2040.

Projections of the price associated with CO_2 emissions (nominal \$/ton) for the high case and the base case (i.e. zero CO_2 price) are shown in Figure 5-24.

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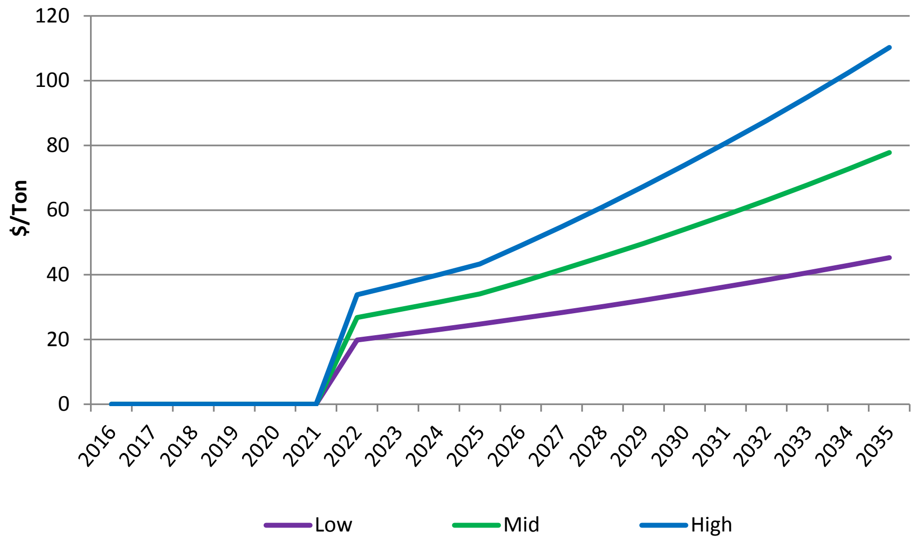
Figure 5-24 – Projections of Price for CO2 ($/ton) for the Low, Mid, and High Avoided Probable Environmental Cost Scenarios



Liberty-Empire used these assumptions for CO_2 prices combined with the previously-described assumptions for avoided energy costs to create the following graphs, which illustrate Liberty-Empire's assumptions for avoided energy costs for each of the avoided probable environmental cost scenarios. Figure 5-25 illustrates Liberty-Empire's assumptions for the avoided energy costs ($/MWh) for the "No CO2 avoided probable environmental cost" scenario.

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Figure 5-25 – Liberty-Empire's Assumptions for Avoided Energy Costs for the No CO_2 Avoided Probable Environmental Cost Scenario

****Confidential in its entirety**[35]**

[redacted]

Liberty-Empire then commissioned ABB to analyze the SPP power market implications associated with this high CO2 case within each of the three market scenarios (base, high, and low natural gas prices).

Figure 5-26 illustrates Liberty-Empire's assumptions for the avoided energy costs ($/MWh) for the three scenarios with and without a carbon price. These prices represent the all-hours KSMO price forecast in nominal dollars per MWh.

[35] 4 CSR 240-2.135(2)(A)1 allows information to be marked as confidential when it is reports, work papers, or other documentation related to work produced by internal or external auditors or consultants.

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Figure 5-26 – Liberty-Empire's Assumptions for the Avoided Energy Costs ($/MWh) for the Low Avoided Probable Environmental Cost Scenario

****Confidential in its entirety**[36]**

[redacted]

(B) The total resource cost test shall be used to evaluate the cost effectiveness of the potential demand-side programs and potential demand-side rates. In each year of the planning horizon—

1. The costs of each potential demand-side program shall be calculated as the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions) plus utility costs to administer, deliver, and evaluate each potential demand-side program;

The demand-side program total resource cost test costs are shown in the table below.

[36] 4 CSR 240-2.135(2)(A)1 allows information to be marked as confidential when it is reports, work papers, or other documentation related to work produced by internal or external auditors or consultants.

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Table 5-81 – Total Resource Cost Test Program Costs

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	1,393,056	2,180,993	2,142,466	2,136,617	2,016,344	2,809,448	2,456,950	2,667,416	2,276,236	2,062,669	1,907,094	1,824,990	1,756,215	1,678,719	1,619,886	1,548,393	1,482,372	1,426,613	1,422,225	1,358,185
Total Residential	350,573	629,557	675,127	609,612	558,594	495,295	462,194	434,647	415,820	396,765	458,394	441,571	421,279	402,363	388,562	371,108	354,053	337,472	321,709	307,223
Residential Lighting	90,510	156,782	152,068	110,418	81,392	45,376	32,205	25,366	23,735	21,630	20,687	19,755	18,481	17,649	17,889	17,083	15,997	14,672	13,711	13,094
Whole House Efficiency	173,359	315,065	374,967	357,933	342,147	323,432	308,780	294,090	281,627	269,403	336,527	325,197	310,559	296,632	286,576	273,719	261,376	249,584	238,168	227,444
Residential Behavioral	86,703	157,709	148,091	141,261	135,055	126,486	121,209	115,192	110,458	105,732	101,180	96,619	92,238	88,082	84,097	80,306	76,681	73,216	69,829	66,685
Total Residential Low Income	51,522	93,613	97,111	92,637	88,562	83,124	79,577	75,644	86,562	82,846	92,713	88,534	84,522	80,785	77,132	73,655	70,393	67,213	64,111	61,224
Low Income Whole House Efficiency	16,841	30,529	37,874	36,132	34,540	32,529	31,093	29,567	42,379	40,553	52,241	49,886	47,627	45,552	43,493	41,532	39,720	37,927	36,179	34,550
Low Income Behavioral	34,681	63,084	59,237	56,505	54,022	50,595	48,484	46,077	44,183	42,293	40,472	38,648	36,895	35,233	33,639	32,122	30,672	29,286	27,932	26,674
Low Income Weatherization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Business	990,961	1,457,823	1,370,229	1,434,368	1,369,188	1,297,112	1,241,574	1,177,753	1,124,773	1,092,080	1,013,918	968,132	938,488	897,790	869,957	832,238	798,824	774,551	800,553	764,506
C&I Program	990,961	1,457,823	1,370,229	1,434,368	1,369,188	1,297,112	1,241,574	1,177,753	1,124,773	1,092,080	1,013,918	968,132	938,488	897,790	869,957	832,238	798,824	774,551	800,553	764,506
Demand Response	-	-	-	-	-	933,917	673,606	979,372	649,082	490,978	342,069	326,753	311,926	297,781	284,236	271,393	259,103	247,377	235,852	225,232
Time of Use Rate	-	-	-	-	-	174,310	203,456	359,056	204,268	128,187	55,077	52,604	50,129	47,809	45,554	43,464	41,438	39,526	37,633	35,938
Critical Peak Pricing	-	-	-	-	-	190,479	232,164	388,872	227,431	156,836	91,890	87,834	83,926	80,109	76,497	73,051	69,775	66,636	63,534	60,673
Inclining Block Rates	-	-	-	-	-	448,949	187,051	177,765	170,460	163,166	156,142	149,104	142,343	135,929	129,780	123,929	118,334	112,988	107,761	102,909
Time of Use Rate (Non Res)	-	-	-	-	-	11,095	6,430	8,672	6,151	4,817	3,581	3,388	3,268	3,092	2,983	2,822	2,723	2,576	2,482	2,370
Critical Peak Pricing (Non Res)	-	-	-	-	-	11,353	6,876	9,119	6,542	5,277	4,125	3,978	3,769	3,635	3,444	3,321	3,148	3,035	2,873	2,743
Real Time Pricing	-	-	-	-	-	97,731	37,628	35,889	34,230	32,695	31,253	29,845	28,491	27,208	25,977	24,806	23,686	22,616	21,569	20,598

2. The costs of each potential demand-side rate shall be calculated as the sum of all incremental costs that are due to the rate (including both utility and participant contributions) plus utility costs to administer, deliver, and evaluate each potential demand-side rate; and

Table 5-81 above details the Total Resource Cost Test Program Costs.

3. For purposes of this test, the costs of potential demand-side programs and potential demand-side rates shall not include lost revenues or utility incentive payments to customers.

The total resource cost test did not include lost revenues or utility payments to customers.

(C) The utility cost test shall also be performed for purposes of comparison. In each year of the planning horizon—

1. The costs of each potential demand-side program and potential demand-side rate shall be calculated as the sum of all utility incentive payments plus utility costs to administer, deliver, and evaluate each potential demand-side program or potential demand-side rate;

The demand-side program utility cost test costs are shown in the table below. This include incentives and non-incentives.

Table 5-82 – Utility Cost Test Costs

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**865,104**	**1,435,535**	**1,395,258**	**1,365,848**	**1,272,506**	**2,095,842**	**1,771,880**	**2,016,887**	**1,656,316**	**1,464,965**	**1,313,663**	**1,256,458**	**1,211,573**	**1,158,167**	**1,113,357**	**1,065,096**	**1,020,882**	**979,573**	**973,682**	**929,838**
Total Residential	**267,596**	**477,886**	**498,564**	**447,662**	**408,579**	**358,031**	**332,755**	**312,193**	**298,989**	**285,419**	**310,571**	**298,412**	**284,720**	**271,942**	**261,825**	**250,067**	**238,600**	**227,482**	**216,797**	**207,035**
Residential Lighting	74,276	125,572	121,973	88,357	64,985	35,799	23,898	18,603	17,401	15,818	15,137	14,455	13,586	12,974	12,970	12,385	11,649	10,784	10,124	9,668
Whole House Efficiency	106,617	194,604	228,500	218,043	208,539	195,745	187,649	178,399	171,131	163,869	194,254	187,338	178,896	170,887	164,757	157,375	150,271	143,482	136,844	130,682
Residential Behavioral	86,703	157,709	148,091	141,261	135,055	126,486	121,209	115,192	110,458	105,732	101,180	96,619	92,238	88,082	84,097	80,306	76,681	73,216	69,829	66,685
Total Residential Low Income	**49,888**	**90,066**	**92,491**	**88,226**	**84,349**	**79,118**	**75,816**	**72,053**	**81,085**	**77,616**	**84,962**	**81,132**	**77,453**	**74,046**	**70,696**	**67,509**	**64,534**	**61,618**	**58,768**	**56,121**
Low Income Whole House Efficiency	15,207	26,982	33,255	31,721	30,327	28,523	27,333	25,976	36,902	35,324	44,490	42,484	40,558	38,813	37,057	35,387	33,862	32,332	30,836	29,448
Low Income Behavioral	34,681	63,084	59,237	56,505	54,022	50,595	48,484	46,077	44,183	42,293	40,472	38,648	36,895	35,233	33,639	32,122	30,672	29,286	27,932	26,674
Low Income Weatherization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Business	**547,619**	**867,584**	**804,203**	**829,961**	**779,578**	**724,776**	**689,703**	**653,269**	**627,160**	**610,952**	**576,061**	**550,161**	**537,474**	**514,398**	**496,601**	**476,127**	**458,645**	**443,096**	**462,265**	**441,450**
C&I Program	547,619	867,584	804,203	829,961	779,578	724,776	689,703	653,269	627,160	610,952	576,061	550,161	537,474	514,398	496,601	476,127	458,645	443,096	462,265	441,450
Demand Response	**-**	**-**	**-**	**-**	**-**	**933,917**	**673,606**	**979,372**	**649,082**	**490,978**	**342,069**	**326,753**	**311,926**	**297,781**	**284,236**	**271,393**	**259,103**	**247,377**	**235,852**	**225,232**
Time of Use Rate	-	-	-	-	-	174,310	203,456	359,056	204,268	128,187	55,077	52,604	50,129	47,809	45,554	43,464	41,438	39,526	37,633	35,938
Critical Peak Pricing	-	-	-	-	-	190,479	232,164	388,872	227,431	156,836	91,890	87,834	83,926	80,109	76,497	73,051	69,775	66,636	63,534	60,673
Inclining Block Rates	-	-	-	-	-	448,949	187,051	177,765	170,460	163,166	156,142	149,104	142,343	135,929	129,780	123,929	118,334	112,988	107,761	102,909
Time of Use Rate (Non Res)	-	-	-	-	-	11,095	6,430	8,672	6,151	4,817	3,581	3,388	3,268	3,092	2,983	2,822	2,723	2,576	2,482	2,370
Critical Peak Pricing (Non Res)	-	-	-	-	-	11,353	6,876	9,119	6,542	5,277	4,125	3,978	3,769	3,635	3,444	3,321	3,148	3,035	2,873	2,743
Real Time Pricing	-	-	-	-	-	97,731	37,628	35,889	34,230	32,695	31,253	29,845	28,491	27,208	25,977	24,806	23,686	22,616	21,569	20,598

2. For purposes of this test, the costs of potential demand-side programs and potential demand-side rates shall not include lost revenues; and

The utility cost test does not include lost revenues.

3. The costs shall include, but separately identify, the costs of any rate of return or incentive included in the utility's recovery of demand-side program costs.

The demand-side program utility cost test was modified to include an estimated utility incentive of 20% of the total budget, presented in the below tables. The utility incentive was applied at the portfolio level, therefore, only affecting the portfolio level ratio.

Table 5-83 – Utility Cost Test Costs Modified with Utility Incentive

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**692,083**	**1,148,428**	**1,116,206**	**1,092,679**	**1,018,005**	**1,676,673**	**1,417,504**	**1,613,510**	**1,325,053**	**1,171,972**	**1,050,931**	**1,005,166**	**969,259**	**926,534**	**890,686**	**852,077**	**816,706**	**783,658**	**778,945**	**743,871**
Total Residential	**267,596**	**477,886**	**498,564**	**447,662**	**408,579**	**358,031**	**332,755**	**312,193**	**298,989**	**285,419**	**310,571**	**298,412**	**284,720**	**271,942**	**261,825**	**250,067**	**238,600**	**227,482**	**216,797**	**207,035**
Residential Lighting	74,276	125,572	121,973	88,357	64,985	35,799	23,898	18,603	17,401	15,818	15,137	14,455	13,586	12,974	12,970	12,385	11,649	10,784	10,124	9,668
Whole House Efficiency	106,617	194,604	228,500	218,043	208,539	195,745	187,649	178,399	171,131	163,869	194,254	187,338	178,896	170,887	164,757	157,375	150,271	143,482	136,844	130,682
Residential Behavioral	86,703	157,709	148,091	141,261	135,055	126,486	121,209	115,192	110,458	105,732	101,180	96,619	92,238	88,082	84,097	80,306	76,681	73,216	69,829	66,685
Total Residential Low Income	**49,888**	**90,066**	**92,491**	**88,226**	**84,349**	**79,118**	**75,816**	**72,053**	**81,085**	**77,616**	**84,962**	**81,132**	**77,453**	**74,046**	**70,696**	**67,509**	**64,534**	**61,618**	**58,768**	**56,121**
Low Income Whole House Efficiency	15,207	26,982	33,255	31,721	30,327	28,523	27,333	25,976	36,902	35,324	44,490	42,484	40,558	38,813	37,057	35,387	33,862	32,332	30,836	29,448
Low Income Behavioral	34,681	63,084	59,237	56,505	54,022	50,595	48,484	46,077	44,183	42,293	40,472	38,648	36,895	35,233	33,639	32,122	30,672	29,286	27,932	26,674
Low Income Weatherization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Business	**547,619**	**867,584**	**804,203**	**829,961**	**779,578**	**724,776**	**689,703**	**653,269**	**627,160**	**610,952**	**576,061**	**550,161**	**537,474**	**514,398**	**496,601**	**476,127**	**458,645**	**443,096**	**462,265**	**441,450**
C&I Program	547,619	867,584	804,203	829,961	779,578	724,776	689,703	653,269	627,160	610,952	576,061	550,161	537,474	514,398	496,601	476,127	458,645	443,096	462,265	441,450
Demand Response	**-**	**-**	**-**	**-**	**-**	**933,917**	**673,606**	**979,372**	**649,082**	**490,978**	**342,069**	**326,753**	**311,926**	**297,781**	**284,236**	**271,393**	**259,103**	**247,377**	**235,852**	**225,232**
Time of Use Rate	-	-	-	-	-	174,310	203,456	359,056	204,268	128,187	55,077	52,604	50,129	47,809	45,554	43,464	41,438	39,526	37,633	35,938
Critical Peak Pricing	-	-	-	-	-	190,479	232,164	388,872	227,431	156,836	91,890	87,834	83,926	80,109	76,497	73,051	69,775	66,636	63,534	60,673
Inclining Block Rates	-	-	-	-	-	448,949	187,051	177,765	170,460	163,166	156,142	149,104	142,343	135,929	129,780	123,929	118,334	112,988	107,761	102,909
Time of Use Rate (Non Res)	-	-	-	-	-	11,095	6,430	8,672	6,151	4,817	3,581	3,388	3,268	3,092	2,983	2,822	2,723	2,576	2,482	2,370
Critical Peak Pricing (Non Res)	-	-	-	-	-	11,353	6,876	9,119	6,542	5,277	4,125	3,978	3,769	3,635	3,444	3,321	3,148	3,035	2,873	2,743
Real Time Pricing	-	-	-	-	-	97,731	37,628	35,889	34,230	32,695	31,253	29,845	28,491	27,208	25,977	24,806	23,686	22,616	21,569	20,598

Table 5-84 – Utility Cost Test Ratios Modified with Utility Incentive

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2.79**	**2.90**	**3.05**	**3.20**	**3.36**	**2.26**	**2.81**	**2.66**	**3.42**	**3.84**	**4.18**	**4.23**	**4.28**	**4.41**	**4.53**	**4.64**	**4.67**	**4.71**	**4.72**	**5.10**
Total Residential	**1.58**	**1.74**	**1.86**	**1.90**	**1.95**	**2.02**	**2.19**	**2.24**	**2.27**	**2.29**	**2.24**	**2.26**	**2.29**	**2.34**	**2.39**	**2.42**	**2.44**	**2.46**	**2.49**	**2.70**
Residential Lighting	2.01	2.27	2.39	2.51	2.64	2.85	4.65	4.83	4.92	4.99	5.07	5.15	5.23	5.32	5.41	5.47	5.51	5.54	5.58	6.07
Whole House Efficiency	1.73	1.88	1.99	2.05	2.11	2.22	2.29	2.35	2.39	2.41	2.29	2.32	2.36	2.39	2.42	2.45	2.47	2.49	2.51	2.73
Residential Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Total Residential Low Income	**4.82**	**5.33**	**5.27**	**5.47**	**5.66**	**5.99**	**6.17**	**6.39**	**6.47**	**6.56**	**5.92**	**6.01**	**6.11**	**6.22**	**6.33**	**6.41**	**6.46**	**6.52**	**6.60**	**7.16**
Low Income Whole House Efficiency	1.12	1.24	1.30	1.34	1.37	1.44	1.48	1.52	1.54	1.56	1.41	1.43	1.45	1.48	1.50	1.51	1.53	1.54	1.56	1.69
Low Income Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Low Income Weatherization	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Business	**2.32**	**2.32**	**2.47**	**2.61**	**2.76**	**2.98**	**3.09**	**3.19**	**3.22**	**3.27**	**3.29**	**3.34**	**3.38**	**3.45**	**3.53**	**3.54**	**3.57**	**3.61**	**3.56**	**3.87**
C&I Program	2.32	2.32	2.47	2.61	2.76	2.98	3.09	3.19	3.22	3.27	3.29	3.34	3.38	3.45	3.53	3.54	3.57	3.61	3.56	3.87
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.47**	**0.96**	**1.08**	**2.01**	**2.73**	**3.79**	**3.84**	**3.87**	**4.07**	**4.24**	**4.54**	**4.55**	**4.56**	**4.68**	**5.01**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	0.08	0.21	0.31	0.74	1.27	2.86	2.89	2.93	3.08	3.22	3.44	3.45	3.46	3.56	3.82
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	0.30	0.84	1.24	2.87	4.41	7.28	7.36	7.45	7.87	8.21	8.88	8.88	8.87	9.12	9.76
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	0.80	2.02	2.23	2.41	2.43	2.45	2.47	2.48	2.58	2.68	2.82	2.83	2.84	2.91	3.12
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	0.24	1.39	2.60	5.02	6.89	9.00	9.19	9.22	9.77	10.13	10.94	10.90	11.03	11.27	12.06
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	0.18	1.01	1.87	3.56	4.67	5.78	5.82	5.94	6.24	6.56	7.05	7.11	7.07	7.33	7.85
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	0.04	0.33	0.75	0.99	1.05	1.06	1.07	1.08	1.13	1.17	1.25	1.25	1.25	1.28	1.37

(D) The present value of program benefits minus the present value of program costs over the planning horizon must be positive or the ratio of annualized benefits to annualized costs must be greater than one (1) for a potential demand-side program or potential demand-side rate to pass the utility cost test or the total resource cost test. The utility may relax this criterion for programs that are judged to have potential benefits that are not captured by the estimated load impacts or avoided costs, including programs required to comply with legal mandates.

The demand-side program total resource cost test and utility cost test benefit-cost ratios are shown in the tables below.

(E) The utility shall provide results of the total resource cost test and the utility cost test for each potential demand-side program evaluated pursuant to subsection (5)(B) and for each potential demand–side rate evaluated pursuant to subsection (5)(C) of this rule, including a tabulation of the benefits (avoided costs), demand-side resource costs, and net benefits or costs.

The demand-side program total resource cost test and utility cost test benefit-cost ratios are shown in the tables below.

Table 5-85 – Total Resource Cost Test Program Costs

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**1,393,056**	**2,180,993**	**2,142,466**	**2,136,617**	**2,016,344**	**2,809,448**	**2,456,950**	**2,667,416**	**2,276,236**	**2,062,669**	**1,907,094**	**1,824,990**	**1,756,215**	**1,678,719**	**1,619,886**	**1,548,393**	**1,482,372**	**1,426,613**	**1,422,225**	**1,358,185**
Total Residential	**350,573**	**629,557**	**675,127**	**609,612**	**558,594**	**495,295**	**462,194**	**434,647**	**415,820**	**396,765**	**458,394**	**441,571**	**421,279**	**402,363**	**388,562**	**371,108**	**354,053**	**337,472**	**321,709**	**307,223**
Residential Lighting	90,510	156,782	152,068	110,418	81,392	45,376	32,205	25,366	23,735	21,630	20,687	19,755	18,481	17,649	17,889	17,083	15,997	14,672	13,711	13,094
Whole House Efficiency	173,359	315,065	374,967	357,933	342,147	323,432	308,780	294,090	281,627	269,403	336,527	325,197	310,559	296,632	286,576	273,719	261,376	249,584	238,168	227,444
Residential Behavioral	86,703	157,709	148,091	141,261	135,055	126,486	121,209	115,192	110,458	105,732	101,180	96,619	92,238	88,082	84,097	80,306	76,681	73,216	69,829	66,685
Total Residential Low Income	**51,522**	**93,613**	**97,111**	**92,637**	**88,562**	**83,124**	**79,577**	**75,644**	**86,562**	**82,846**	**92,713**	**88,534**	**84,522**	**80,785**	**77,132**	**73,655**	**70,393**	**67,213**	**64,111**	**61,224**
Low Income Whole House Efficiency	16,841	30,529	37,874	36,132	34,540	32,529	31,093	29,567	42,379	40,553	52,241	49,886	47,627	45,552	43,493	41,532	39,720	37,927	36,179	34,550
Low Income Behavioral	34,681	63,084	59,237	56,505	54,022	50,595	48,484	46,077	44,183	42,293	40,472	38,648	36,895	35,233	33,639	32,122	30,672	29,286	27,932	26,674
Low Income Weatherization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Business	**990,961**	**1,457,823**	**1,370,229**	**1,434,368**	**1,369,188**	**1,297,112**	**1,241,574**	**1,177,753**	**1,124,773**	**1,092,080**	**1,013,918**	**968,132**	**938,488**	**897,790**	**869,957**	**832,238**	**798,824**	**774,551**	**800,553**	**764,506**
C&I Program	990,961	1,457,823	1,370,229	1,434,368	1,369,188	1,297,112	1,241,574	1,177,753	1,124,773	1,092,080	1,013,918	968,132	938,488	897,790	869,957	832,238	798,824	774,551	800,553	764,506
Demand Response	**-**	**-**	**-**	**-**	**-**	**933,917**	**673,606**	**979,372**	**649,082**	**490,978**	**342,069**	**326,753**	**311,926**	**297,781**	**284,236**	**271,393**	**259,103**	**247,377**	**235,852**	**225,232**
Time of Use Rate	-	-	-	-	-	174,310	203,456	359,056	204,268	128,187	55,077	52,604	50,129	47,809	45,554	43,464	41,438	39,526	37,633	35,938
Critical Peak Pricing	-	-	-	-	-	190,479	232,164	388,872	227,431	156,836	91,890	87,834	83,926	80,109	76,497	73,051	69,775	66,636	63,534	60,673
Inclining Block Rates	-	-	-	-	-	448,949	187,051	177,765	170,460	163,166	156,142	149,104	142,343	135,929	129,780	123,929	118,334	112,988	107,761	102,909
Time of Use Rate (Non Res)	-	-	-	-	-	11,095	6,430	8,672	6,151	4,817	3,581	3,388	3,268	3,092	2,983	2,822	2,723	2,576	2,482	2,370
Critical Peak Pricing (Non Res)	-	-	-	-	-	11,353	6,876	9,119	6,542	5,277	4,125	3,978	3,769	3,635	3,444	3,321	3,148	3,035	2,873	2,743
Real Time Pricing	-	-	-	-	-	97,731	37,628	35,889	34,230	32,695	31,253	29,845	28,491	27,208	25,977	24,806	23,686	22,616	21,569	20,598

Table 5-86 – Total Resource Cost Test Program Benefits

Total Portfolio	**1,933,312**	**3,327,827**	**3,399,891**	**3,498,787**	**3,421,443**	**3,792,611**	**3,976,410**	**4,296,990**	**4,525,180**	**4,501,954**	**4,390,919**	**4,253,306**	**4,150,283**	**4,083,956**	**4,030,748**	**3,957,254**	**3,815,033**	**3,690,042**	**3,674,705**	**3,795,815**
Total Residential	**422,709**	**833,709**	**929,499**	**851,997**	**794,718**	**722,826**	**728,865**	**698,555**	**679,738**	**654,042**	**695,315**	**675,296**	**653,374**	**636,600**	**626,234**	**606,042**	**582,145**	**559,475**	**538,820**	**558,471**
Residential Lighting	149,006	284,739	291,600	221,944	171,243	101,927	111,189	89,767	85,575	78,974	76,677	74,430	71,051	68,966	70,143	67,762	64,150	59,729	56,531	58,726
Whole House Efficiency	184,143	366,059	453,576	447,272	440,488	434,830	429,867	419,807	408,186	395,423	445,376	434,661	421,444	408,933	398,878	385,329	371,073	357,381	344,108	357,381
Residential Behavioral	89,559	182,911	184,323	182,781	182,987	186,070	187,810	188,980	185,977	179,644	173,262	166,204	160,880	158,700	157,213	152,950	146,922	142,364	138,180	142,364
Total Residential Low Income	**240,298**	**480,215**	**487,415**	**482,289**	**477,353**	**473,710**	**467,872**	**460,200**	**524,276**	**508,818**	**503,117**	**487,528**	**473,004**	**460,365**	**447,458**	**432,778**	**416,872**	**401,951**	**387,589**	**401,951**
Low Income Whole House Efficiency	17,096	33,533	43,069	42,403	41,684	41,173	40,584	39,582	56,921	55,103	62,861	60,880	58,983	57,342	55,505	53,582	51,734	49,818	47,959	49,818
Low Income Behavioral	35,824	73,164	73,729	73,112	73,195	74,428	75,124	75,592	74,391	71,858	69,305	66,481	64,352	63,480	62,885	61,180	58,769	56,946	55,272	56,946
Low Income Weatherization	187,379	373,518	370,617	366,774	362,474	358,109	352,164	345,026	392,965	381,857	370,951	360,167	349,668	339,543	329,068	318,015	306,370	295,188	284,359	295,188
Total Business	**1,270,305**	**2,013,903**	**1,982,977**	**2,164,501**	**2,149,372**	**2,158,753**	**2,133,628**	**2,083,946**	**2,018,835**	**1,996,994**	**1,894,377**	**1,837,327**	**1,815,640**	**1,775,520**	**1,751,089**	**1,685,007**	**1,637,104**	**1,601,786**	**1,644,783**	**1,707,050**
C&I Program	1,270,305	2,013,903	1,982,977	2,164,501	2,149,372	2,158,753	2,133,628	2,083,946	2,018,835	1,996,994	1,894,377	1,837,327	1,815,640	1,775,520	1,751,089	1,685,007	1,637,104	1,601,786	1,644,783	1,707,050
Demand Response	**-**	**-**	**-**	**-**	**-**	**437,321**	**646,045**	**1,054,288**	**1,302,331**	**1,342,100**	**1,298,110**	**1,253,155**	**1,208,265**	**1,211,471**	**1,205,967**	**1,233,427**	**1,178,911**	**1,126,831**	**1,103,514**	**1,128,343**
Time of Use Rate	-	-	-	-	-	13,141	43,711	110,526	151,229	162,593	157,444	152,119	146,740	147,043	146,473	149,589	143,088	136,909	134,105	137,147
Critical Peak Pricing	-	-	-	-	-	57,979	195,482	480,903	652,532	691,354	668,847	646,668	624,906	630,693	628,203	648,459	619,476	591,064	579,487	592,096
Inclining Block Rates	-	-	-	-	-	357,297	378,523	396,439	410,640	395,985	382,602	368,177	353,417	350,187	348,010	350,030	334,652	320,678	313,221	320,678
Time of Use Rate (Non Res)	-	-	-	-	-	2,636	8,922	22,504	30,852	33,176	32,226	31,137	30,140	30,216	30,215	30,884	29,665	28,418	27,960	28,594
Critical Peak Pricing (Non Res)	-	-	-	-	-	2,041	6,965	17,060	23,262	24,667	23,862	23,147	22,373	22,664	22,590	23,414	22,390	21,456	21,064	21,522
Real Time Pricing	-	-	-	-	-	4,228	12,442	26,856	33,815	34,325	33,128	31,906	30,689	30,669	30,475	31,052	29,641	28,306	27,678	28,306

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Table 5-87– Total Resource Cost Test Benefit-Cost Ratio

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**1.39**	**1.53**	**1.59**	**1.64**	**1.70**	**1.35**	**1.62**	**1.61**	**1.99**	**2.18**	**2.30**	**2.33**	**2.36**	**2.43**	**2.49**	**2.56**	**2.57**	**2.59**	**2.58**	**2.79**
Total Residential	**1.21**	**1.32**	**1.38**	**1.40**	**1.42**	**1.46**	**1.58**	**1.61**	**1.63**	**1.65**	**1.52**	**1.53**	**1.55**	**1.58**	**1.61**	**1.63**	**1.64**	**1.66**	**1.67**	**1.82**
Residential Lighting	1.65	1.82	1.92	2.01	2.10	2.25	3.45	3.54	3.61	3.65	3.71	3.77	3.84	3.91	3.92	3.97	4.01	4.07	4.12	4.49
Whole House Efficiency	1.06	1.16	1.21	1.25	1.29	1.34	1.39	1.43	1.45	1.47	1.32	1.34	1.36	1.38	1.39	1.41	1.42	1.43	1.44	1.57
Residential Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Total Residential Low Income	**4.66**	**5.13**	**5.02**	**5.21**	**5.39**	**5.70**	**5.88**	**6.08**	**6.06**	**6.14**	**5.43**	**5.51**	**5.60**	**5.70**	**5.80**	**5.88**	**5.92**	**5.98**	**6.05**	**6.57**
Low Income Whole House Efficiency	1.02	1.10	1.14	1.17	1.21	1.27	1.31	1.34	1.34	1.36	1.20	1.22	1.24	1.26	1.28	1.29	1.30	1.31	1.33	1.44
Low Income Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Low Income Weatherization	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Business	**1.28**	**1.38**	**1.45**	**1.51**	**1.57**	**1.66**	**1.72**	**1.77**	**1.79**	**1.83**	**1.87**	**1.90**	**1.93**	**1.98**	**2.01**	**2.02**	**2.05**	**2.07**	**2.05**	**2.23**
C&I Program	1.28	1.38	1.45	1.51	1.57	1.66	1.72	1.77	1.79	1.83	1.87	1.90	1.93	1.98	2.01	2.02	2.05	2.07	2.05	2.23
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.47**	**0.96**	**1.08**	**2.01**	**2.73**	**3.79**	**3.84**	**3.87**	**4.07**	**4.24**	**4.54**	**4.55**	**4.56**	**4.68**	**5.01**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	0.08	0.21	0.31	0.74	1.27	2.86	2.89	2.93	3.08	3.22	3.44	3.45	3.46	3.56	3.82
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	0.30	0.84	1.24	2.87	4.41	7.28	7.36	7.45	7.87	8.21	8.88	8.88	8.87	9.12	9.76
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	0.80	2.02	2.23	2.41	2.43	2.45	2.47	2.48	2.58	2.68	2.82	2.83	2.84	2.91	3.12
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	0.24	1.39	2.60	5.02	6.89	9.00	9.19	9.22	9.77	10.13	10.94	10.90	11.03	11.27	12.06
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	0.18	1.01	1.87	3.56	4.67	5.78	5.82	5.94	6.24	6.56	7.05	7.11	7.07	7.33	7.85
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	0.04	0.33	0.75	0.99	1.05	1.06	1.07	1.08	1.13	1.17	1.25	1.25	1.25	1.28	1.37

Table 5-88 – Utility Cost Test Program Costs

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**865,104**	**1,435,535**	**1,395,258**	**1,365,848**	**1,272,506**	**2,095,842**	**1,771,880**	**2,016,887**	**1,656,316**	**1,464,965**	**1,313,663**	**1,256,458**	**1,211,573**	**1,158,167**	**1,113,357**	**1,065,096**	**1,020,882**	**979,573**	**973,682**	**929,838**
Total Residential	**267,596**	**477,886**	**498,564**	**447,662**	**408,579**	**358,031**	**332,755**	**312,193**	**298,989**	**285,419**	**310,571**	**298,412**	**284,720**	**271,942**	**261,825**	**250,067**	**238,600**	**227,482**	**216,797**	**207,035**
Residential Lighting	74,276	125,572	121,973	88,357	64,985	35,799	23,898	18,603	17,401	15,818	15,137	14,455	13,586	12,974	12,970	12,385	11,649	10,784	10,124	9,668
Whole House Efficiency	106,617	194,604	228,500	218,043	208,539	195,745	187,649	178,399	171,131	163,869	194,254	187,338	178,896	170,887	164,757	157,375	150,271	143,482	136,844	130,682
Residential Behavioral	86,703	157,709	148,091	141,261	135,055	126,486	121,209	115,192	110,458	105,732	101,180	96,619	92,238	88,082	84,097	80,306	76,681	73,216	69,829	66,685
Total Residential Low Income	**49,888**	**90,066**	**92,491**	**88,226**	**84,349**	**79,118**	**75,816**	**72,053**	**81,085**	**77,616**	**84,962**	**81,132**	**77,453**	**74,046**	**70,696**	**67,509**	**64,534**	**61,618**	**58,768**	**56,121**
Low Income Whole House Efficiency	15,207	26,982	33,255	31,721	30,327	28,523	27,333	25,976	36,902	35,324	44,490	42,484	40,558	38,813	37,057	35,387	33,862	32,332	30,836	29,448
Low Income Behavioral	34,681	63,084	59,237	56,505	54,022	50,595	48,484	46,077	44,183	42,293	40,472	38,648	36,895	35,233	33,639	32,122	30,672	29,286	27,932	26,674
Low Income Weatherization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Business	**547,619**	**867,584**	**804,203**	**829,961**	**779,578**	**724,776**	**689,703**	**653,269**	**627,160**	**610,952**	**576,061**	**550,161**	**537,474**	**514,398**	**496,601**	**476,127**	**458,645**	**443,096**	**462,265**	**441,450**
C&I Program	547,619	867,584	804,203	829,961	779,578	724,776	689,703	653,269	627,160	610,952	576,061	550,161	537,474	514,398	496,601	476,127	458,645	443,096	462,265	441,450
Demand Response	**-**	**-**	**-**	**-**	**-**	**933,917**	**673,606**	**979,372**	**649,082**	**490,978**	**342,069**	**326,753**	**311,926**	**297,781**	**284,236**	**271,393**	**259,103**	**247,377**	**235,852**	**225,232**
Time of Use Rate	-	-	-	-	-	174,310	203,456	359,056	204,268	128,187	55,077	52,604	50,129	47,809	45,554	43,464	41,438	39,526	37,633	35,938
Critical Peak Pricing	-	-	-	-	-	190,479	232,164	388,872	227,431	156,836	91,890	87,834	83,926	80,109	76,497	73,051	69,775	66,636	63,534	60,673
Inclining Block Rates	-	-	-	-	-	448,949	187,051	177,765	170,460	163,166	156,142	149,104	142,343	135,929	129,780	123,929	118,334	112,988	107,761	102,909
Time of Use Rate (Non Res)	-	-	-	-	-	11,095	6,430	8,672	6,151	4,817	3,581	3,388	3,268	3,092	2,983	2,822	2,723	2,576	2,482	2,370
Critical Peak Pricing (Non Res)	-	-	-	-	-	11,353	6,876	9,119	6,542	5,277	4,125	3,978	3,769	3,635	3,444	3,321	3,148	3,035	2,873	2,743
Real Time Pricing	-	-	-	-	-	97,731	37,628	35,889	34,230	32,695	31,253	29,845	28,491	27,208	25,977	24,806	23,686	22,616	21,569	20,598

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Table 5-89 – Utility Cost Test Program Benefits

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**1,933,312**	**3,327,827**	**3,399,891**	**3,498,787**	**3,421,443**	**3,792,611**	**3,976,410**	**4,296,990**	**4,525,180**	**4,501,954**	**4,390,919**	**4,253,306**	**4,150,283**	**4,083,956**	**4,030,748**	**3,957,254**	**3,815,033**	**3,690,042**	**3,674,705**	**3,795,815**
Total Residential	**422,709**	**833,709**	**929,499**	**851,997**	**794,718**	**722,826**	**728,865**	**698,555**	**679,738**	**654,042**	**695,315**	**675,296**	**653,374**	**636,600**	**626,234**	**606,042**	**582,145**	**559,475**	**538,820**	**558,471**
Residential Lighting	149,006	284,739	291,600	221,944	171,243	101,927	111,189	89,767	85,575	78,974	76,677	74,430	71,051	68,966	70,143	67,762	64,150	59,729	56,531	58,726
Whole House Efficiency	184,143	366,059	453,576	447,272	440,488	434,830	429,867	419,807	408,186	395,423	445,376	434,661	421,444	408,933	398,878	385,329	371,073	357,381	344,108	357,381
Residential Behavioral	89,559	182,911	184,323	182,781	182,987	186,070	187,810	188,980	185,977	179,644	173,262	166,204	160,880	158,700	157,213	152,950	146,922	142,364	138,180	142,364
Total Residential Low Income	**240,298**	**480,215**	**487,415**	**482,289**	**477,353**	**473,710**	**467,872**	**460,200**	**524,276**	**508,818**	**503,117**	**487,528**	**473,004**	**460,365**	**447,458**	**432,778**	**416,872**	**401,951**	**387,589**	**401,951**
Low Income Whole House Efficiency	17,096	33,533	43,069	42,403	41,684	41,173	40,584	39,582	56,921	55,103	62,861	60,880	58,983	57,342	55,505	53,582	51,734	49,818	47,959	49,818
Low Income Behavioral	35,824	73,164	73,729	73,112	73,195	74,428	75,124	75,592	74,391	71,858	69,305	66,481	64,352	63,480	62,885	61,180	58,769	56,946	55,272	56,946
Low Income Weatherization	187,379	373,518	370,617	366,774	362,474	358,109	352,164	345,026	392,965	381,857	370,951	360,167	349,668	339,543	329,068	318,015	306,370	295,188	284,359	295,188
Total Business	**1,270,305**	**2,013,903**	**1,982,977**	**2,164,501**	**2,149,372**	**2,158,753**	**2,133,628**	**2,083,946**	**2,018,835**	**1,996,994**	**1,894,377**	**1,837,327**	**1,815,640**	**1,775,520**	**1,751,089**	**1,685,007**	**1,637,104**	**1,601,786**	**1,644,783**	**1,707,050**
C&I Program	1,270,305	2,013,903	1,982,977	2,164,501	2,149,372	2,158,753	2,133,628	2,083,946	2,018,835	1,996,994	1,894,377	1,837,327	1,815,640	1,775,520	1,751,089	1,685,007	1,637,104	1,601,786	1,644,783	1,707,050
Demand Response	**-**	**-**	**-**	**-**	**-**	**437,321**	**646,045**	**1,054,288**	**1,302,331**	**1,342,100**	**1,298,110**	**1,253,155**	**1,208,265**	**1,211,471**	**1,205,967**	**1,233,427**	**1,178,911**	**1,126,831**	**1,103,514**	**1,128,343**
Time of Use Rate	-	-	-	-	-	13,141	43,711	110,526	151,229	162,593	157,444	152,119	146,740	147,043	146,473	149,589	143,088	136,909	134,105	137,147
Critical Peak Pricing	-	-	-	-	-	57,979	195,482	480,903	652,532	691,354	668,847	646,668	624,906	630,693	628,203	648,459	619,476	591,064	579,487	592,096
Inclining Block Rates	-	-	-	-	-	357,297	378,523	396,439	410,640	395,985	382,602	368,177	353,417	350,187	348,010	350,030	334,652	320,678	313,221	320,678
Time of Use Rate (Non Res)	-	-	-	-	-	2,636	8,922	22,504	30,852	33,176	32,226	31,137	30,140	30,216	30,215	30,884	29,665	28,418	27,960	28,594
Critical Peak Pricing (Non Res)	-	-	-	-	-	2,041	6,965	17,060	23,262	24,667	23,862	23,147	22,373	22,664	22,590	23,414	22,390	21,456	21,064	21,522
Real Time Pricing	-	-	-	-	-	4,228	12,442	26,856	33,815	34,325	33,128	31,906	30,689	30,669	30,475	31,052	29,641	28,306	27,678	28,306

Table 5-90 – Utility Cost Test Benefit-Cost Ratio

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**2.23**	**2.32**	**2.44**	**2.56**	**2.69**	**1.81**	**2.24**	**2.13**	**2.73**	**3.07**	**3.34**	**3.39**	**3.43**	**3.53**	**3.62**	**3.72**	**3.74**	**3.77**	**3.77**	**4.08**
Total Residential	**1.58**	**1.74**	**1.86**	**1.90**	**1.95**	**2.02**	**2.19**	**2.24**	**2.27**	**2.29**	**2.24**	**2.26**	**2.29**	**2.34**	**2.39**	**2.42**	**2.44**	**2.46**	**2.49**	**2.70**
Residential Lighting	2.01	2.27	2.39	2.51	2.64	2.85	4.65	4.83	4.92	4.99	5.07	5.15	5.23	5.32	5.41	5.47	5.51	5.54	5.58	6.07
Whole House Efficiency	1.73	1.88	1.99	2.05	2.11	2.22	2.29	2.35	2.39	2.41	2.29	2.32	2.36	2.39	2.42	2.45	2.47	2.49	2.51	2.73
Residential Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Total Residential Low Income	**4.82**	**5.33**	**5.27**	**5.47**	**5.66**	**5.99**	**6.17**	**6.39**	**6.47**	**6.56**	**5.92**	**6.01**	**6.11**	**6.22**	**6.33**	**6.41**	**6.46**	**6.52**	**6.60**	**7.16**
Low Income Whole House Efficiency	1.12	1.24	1.30	1.34	1.37	1.44	1.48	1.52	1.54	1.56	1.41	1.43	1.45	1.48	1.50	1.51	1.53	1.54	1.56	1.69
Low Income Behavioral	1.03	1.16	1.24	1.29	1.35	1.47	1.55	1.64	1.68	1.70	1.71	1.72	1.74	1.80	1.87	1.90	1.92	1.94	1.98	2.13
Low Income Weatherization	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Business	**2.32**	**2.32**	**2.47**	**2.61**	**2.76**	**2.98**	**3.09**	**3.19**	**3.22**	**3.27**	**3.29**	**3.34**	**3.38**	**3.45**	**3.53**	**3.54**	**3.57**	**3.61**	**3.56**	**3.87**
C&I Program	2.32	2.32	2.47	2.61	2.76	2.98	3.09	3.19	3.22	3.27	3.29	3.34	3.38	3.45	3.53	3.54	3.57	3.61	3.56	3.87
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.47**	**0.96**	**1.08**	**2.01**	**2.73**	**3.79**	**3.84**	**3.87**	**4.07**	**4.24**	**4.54**	**4.55**	**4.56**	**4.68**	**5.01**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	0.08	0.21	0.31	0.74	1.27	2.86	2.89	2.93	3.08	3.22	3.44	3.45	3.46	3.56	3.82
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	0.30	0.84	1.24	2.87	4.41	7.28	7.36	7.45	7.87	8.21	8.88	8.88	8.87	9.12	9.76
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	0.80	2.02	2.23	2.41	2.43	2.45	2.47	2.48	2.58	2.68	2.82	2.83	2.84	2.91	3.12
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	0.24	1.39	2.60	5.02	6.89	9.00	9.19	9.22	9.77	10.13	10.94	10.90	11.03	11.27	12.06
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	0.18	1.01	1.87	3.56	4.67	5.78	5.82	5.94	6.24	6.56	7.05	7.11	7.07	7.33	7.85
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	0.04	0.33	0.75	0.99	1.05	1.06	1.07	1.08	1.13	1.17	1.25	1.25	1.25	1.28	1.37

(F) If the utility calculates values for other tests to assist in the design of demand-side programs or demand-side rates, the utility shall describe and document the tests and provide the results of those tests.

Three other benefit-cost tests were utilized to analyze cost-effectiveness from different perspectives:

- **Participant Cost Test** quantifies the benefits and costs to the customer due to program participation.
- **Ratepayer Impact Measure (“RIM”) Cost Test** measures what happens to a customer’s rates due to changes in utility revenues and operating costs.
- **Societal Cost Test** measures the effects of a program on society as a whole.

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Table 5-91 – Participant Cost Test Benefit-Cost Ratio

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**5.04**	**6.19**	**6.37**	**6.29**	**6.39**	**7.22**	**7.49**	**7.76**	**8.17**	**8.34**	**8.49**	**8.66**	**8.82**	**9.00**	**9.10**	**9.25**	**9.40**	**9.48**	**9.45**	**10.18**
Total Residential	**9.40**	**9.86**	**9.65**	**10.08**	**10.48**	**11.01**	**11.80**	**12.04**	**12.29**	**12.53**	**11.11**	**11.27**	**11.49**	**11.70**	**11.83**	**12.02**	**12.21**	**12.39**	**12.55**	**13.55**
Residential Lighting	6.50	6.62	6.78	6.93	7.08	7.22	11.19	11.19	11.37	11.51	11.71	11.91	12.21	12.38	12.21	12.35	12.59	12.95	13.18	14.29
Whole House Efficiency	7.07	7.46	7.56	7.73	7.90	8.08	8.31	8.47	8.63	8.79	8.26	8.38	8.53	8.67	8.77	8.89	9.00	9.09	9.17	9.93
Residential Behavioral	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Residential Low Income	**94.59**	**96.30**	**76.59**	**78.48**	**80.40**	**82.22**	**84.54**	**86.60**	**68.98**	**70.56**	**52.82**	**53.91**	**54.97**	**55.95**	**56.91**	**57.82**	**58.64**	**59.42**	**60.14**	**65.08**
Low Income Whole House Efficiency	8.54	8.49	8.52	8.70	8.87	9.09	9.32	9.49	9.47	9.63	8.94	9.09	9.24	9.40	9.53	9.65	9.78	9.88	9.96	10.76
Low Income Behavioral	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Low Income Weatherization	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Business	**3.09**	**3.83**	**3.90**	**3.94**	**4.00**	**4.05**	**4.13**	**4.21**	**4.31**	**4.41**	**4.50**	**4.59**	**4.70**	**4.81**	**4.88**	**4.93**	**5.03**	**5.08**	**5.25**	**5.66**
C&I Program	3.09	3.83	3.90	3.94	4.00	4.05	4.13	4.21	4.31	4.41	4.50	4.59	4.70	4.81	4.88	4.93	5.03	5.08	5.25	5.66
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 5-92 – Ratepayer Impact Cost Test Benefit-Cost Ratio

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**0.39**	**0.36**	**0.36**	**0.37**	**0.38**	**0.36**	**0.39**	**0.42**	**0.45**	**0.46**	**0.46**	**0.45**	**0.45**	**0.46**	**0.46**	**0.47**	**0.46**	**0.46**	**0.45**	**0.46**
Total Residential	**0.27**	**0.28**	**0.28**	**0.28**	**0.27**	**0.27**	**0.27**	**0.27**	**0.27**	**0.27**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**	**0.26**
Residential Lighting	0.52	0.55	0.56	0.58	0.59	0.61	0.68	0.68	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.70
Whole House Efficiency	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.25
Residential Behavioral	0.18	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.22	0.23	0.23	0.23	0.22	0.22	0.22	0.23
Total Residential Low Income	**0.27**	**0.27**	**0.28**	**0.28**	**0.28**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.29**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**	**0.28**
Low Income Whole House Efficiency	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.24	0.24	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.23
Low Income Behavioral	0.18	0.19	0.20	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.22	0.23	0.23	0.23	0.22	0.22	0.22	0.23
Low Income Weatherization	0.30	0.30	0.31	0.31	0.31	0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Total Business	**0.51**	**0.45**	**0.46**	**0.47**	**0.48**	**0.50**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.49**	**0.50**
C&I Program	0.51	0.45	0.46	0.47	0.48	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.49	0.50
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.23**	**0.38**	**0.49**	**0.71**	**0.79**	**0.85**	**0.85**	**0.84**	**0.86**	**0.88**	**0.92**	**0.91**	**0.89**	**0.89**	**0.91**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	0.07	0.17	0.23	0.41	0.53	0.69	0.68	0.67	0.69	0.71	0.74	0.73	0.71	0.72	0.73
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	0.29	0.73	1.03	2.00	2.64	3.42	3.41	3.40	3.54	3.64	3.87	3.82	3.76	3.80	3.91
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	0.26	0.34	0.37	0.39	0.38	0.38	0.38	0.37	0.38	0.38	0.39	0.39	0.38	0.38	0.38
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	0.19	0.63	0.86	1.09	1.14	1.17	1.16	1.14	1.17	1.19	1.24	1.22	1.19	1.19	1.20
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	0.18	0.90	1.55	2.62	3.16	3.61	3.60	3.63	3.78	3.92	4.18	4.15	4.09	4.18	4.34
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	0.04	0.26	0.47	0.58	0.59	0.59	0.59	0.59	0.61	0.63	0.66	0.65	0.65	0.65	0.68

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Table 5-93 – Societal Cost Test Benefit-Cost Ratio

Program	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Total Portfolio	**1.75**	**1.97**	**2.05**	**2.12**	**2.21**	**1.75**	**2.08**	**2.04**	**2.50**	**2.76**	**2.94**	**2.99**	**3.06**	**3.16**	**3.25**	**3.35**	**3.41**	**3.46**	**3.51**	**3.76**
Total Residential	**1.57**	**1.73**	**1.81**	**1.86**	**1.91**	**2.00**	**2.16**	**2.22**	**2.27**	**2.31**	**2.17**	**2.21**	**2.26**	**2.33**	**2.39**	**2.45**	**2.50**	**2.55**	**2.62**	**2.80**
Residential Lighting	1.89	2.08	2.20	2.31	2.41	2.58	3.97	4.08	4.17	4.24	4.32	4.41	4.52	4.61	4.65	4.73	4.81	4.92	5.02	5.42
Whole House Efficiency	1.47	1.61	1.69	1.75	1.81	1.90	1.98	2.04	2.09	2.14	1.96	2.01	2.06	2.11	2.16	2.21	2.26	2.31	2.37	2.54
Residential Behavioral	1.44	1.61	1.72	1.79	1.88	2.03	2.13	2.25	2.32	2.37	2.41	2.45	2.51	2.60	2.71	2.78	2.84	2.91	2.99	3.19
Total Residential Low Income	**6.28**	**6.91**	**6.78**	**7.05**	**7.32**	**7.76**	**8.03**	**8.34**	**8.37**	**8.56**	**7.65**	**7.83**	**8.03**	**8.25**	**8.47**	**8.67**	**8.85**	**9.04**	**9.26**	**9.93**
Low Income Whole House Efficiency	1.42	1.55	1.61	1.66	1.72	1.81	1.88	1.94	1.97	2.01	1.81	1.86	1.91	1.96	2.01	2.06	2.11	2.16	2.21	2.37
Low Income Behavioral	1.44	1.61	1.72	1.79	1.88	2.03	2.13	2.25	2.32	2.37	2.41	2.45	2.51	2.60	2.71	2.78	2.84	2.91	2.99	3.19
Low Income Weatherization	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Business	**1.57**	**1.75**	**1.84**	**1.92**	**2.00**	**2.12**	**2.19**	**2.27**	**2.32**	**2.37**	**2.44**	**2.49**	**2.56**	**2.63**	**2.70**	**2.74**	**2.81**	**2.86**	**2.90**	**3.12**
C&I Program	1.57	1.75	1.84	1.92	2.00	2.12	2.19	2.27	2.32	2.37	2.44	2.49	2.56	2.63	2.70	2.74	2.81	2.86	2.90	3.12
Demand Response	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**0.57**	**1.11**	**1.20**	**2.20**	**2.99**	**4.17**	**4.23**	**4.29**	**4.50**	**4.70**	**5.02**	**5.05**	**5.08**	**5.23**	**5.58**
Time of Use Rate	n/a	n/a	n/a	n/a	n/a	0.09	0.24	0.34	0.82	1.41	3.20	3.25	3.30	3.47	3.63	3.87	3.91	3.94	4.07	4.34
Critical Peak Pricing	n/a	n/a	n/a	n/a	n/a	0.31	0.86	1.26	2.91	4.48	7.40	7.49	7.58	8.01	8.36	9.03	9.04	9.04	9.30	9.94
Inclining Block Rates	n/a	n/a	n/a	n/a	n/a	1.00	2.51	2.74	2.94	2.98	3.03	3.08	3.12	3.24	3.38	3.55	3.59	3.64	3.75	4.00
Time of Use Rate (Non Res)	n/a	n/a	n/a	n/a	n/a	0.27	1.56	2.90	5.57	7.67	10.06	10.31	10.39	11.02	11.43	12.32	12.33	12.55	12.85	13.73
Critical Peak Pricing (Non Res)	n/a	n/a	n/a	n/a	n/a	0.18	1.03	1.90	3.61	4.75	5.88	5.92	6.04	6.35	6.67	7.17	7.24	7.20	7.47	7.99
Real Time Pricing	n/a	n/a	n/a	n/a	n/a	0.05	0.37	0.84	1.10	1.17	1.18	1.20	1.21	1.27	1.32	1.41	1.42	1.42	1.46	1.56

(G) The utility shall describe and document how it performed the cost effectiveness assessments pursuant to section (5) and shall describe and document its methods and its sources and quality of information.

Liberty-Empire engaged AEG to conduct a Demand-Side Management Potential Study and assist with demand-side program design in Liberty-Empire's Missouri service territory. As part of the potential study, a comprehensive list of EE/DR measures was developed and screened for cost-effectiveness (i.e. a TRC benefit-cost ratio of at least 1.0). Each measure was characterized with energy and demand savings, incremental cost, service life, and other performance factors, drawing upon data from well-vetted national and regional sources. Energy-efficient measure energy and demand impacts were calculated using generally accepted engineering algorithms based on a set of reasonable assumptions. Because of the diversity in equipment and energy consumption patterns across multiple building types and end-uses, there exists a variability in these savings estimates as they relate to program design and target markets, particularly at the planning stage of these programs.

The TRC test is the primary method of assessing the cost-effectiveness of energy efficient measures and programs. The TRC test is a widely-accepted methodology that has been used across the United States for over twenty-five years. TRC measures the net costs and benefits of an energy efficiency program as a resource option based on the total costs of the program, including both the participant's and the utility's costs. This test represents the combination of the effects of a program on both participating and non-participating customers.

Four other main benefit-cost tests were utilized to analyze cost-effectiveness from different perspectives:

- **Participant Cost Test** ("PCT") quantifies the benefits and costs to the customer due to program participation.

- **Ratepayer Impact Measure Cost Test** ("RIM") measures what happens to a customer's rates due to changes in utility revenues and operating costs.
- **Utility Cost Test** ("UCT") measures the net costs of a program as a resource option based on the costs incurred by the program administrator, excluding any net costs incurred by the participant.
- **Societal Cost Test** ("SCT") measures the effects of a program on society as a whole.

The cost-effectiveness analysis was performed using Liberty-Empire-specific data. The input data gathered for the model is listed in Table 5-94.

Table 5-94 – Cost-Effectiveness Model Inputs

General Inputs	Specific-Project Inputs
Retail Rate ($/kWh)	Utility Project Costs (Administrative & Incentives)
Commodity Cost ($/kWh)	Direct Participant Project Costs ($/Participant)
Demand Cost ($/kW-Year)	Measure Life (Years)
Environmental Damage Cost ($/kWh)	kWh/Participant Saved (Net and Gross)
Discount Rate (%)	kW/Participant Saved (Net and Gross)
Inflation Rate (%)	Number of Participants
Line Losses (%)	

Measures that were cost-effective within LoadMAP are included in the economic and achievable potential. The DSM Potential Study MAP and RAP was exported into the DSM Program Design. The measures were vetted for inclusion in a DSM program and measures were bundled into programs and re-screened for cost-effectiveness.

AEG utilized its BenCost model[37] to perform the benefit-cost screening and develop the DSM Program Design. AEG considered several energy efficiency portfolios based on the cost-effective measures:

[37] The model is consistent with the California Standard Practice Manual.

- **RAP Program Design Portfolio**. The Realistic Achievable Potential ("RAP") candidates from the DSM Potential Study that Liberty-Empire proposes passing to the integration phase. This portfolio reflects expected program participation given barriers to customer acceptance and non-ideal implementation conditions. These measures are delivered under less than ideal market conditions.
- **MAP Program Design Portfolio**. The Maximum Achievable Potential ("MAP") candidates from the DSM Potential Study that Liberty-Empire proposes passing into the integration phase. This portfolio reflects expected program participation given ideal market implementation and few barriers to customer adoption. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with dealers and delivery partners. Under this scenario, incentives represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **RAP- Portfolio**. Alternative demand-side portfolio designed to represent one-half of the RAP Program Design portfolio participation.
- **RAP+ Portfolio**. Alternative demand-side portfolio designed to represent the midpoint between the RAP Program Design and MAP Program Design portfolios.
- **Aggressive Capacity Portfolio**. Alternative demand-side portfolio designed to utilize demand-side resources to meet additional future capacity.

Liberty-Empire provided several different commodity cost scenarios, each described in Section 5: Demand-Side Program Cost-Effectiveness. For the purposes of this Demand Side Management analysis, the base avoided energy cost scenario and the "base + carbon" scenario, which incorporated a cost for avoided CO_2 emissions, were used to screen measures. The energy efficiency portfolios described above were screened using the base scenario. The RAP Program Design Portfolio was also screened utilizing the "base + carbon" scenario.

Except for the low-income programs, the programs were designed to be cost-effective. Measures were bundled based on the end-use, sector and implementation.

The measure lifetime, gross energy and demand savings per unit and incremental cost per unit are detailed in Section 3.7. Source documentation is shown in the following tables.

Table 5-95 – End-Use Measure Documentation

Measure Name	Sources
LED	Missouri/DOE
LED 2020	Missouri/DOE
LED 2025 +	Missouri/DOE
Specialty LED	Missouri/DOE
ENERGY STAR Dehumidifier	Missouri/Energy Star/DOE
ENERGY STAR Air Purifier	Missouri
Air Sealing	Missouri/Michigan
Attic Insulation R-38	Missouri/Michigan
Wall Insulation R-11	Missouri/Michigan
Foundation Insulation R-13	Missouri/Michigan
Floor Insulation R-30	Missouri/Michigan
Duct Installation & Sealing	Missouri/Illinois
Faucet Aerator	Missouri/Illinois
Low Flow Showerhead	Missouri/Illinois
Hot Water Pipe Insulation	Missouri
Water Heater Wrap	Missouri
CAC SEER 15, EER 12.5	Missouri/CEE/DOE
CAC SEER 16, EER 13	Missouri/CEE/DOE
CAC SEER 17, EER 13	Missouri/CEE/DOE
ASHP SEER 15, HSPF 8.5	Missouri/CEE/DOE
ASHP SEER 16, HSPF 9	Missouri/CEE/DOE
ASHP SEER 18, HSPF 10	Missouri/CEE/DOE
Advanced Thermostat	Missouri
Furnace Blower Motor	Missouri
Heat Pump Water Heater ≤55 gallons	Missouri/NEEA/DOE/Illinois
Heat Pump Water Heater >55 gallons	Missouri/NEEA/DOE/Illinois
Behavioral Reports	Potential Study

Measure Name	Sources
Low Income Weatherization	Liberty-Empire Low Income Eval
Water Heater - Desuperheater	Ameren MO/Illinois
Water Heater - Temperature Set Back	Illinois
Connected Home Management System	PG&E/HI TRM
Air Cooled Chiller	Missouri
Water Cooled Chiller	Missouri
Room Air Conditioner (12 EER)	Illinois
CAC <65 kBtu (SEER 14)	Missouri/CEE
CAC 65<135 kBtu (EER 11.7)	Missouri/CEE
CAC 135<240 kBtu (EER 11.7)	Missouri/CEE
CAC 240<760 kBtu (EER 10.5)	Missouri/CEE
CAC ≥760 kBtu (EER 9.9)	Missouri/CEE
Heat Pump <65 kBtu (SEER 14, HSPF 8.5)	Missouri/CEE
Heat Pump 65<135 kBtu (EER 11.3, COP 3.4)	Missouri/CEE
Heat Pump 135<240 kBtu (EER 10.9, COP 3.2)	Missouri/CEE
Heat Pump ≥240 kBtu (EER 10.3, COP 3.2)	Missouri/CEE
Packaged Terminal Air Conditioner	Missouri
Packaged Terminal Heat Pump	Missouri
Variable Speed Drive - Chilled Water Pump	Illinois
Variable Speed Drive - Hot Water Pump	Illinois
Demand Controlled Ventilation	Missouri/Illinois
ENERGY STAR Steamer	Missouri
ENERGY STAR Dishwasher	Illinois
ENERGY STAR Hot Food Holding Cabinets	Missouri
ENERGY STAR Electric Convention Oven	Missouri
ENERGY STAR Electric Fryer	ENERGY STAR
Evaporator Fan Control	Missouri
Strip Curtain for Walk-In Cooler/Freezer	ENERGY STAR/Missouri
Night Covers for Open Refrigerated Display Cases	Illinois
Door Heater Controls	Missouri
Refrigeration Economizer	Missouri/Illinois
Kitchen Demand Ventilation Controls	Missouri/Illinois
Directional LED Bulb (<15W)	Missouri
Directional LED Bulb (≥15W)	Missouri
High Bay Fluorescent Fixture (HP T8 >4 lamps)	Illinois

Measure Name	Sources
High Bay Fluorescent Fixture (HP T8 ≤4 lamps)	Illinois
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 >4 lamps)	Missouri
High Bay Fluorescent Fixture w/ HE Electronic Ballast (T5 ≤4 lamps)	Missouri
LED Exit Sign	Illinois
LED Flood Light (<15W)	Illinois
LED Flood Light (≥15W)	Illinois
LED Recessed Fixture (1x4)	Missouri
LED Recessed Fixture (2x2)	Missouri
LED Recessed Fixture (2x4)	Missouri
Lighting Optimization - Remove 4ft Lamp from T8 System	Missouri
Lighting Optimization - Remove 8ft Lamp from T8 System	Missouri
Omnidirectional LED Bulb (<10W)	Missouri
Omnidirectional LED Bulb (≥10W)	Missouri
LED Parking Garage/Canopy (<30W)	Missouri/Illinois
LED Parking Garage/Canopy (30-75W)	Missouri/Illinois
LED Parking Garage/Canopy (≥75W)	Missouri/Illinois
LED Wall Mounted Area Lights (<30W)	Illinois
LED Wall Mounted Area Lights (30-75W)	Illinois
LED Wall Mounted Area Lights (≥75W)	Illinois
LED Direct Linear Ambient fixtures <=35W	Illinois/Xcel
LED Direct Linear Ambient fixtures 36W-60W	Illinois/Xcel
LED Direct Linear Ambient fixtures 61W-100W	Illinois/Xcel
LED linear replacement lamps (Type A or AB) 2 foot	Missiori/DLC
LED linear replacement lamps (Type A or AB) 4 foot	Missiori/DLC
LED Refrigerator Case Light	Minnesota
Photocell Occupancy Sensor	MN/Illinois
Wall-Mount Occupancy Sensor	Missouri
VFD Fans and Blowers	Potential Study
Zero-Loss Condensate Drain	Missouri
Compressed Air Nozzle	Missouri
VSD Ventilation	NWPC 7th Plan (Potential Study)
C&I Custom Rebate	Estimate

Measure Name	Sources
Small C&I Retrocommissioning	Potential Study
Large C&I Retrocommissioning	Potential Study
Time of Use Rate	Potential Study
Critical Peak Pricing	Potential Study
Inclining Block Rate	Potential Study
Time of Use Rate (Non Res)	Potential Study
Critical Peak Pricing (Non Res)	Potential Study
Real Time Pricing	Potential Study

Several sources of data were used to characterize the energy efficiency measures. AEG used recent studies performed for the Midwest, AEG data (e.g., DEEM database), and national and well-vetted regional data sources:

- AEG's Database of Energy Efficiency Measures.
- Consortium for Energy Efficiency. Program Resources.[38]
- ENERGY STAR. Energy Efficiency Product Specifications.[39]
- U.S. Department of Energy. Current Rulemakings and Notices.[40]
- Missouri Dept. of Economic Development, Division of Energy. Missouri Technical Reference Manual – 2017.
- Illinois Statewide Technical Reference Manual for Energy Efficiency. Draft Version 7.0 Effective January 1, 2019.
- Arkansas Public Service Commission. Arkansas Technical Reference Manual. Version 7.0 (August 31, 2017).
- State of Minnesota. Technical Reference Manual for Energy Conservation Improvement Programs. Version 2.1. Effective January 1, 2017 – December 31, 2018.

[38] Consortium for Energy Efficiency. Program Resources. https://www.cee1.org/
[39] Energy Star. Product Specifications and Partner Commitments Search. http://www.energystar.gov/products/spec/
[40]Energy Starroduct Specifications and Partner Commitments Search. http://www.energystar.gov/products/spec/ ngs-and-notices

- Iowa Utilities Commission Broad. Iowa Energy Efficiency Statewide Technical Reference Manual Version 2.0. Effective January 1, 2018
- Michigan Public Service Commission (2018). Michigan Energy Measures Database. Prepared by Morgan Marketing Partners.
- Ameren Missouri 2017 Integrated Resource Plan. Appendix A – Technical Resource Manual.
- ComEd. ComEd Programs NTG Approach for EPY10.[41]

[41] Energy Star. Product Specifications and Partner Commitments Search.
http://www.energystar.gov/products/spec/
ngs-and-n

SECTION 6 TOTAL RESOURCE COST TEST

(6) Potential demand-side programs and potential demand-side rates that pass the total resource cost test including probable environmental costs shall be considered as demand-side candidate resource options and must be included in at least one (1) alternative resource plan developed pursuant to 4 CSR 240-22.060(3).

Potential demand-side programs and demand-side rate pilot programs that passed the total resource cost test (i.e. achieved a TRC benefit-cost ratio of at least 1.0) were considered as a demand-side candidate resource options and were included in at least one of the five alternative resource plans.

(A) The utility may bundle demand-side candidate resource options into portfolios, as long as the requirements pursuant to section (1) are met and as long as multiple demand-side candidate resource options and portfolios advance for consideration in the integrated resource analysis in 4 CSR 240-22.060. The utility shall describe and document how its demand-side candidate resource options and portfolios satisfy these requirements.

Measures that were cost-effective within LoadMAP are included in the economic and achievable potential. The DSM Potential Study MAP and RAP were exported into the DSM Program Design. The measures were vetted for inclusion in a DSM program and measures were bundled into programs and re-screened for cost-effectiveness.

AEG utilized its BenCost model[42] to perform the benefit-cost screening and develop the DSM Program Design. AEG considered several energy efficiency portfolios based on the cost-effective measures.

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[42] Notices
del is consistent with the California Standard Practice Manual.

- **RAP Program Design Portfolio**. The Realistic Achievable Potential (RAP) candidates from the DSM Potential Study that Liberty-Empire proposes passing to the integration phase. This portfolio reflects expected program participation given barriers to customer acceptance and non-ideal implementation conditions. These measures are delivered under less than ideal market conditions.
- **MAP Program Design Portfolio**. The Maximum Achievable Potential (MAP) candidates from the DSM Potential Study that Liberty-Empire proposes passing into the integration phase. This portfolio reflects expected program participation given ideal market implementation and few barriers to customer adoption. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with dealers and delivery partners. Under this scenario, incentives represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **RAP- Portfolio**. Alternative demand-side portfolio designed to represent one-half of the RAP Program Design portfolio participation.
- **RAP+ Portfolio**. Alternative demand-side portfolio designed to represent the midpoint between the RAP Program Design and MAP Program Design portfolios.
- **Aggressive Capacity Portfolio**. Alternative demand-side portfolio designed to utilize demand-side resources to meet additional future capacity.

Liberty-Empire provided several different commodity cost scenarios, each described in Section 5: Demand-Side Program Cost-Effectiveness. For the purposes of this Demand Side Management analysis, the base avoided energy cost scenario and the base + carbon scenario, which incorporated a cost for avoided CO_2 emissions, were used to screen measures. The energy efficiency portfolios described above were screened using the base scenario. The RAP Program Design Portfolio was also screened utilizing the base + carbon scenario.

(B) For each demand-side candidate resource option or portfolio, the utility shall describe and document the time-differentiated load impact estimates over the planning horizon at the level of

detail required by the supply system simulation model that is used in the integrated resource analysis, including a tabulation of the estimated annual change in energy usage and in diversified demand for each year in the planning horizon due to the implementation of the candidate demand-side resource option or portfolio.

The time-differentiated load impacts for each demand-side candidate resource option is provided in the program design workbooks. The time-differentiated load impact by program scenario is shown in 100 below.

(C) The utility shall describe and document its assessment of the potential uncertainty associated with the load impact estimates of the demand-side candidate resource options or portfolios. The utility shall estimate—

The demand-side program cost-effectiveness evaluation included an analysis of five program scenarios to account for potential uncertainty.

1. The impact of the uncertainty concerning the customer participation levels by estimating and comparing the maximum achievable potential and realistic achievable potential of each demand-side candidate resource option or portfolio; and

The demand-side program cost-effectiveness evaluation included an analysis of five program scenarios with varying participation levels and incentives to account for potential uncertainty.

2. The impact of uncertainty concerning the cost effectiveness by identifying uncertain factors affecting which end-use resources are cost effective. The utility shall identify how the menu of cost effective end-use measures changes with these uncertain factors and shall estimate how these changes affect the load impact estimates associated with the demand-side candidate resource options.

The demand-side program cost-effectiveness evaluation included an analysis of nine program scenarios with varying participation levels and incentives to account for potential uncertainty.

- **RAP Program Design Portfolio**. The Realistic Achievable Potential (RAP) candidates from the DSM Potential Study that Liberty-Empire proposes passing to the integration phase. This portfolio reflects expected program participation given barriers to customer acceptance and non-ideal implementation conditions. These measures are delivered under less than ideal market conditions.
- **MAP Program Design Portfolio**. The Maximum Achievable Potential (MAP) candidates from the DSM Potential Study that Liberty-Empire proposes passing into the integration phase. This portfolio reflects expected program participation given favorable market implementation and few barriers to customer adoption. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with dealers and delivery partners. Under this scenario, incentives represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **RAP- Portfolio**. Alternative demand-side portfolio designed to represent one-half of the RAP Program Design portfolio participation.
- **RAP+ Portfolio**. Alternative demand-side portfolio designed to represent the midpoint between the RAP Program Design and MAP Program Design portfolios.
- **Aggressive Capacity Portfolio**. Alternative demand-side portfolio designed to utilize demand-side resources to meet additional future capacity.

Liberty-Empire provided several different commodity cost scenarios, each described in Section 5: Demand-Side Program Cost-Effectiveness. For the purposes of this Demand Side Management analysis, the base avoided energy cost scenario and the base + carbon scenario, which incorporated a cost for avoided CO_2 emissions, were used to screen measures. The energy efficiency portfolios described above were screened using the base scenario. The RAP Program Design Portfolio was also screened utilizing the base + carbon scenario.

NP

Table 5-96 – Comparison of Incremental Participation by Scenario

Incremental Participation	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
RAP- Program Design	12,738	25,216	25,432	24,630	24,007	125,272	129,252	137,032	140,926	142,819	142,954	143,021	143,099	143,153	143,231	143,288	143,325	143,361	143,435	143,435
RAP Program Design	25,471	50,429	50,859	49,256	48,011	150,537	158,502	174,062	181,846	185,632	185,903	186,036	186,194	186,301	186,457	186,572	186,645	186,718	186,865	186,865
RAP+ Program Design	30,541	60,280	60,708	58,565	56,959	160,609	170,311	189,096	198,187	202,624	202,871	202,948	203,083	203,187	203,254	203,296	203,302	203,350	203,432	203,432
MAP Program Design	35,607	70,127	70,552	67,870	65,902	170,672	182,112	204,124	214,527	219,613	219,830	219,856	219,969	220,071	220,050	220,016	219,956	219,976	219,994	219,994
Aggressive Capacity Program Design	25,471	50,429	50,859	49,256	48,011	150,708	158,959	189,096	198,187	202,624	202,871	202,948	203,083	220,071	220,050	220,016	219,956	219,976	219,994	219,994
CO2 Scenario Program Design	25,496	50,460	50,911	49,321	48,077	150,605	158,693	174,249	182,032	185,819	185,979	186,103	186,260	186,368	186,523	186,639	186,712	186,785	186,932	186,932

Table 5-97 – Comparison of Net MWh Savings by Scenario

Net MWh	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
RAP- Program Design	2,783	5,470	5,562	5,712	5,691	15,098	15,495	16,235	16,712	16,917	17,022	17,032	17,071	17,094	17,139	17,133	17,161	17,191	17,449	17,449
RAP Program Design	5,535	10,940	11,138	11,438	11,381	20,938	21,752	23,235	24,162	24,594	24,804	24,837	24,918	24,963	25,050	25,037	25,100	25,155	25,672	25,672
RAP+ Program Design	6,827	12,818	13,171	13,353	13,256	22,869	23,833	25,631	26,601	26,941	27,309	27,327	27,451	27,484	27,503	27,506	27,540	27,679	28,070	28,070
MAP Program Design	8,107	14,710	15,224	15,300	15,146	24,834	25,938	28,060	29,076	29,326	29,846	29,844	30,018	30,040	30,010	30,027	30,035	30,218	30,486	30,486
Aggressive Capacity Program Design	5,535	10,940	11,138	11,438	11,381	20,944	21,771	25,631	26,601	26,941	27,309	27,327	27,451	30,040	30,010	30,027	30,035	30,218	30,486	30,486
CO2 Scenario Program Design	5,568	10,982	11,210	11,532	11,475	21,056	22,215	23,684	24,611	25,043	24,949	24,954	25,035	25,080	25,168	25,155	25,218	25,273	25,789	25,789

Table 5-98 – Comparison of Net Coincidence MW Savings by Scenario

Net MW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
RAP- Program Design	1.22	2.00	2.03	2.08	2.05	9.74	12.34	17.20	19.51	20.62	20.66	20.70	20.75	20.79	20.84	20.87	20.90	20.94	21.01	21.01
RAP Program Design	2.42	4.00	4.05	4.16	4.09	13.09	18.33	28.04	32.63	34.89	34.97	35.04	35.15	35.23	35.33	35.38	35.45	35.52	35.67	35.67
RAP+ Program Design	2.99	4.78	4.95	5.00	4.91	14.68	21.47	33.88	39.63	42.43	42.57	42.66	42.80	42.90	42.98	43.03	43.11	43.24	43.38	43.38
MAP Program Design	3.54	5.56	5.84	5.85	5.72	16.30	24.60	39.72	46.64	49.97	50.17	50.27	50.44	50.56	50.66	50.71	50.82	50.92	51.06	51.06
Aggressive Capacity Program Design	2.42	4.00	4.05	4.16	4.09	13.10	18.36	33.88	39.63	42.43	42.57	42.66	42.80	50.56	50.66	50.71	50.82	50.92	51.06	51.06
CO2 Scenario Program Design	2.43	4.00	4.06	4.18	4.11	13.11	18.38	28.08	32.68	34.93	34.98	35.05	35.17	35.24	35.35	35.39	35.46	35.54	35.68	35.68

Table 5-99 – Comparison of Incentives by Scenario

Total Incentives	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
RAP- Program Design	$234,457	$402,635	$414,778	$433,388	$424,756	$416,273	$410,863	$408,247	$413,672	$419,150	$437,812	$438,502	$443,468	$444,768	$450,175	$450,312	$453,402	$456,647	$488,583	$488,583
RAP Program Design	$464,304	$806,046	$830,388	$868,175	$849,789	$833,241	$822,334	$817,258	$827,304	$838,590	$876,055	$878,165	$888,294	$890,765	$901,388	$901,563	$908,226	$914,293	$977,351	$977,351
RAP+ Program Design	$651,226	$1,047,743	$1,116,409	$1,137,833	$1,111,234	$1,088,713	$1,072,441	$1,068,300	$1,078,550	$1,074,396	$1,148,664	$1,149,243	$1,164,761	$1,168,653	$1,169,003	$1,169,475	$1,175,445	$1,188,767	$1,241,351	$1,241,351
MAP Program Design	$941,790	$1,430,022	$1,546,896	$1,552,364	$1,508,151	$1,476,649	$1,448,387	$1,447,562	$1,456,435	$1,439,231	$1,558,838	$1,556,555	$1,582,805	$1,588,081	$1,574,175	$1,575,950	$1,581,555	$1,608,870	$1,650,451	$1,650,451
Aggressive Capacity Program Design	$464,304	$806,046	$830,388	$868,175	$849,789	$835,161	$946,160	$1,068,300	$1,078,550	$1,074,396	$1,148,664	$1,384,288	$1,404,171	$1,588,081	$1,574,175	$1,575,950	$1,581,555	$1,608,870	$1,650,451	$1,650,451
CO2 Scenario Program Design	$468,374	$811,346	$839,248	$877,735	$859,349	$844,551	$889,644	$882,568	$892,614	$903,900	$891,365	$889,475	$899,604	$902,075	$912,698	$912,873	$919,536	$925,603	$988,661	$988,661

Table 5-100 – Comparison of Total Utility Administrative Costs by Scenario

Administration Costs	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
RAP- Program Design	$293,024	$471,028	$461,012	$463,120	$451,468	$1,566,312	$1,117,000	$1,365,419	$1,146,847	$1,044,145	$951,363	$951,876	$957,881	$957,839	$960,294	$962,220	$963,006	$965,690	$982,308	$982,308
RAP Program Design	$484,305	$842,276	$847,227	$851,512	$827,919	$2,060,264	$1,739,256	$2,236,020	$1,798,349	$1,593,226	$1,407,423	$1,408,856	$1,421,011	$1,420,832	$1,425,551	$1,429,472	$1,431,392	$1,436,506	$1,469,486	$1,469,486
RAP+ Program Design	$597,639	$1,013,269	$1,038,102	$1,030,419	$998,054	$2,283,879	$2,015,143	$2,611,222	$2,080,508	$1,834,813	$1,624,143	$1,623,269	$1,640,018	$1,638,166	$1,638,011	$1,641,530	$1,641,437	$1,652,506	$1,676,697	$1,676,697
MAP Program Design	$736,212	$1,218,568	$1,263,825	$1,244,620	$1,201,251	$2,539,653	$2,322,267	$3,018,318	$2,393,786	$2,108,951	$1,875,352	$1,872,302	$1,894,823	$1,891,464	$1,885,287	$1,888,666	$1,887,065	$1,905,451	$1,921,018	$1,921,018
Aggressive Capacity Program Design	$484,305	$842,276	$847,227	$851,512	$827,919	$2,061,848	$1,781,501	$2,761,718	$2,080,508	$1,834,813	$1,624,143	$1,691,235	$1,709,135	$2,347,689	$1,885,287	$1,888,666	$1,887,065	$1,905,451	$1,921,018	$1,921,018
CO2 Scenario Program Design	$490,164	$849,513	$859,302	$865,019	$841,427	$2,074,418	$1,784,340	$2,279,963	$1,842,290	$1,637,169	$1,423,860	$1,423,007	$1,435,163	$1,434,984	$1,439,704	$1,443,624	$1,445,544	$1,450,659	$1,483,638	$1,483,638

SECTION 7 DEVELOPMENT OF EVALUATION PLANS

(7) For each demand-side candidate resource option identified in section (6), the utility shall describe and document the general principles it will use to develop evaluation plans pursuant to 4 CSR 240-22.070(8). The utility shall verify that the evaluation costs in subsections (5)(B) and (5)(C) are appropriate and commensurate with these evaluation plans and principles.

Liberty-Empire has designated approximately 5% of its portfolio budget for Evaluation, Measurement and Verification ("EM&V") activities. To cost-effectively evaluate Liberty-Empire's DSM programs, the evaluation contractor will evaluate each program every two years, starting with the beginning of the second program year. This plan provides a high level, multi-year evaluation approach for Liberty-Empire's energy efficiency program portfolio.

<u>Project Initiation Meetings</u>

The evaluation contractor will meet with Liberty-Empire staff (and their contractors, if desired) annually in person or via teleconference to discuss evaluation objectives, a common set of expectations about what the evaluation will provide, and an agreement on the methods to be used to evaluate each program. The meeting will also provide an opportunity to review the data requirements for meeting the study objectives, establish the schedule of deliverables, set up a communications protocol, and develop a good working relationship.

<u>Evaluation Plans</u>

Program evaluation supports the need for public accountability, oversight, validation of program performance and cost-effective program improvements. An evaluation plan provides a roadmap for program evaluation activities, identifying evaluation objectives, the evaluation approach, data collection, sampling plans, and work schedule.

The evaluation contractor will develop detailed evaluation plans for each program. The plans will support a comprehensive approach, designed to be revised and extended into future years. The evaluation plan will include study strategies and techniques, study objectives, key researchable issues, data collection and analysis approaches, sampling strategies, timelines, and deliverables by the programs to be evaluated that year.

Program Design and Delivery Review

A program design and delivery review will be completed as part of the Year 1 process evaluation. This will include staff interviews and a review of the tracking system.

The evaluation contractor will conduct in-depth interviews with Liberty-Empire design and delivery staff. The interviews with program managers and staff will discuss the roles and responsibilities of staff and trade allies; program goals, successes, and challenges in meeting these goals; the effectiveness of the programs' operations relative to the defined program goals and objectives; reasons for variance in program performance by customer class or territory; and areas in need of improvement in program design and implementation. The evaluation contractor will complete an interim memo summarizing the results of the program design and delivery review.

Quality program tracking systems are integral for effective program planning, implementation and evaluation. The evaluation contractor will evaluate Liberty-Empire's tracking system including initial data validation (application processing, measure and savings capture and validation, audit trail, and system location), security, and data granularity (types of data being captured, QA/QC processes, data thresholds and back-up data capture, refresh rate and automated validations).

Evaluation Management and Reporting

The evaluation contractor will meet with Liberty-Empire in person or via teleconference to summarize tasks completed for the month, problems encountered and solutions implemented, schedule and budget issues and updates, and tasks planned in the next month. The evaluation contractor will have ad-hoc meetings with Liberty-Empire staff as needed to resolve issues as they arise and maintain ongoing communication.

It is imperative that the evaluation provide and discuss preliminary findings at the end of each data collection and analysis activity. This type of regular reporting ensures that the findings from each activity can be used to modify the programs as needed to improve their performance. The evaluation contractor will provide Liberty-Empire with interim evaluation memorandum reports that will summarize preliminary evaluation findings and potential recommendations stemming from those findings.

The evaluation contractor will compile and synthesize the results of all evaluation activities each year into an annual comprehensive evaluation report that will identify key findings and recommendations at the cross-cutting and sector level (residential and commercial) as well as program level. The annual evaluation reports will be finalized by the end of each calendar year.

Process Evaluation Approach

Process evaluations will be conducted for each program at the end of the first year. The purpose is to assess the effectiveness of program processes, evaluate the achievements of program objectives, and make recommendations for program improvements. A good process evaluation will:

1. Assist program implementers and managers with managing programs to achieve cost-effective savings while maintaining high levels of customer satisfaction.
2. Determine awareness levels to refine marketing strategies and reduce barriers to participation.

3. Provide recommendations for changing the program's structure, management, administration, design, delivery, operations or targets.
4. Determine if best practices should be incorporated.
5. Gather information from a variety of sources to address the issues stated above.

The process evaluations will provide recommendations to Liberty-Empire, program implementers, and other program stakeholders on program design, delivery, and administration. The evaluation contractor will develop individual program plans that identify project objectives, data resources and collection, key researchable issues, budget and timeline. Once the evaluation plans have been reviewed by Liberty-Empire, the evaluation contractor will design the sample plan and data collection instruments, and collect and analyze the data. The evaluation contractor will synthesize the findings and present recommendations to Liberty-Empire in draft and final evaluation reports.

Data Collection and Sampling Plan

The data collection plan will define the specific data collection requirements, along with the source of the information and the use to which that the data will be put, the timing of the data collection, in relation to the rest of the plan, to assure that it meets the overall needs of the study, and the scheduling method and plan or coordinating contacts.

The sampling plan will describe the sample design, interview methodology and stratification of each program. Interviews of the major personnel categories will include Liberty-Empire staff, program managers, third party implementers, participating and non-participating customers, and participating and non-participating trade allies, in addition to others.

The sample size of each group will be calculated at a 90% confidence interval with an error margin of +/- 10%. The number of completed interviews will provide a sufficient sample to meet the confidence interval requirements. The interview methodology will range depending on the market actor being interviewed, from on-site interviews, in-depth interviews or computer-assisted telephone interviews.

Program Design and Delivery Staff Interviews

Interviews with program staff will be conducted in-person and will focus on the program history and design, identifying areas for program improvement and the overall effectiveness of the program. The third-party implementer interviews will be conducted at the locations where program files are maintained. Particular attention will be paid to the contractor's perception of how the programs operate, what program data are tracked and captured, how the data are managed and maintained, and how program subcontractor(s) are managed, if applicable.

Questions will be based on both portfolio- and program-level activities and achievements. Answers to these questions will help identify process improvements that can make the program more efficient and consequently more cost-effective and will be summarized in a chapter of the process evaluation report.

Customer Data Collection

Surveys of participating customers will be conducted via telephone. Participating customers will be asked about their experiences with the program, including the effectiveness and satisfaction with the program, the contractor/trade allies, the equipment itself, and marketing outreach. Participants will also answer a series of questions regarding program awareness, attitudes of energy efficiency and energy conservation, overall satisfaction, and barriers to participation, spillover and areas of improvement. The findings from the customer surveys will be summarized in a chapter of the process evaluation and the data tables from these surveys will be provided in separate appendices.

Trade Ally Data Collection

Trade allies will be asked about clarity of program rules, usefulness of support materials, marketing and coordination efforts and application processes. These responses will be instrumental in developing recommendations for improvement that will improve program effectiveness and customer satisfaction and remove barriers to participation. Trade ally interviews will also attempt to gather information that could be used to assess market effects or other program-related impacts such as free-ridership and spillover.

Non-Participating Customer and Trade Ally Data Collection

Where appropriate, interviews with non-participating customers and trade allies will be conducted to better understand the market, free ridership, spillover and how the program can increase participation and effects in the market. These interviews will also provide insights into removing barriers to participation and improved marketing methods and messages.

Document Review

In addition to stakeholder interviews, the evaluation contractor will collect program materials, including process flowcharts, and marketing and outreach materials such as point of purchase (POP) materials, print and radio advertising copy and any cooperative marketing materials developed. The evaluation contractor will also request information on actual activities, such as completed marketing campaigns. Marketing schedules and quantitative data, such as enrollments per month, will be overlaid to determine the impacts of these campaigns.

Impact Evaluation Approach

Impact evaluations estimate gross and net demand, energy savings and the cost-effectiveness of installed systems. They are used to verify measure installations, identify key energy assumptions and provide the research necessary to calculate defensible and accurate savings attributable to the program. Impact evaluations are typically conducted one year after the program is implemented because program results may not be accessible or apparent before then.

The evaluation contractor will adhere to the state evaluation protocols to obtain unbiased and reliable estimates of program-level net energy and demand savings over the life of the expected net impact. Measurement and Verification (“M&V”) may be conducted at a higher level of rigor or with greater precision than the protocols (depending on resources or program goals), where more inputs measured or metered, but M&V may not use a lower level of rigor than is specified in the evaluation protocol.

Program level impact evaluations will be conducted to verify measure installations and identify key energy assumptions for equipment life, incremental equipment cost, program budget information, number of participants, free ridership and spillover. The evaluation will also provide the necessary research to calculate defensible and accurate savings attributable to the program. The primary data collection methodologies for the impact evaluation will include:

- Strategies to measure and verify energy efficiency installation and determine energy impacts for each program, as appropriate, in kilowatt-hour or kilowatt reductions
    - Sample for field verification activities
    - Field verification activities and observations
    - Adjusted measure savings values based on field activities and data reviews
- Program-specific realization rates
- Energy savings based on four annual time periods (on-peak and off-peak)
- Billing analyses
- Applications and supporting documentation provided to Liberty-Empire from customers, as appropriate
- Conclusions and recommendations for more accurately estimating energy savings for each program

Secondary data sources will be used for assumptions that do not require primary data collection. The evaluation contractor will use inputs specific to Liberty-Empire, including avoided costs and discounts rates to conduct cost-effectiveness analysis and program screening. The program evaluator will evaluate cost-effectiveness using the standard California tests including Total Resource Cost, Societal Cost Test, Participant Test, Utility Test and Rate Impact Measure Test. These tests consider the overall costs and benefits from various perspectives. All results will be provided with estimates of present value benefits, cost, net benefits and benefit-cost ratios. The analysis will include both a retrospective look at the program to date and a prospective analysis of the future of the program.

All work will be designed to meet the appropriate International Performance Measurement and Verification Protocol ("IPMVP") and the State of Missouri EM&V protocols.

SECTION 8 DEMAND-SIDE RESOURCES AND LOAD-BUILDING PROGRAMS

(8) Demand-side resources and load-building programs shall be separately designed and administered, and all costs shall be separately classified to permit a clear distinction between demand-side resource costs and the costs of load-building programs. The costs of demand-side resource development that also serve other functions shall be allocated between the functions served.

Liberty-Empire did not include any load-building programs in the IRP.

AEG Applied Energy Group

EMPIRE DISTRICT DSM POTENTIAL STUDY

Report prepared for:

EMPIRE DISTRICT ELECTRIC COMPANY (LIBERTY UTILITIES)

JUNE 2019

Energy Solutions. Delivered.

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AEG
Applied Energy Group

EMPIRE DISTRICT ENERGY EFFICIENCY PROGRAM DESIGN

Report prepared for:
EMPIRE DISTRICT ELECTRIC COMPANY (LIBERTY UTILITYIES)

JUNE 2019

Energy Solutions Delivered.

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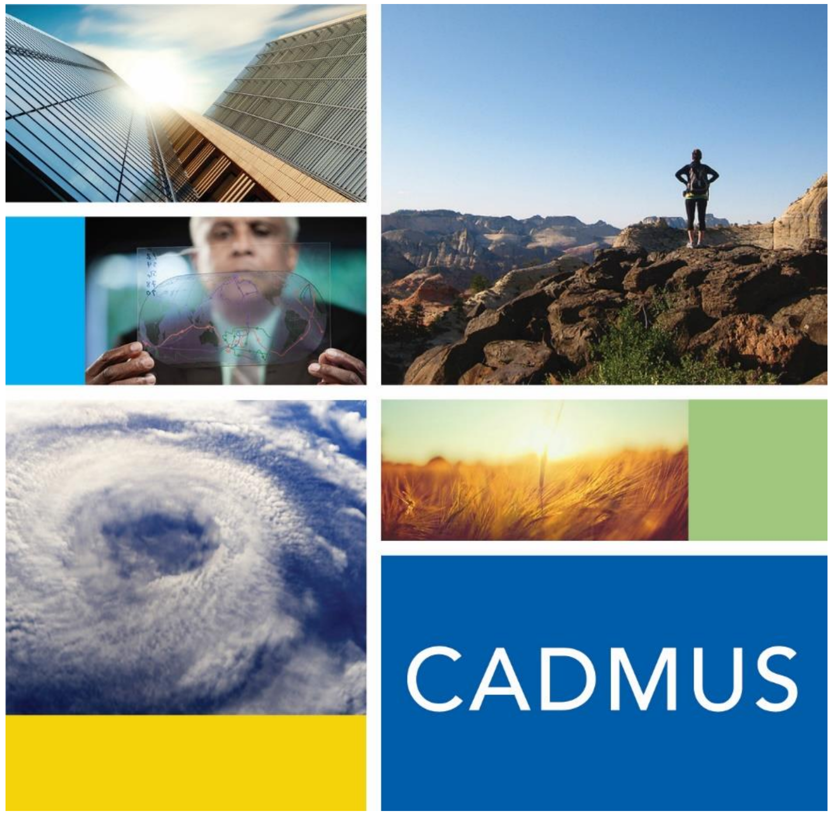

The Empire District Electric Company PAYS Feasibility Study

May 31, 2018

The Empire District Electric Company
602 South Joplin Avenue
Joplin, Missouri 64802

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Executive Summary

The Empire District Electric Company (Empire) commissioned a feasibility study to determine if Pay As You Save (PAYS) is a viable program design for the company to offer residential electric customers as part of its energy efficiency portfolio of programs. PAYS, registered by the U. S. Patent and Trademark Office, is a system developed by the Energy Efficiency Institute, Inc. (EEI).[1] Through the PAYS program, the utility pays all or part of the up-front cost for energy efficiency upgrades, and it recovers those funds through an on-bill tariff. The monthly tariff charged to the customer can be no more than 80% of the average monthly bill savings and last no longer than 80% of the measure's effective useful life. The design of the tariff ensures that the measure is an immediate cash-positive investment for the participant, and that its cost-effective over the life of the measure.

Objectives

To assess whether PAYS would be a feasible program model for Empire to offer customers, Cadmus investigated the following research topics:

- What measures are suitable for a PAYS tariff? (Based on electric savings only.)
- Could PAYS support enough of the up-front cost to be meaningful support for customers?
- What are the costs to launch and operate a PAYS program, under what circumstances could a PAYS program be cost-effective?
- Is there a gap in the market for financing in Empire's territory, and could a utility-administered financing program increase uptake of energy efficiency?

Key Findings

Measure Analysis

Cadmus reviewed costs and savings for 25 measures and four packages of measures to determine what percent of the measure or project cost could be covered by the PAYS tariff.

Just over half of the measures assessed only provide sufficient savings to allow PAYS financing to cover 30% or less of the cost of the measure over its expected useful life. Several measures provide savings sufficient for PAYS to finance from 50% to just over 100% of the full measure cost. A last group of measures provided sufficient savings for a reduced tariff to cover the full up-front cost over just 10 years, a term less than the maximum 80% of the EUL. This group of measures and packages included primarily ASHPs installed on an early replacement (ER) basis to replace electric heating equipment. ER measures provide far more savings than ROF measures because the baseline to calculate savings is the

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existing working equipment, which is typically less efficient than the current minimum federal standard that serves as the baseline for ROF equipment.

Federal census data indicates 43% of Empire customers have electric heat, indicating a potentially large market for the measures most likely to be well-suited to PAYS.

Customer Rate Sensitivity

Cadmus tested the sensitivity of the original measure-level financial analysis (discussed above) to four different rate structures: declining block (based on current Empire rates), inclining block (increased rate to discourage usage in the summer), time-of-use (TOU) rates (increased price for on-peak times throughout the year), and a decoupled rate structure (removing the utilities dis-incentive to achieve energy efficiency savings). For most measures, the reduced price in the winter months from the declining block, inclining block and TOU rates reduced the total bill savings from the measure, and therefore reduced the percentage of PAYS financing under the program rules. The decoupled rate structure increased rates by 1% per year, resulting in an increase in bill savings. However, the effect was modest, with no measure showing more than a 16% increase in the percentage of the measure cost that could be financed through PAYS.

Cost-effectiveness

Cadmus used the total resource cost test (TRC), the program administrator cost test (PAC), and the Ratepayer Impact Measure Test (RIM) to assess the potential cost-effectiveness of a PAYS program. Table 1 shows the program cost assumptions and inputs used in the analysis.

Table 1. Cost-effectiveness Inputs and Assumptions

Parameter	Value
Utility Assumptions	
Utility Cost of Capital / Interest Rate	5.73%
Opportunity Cost	2.88%
Line Loss	7.13%
Nonpayments /Nonpayment Loss Reserve fee	5.00%
NTG Ratio	1.0/0.62
Tariff Duration (years)	10
Annual Program Costs	
Utility Administration	$82,500
Marketing	$25,460
Evaluation	$30,000
Tariff Implementation Costs (<=71 participants) Fixed	$60,000
Tariff Implementation Costs (72 or more participants) Per Participant	$838

Under the TRC, the combined program achieves a benefits-to-savings ratio of 1:1 at 44 or 70 participants, depending on the assumed NTG ratio. When the program was evaluated with either the ER

ASHP or the ER standard whole home package as the only measure included in the program, the breakeven participation level under the TRC test, assuming full savings, dropped to 38 and 39 participants, respectively (Table 2). Where participation consists entirely of HPWHs installed on a ROF basis, the program is never cost-effective.

Table 2. TRC Breakeven Participation

Program	NTG=1	NTG=0.62
Combined program (45% ER ASHP, 45% ER standard whole-home package, and 10% ROF HPWH)	44	70
ASHP Replacement only	38	62
Standard whole-home package only	39	63

PAYS Set up and Administration

Based on the experience of PAYS programs offered by electric cooperatives in Virginia, North Carolina and Kentucky, the major hurdles to launching a PAYS program include achieving stakeholder approval, especially from regulators and government bodies, and sourcing capital.

Little information was available about potential legal or regulatory obstacles that Empire might face to offering a PAYS program. Empire staff was unsure if key aspects of the program, such as tying the tariff to the meter, were feasible under existing laws and regulations. The North Carolina program administrator reported that they did not perceive these issues as obstacles in their unregulated context. The Kentucky implementer interviewed was not involved in the initial program design and could not comment on this issue. The Kentucky program implementer did say that much of the delay in launching a PAYS program in his jurisdiction was due to the process to obtain approval from the state attorney general's office, and the Kentucky Public Service Commission. Both agencies were primarily concerned about the potential impact on nonparticipating ratepayers, and the implementer reported that the regulatory approval process was a primary cause of the long project development process for the first cooperative to propose a tariff.

The cooperatives both relied, wholly or in part, on federal grants to provide program capital. Empire, as a privately held company, is not eligible for these grant funds. Empire may be able to use capital intended for its DSM programs, but staff was not sure of the regulatory implications of this approach. Empire would need to consult the Missouri Energy Efficiency Investment Act (MEEIA), which governs how the IOUs fund and operate their energy efficiency programs, allows this use of funds, and the Missouri Public Service Commission.

Participation levels across four other programs that Cadmus reviewed (the programs in North Carolina and Kentucky, as well as programs in Arkansas and South Carolina) has participation rates ranging from 58 per year (Kentucky) to 198 per year (Arkansas). Cadmus identified several key characteristics of other PAYS programs that may have contributed to higher participation and savings. These included installing primarily heating and weatherization measures, targeting high-usage homes that rely on electricity for space heating, expecting a certain level of nonpayment and using a nonpayment loss reserve to cover costs and protect ratepayers.

Available Financing Options and Program Alternatives

In Empire's territory, there are no energy- specific financing programs for electric measures, with the exception of PACE. However, PACE opportunities are limited to a small program in Taney County and a program that was approved in Joplin, Missouri in early 2018, but which had not yet launched at the time of this study. Empire customers have access to traditional unsecured and secured financing options from local and national lenders, as well as contractor or manufacturer financing options. Traditional unsecured loans are likely accessible to customers with poor credit and to renters, but are likely expensive. Rates vary widely but may start around 9% and increase for customers with lower credit scores. Secured financing is only available to homeowners, and then only to those homeowners with equity in their homes. Rates start much lower, at around 4%, but also increase based on the customer's credit score and other factors.

Cadmus compared four energy efficiency program design models to assess which might be most beneficial to Empire customers and to Empire's ability to achieve savings. These models included property assessed clean energy programs (PACE), a leasing model, non-PAYS on-bill financing, and PAYS. We found that PAYS financing is uniquely well-suited to serve the rental market, a segment of the residential population that traditional rebate programs typically do not serve well due to the split incentive barrier. PAYS ties the tariff to the meter, rather than the borrower. Tenants pay the financing charge and enjoy the saving benefit, but only so long as they live in the property, thus removing the barrier. PAYS is also well-suited to serve customers with poor credit, who may pay a premium to use traditional financing, or not have access to traditional financing at all.

On the other hand, PAYS is not well-suited to provide financing support for a broad array of measures, since the allowed tariff is dependent on the measure's expected savings. Finally, PAYS is not well-suited to serve customers with gas heat when only electricity savings are considered, since most measures will not achieve sufficient electric savings to allow for a meaningful amount of the measure cost to be financed. PAYS complexity makes it a more burdensome program model for a utility to administer, relative to other programs. But for certain key markets, it has the best potential for driving increased uptake of energy efficiency savings.

Potential for Financing to Increase Energy Efficiency Savings

A survey of 201 Empire customers found that financing is important for home energy upgrades, and that finding affordable, accessible financing is a barrier for some customers. Nearly half (48%) of the respondents who used financing to make an energy-related improvement reported they would have delayed or downgraded their recent purchase if financing had not been available. In addition, 57% said they would have considered a higher-efficiency model if more affordable financing had been available.

When asked about their concerns if faced with the need to make an $5,000 upgrade to their heating and cooling system, respondents were most likely to be concerned about not having sufficient cash to pay the up-front cost (69%) and an aversion to high interest rates (69%). Low income respondents were significant more likely than other respondents to be concerned about knowing what financing options were available to them, and whether they could qualify for a loan. Renters were significantly more likely than homeowners to be concerned about qualifying for a loan. A PAYS program can address all of these concerns, for certain projects in all-electric homes.

Even a modest amount of PAYS financing ($300), together with a rebate, was enough to convince some respondents to select the high-efficiency option when they originally selected the standard option presented with the rebate alone. When presented with an early replacement scenario, which offered substantial energy savings in exchange for replacing working HVAC equipment, 67% of homeowners said that they would likely take advantage of the PAYS offer. Overall, the prospect of an on-bill tariff did not seem to be an obstacle for respondents.

Although financing is a barrier for some customers, a significant minority of Empire customers have negative attitudes toward financing and little appetite for long-term investments. Nearly a third of respondents who used cash for a recent purchase reported an aversion to using financing unless absolutely necessary. In addition, respondents' willingness to use financing fell sharply, to 35%, once interest rates rose above 3%. When asked why they didn't take advantage of the utility offer for a whole-home upgrade, survey respondents were most likely to indicate they did not think the project was cost-effective (22%).

Conclusion

Based on the study findings, Cadmus concludes that a PAYS program is feasible (TRC greater than 1) for Empire under certain scenarios described in this report.

Introduction

Pay as you Save (PAYS) uses an opt-in tariff mechanism to promote the installation of energy efficiency measures, while overcoming barriers associated with traditional energy-efficiency program designs. Cadmus investigated the feasibility for The Empire District Electric Company (Empire) to offer a PAYS program, and whether PAYS—or other program designs involving financing—would be likely to drive increased uptake of rebate-eligible efficiency measures.

Study Objectives and Scope

To be feasible, a PAYS program must be cost-effective, and allow customers to install measures that have up-front costs high enough to be reasonable candidates for financing. At the same time, the program must not present any legal or regulatory obstacles. To be effective, the program should address a gap in the private market for financing energy efficiency upgrades so that it increases the uptake of energy-efficient improvements beyond what the market would achieve without PAYS.

Cadmus used primary and secondary research and analysis to investigate whether PAYS would be a feasible and positive addition to Empire's energy efficiency portfolio. The specific research topics addressed by this study include:

- What portion of the measure cost could be financed through PAYS, within the defined tariff structure?
- What is the cost to set up the PAYS infrastructure and operate the program?
- What volume of participation is required for the program to be cost-effective?
- What impact do different rate structures have on measure- and program-level cost-effectiveness?
- Are there any regulatory or legal impediments to offering the PAYS model?
- Are there other existing financing solutions that effectively serve the PAYS market segment?
- What are customers' attitudes and awareness of energy- and non-energy-related financing options available in the Empire for home improvement projects? Does PAYS fill a gap in this market?
- What design features (rate, term, down payment requirement) are customers most likely to find attractive?

This study focused primarily on potential installations to achieve electricity savings in single family residential homes.[2]

About Empire

Empire is an investor-owned utility (IOU) that provides electric and gas service across southern Missouri and has approximately 130,000 residential electric customers across 16 counties. Empire currently offers energy efficiency programs for residential and multifamily customers. For all residential customers, Empire offers a program that provides rebates for central air conditioners and air source heat pumps (ASHPs), with about 75% of current participation from ASHPs. For multifamily customers, Empire offers direct install kit programs.

About PAYS

PAYS, which is a registered service mark, was developed by the Energy Efficiency Institute, Inc. (EEI). Through the PAYS program, the utility pays all or part of the up-front cost for energy efficiency upgrades, and it recovers costs through an on-bill tariff. According to EEI, the program design has three essential components[3]:

- A tariffed charge assigned to a meter location, not to an individual customer
- Billing and payment on the utility bill with disconnection for non-payment
- Independent certification that products are appropriate and savings estimates exceed payments for the near and long term

The PAYS design requires that the tariff amount, per year, be no more than 80% of the expected annual bill savings, and that the tariff be charged to the customer for no more than 80% of the EUL of the measure installed. The 20% cushion is designed to ensure that the customer realizes immediate cost savings from implementing the measure. To allow measures to be financed, the utility may require a copayment from the participant for any portion of the measure cost that is not recoverable within the structure of the PAYS tariff. This analysis only considered electricity savings in the calculation of costs and benefits. In some cooperative PAYS programs, however, savings from non-electric fuels are also accounted for in the determination of a PAYS investment amount.

Though no specific program structure is required under PAYS, the program is typically delivered as a direct-install style program, where the administrator (or a subcontracted implementer) recruits

[2] The customer survey included responses from respondents in single-family and multifamily homes, and both owners and renters.

[3] Accessed 3/12/2018: http://www.eeivt.com/

customers likely to benefit from the program (such as lower-income customers in higher usage homes, or renters in higher usage apartments). The program administrator conducts an assessment on the home to identify savings opportunities and prepare a project proposal for the customer. This proposal will include the project cost, the amount that can be financed through PAYS, any necessary copay from the customer (if the full amount cannot be financed), estimated monthly savings, and the monthly tariff the utility will charge to recover the financed amount. If the homeowner agrees, the utility will either identify a contractor or help the customer select a contractor to install the upgrades, and perform a quality check on the completed project. The process to assess savings opportunities and review the project upon completion may involve a comprehensive energy audit, with a blower test and test-out (if shell measures are installed). The PAYS administrator typically absorbs the cost of the audit and test-out.

PAYS is currently offered by these cooperative/municipal utilities from around the country:

- Midwest Energy in Kansas
- Six cooperatives in Kentucky (through the How$mart KY program)
- Ouachita Electric Cooperative in Arkansas
- Roanoke Electric Cooperative in Virginia
- Sonoma County Water District

Methodology

Cadmus conducted several primary and secondary data collection tasks to assess the feasibility of PAYS from the perspectives of cost-effectiveness, program best practices, and market need.

Interviews

Cadmus interviewed Empire program staff and managers of PAYS programs in other utility jurisdictions. The interview with Empire staff addressed the utility's experience with and capacity for energy efficiency programs and collected their feedback on the potential benefits and limitations of the PAYS model. The external interviews collected data on the potential barriers and opportunities related to the PAYS model and lessons learned from implementation. Cadmus also requested itemized costs for PAYS administration from these PAYS managers.

As we were not aware of PAYS programs that have been implemented by IOUs (though many IOUs have implemented on-bill financing programs), we conducted external interviews with program implementers that oversee the PAYS programs of cooperative utilities. Specifically, we interviewed the PAYS administration staff at these organizations:

- Roanoke Electric Cooperative, a cooperative utility in North Carolina that administers a PAYS program branded as Upgrade to $ave.
- Mountain Association for Community Economic Development (MACED), a Kentucky community non-profit organization that administers the How$mart KY PAYS program in partnership with six eastern-Kentucky cooperative utilities.

Secondary Data Review

Cadmus reviewed several secondary resources to inform this study.

We used documentation and analysis of prior PAYS programs to understand program design elements and costs, and typical participation and installations. Our review included these resources:

- Ouachita Electric HELP PAYS program results[4]
- South Carolina Help My House Pilot Program Summary Report[5]

4 The Ouachita Electric HELP PAYS program is available at: http://www.oecc.com/pdfs/Ouachita%20Electric%20HELP%20PAYS%20Program%20-%20First%204%20Months%20of%20Activity.pdf

5 South Carolina Help My House Pilot Program Summary Report is available at: http://www.eesi.org/files/HelpMyHouseFinalSummaryReport_June2013.pdf

- Example customer contracts and audits from prior PAYS programs
- PAYS program administrator pricing and proposal sheets

We also consulted other evaluations and unpublished research on other on-bill financing programs, including:

- 2015 Illinois On-bill Financing Program Evaluation (IL OBF)[6]
- Unpublished Cadmus research

We used details posted online about available Empire rebates and financing options, and other energy-specific financing programs available to Empire customers, to inform the financing gap analysis. Our review included these websites:

- Empire's current gas and electric energy efficiency programs, including its on-bill financing program for gas equipment upgrades[7]
- Property Assessed Clean Energy programs in Missouri from the Missouri Division of Energy[8] and Missouri Clean Energy District.[9]

Finally, we consulted federal statistical research to assess the building stock composition in Empire's service territory. We used data from both of the following sources:

- The U.S. Census Bureau's Five-Year American Community Survey. [10]
- The U.S. Energy Information Administration's Residential Energy Consumption Survey. [11]

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6 Cadmus. *Illinois On-bill Financing Program Evaluation*. Prepared for the Illinois Energy Association. June 1, 2015. Available online: https://www.icc.illinois.gov/docket/files.aspx?no=11-0689&docId=230270

7 Empire District. "Energy Solutions." Accessed March 13, 2018. Available at: https://www.empiredistrict.com/Energy/Solutions

8 Missouri Department of Economic Development. "Property Assessed Clean Energy." Accessed March 13, 2018. Available at: https://energy.mo.gov/assistance-programs/pace

9 Missouri Clean Energy District. Accessed March 13, 2018. Available at: https://www.mced.mo.gov/

10 US Census Bureau. "American Community Survey, 2015 5-Year Estimates." Available at: https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

11 US Energy Information Administration. "Residential Energy Consumption Survey." Available at: https://www.eia.gov/consumption/residential/

Measure-Level Financial Analysis

Starting with a list of common energy efficiency measures providing electrical savings in the Missouri Technical Resource Manual (TRM), we selected those measures that are likely to require financing (i.e., have a measure cost above a minimum threshold of about $250), and are not portable (i.e., will remain at the meter site regardless of transition of occupants). We added LEDs to this list to be considered as part of packaged upgrades. The list of measures we developed is illustrative, and not meant to be an exclusive list of what measures might be beneficial or eligible in a PAYS program. In most cases the specification of efficiency, capacity, square footage, or other details represents what information was available in TRM sources.

Table 3 shows the final list of measures we analyzed by end-use category. Since most PAYS programs typically involve a home energy audit that identifies multiple measures that are installed in one house, we also modeled two versions of a "whole home package". The standard package includes an ASHP and weatherization, as well as five LEDs. The comprehensive package includes the same measures, plus a HPWH and 4 windows. These "packages" are meant to be illustrative of the types of measures that might be installed in a whole home scenario, rather than exhaustive. (Cadmus did not include an energy audit as a measure, but included it as part of the implementation costs of the program).

Table 3. List of Measures

End-Use Category	Measure
Building Shell	Air Sealing
	Insulation (attic, wall)
	Windows
HVAC	Air Source Heat Pump (ASHP)
	Central Air Conditioner (CAC)
	Duct Sealing
Hot Water	Heat Pump Water Heater (HPWH)
Lighting and Appliances	Clothes Dryer
	Clothes Washer
	Refrigerator
Whole Home Packages	Standard: ASHP, air sealing, attic insulation, five LEDs
	Comprehensive: ASHP, air sealing, attic insulation, five LEDs, HPWH, duct sealing

Cadmus collected deemed values for estimated useful life (EUL), per-unit energy savings, demand reduction, incremental measure costs and full measure costs from the Missouri TRM[12] where available. We determined savings and demand reduction for both replace-on-failure (ROF) and early replacement (ER) scenarios where appropriate.[13] In cases where the Missouri TRM did not provide deemed values, or did not provide deemed inputs for savings algorithms, Cadmus used information from the Ameren Missouri TRM (Ameren TRM)[14] or the Illinois Statewide TRM for Energy Efficiency (IL TRM)[15]. For central air conditioner, clothes washer and dryer, air source heat pump, and wall insulation, we used the average of a random sample of retail prices posted online to determine a full measure cost estimate since no deemed estimates were available. Cadmus sampled retail prices from Home Depot, Ace Hardware, Ingram's Water and Air, AC Wholesalers, and Sears.

Cadmus calculated the monthly bill savings for each measure by multiplying the monthly energy savings by Empire's residential base variable rate for electricity, or $0.13006.[16] (Cadmus also assessed the sensitivity of this analysis to different rate structures. See Customer Rate Sensitivity Analysis for a discussion of the results.)

Cadmus determined the maximum measure cost that could be financed through PAYS for each measure as the present value of the maximum PAYS tariff (80% of the expected monthly bill savings) over a duration equal to 80% of the measure's EUL, discounted at the interest rate of 5.73%.[17]For those measures where the maximum PAYS tariff resulted in a financed amount greater than the full cost of the measure, including interest and fees, Cadmus assessed a reduced tariff based on a duration of 10 years (in all cases, shorter than 80% of the measure EUL). We selected the 10-year duration to reduce the

12 Missouri Technical Reference Manual Volume 3: Residential Measures: https://energy.mo.gov/sites/energy/files/MOTRM2017Volume3.pdf

13 Cadmus used the TRM definition of "early replacement" for each measure. Typically, TRMs define early replacement savings assuming the measure replaced had one-third of its useful life remaining.

14 Ameren Missouri Technical Resource Manual Appendix F: http://dsmexplorer.esource.com/documents/Ameren%20Missouri%20-%202.10.2016%20-%202016%20TRM.pdf

15 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 6.0: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_6/Final/IL-TRM_Effective_010118_v6.0_Vol_3_Res_020817_Final.pdf

16 Empire District Residential Service Schedule RG, P.S.C. Missouri No. 5 Sec 1, 19th Revised Sheet No. 1. Available online: https://www.empiredistrict.com/Home/Document/3051

17 See the Administration Requirements section for an explanation of the interest rate.

total amount paid by the account holder and reduce the chance that the tariff will need to be transferred to another occupant, while still allowing for a very low monthly tariff charge.

Customer Rate Sensitivity Analysis

The PAYS program design is highly dependent on the customer bill savings, which set the threshold for the maximum tariff and therefore the maximum amount of financing available through the program. For the analysis of maximum PAYS financing by measure discussed in the previous section (see Measure-Level Financial Analysis) Cadmus used a flat per-kWh rate of $0.13006, which is Empire current base residential rate. However, the current Empire rate structure applies a reduced rate for usage above 600 kWh in the winter, designed to provide cost relief to homes that use electric heat. Because it is difficult to determine what percentage of measure savings would offset usage above the threshold, Cadmus did not incorporate this declining block structure into the primary analysis. In addition, Empire and the Missouri Public Service Commission are considering adopting alternative residential rate structures to encourage less energy consumption overall, or reduced usage during peak demand. These variations in rate structure have the potential to impact the amount of PAYS financing available for any measure, and the feasibility of the program.

To assess the sensitivity of the amount of PAYS financing available to the rate structure, Cadmus used similar rate structures offered by Empire or near-by utilities to model four alternative rate structures.

Block rates charge customers for consumption above a threshold at a different rate than usage below the threshold. Cadmus modeled Empire's current declining block rate, which has a single rate in the summer months, but a decreased rate for usage above the threshold of 600 kWh in the winter months. We also modeled a hypothetical inclining summer block rate structure, with a rate increase for usage above 600 kWh in the summer months that would encourage greater energy efficiency in the high-demand period. (The inclining block rate structure maintains the established declining block rates in the winter months, since the goal of utility bill relief in the winter still applies.) The inclining block rate proportions are modeled on the current inclining block rate in Consumers Energy territory in Michigan, and adjusted to reflect Empire Missouri's base rate.[18]

Whether a particular home would be able to reduce above-threshold usage by installing a given measure is dependent on a number of circumstances particular to that specific home and measure. This analysis determines the most extreme impact by applying the above-threshold rate to all savings. In fact, in most scenarios, the actual impact would be somewhat less.

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[18] Michigan Public Service Commission, Consumers Energy Electric Rate Book, Residential Service Secondary Rate RS, March 2017. Available online at: http://www.michigan.gov/documents/mpsc/consumers13curcandd_579015_7.pdf

Time-of-use (TOU) rates are typically used to encourage demand reduction during peak times of the day, throughout the year. A TOU rate sets a higher price for energy used during peak times, encouraging customers to shift usage to off-peak periods. Cadmus modeled a TOU rate in response to Empire request to consider real-time pricing. A TOU rate approximates a real-time pricing approach, but does not peg the rate to wholesale prices. The fixed on-peak and off-peak rates facilitate billing and allow customers to plan ahead to optimally shift load to off-peak times (which typically include weekends and holidays). Cadmus adopted Ameren Missouri's existing optional TOU rates for this analysis.[19]

A **decoupled rate** is designed to avoid penalizing the utility for achieving energy efficiency. Decoupling rate adjustments allow a utility to increase variable rates charged to customers to offset any revenue losses due to efficiency gains, so that the revenue stream remains constant and sufficient to meet the utility's revenue needs. Any decoupling rate adjustment is likely to be uneven, as it depends on the revenue lost to efficiency gains in the prior years and any limitations set by regulators. For example, the decoupled rate adjustment for Liberty Utilities in Massachusetts allows for up to a 3% increase per period (peak or off-peak) relative to the prior period of the same type.[20] Cadmus used a simplified version of this structure, modelling the decoupled rate as a 1% annual rate increase to the base rate of $0.13006 per kWh over a 25-year period (the longest EUL for any of the measures analyzed).

[19] Ameren Missouri Residential Service Rate, Missouri P.S.C. Schedule 3rd Revised Sheet No. 54. Available online: https://www.ameren.com/-/media/rates/files/missouri/uecsheet54rate1mres.ashx

[20] Massachusetts Department of Public Utilities 17-93-A, Exhibit LU-2.

Table 4 shows the modeled rate structures.

Table 4. Alternative Rate Structures

Threshold	Rates ($/kWh)	
	Summer (June to October)	Winter (November to May)
Declining Block		
Tier 1: First 600 kWh	$0.1301	$0.1301
Tier 2: Additional kwh	$0.1301	$0.1057
Inclining Summer Block		
Tier 1: First 600 kWh	$0.1057	$0.1301
Tier 2: Additional kwh	$0.1500	$0.1057
Time of Use (TOU)		
On-peak hours	$0.3150	$0.0876
Off-peak hours	$0.0787	$0.0600
Decoupled Rate–		
Year 1	$0.1301	$0.1301
Annual Rate Increase	1%	1%

Cadmus used the load shapes provided by Empire to distribute the annual savings for each measure across each hour, day and month of the year. The load shape applied to each measure is provided in Appendix B. Monthly savings percentages by load shape are provided in Appendix C.

Because these load shapes are general to the territory, and therefore reflect a large percentage of customers that use gas heat, we created a hybrid load shape to accurately model monthly and hourly savings for measures that assume electric space heating: ASHPs, building shell measures, and the package measures. This load shape, labeled “All Electric Home”, is the weighted average of the monthly savings for three measures modeled with three different load shapes. Table 5 shows the measures and the load shapes applied.

Table 5. Components of the All-Electric Home Load Shape

Measure	Load Shape
Refrigerator	Appl_InteriorEquipment
HPWH	Water Heater
ASHP, 15 SEER, early replacement – heating savings only	Heating_Gas
ASHP, 15 SEER, early replacement – cooling savings only	Electricity_HVAC, June-Sept percentages only, normalized to sum to 100%

To determine annual bill savings for the declining and inclining block structures, we aggregated savings by month, and applied the Tier 2 rate for that month. For annual savings under TOU rates, Cadmus mapped the annual savings to each hour of the year, defined in the load shape as on- or off-peak, and applied the appropriate rate to each hour’s savings. For all three rate structures, Cadmus then calculated the weighted average dollar-per-kwh rate for the year, and applied that rate to the original measure-level analysis to determine the maximum tariff and the percentage of the measure cost that could be financed though PAYS.

To assess the impact of decoupled rates on PAYS feasibility, Cadmus calculated the average annual bill savings amount over the measure useful life, using the increasing decoupled rates. Cadmus did not discount the future savings to enable direct comparison of PAYS financing under the decoupled rates with PAYS financing in the primary analysis.

Program Level Cost-Effectiveness

For the program to achieve cost-effectiveness, the program measures must be able to generate sufficient savings to cover their own cost and additional savings that contribute to covering fixed or general costs, such as program administration. To assess the potential for cost-effectiveness at the program level, Cadmus selected two measures estimated to provide energy bill savings well in excess of the measure cost, based on the measure-level analysis: ASHPs and the standard whole home package, assuming an early-replacement scenario for both. We also included a third measure, a HPWH installed on a replace-on-failure basis. These measures are not the only measures that could cost-effectively be incorporated into a PAYS program, but are meant to be illustrative of the potential for cost-effectiveness across measures with different savings to cost ratios. The three measures are described in Table 6.

Table 6. Measures Used in Program Cost-Effectiveness Analysis

Measure	Baseline
Measure 1: ASHP	
SEER 15, 2 ton	Working electric furnace and CAC (Early Replacement)
Measure 2: Standard Whole Home Package	
ASHP (15 SEER, 2 ton)	Working electric furnace and CAC (Early Replacement)
Air Sealing	N/A
Ceiling Insulation to R-38	R-19
LEDs (n=5)	43-watt baseline 10.1-watt replacement
Measure 3: HPWH	
Heat Pump Water Heater	Federal standard electric water heater (Replace on Failure)

We applied the following standard cost-effectiveness tests:

- Program Administrator's Cost (PAC) test
- Total Resource Cost (TRC) test
- Ratepayer Impact Measure (RIM) test

Programs or measures are cost-effective when total benefits exceed total costs, or where the benefit to cost ratio (BC ratio) exceeds 1. The California Standard Practice Manual for assessing DSM program cost-effectiveness describes the basic benefit and cost methodologies we used for the tests. Cadmus modified these methodologies to incorporate costs specific to financing, such as opportunity cost of using capital for financing, nonpayment loss protection fees assigned to participants, and financing costs for the participants. Benefits and costs included in the tests are listed in Table 7.

Table 7. Benefits and Cost by Test Perspective

Parameter	PAC	TRC	RIM
Benefits			
Avoided Energy	✓	✓	✓
Avoided Capacity	✓	✓	✓
Line Loss	✓	✓	✓
Costs			
Program Administration	✓	✓	✓
Marketing	✓	✓	✓
Loan Administration Costs	✓	✓	✓
Loan Default Fee/Cost		✓	
Loan Opportunity/Carrying Cost	✓	✓	✓
Lost Revenue			✓
Measure Rebates	✓		✓
Incremental Measure Cost		✓	

PAC Test

The PAC test measures the dollar benefits of energy and demand savings against the utility's cost to determine if the value of the energy savings achieved is sufficient to cover the utility's costs of offering the program. Program benefits are equal to avoided energy and capacity, therefore a BC ratio greater than 1 indicates that it is less expensive for the utility to save energy by running the program than it would be to serve existing load.

Table 7 list the costs and benefits included in the different tests. The main benefits in the PAC are avoided energy, capacity, and transmission and distribution costs from reduced energy use due to measures install through the program.

The test looks at the lifetime costs and benefits. Therefore, savings over the useful life of the measure are included, discounted back to the present. Costs included in the PAC are the utilities' costs to operate the program. These include costs for utility administration, marketing, evaluation, implementation, and the utility's opportunity cost of capital. Utility nonpayment losses are assumed to be 5% of the total financing balance. The nonpayment losses and are not included in the test as the 5% fee charged to participants to cover nonpayment (a benefit or income to the utility) is directly offset by the assumed nonpayment rate of 5%.

TRC Test

The TRC test measures the dollar benefits of energy savings against all costs paid by either the participant or the utility to install the measures, and attempts to determine cost-effectiveness at a more holistic level (though it does not recognize non-energy benefits). In effect, the test answers the question: *Is the combined group (utility and participants) saving money by implementing this program and these projects?*

The TRC test considers costs to customers and the utility for measures financed through the program as well as benefits. Table 7 lists the components of the TRC test. The benefits included in the TRC tests, as in the PAC, are the avoided energy, capacity, and transmission and distribution costs. As participants reduce their energy use, the utility avoids fuel purchases and defers capacity and transmission and distribution construction, maintenance, and upgrades. Line losses are also reduced and counted as a benefit.

The costs included in the TRC are the utility costs to operate the program, as in the PAC. Unlike the PAC, the TRC also includes the participant costs. Participant costs include the incremental measure cost and the financing costs. The incremental measure cost is the amount the participant pays in excess of the standard equipment cost to purchase the more efficient equipment. The financing cost is the present value of the interest that the participant will pay over the life of the tariff.

RIM Test

The RIM test measures the impact on all ratepayers (participants and nonparticipants) who may experience rate increases designed to recover lost revenues. The RIM is similar to the PAC in that benefits include avoided energy costs, capacity costs, and line losses, however lost revenue from decreased energy use is included as an additional cost.

Many programs do not pass the RIM test because, while energy efficiency programs reduce costs, they also reduce sales. As a consequence, the average rate per unit of energy may increase. A passing RIM test indicates rates, as well as costs, will go down as a result of the program. Typically, this happens only for demand response programs or programs that are targeted to the highest marginal cost hours (when marginal costs are greater than retail rates).

Net-to-Gross Ratio

Applying the NTG ratio to the benefits and variable costs (nonpayment loss fee, participant financing costs, and measure cost) included in the cost-effectiveness tests determines whether the additional savings achieved by the program (beyond what people would have done on their own or with rebates) are sufficient to make the program cost-effective.

Cadmus assessed cost-effectiveness using both a net-to-gross (NTG) ratio of 1 (equivalent to gross savings) and a NTG ratio of 0.62. A NTG ratio of 1 is a reasonable estimate for NTG for a typical PAYS program that targets low income, high energy usage homes with working equipment. Without the trigger of broken or failing equipment, where the home has existed with high energy bills for several years, it is unlikely the participant would install efficiency measures on their own, even with the incentive of a rebate. This implies very low freeridership, and minimal contribution from the rebate program. At the same time, the energy audit will assess all cost-effective upgrades and advise participants that they have made significant improvements to the energy usage. As a result, the program is unlikely to generate much spillover.

To allow for a program design that is less proactive on the part of the administrator, and to account for overlap with the existing central air-conditioner rebate program, Cadmus also modeled cost-effectiveness assuming a 0.62 NTG ratio, which was the average attribution to financing from 2016 meta study of different approaches to attributing savings across complementary rebate and financing programs.[21]

Breakeven Analysis

The Cadmus team conducted a breakeven analysis to determine what level of participation, given the relative costs and benefits per measure, would be necessary for the program to be cost-effective and achieve a benefit/cost ratio of 1:1. This is useful for planning in the event that a program is not cost-effective based on expected participation levels. We conducted this analysis using the TRC and PAC costs and benefits and applied this analysis to the combined-measure program and each single-measure program scenario.

[21] Cadmus. *HERO Program Savings Allocation Methodology Study: Final Report*. Prepared for Pacific Gas & Electric, San Diego Gas and Electric, Southern California Edison, and Southern California Gas Company. October 3, 2016. Available online: http://www.calmac.org/publications/HERO_Allocation_Method_Study_Final_Report.pdf

Inputs

Benefits included avoided energy, capacity and transmission and distribution, and line losses. To calculate this amount, we used measure data collected for the measure-level financial analysis. We then applied the avoided costs, line losses, and retail rates provided by the utility.[22]

Table 8 shows the utility assumptions and associated program costs (see the Administration Requirements for PAYS section for a more detailed discussion of program costs). Fixed utility program costs include general program administration costs, marketing costs, evaluation costs (4% of the ASHP program). We assumed that program implementation and origination costs would be fixed at $60,000 for participation less than 72 customers. For 72 or more customers, we assumed implementation costs would be $838 per customer. We assumed tariff nonpayment and write-offs due to customer complaints or other factors would be 5%, and a nonpayment loss fee of 5% would offset the nonpayment. Empire currently offers a $250 rebate for ASHPs (SEER 15 to 15.9), which is included in the ASHP calculations, and in the standard package calculations (since the ASHP is one component of the package). The opportunity cost of capital/carrying cost represents the lost opportunity/expense of interest payments. Detailed cost-effectiveness assumptions are provided in Appendix A: Cost-Effectiveness Detailed Results.

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[22] Hourly load profiles from the U.S. Department of Energy Open Data Catalog, base case for Kansas City, MO, were used in combination with the utility supplied avoided costs to calculate end use-specific avoided energy benefits. Source: https://openei.org/doe-opendata/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states

Table 8. Assumptions and Program Costs

Parameter	Value	Source
Utility Assumptions		
Utility Cost of Capital/Interest rate	5.73%	Interviews and secondary research
Opportunity Cost	2.88%	U. S. Department of the Treasury bond rate
Line Loss	7.13%	Empire
Nonpayments /Nonpayment Loss Reserve fee	5.00%	Interviews and secondary research
NTG Ratio	1.0 /0.62	Cadmus 2016[23]
Tariff Duration (years)	10	Measure estimated useful life (see Measure-Level Financial Analysis)
Annual Program Costs		
Utility Administration	$82,500	Assumed net cost for 1 full time employee equivalent (FTE)
Marketing	$25,460	Cadmus 2015 (IL OBF)
Evaluation	$30,000	Cadmus 2015 (IL OBF)
Tariff Implementation Costs (<=71 participants) Total	$60,000	Interviews and secondary research
Tariff Implementation Costs (72 or more participants) Per Participant	$838	Interviews and secondary research

Table 9 shows measure-specific inputs used in the cost-effectiveness analysis. Utility participant rebates are $250 for the ASHP, which is also included in the standard package. No rebate is available for the HPWH. Measure costs and savings for the ASHP and whole-home package measures assume an early replacement (ER) scenario, while heat pump water heater costs and savings assume the measure is replacing a failed appliance (ROF).

[23] Cadmus. *HERO Program Savings Allocation Methodology Study: Final Report*. Prepared for Pacific Gas & Electric, San Diego Gas and Electric, Southern California Edison, and Southern California Gas Company. October 3, 2016. Available online: http://www.calmac.org/publications/HERO_Allocation_Method_Study_Final_Report.pdf

Table 9. Measure Inputs

Measure	Scenario	EUL	RUL	kWh Savings	kW Savings	Measure Cost	Rebate
ASHP	ER	18	6	10,668	1.10	$3,400	$250
Standard Whole-Home Package	ER	19	6	11,745	1.26	$3,416	$250
HPWH	ROF	13	0	1,640	0.08	$1,000	$0

Customer Survey

Cadmus conducted an online survey of Empire's electric customers in Missouri to gauge market need for energy efficiency financing assistance and probable response to a PAYS or other on-bill financing programs. The customer survey addressed the following research topics:

- Need and access to financing for home improvements
- Customer barriers to uptake of higher efficiency central air conditioners and heat pumps
- Customer familiarity with different types of financing and the frequency of using these options
- Willingness to pay interest in financing energy purchases
- Acceptance of a tariffed financing program, in particular upon moving into a home under an existing tariff obligation
- Willingness to contribute a copayment for certain measures
- Customer demographics and building characteristics

Cadmus fielded the survey to a proprietary panel provided by Qualtrics. The survey sample consisted of 210 eligible respondents: 132 homeowners (63%) and 78 renters (37%). Cadmus screened the respondents to ensure they lived in one of the 16 Missouri counties served by Empire. In addition, we stratified the sample to represent the distribution of age in the territory, as shown in Table 10.

Table 10. Distribution of Survey Respondents by Age Group

Age Group	Distribution*
20 - 34	27%
35 - 49	24%
50 - 64	26%
65 and over	24%

*American Community Survey, 2015 5-Year Estimates

Financial Analysis

Measure Costs and Savings

To determine whether a PAYS program would be feasible for Empire, Cadmus collected estimates of the expected savings and costs related to common energy efficiency measures, to identify the best opportunities for cost-effective savings that also present a sufficient upfront cost barrier that financing might be necessary. Cadmus created a database of deemed costs and savings for each of the target measures, assuming different baseline scenarios. The Methodology section of this report provides details on Cadmus' data sources and our approach to collecting and analyzing this data. Table 11 shows the measures Cadmus analyzed for inclusion in a PAYS program. Measure savings are highly sensitive to the baseline conditions. For heating and cooling equipment, measures installed in place of working, older equipment (the ER scenario) achieve much higher savings than the same equipment installed on an ROF basis.

Table 11. Per-Unit Costs and Savings

Item #	Measure	Efficiency Level	Baseline Equipment	Scenario	Capacity/ Size	Per-Unit kWh Savings	Full Measure Cost	Source
1	**CAC**	SEER 14.5	Federal standard (13 SEER, 11 EER)	ROF	1 ton	183	$2,200	Missouri
2	**CAC**	SEER 14.5	SEER 10 (Est.); Federal standard (13 SEER, 11 EER)	ER	1 ton	360	$2,200	Missouri
3	**Clothes Dryer**	ENERGY STAR	Federal standard	ROF	8.45 lbs load	160	$445	Missouri
4	**Clothes Washer**	CEE Tier 1	Federal standard	ROF	3.45 cubic feet	99	$747	Missouri
5	**Clothes Washer**	CEE Tier 2	Federal standard	ROF	3.45 cubic feet	134	$1,019	Missouri
6	**Clothes Washer**	CEE Tier 3	Federal standard	ROF	3.45 cubic feet	152	$1,079	Missouri
7	**Refrigerator**	CEE Tier 1	Federal standard	ROF	22.5 cubic feet	58	$753	Missouri
8	**Refrigerator**	CEE Tier 2	Federal standard	ROF	22.5 cubic feet	87	$762	Missouri
9	**Refrigerator**	CEE Tier 3	Federal standard	ROF	22.5 cubic feet	117	$801	Missouri
10	**HPWH**	EF 2.0,	Federal standard electric water heater	ROF	50 gallons	1,640	$1,575	Illinois
11	**HPWH**	EF 2.0, 50 gallons	Efficiency = .904	ER	50 gallons	1,777	$1,575	Illinois

Item #	Measure	Efficiency Level	Baseline Equipment	Scenario	Capacity/ Size	Per-Unit kWh Savings	Full Measure Cost	Source
12	**Air Sealing**	Conservative deemed approach	Single-family ASHP for heating and cooling	N/A	1920	591	$500	Missouri
13	**Duct Sealing**	Level 2	HVAC	N/A	Not indicated	641	$325	Ameren
14	**Window Replacement**	Efficient Products	Not indicated in TRM	N/A	199 sq ft	106	$6,515	Ameren
15	**Ceiling Insulation**	Insulated to R-38	R-19, 15 SEER ASHP heat	N/A	1387 sq ft	369	$638	Missouri
16	**Wall Insulation**	R5	R11	N/A	990 sq ft	154	$1,488	Illinois
17	**LEDs**	Interior	43 Watt baseline	ROF	10.1 Watt	23	$5	Missouri
18	**ASHP**	15 SEER 2 ton	Electric Furnace and SEER 6.8 CAC	ER	2 ton	10,668	$5,088	Missouri
19	**ASHP**	15 SEER 2 ton	Gas or propane furnace	ER	2 ton	(5,771)	$5,088	Missouri
20	**ASHP**	15 SEER 2 ton	ASHP	ROF	2 ton	307	$5,088	Missouri
21	**ASHP**	15 SEER 2 ton	ASHP	ER	2 ton	1,774	$5,088	Missouri
22	**ASHP**	16 SEER 2 ton	Electric Furnace and SEER 6.8 CAC	ER	2 ton	10,736	$6,240	Missouri
23	**ASHP**	16 SEER 2 ton	Gas or propane furnace	ER	2 ton	(5,702)	$6,240	Missouri
24	**ASHP**	16 SEER 2 ton	ASHP	ROF	2 ton	376	$6,240	Missouri
25	**ASHP**	16 SEER 2 ton	ASHP	ER	2 ton	1,843	$6,240	Missouri
P1	**Standard Whole Home (ASHP, air sealing, attic insulation, five LEDs)**	See individual measures	See individual measures	ROF	See individual measures	1,384	$6,251	See individual measures
P2	**Standard Whole Home (ASHP, air sealing, attic insulation, five LEDs)**	See individual measures	See individual measures	ER	See individual measures	11,745	$6,251	See individual measures
P3	**Comprehensive Whole Home (Standard package plus HPWH and duct sealing)**	See individual measures	See individual measures	ROF	See individual measures	3,665	$8,151	See individual measures
P4	**Comprehensive Whole Home (Standard package plus HPWH and duct sealing)**	See individual measures	See individual measures	ER	See individual measures	14,163	$8,151	See individual measures

The first step in the measure analysis was to determine what percentage of an individual measure cost could be financed using the maximum tariff allowed under PAYS requirements. We calculated the amount that could be financed as the present value of the sum of the maximum tariff amount (80% of the average monthly savings) paid over 80% of the measure EUL, discounted at the interest rate of 5.7%. The measure cost in this case included a 5% nonpayment loss fee, and was net of available Empire rebates[24]. Empire offers rebates ranging from $250 to $450 for ASHPs and CACs.

We found that the maximum tariff did not allow for the full measure cost to be financed in most cases. Two measures, the 15 SEER and 16 SEER ASHP that replaced working gas or propane furnaces, result in negative electric savings by replacing gas use with electricity. No tariff is possible for those two measures. For seventeen of the twenty-five measures and four packages we analyzed, less than 50% of the measure cost could be financed through a PAYS program. These measures tended to be ROF scenarios, with the exception of the central air conditioner and two air source heat pumps. In addition, all home appliances (refrigerators and clothes washers) that we analyzed were included in this group. For these measures the average copayment (measure cost not covered by PAYS financing) required is $2,652. The estimated savings, costs and potential PAYS financing for these measures is shown in Table 12 (ordered from lowest percentage of cost financed to highest).

24 See Administration Requirements for an explanation of the interest rate and the nonpayment loss reserve fee.

Table 12. Measures that Allow for Less than 50% PAYS Financing

Item #	Measure	Baseline Equip	Scenario	Empire Rebate	Financed Cost*	Max Monthly Tariff	PAYS Financing	PAYS Financing (% of financed cost)	Customer Copay
14	Window Replacement	Not indicated in TRM	N/A	$0	$6,841	$1	$115	2%	$6,726
20	ASHP, 15 SEER	ASHP	ROF	$250	$5,080	$3	$313	6%	$4,767
24	ASHP, 16 SEER	ASHP	ROF	$350	$6,185	$3	$383	6%	$5,802
7	Refrigerator	Federal standard	ROF	$0	$791	$1	$57	7%	$734
1	Central Air Conditioner	Federal standard (13 SEER, 11 EER)	ROF	$0	$2,310	$2	$186	8%	$2,124
8	Refrigerator	Federal standard	ROF	$0	$800	$1	$86	11%	$714
5	Clothes Washer	Federal standard	ROF	$0	$1,070	$1	$115	11%	$955
4	Clothes Washer	Federal standard	ROF	$0	$784	$1	$85	11%	$699
6	Clothes Washer	Federal standard	ROF	$0	$1,133	$1	$130	12%	$1,003
16	Wall Insulation	R5, CAC/Furnace	N/A	$0	$1,562	$1	$190	12%	$1,372
9	Refrigerator	Federal standard	ROF	$0	$841	$1	$114	14%	$727
2	Central Air Conditioner	SEER 10 (Est.)	ER	$0	$2,310	$3	$366	16%	$1,944
P1	Standard Whole Home	See individual measures	ROF	$250	$6,301	$12	$1,380	22%	$4,921
3	Clothes Dryer	Federal standard	ROF	$0	$468	$1	$138	29%	$330
25	ASHP, 16 SEER	ASHP	ER	$350	$6,185	$16	$1,878	30%	$4,307
21	ASHP, 15 SEER	ASHP	ER	$250	$5,080	$15	$1,808	36%	$3,272
P3	Comprehensive Whole Home	See individual measures	ROF	$250	$8,296	$32	$3,606	43%	$4,690

*Financed Cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the financed amount.

Table 13 shows those measures where the maximum PAYS tariff covered most or all of the financed cost, including the loss reserve fee. In some cases, the maximum tariff recovered more than the full cost of the measure, and therefore could be reduced, or collected over a slightly shorter duration. This group of measures included building shell, and hot water heater measures and included both replace-on-failure and early-replacement scenarios. The HPWH are the most expensive items, and therefore the most likely to prevent an up-front cost barrier that might require financing. For the most expensive measures even the partial amount of financing provided by PAYS covers a significant portion of the up-front cost, and represent an amount of money that might commonly be financed.

Table 13. Measures that Allow Majority or Full Financing with Maximum PAYS Tariff

Item #	Measure	Baseline Equipment	Scenario	Empire Rebate	Financed Cost*	Max Monthly Tariff	PAYS Financing	PAYS Financing (% of financed cost)	Customer Copay
15	Ceiling Insulation	R-19, 15 SEER ASHP heat	N/A	$0	$670	$3	$457	68%	$213
10	Heat Pump Water Heater	Federal standard	ROF	$0	$1,654	$14	$1,335	81%	$319
11	Heat Pump Water Heater	Efficiency = .904	ER	$0	$1,654	$15	$1,446	87%	$207
12	Air Sealing	ASHP heat	N/A	$0	$525	$5	$533	100%	$0

*Financed Cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the financed amount

For some early-replacement measures, the maximum PAYS tariff recovered far more than the total up-front cost. For those measures where the PAYS formula allowed for a financed amount greater than the full cost of the measure, including interest and fees, Cadmus assessed a tariff based on a tariff duration of 10 years (in all cases, shorter than 80% of the measure EUL). We selected the 10-year duration to reduce the total interest paid by the participant, while still allowing for a low monthly tariff charge. The five measures or packages where a 10-year tariff duration was possible are shown in Table 14, with additional information on the full measure cost, rebate, maximum monthly tariff (80% of monthly savings), percentage of total cost financed. No co-payment is needed for these measures.

Table 14. Measures with 10-Year Financing Potential

Item #	Measure	Baseline Equipment	Scenario	Empire Rebate	Financed Cost*	Adjusted Monthly Tariff	PAYS Financing	PAYS Financing (% of financed cost)	Customer Copay
P4	Comprehensive Whole Home	See individual measures	ER	$250	$8,296	$91	$8,296	100%	$0
22	ASHP, 16 SEER	Electric Furnace and SEER 6.8 CAC	ER	$350	$6,185	$68	$6,185	100%	$0
P2	Standard Whole Home	See individual measures	ER	$250	$6,301	$69	$6,301	100%	$0
13	Duct Sealing	Not indicated in TRM	N/A	$0	$341	$4	$341	100%	$0
18	ASHP, 15 SEER	Electric Furnace and SEER 6.8 CAC	ER	$250	$5,080	$56	$5,080	100%	$0

*Financed Cost is the full measure cost, less any available rebate, plus the 5% nonpayment loss fee, which is included in the financed amount.

Sensitivity to Interest Rates

Cadmus considered the 5.7% interest rate to be the most realistic scenario, and applied that to the program cost-effectiveness analysis (see discussion in Administration Requirements for PAYS). However, we also evaluated the sensitivity of the percentage of the measure cost that could be financed through PAYS to the interest rate charged, considering a 0% and 3% rate in addition to the 5.7% rate.

As shown in

Table 15, reducing the interest rate does allow increase the percentage of the full measure cost that can be financed by PAYS. However, the increase is less for those measures where PAYS only covers a small percentage of the measure cost at 5.7%, and greatest for those measures where PAYS already covers the full amount of the measure cost. Even at 0% interest, there would be no change to the grouping of measures presented in the previous section: measures where PAYS can finance less than 50%, measures where the maximum tariff covers 50% or more, and measures where the maximum tariff can be substantially reduced, and PAYS can still finance the full upfront cost.

Table 15. Sensitivity of PAYS Financed Amount as a Percentage of Cost to Interest Rate

Item #	Measure	Baseline Equip	Scenario	Financed Cost	PAYS Financing (% of total measure cost)		
					5.7% Interest	3% Interest	0% Interest
1	CAC	Federal standard	ROF	$2,310	8.1%	9.6%	11.9%
2	CAC	10 SEER	ER	$3,584	10.2%	12.2%	15.0%
3	Clothes Dryer**	Federal standard	ROF	$468	29.5%	33.9%	40.0%
4	Clothes Washer**	Federal standard	ROF	$784	10.8%	12.5%	14.7%
5	Clothes Washer**	Federal standard	ROF	$1,070	10.8%	12.4%	14.6%
6	Clothes Washer**	Federal standard	ROF	$1,133	11.5%	13.2%	15.6%
7	Refrigerator**	Federal standard	ROF	$791	7.2%	8.5%	10.4%
8	Refrigerator**	Federal standard	ROF	$800	10.7%	12.7%	15.4%
9	Refrigerator**	Federal standard	ROF	$841	13.6%	16.1%	19.6%
10	HPWH	Federal standard electric water heater	ROF	$1,654	80.7%	92.1%	**107.3%**
11	HPWH	EF = .904	ER	$1,654	87.5%	99.8%	**116.3%**
12	Air Sealing	Conservative deemed approach	ROF	$525	**101.6%**	**118.0%**	**140.6%**
13	Duct Sealing	N/A	N/A	$341	**355.1%**	**430.8%**	**543.0%**
14	Window Replacement	N/A	N/A	$541	**105.6%**	**128.1%**	**161.5%**
15	Ceiling Insulation (to R-38)	R-19, ASHP	N/A	$670	68.2%	86.2%	**114.7%**
16	Wall Insulation	N/A	ROF	$1,562	12.2%	15.4%	20.5%
18	ASHP, 15 SEER	Elec Furnace, CAC (SEER 6.8)	ER	$5,080	**214.0%**	**255.2%**	**314.6%**
19	ASHP, 15 SEER	Gas or propane furnace	ER	$5,080	-241.4%	-287.9%	-354.9%
20	ASHP, 15 SEER	ASHP	ROF	$5,080	6.2%	7.4%	9.1%
21	ASHP, 15 SEER	ASHP	ER	$5,080	84.2%	**100.5%**	**123.9%**
22	ASHP, 16 SEER	Elec Furnace, CAC	ER	$6,185	**176.9%**	**211.0%**	**260.1%**

Item #	Measure	Baseline Equip	Scenario	Financed Cost	PAYS Financing (% of total measure cost)		
					5.7% Interest	3% Interest	0% Interest
23	ASHP, 16 SEER	Gas or propane furnace	ER	$6,185	-197.1%	-235.1%	-289.9%
24	ASHP, 16 SEER	ASHP	ROF	$6,185	6.2%	7.4%	9.1%
25	ASHP, 16 SEER	ASHP	ER	$6,185	70.3%	83.9%	**103.4%**
P1	Standard Whole Home	See individual measures	ROF	$6,301	21.9%	26.0%	31.8%
P2	Standard Whole Home	See individual measures	ER	$6,301	**189.4%**	**225.8%**	**278.2%**
P3	Comprehensive Whole Home	See individual measures	ROF	$10,119	49.8%	58.9%	71.9%
P4	Comprehensive Whole Home	See individual measures	ER	$10,119	**155.3%**	**184.7%**	**226.8%**

Customer Rate Sensitivity Analysis

Cadmus assessed the sensitivity of the measure-level analysis to four alternative rate structures, as defined in the Methodology section. Table 16 shows how the percentage of the measure cost that can be financed through PAYS changes with each rate structure.

Table 16. Percentage of Measure Cost Financed by PAYS, by Rate Structure

Item #	Measure	Scenario	PAYS Financing (% of total measure cost)				
			Original Analysis	Declining Block	Inclining Block	TOU	Decoupled Rate
1	**CAC**	ROF	8.1%	8.1%	9.3%	9.1%	8.8%
2	**CAC**	ER	15.9%	15.9%	18.3%	17.9%	17.3%
3	**Clothes Dryer**	ROF	29.5%	25.8%	27.3%	23.0%	31.5%
4	**Clothes Washer**	ROF	10.8%	9.5%	10.0%	8.5%	11.6%
5	**Clothes Washer**	ROF	10.8%	9.4%	10.0%	8.4%	11.5%
6	**Clothes Washer**	ROF	11.5%	10.1%	10.6%	9.0%	12.3%
7	**Refrigerator**	ROF	7.2%	6.3%	6.7%	5.6%	7.8%
8	**Refrigerator**	ROF	10.7%	9.4%	9.9%	8.4%	11.6%
9	**Refrigerator**	ROF	13.6%	11.9%	12.6%	10.6%	14.7%
10	**HPWH**	ROF	80.7%	69.4%	72.5%	55.2%	85.7%
11	**HPWH**	ER	87.5%	75.2%	78.5%	59.8%	92.9%

12	**Air Sealing**	N/A	**101.6%**	84.9%	86.8%	62.0%	**109.0%**
13	**Duct Sealing**	N/A	**204.5%**	**171.0%**	**174.9%**	**124.9%**	**212.8%**
14	**Windows**	N/A	1.7%	1.4%	1.4%	1.0%	1.8%
15	**Ceiling Insulation**	N/A	68.2%	57.0%	58.3%	41.6%	56.8%
16	**Wall Insulation**	N/A	12.2%	10.2%	10.4%	7.4%	10.1%
17	**LEDs**	ROF	**132.8%**	**114.3%**	**119.4%**	86.4%	**134.8%**
18	**ASHP, 15 SEER**	ER	**214.0%**	**178.9%**	**183.0%**	**130.6%**	**233.2%**
19	**ASHP, 15 SEER**	ER	-115.7%	-92.3%	-90.7%	-70.7%	-126.1%
20	**ASHP, 15 SEER**	ROF	6.2%	5.3%	5.5%	3.8%	6.7%
21	**ASHP, 15 SEER**	ER	35.6%	30.6%	32.0%	21.7%	38.8%
22	**ASHP, 16 SEER**	ER	**176.9%**	**148.1%**	**151.6%**	**108.0%**	**192.8%**
23	**ASHP, 16 SEER**	ER	-93.9%	-74.7%	-73.2%	-57.3%	-102.4%
24	**ASHP, 16 SEER**	ROF	6.2%	5.5%	5.9%	3.8%	6.7%
25	**ASHP, 16 SEER**	ER	30.4%	26.3%	27.6%	18.5%	33.1%
P1	**Standard Whole Home**	ROF	21.9%	18.4%	18.9%	13.4%	23.2%
P2	**Standard Whole Home**	ER	**189.4%**	**159.1%**	**163.2%**	**115.6%**	**194.7%**
P3	**Comprehensive Whole Home**	ROF	43.5%	34.8%	35.7%	25.3%	42.0%
P4	**Comprehensive Whole Home**	ER	**171.7%**	**142.9%**	**146.6%**	**103.9%**	**180.2%**

The impact of the different rate structures depends on the bill savings to cost ratio of the measure over the duration of the tariff and the relationship of the load shape to the rate structure. The amount of PAYS financing is dependent on the measure's savings to cost ratio. As the bill savings to cost ratio increases, any change to the bill savings has a more pronounced effect on the percentage of the measure cost that can be financed through PAYS. For example, the percentage of the replace-on-failure CAC (Measure 1) cost that can be financed varies by just 1.2% from the least beneficial structure (declining block) to the most beneficial structure (inclining block), and achieves only a maximum of 9.3% financing. This is because the bill savings are so small relative to the measure cost that even a large incremental change in bill savings (by percent) accounts for only a small fraction of the measure cost. On the other hand, the percentage of financing for an early replacement 15 SEER ASHP (Measure 18) ranges from 131% under the TOU rates to 233% under the decoupled structure. For this measure, the bill savings are higher than the measure cost, and so an incremental change in bill savings results in an even larger change in the maximum PAYS financing.

The relationship of the rate structure to the measure load shape also has a significant impact on sensitivity. The declining block rate applies a lower price to savings during the winter season (October through May). This coincides with the majority of savings from electric heating measures. Since the only difference between the original analysis and the declining block rate was a rate decrease, the percentage of PAYS financing dropped somewhat for all measures under this rate structure. However, the effect was most pronounced for measures that make electric heating more efficient. For example, a clothes dryer (Measure 3) is not weather sensitive. Under the original analysis, a clothes dryer supported 29% PAYS financing. Under the declining block rates, this drops to 26%. Ceiling insulation, on the other hand, is assumed in our analysis to be reducing the heating load for an ASHP. Ceiling insulation savings allowed for 68% PAYS financing in the original analysis. Under the declining block rate, the percentage of savings drops to 57%.

The inclining block and TOU rates also applied a lower rate to savings in the winter months (and, for TOU, off-peak times), but applied a higher price to savings during summer months (June – September) or peak times. These rates also reduced the total bill savings for almost all measures, because the increase in bill savings during the summer was more than offset by the reduction in bill savings during the winter. TOU rates tended to reduce PAYS financing more than inclining block rates. For example, PAYS financing for a clothes washer (Measure 6) decreased from 12% in the original analysis to 10% under the inclining block rates and 8% under TOU rates. CACs were the only measure that showed an increase in PAYS financing under the inclining block and TOU rates, because the savings are concentrated in the high-price summer and on-peak times. But the impact was not enough to make PAYS viable for CACs. The maximum amount financed (18.3% for an early-replacement CAC under inclining block rates, Measure 2) is still well below 50%.

The decoupled rate structure increased the amount of PAYS financing for all measures, relative to the original analysis, simply by increasing the rates and holding all else equal. The impact of the increase in bill savings was modest however, resulting in an increase in PAYS financing of 3% to 13% for all measures.

Program Cost-Effectiveness

Cadmus performed cost-effectiveness for a PAYS program using three different tests: the PAC test, the TRC test, and the RIM test. We applied these tests to different program scenarios that incorporated one or more of three different measures: an ASHP, a whole-home package of upgrades, and a HPWH, assuming measures were installed in an all-electric home with a working electric furnace and central air-conditioner, and failed water heater. (Measure details are provided in the Methodology section).

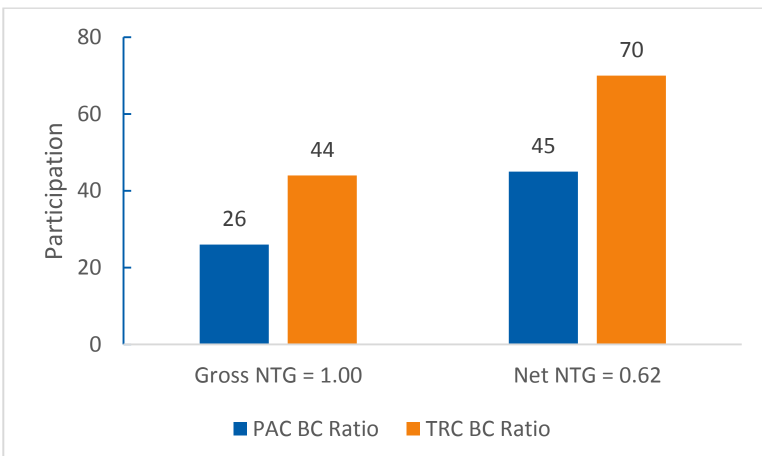
In the first program scenario, we assumed the program included all three measures. Then, we ran the tests again assuming single-measure programs, for each of the three measures (i.e., we tested a program that allowed only ASHPs, and then a program that allowed only the whole-home package, and then only the HPWH.)

For each program scenario and east test, we conducted a breakeven analysis to determine what level of participation was necessary for the program to have a cost-benefit ratio of 1, and then assessed cost-effectiveness across a range of participation levels to illustrate sensitivity. Finally, for all analyses, we considered measure savings with a NTG ratio of 1, and measure savings with an NTG ratio of 0.62.

Combined-Measure Program Results

For the combined program scenario, Cadmus assumed measure distribution of 45% ASHP installation, 45% Standard Whole Home Package, and 10% HPWHs. Cadmus assessed the breakeven participation level under the PCT and TRC tests using both an assumed NTG of 1.00 and an assumed NTG of 0.62. The PAC breakeven participation level for an NTG of 1.00 is 26, and for an NTG of 0.62 is 45. Under the TRC test, the breakeven participation level for an NTG of 1.00 is 44, and the breakeven participation level at an NTG of 0.62 is 70 (Figure 1). The breakeven analysis shows a PAYS program that financed primarily early-replacement measures in all-electric homes would be cost-effective even at relatively low levels of program participation. Breakeven results are not shown for the RIM test since the program is not cost-effective from the RIM perspective, regardless of the level of participation.

Figure 1. Combined Program Breakeven Participation Levels by Test



Cadmus also completed cost-effectiveness for program participation levels of 20, 80, and 200 to provide a range of results for the PAC, TRC and RIM tests. Figure 2 shows the PAC results, where the participation levels of 80 and 200 are cost-effective, but a participation level of 20 is not.

Figure 2. PAYS Program PAC Results at different Participation Levels

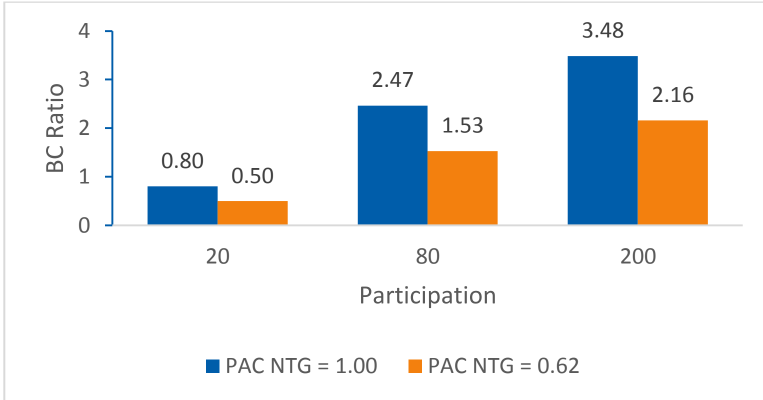


Figure 3 shows the TRC results as similar to the PAC, with the program being cost-effective at participation levels of 80 and 200 customers.

Figure 3. PAYS Program TRC Results at different Participation Levels

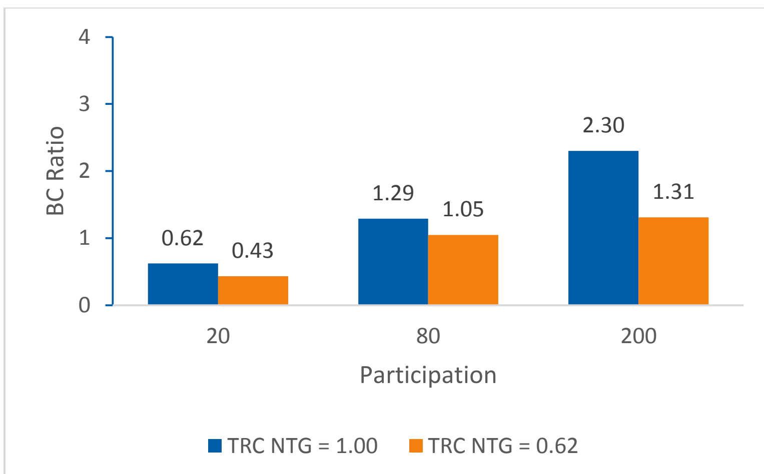
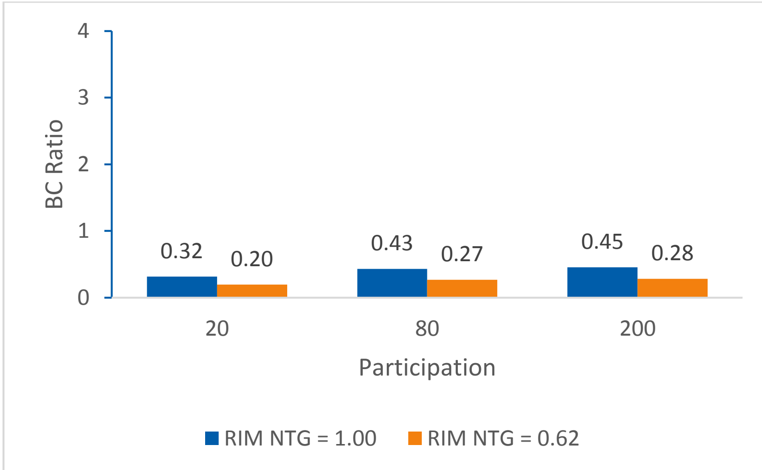


Figure 4 shows the RIM results. Under the RIM test, the program never achieves cost-effectiveness, regardless of the number of participants. Most energy efficiency programs do not pass the RIM test because while energy efficiency programs reduce costs, they also reduce sales. Typically, only demand response programs or programs that are targeted to the highest marginal cost hours (when marginal costs are greater than retail rates) pass the RIM test.

Figure 4. PAYS Program RIM Results



Single-Measure Program Cost-Effectiveness

Cadmus assessed the cost-effectiveness of a program that consisted of one measure type, for each of the three measures. Table 17 shows the breakeven quantities for the ASHP replacement and the whole-home measures. A single-measure program based on the HPWH measure is not cost-effective.

Table 17. Single-Measure Program Breakeven Quantities

Measure	PAC (NTG =1)	PAC (NTG=0.62)	TRC (NTG =1)	TRC (NTG=0.62)
ASHP	23	40	38	62
Standard Whole Home	23	41	39	63

Table 18 shows BC ratios for all three measures for both gross and net results. The PAC and TRC tests are cost-effective at 80 and 200 participants for all measures but HPWH. The HPWH measure is not cost-effective as a standalone program. Detailed cost-effectiveness results including benefits and costs by test are show in the appendix.

Table 18. Single-Measure Program Cost-Effectiveness Results

Quantity	NTG=1			NTG=0.62		
	PAC	TRC	RIM	PAC	TRC	RIM
All-electric ASHP replacement						
20	0.88	0.67	0.34	0.54	0.47	0.27
80	2.69	1.37	0.46	1.67	1.12	0.42
200	3.81	1.62	0.49	2.36	1.39	0.45
Whole-Home Standard Package						
20	0.88	0.67	0.32	0.54	0.47	0.26
80	2.61	1.35	0.42	1.62	1.11	0.38
200	3.62	1.58	0.44	2.25	1.37	0.41
HPWH						
20	0.08	0.08	0.07	0.05	0.05	0.05
80	0.30	0.22	0.17	0.19	0.16	0.13
200	0.48	0.30	0.22	0.30	0.23	0.17

Market Research Results

Cadmus used interviews, secondary research and a survey of Empire customers to assess the requirements for Empire to set up and administer a PAYS program. We also researched whether customer face a financing barrier, whether other existing financing options address that barrier, and whether other energy-specific financing program models might better serve Empire's customers.

Requirements to Set Up and Operate PAYS

Cadmus conducted interviews and secondary research to determine key costs for the set-up and administration of a PAYS program. Both the detail on associated costs, and the costs themselves, vary widely across sources, and no examples perfectly represent Empire's circumstances. Cadmus used the best available information, as well as our professional judgment to estimate potential administrative costs for a PAYS program administered by Empire.

Requirements to Design and Launch a PAYS Program

Set-up costs were difficult to quantify, and were not included in cost-effectiveness analyses in order to avoid unfairly over-burdening the program costs. However, this section presents a qualitative assessment of the time and resources needed to start-up a PAYS program.

Lead Time

Interviewees at Roanoke and MACED reported varying estimates of the lead time and cost of implementing a program. Roanoke staff estimated an implementation timeline of 6-9 months. As a cooperative utility, Roanoke was not required to obtain approval from the North Carolina Utilities Commission for its tariff. Major steps for Roanoke were developing a detailed program design, and sourcing capital. Roanoke did not dedicate much time to stakeholder engagement, or market research. In Kentucky, MACED staff reported that, of the six utilities that it partners with to implement the How$martKY program, the approval of the first tariff took roughly 18 months and faced significant legal scrutiny from regulators and the attorney general's office, but later tariffs were approved in speedier fashion.

Specific up-front costs were not reported by either program. However, such costs could include the following categories:

- Staff time, including both program design and legal/regulatory support
- Updates to utility billing software and systems
- Consulting and licensing fees for PAYS program design and intellectual property (estimated at between $40,000 and $50,000, based on other Cadmus research).

An on-bill financing program implemented by IOUs in Illinois required nearly two years to launch, and an additional two years for all five participating utilities to offer financing for common measures and to register participation. Major factors in the start-up process included coordinating across five utilities to select and contract with a single implementer/lender, complete significant upgrades to billing systems to track financing payments and remit payments to the lender, and to coordinate program design across multiple utilities, including gas and electric utilities with overlapping territories.

Sourcing Capital

To secure funding for home retrofits, Roanoke took advantage of special lending programs available to cooperatives through the USDA Rural Utilities Service, while MACED used a combination of philanthropic program-related investments and federal funds. In contrast, the Illinois IOUs subcontracted with a lender specializing in the delivery of on-bill financing programs. The lender sourced capital from outside investors. Notably, the lender was able to secure funds at the same rate at which the utilities could borrow money for internal operations, due to the utilities' blanket agreement to guarantee payments to the lender, regardless of whether the borrower had completed their payment to the utility. The utilities adopted some risk from potential nonpayment, but the expected risk was considered to be negligible due to the relatively small size of the program.

Another option for Empire could be to incorporate the capital into their energy efficiency program budget, assuming the Missouri Energy Efficiency Investment Act (MEEIA), which governs how the IOUs fund and operate their energy efficiency programs, allows this use of funds. Empire does not currently have an approved MEEIA portfolio, so approval of the portfolio as a whole would have to be sought alongside approval of a financing program. Empire staff was not able to comment on the potential for MEEIA funds to be used in this manner.

For the cost-effectiveness evaluation, Cadmus assumed any costs to source funds were compensated by interest payments from borrowers.

Legal Considerations

Cadmus identified the following issues that may have legal or regulatory implications for Empire should they move forward with a PAYS program. Cadmus does not have legal expertise on staff and cannot comment on the actual risk associated with any of the issues listed below. This list should be considered a starting point for future research.

- Requirements or restrictions related to consumer financing
- Tying the tariff to the meter
- Providing the customer with an expected level of bill savings
- Potential liability if resident turnover results in lower savings
- Potential liability for measure operations or maintenance

Interviews with Empire staff and other PAYS administrators did not provide clarity on legal considerations that may affect a PAYS program. Empire staff noted that tying the tariff to the meter might create a difficult customer relations situation for the utility, but was not sure if existing laws or regulations could also be a barrier to this aspect of the program.

Roanoke noted that they did not need to obtain regulatory approval. They worked with EEI and Clean Energy Works (a nonprofit) to develop a detailed program design. Roanoke does tie the tariff to the meter, but noted they did no research on the legal implications of this, they "just did it." Roanoke currently does not perform post-installation monitoring or verification for PAYS projects, but is considering it for the future. Roanoke has had over 400 participants, but did not report concerns about meter transfers, actual savings achieved, or maintenance of installed equipment.

MACED did not provide details on the issues raised by stakeholders, especially the Kentucky Public Service Commission or the state's attorney general, but did note that discussions mostly centered on protecting ratepayers at large from risks associated with the lending aspect of the program. It was not clear if the MACED program tied the tariff to the meter, or what protocols they had in place to deal with issues that might arise when the meter transferred to a new account.

Administration Requirements for PAYS

Cadmus sourced annual administrative costs primarily from interviews, the IL OBF report, and unpublished Cadmus research including a third-party implementer proposed rate sheet. Where costs were available from multiple sources, Cadmus averaged reported costs.

The PAYS administrators Cadmus interviewed used two different structures. Roanoke, after initially managing the implementation of its Upgrade to $ave program internally, later hired a third-party program operator to oversee the audit and installation process, through Roanoke still performs test-out audits directly. In Kentucky, MACED implements the How$martKY program on behalf of six regional cooperatives. Historically, MACED has managed all field work and data management required by the program, but has since shifted portions of this work to utilities in some cases.

Staff at both companies provided per-participant cost estimates for program administration. Cadmus also reviewed a rate sheet provided to Cadmus by a third-party program implementer. Implementation costs were not specifically broken out by any of the three sources. However, Roanoke and MACED described the implementer role as including outreach, energy audits, and project management for participants. MACED's costs also included quality control, which may not be included in the other two costs. As shown in Table 19, these costs averaged $777 per participant.

Table 19. Estimated Per-Participant Implementation Costs for PAYS

Source	Cost Per Participant
Roanoke	$630
MACED	$1,000
Third-party implementer	$700
Average	**$777**

The IL OBF evaluation also provided utility costs. However, the Illinois program was coordinated across five utilities, and included outreach to hundreds of contractors across the state, whereas an Empire program would be contained within one utility. A typical PAYS program involves just a few auditors and contractors, acting as subcontractors, to manage audits and installations. Cadmus considered the Illinois program model was sufficiently different from a typical PAYS program that we did not include the per-participant implementation costs in our calculation.

Nevertheless, the Illinois evaluation identified several fixed and variable costs that were not specifically noted to be included in the PAYS implementation cost, but that we expect would affect the utility. These included costs for the call center, marketing, and evaluation. Cadmus calculated the average cost across the five Illinois utilities for each category, and included these in the cost-effectiveness analysis as program-level costs. In addition, the PAYS third-party implementer assumes a minimum implementation fee of $5,000 per month if participation does not exceed 71 homes. Cadmus assumes this minimal implementation cost would apply to most program models, and so structured the cost-effectiveness analysis to apply the $60,000 per year minimum for participation levels below 72, and to use the per-participant variable cost for participation of 72 and above.

As a financing program, PAYS administration costs include a cost of capital. Cadmus assumes the utility would set the interest rate equal to the cost of capital, as the Illinois Energy Efficiency Loan Program and the Roanoke Upgrade to $ave program do, to avoid making money from the implementation of the program and to minimize costs to participations. However, the Roanoke Upgrade to $ave program relies on low-cost funds provided through a federal grant for which Empire would not be eligible. Therefore, Cadmus used the average of the Illinois OBF program's published 2018 interest rate, and the Empire cost of capital, to determine the interest rate used in the cost-effectiveness analysis (Table 20).

Table 20. Inputs to Determine a PAYS Interest Rate

Source	Rate
Illinois Energy Efficiency Loan Program interest rate (2018)	5.74%
Empire cost of capital (2016)	5.71%
Average	**5.73%**

Cadmus used the 10-year rate for a U. S. Treasury Bond as the opportunity cost of providing financing capital. The opportunity cost is calculated as the present value of the interest payments on the financed amount, discounted at the opportunity cost rate. This approach followed precedent from the IL OBF study and other research we have conducted.

Finally, Cadmus assumed that Empire would establish a nonpayment loss reserve. (See a more detailed discussion of the nonpayment loss reserve in the following sections.) The nonpayment loss reserve, funded through a 5% one-time fee on the cost of the financed measures, protects ratepayers from lost revenue associated with tariff nonpayment, tariff write-offs, and costs related to shutting off or reinstating service for delinquent customers. The nonpayment loss reserve would be managed in the same manner as the financing capital, and therefore not incur extra management costs.

Cadmus modeled the loss reserve fee on that implemented by the MACED How$mart KY program, and assumed it would be sufficient to cover all nonpayment and related costs. Therefore, Cadmus did not model these costs separately. There were no available estimates for write-offs or shut-off/turn-on costs. However, the IL OBF report estimated a nonpayment rate of 0.16% in its first three years, the Roanoke Upgrade to $ave program referenced an effective default rate of 0.75%, but noted they are still working with some of those customers, and the MACED How$mart KY program referenced a default rate of 1.9%. Cadmus assumed this fee was included in the financed amount.

Table 21 shows the fixed annual costs applied in the program cost-effectiveness analysis, and Table 22 shows variable costs, assessed on a per participant basis, used in the cost-effectiveness analysis.

Table 21. Fixed Costs for Administering PAYS

Cost Category	Cost	Basis	Source*
Utility Administration	$82,500	One FTE across multiple employees; costs assume mid-level salary plus benefits multiplier	Empire
Marketing	$25,460	Average of actual costs	Cadmus 2015 (IL OBF)
Evaluation	$30,000	4% of total program costs (Based on ASHP single-measure program total, assume 100 participants)	Cadmus 2015 (IL OBF)
Implementation (71 or fewer participants)	$60,000	$5,000 per month minimum fee	Third-party implementer project cost estimate
Cost of Capital	5.73%	Equal to interest rate	Average across various sources
Opportunity Cost	2.88%	U. S. Treasury Bond, 10-year rate	Cadmus 2015 (IL OBF)

*

Table 22. Variable Costs for Administering PAYS (Per Participant)

Cost Category	Cost Per Participant	Basis	Source
Program Implementation (72 or more participants)	$777	Per-participant fee	Third-party implementer project cost estimate
Call Center	$61	Average actual cost	Cadmus 2015 (IL OBF)
Customer nonpayment and write-offs	N/A	Covered by nonpayment loss reserve; nonpayments assumed to be 2% or less	Assumed
Shut-off fee	N/A	Assume necessary for less than 1% of customers, minimal cost	Assumed
Total	**$838**		

Implementation Lessons from Prior PAYS Programs

To date, most PAYS programs, such as those in Kentucky, Arkansas, South Carolina, and North Carolina, have been administered by rural electric cooperatives. As noted by Empire staff, Empire also has a large rural electric customer population. As a result, an Empire program may see similar attributes among participants as regional cooperative utility programs. Though interviews with PAYS program administrators and secondary research, Cadmus observed the following trends characterizing the design and implementation in other PAYS programs.

- **An expected measure mix of heat pumps and weatherization.** Interviews and a review of program documents confirmed that participation in these programs has largely consisted of a combination of heat pump installation and weatherization measures. Roanoke and MACED's programs are both structured to offer two primary measures packages: a HVAC upgrade (which is nearly always a high-efficiency heat pump) and a suite of envelope and miscellaneous measures such as roof and ceiling insulation, caulking, air and duct sealing, LEDs, water heater blankets, and programmable thermostats. The interview findings are confirmed by published measure data from programs in Arkansas (HELP PAYS) and South Carolina (Help My House), which show that more than 80% of participants received a heat pump, air sealing, duct sealing, and attic insulation in each program. These program offerings seen in jurisdictions elsewhere are in line with the cost-effectiveness results discussed above (see **Cost-effectiveness** section.)
- **Participation led by electric-heated homes.** Interviews with program managers at Roanoke and MACED reported that a large number of program participants in these PAYS program have electric heat. This is confirmed by the South Carolina Help My House pilot, in which 47% of participating households installed a heat pump that replaced an electric furnace, while 42% installed a heat pump that replaced an existing heat pump. It is expected that this would be the likely result of a program in Empire's service territory as well. In interviews with Empire staff, program managers reported that, due to the terrain of their service area, there are pockets of communities that cannot be served by natural gas distribution infrastructure and that have particularly high rates of electric heat.
- **Participation from high consumption homes.** Directly related to the high rate of electric-heat customers participating in programs, external interviewees have found that utility customers with high levels of consumption have disproportionately participated in their PAYS programs. Interviewees noted that their programs are not limited to homes with high consumption, but that they have promoted the program to customers who have complained about high bills as a mitigation measure and expect that this has resulted in some degree of participation.
- **Inclusion of a nonpayment loss reserve.** Both Roanoke and MACED programs incorporate a nonpayment loss reserve, which was recommended by interviewees. To date, Roanoke has experienced a low nonpayment rate of only 0.75% (three participants out of 400 to date), compared to a business-as-usual rate of 0.25% for their utility. MACED's rate has been slightly higher at 1.9% of dispersed funds, which MACED attributes to early program struggles with

customer contracting. Both programs have set aside a portion of program funds to serve as a nonpayment loss reserve, and staff feels they are within their limits.

- **Participation.** Participation has been reasonably strong, ranging from an average of 58 homes per year (MACED) to 198 (Ouachita HELP PAYS). Participation within each program we reviewed is: the Roanoke Upgrade to $ave program has completed over 400 projects from 2014 to 2017, the MACED program has completed 289 projects since 2011, the South Carolina Help my House pilot completed 125 projects from 2011 to 2012, and Arkansas Ouachita HELP PAYS program completed 198 projects from 2016 to 2017 (representing nearly 10% of their residential meters).

Empire Experience with Program Administration

Empire staff reported that administration of Empire's energy efficiency programs across their electricity service territories in Missouri, Oklahoma, Kansas, and Arkansas, and gas service territories in Missouri and Iowa, were consolidated in the summer of 2017, and are now administered by one employee.

Empire's gas and electricity programs are administered separately in terms of regulation and service area. Empire currently offers four programs to residential customers, including programs for single family and multi-family customers. For single-family customers, Empire offers rebates for cooling equipment to residential electric customers, and on-bill financing for residential gas customers. Staff reports the gas on-bill lending program is not well-subscribed.

Empire staff believed a PAYS program had potential benefits for customers, by reducing energy bills and increasing customer satisfaction for participants. They noted that Empire's service territory has many similarities to the cooperative that are implementing PAYS, in that it's smaller than many IOU territories, with a high concentration of rural customers, renters, and a large number of customers using electricity for heating. Staff also noted that their current rebate program for cooling equipment processes primarily rebates for ASHPs (about 75%) but that nearly all are replacements for failed equipment (ROF).

The primary concerns raised by Empire staff with regard to offering a PAYS program related to customer communications, potential legal and regulatory obstacles, and administrative complexity. Staff noted that within the company, energy efficiency is a priority, especially for lower-income customers. However, staff considered a PAYS program to be a difficult concept to communicate to customers. Although staff considered PAYS to potentially be a valuable tool for promoting energy efficiency to renters, the complexities involved in a transaction that included a renter, a landlord, and the utility would be difficult to communicate, and agreements might be difficult to enforce once a new tenant was involved. There was a also a hesitation within the company to involve the utility in any kind of real estate transaction, such a property owner trying to sell a property with a PAYS tariff attached.

Administratively, staff noted that Empire has tended to maintain implementation in-house moreso than other larger utilities. This allows Empire staff to develop a deeper understanding of program operations, and have more flexibility and control. Their preference was to keep all administration of a PAYS program in-house as well. However, they reported that PAYS administration would likely require hiring additional staff, as existing staff were fully booked. They expected PAYS to require more staff time than the existing rebate programs, especially in order to manage customer communications.

Comparison of Financing Program Design Alternatives

To understand the potential need for and relative benefit of a PAYS program compared to alternative means of financing, Cadmus evaluated two key factors: (1) the current availability of financing programs in Empire's service area, and (2) the comparative benefits and drawbacks of a range of potential financing offerings.

Energy Financing Programs Available in Empire's Service Territory

While somewhat sparse, there are several existing dedicated options for energy efficiency finance available in Empire's electric service area in Missouri, including the following:

- **Property Assessed Clean Energy (PACE) Programs.** PACE programs are authorized in Missouri, but individual municipalities must choose to participate. Two PACE districts have jurisdictions that could overlap with Empire's service area, but only a small number of municipalities have signed on to these programs.[25]
- **Utility On-Bill Financing.** Empire currently has an on-bill financing program that is active for gas upgrades. Empire staff report that this program has low subscription rates. This program is not an energy efficiency program, and as such, it does not have energy savings requirements.
- **Bank and Credit Union Lending.** As with any other area, Empire customers have a range of options for both (unsecured) personal loans and home equity loans (which require collateral). Rates and conditions vary widely across lenders and depending on applicant credit scores.

The details of these options are summarized in Table 23. While there are both utility and PACE financing programs active in Empire's service territory, they are not broadly available. Only a small number of municipalities in the area served by Empire have authorized PACE districts, and Empire's own financing program serves only gas heating upgrades. Additionally, both of these programs are restricted to homeowners. A variety of private-sector options are available, but these either require home equity loan or charge high interest rates.

[25] This includes Joplin, the largest community served by Empire District in Missouri, which joined the Show Me PACE program in February 2018.

Table 23. Comparison of Home Energy Financing Options in Empire Service Area

Program Type	Property Assessed Clean Energy	On-bill Finance	Unsecured Personal Loan	Secured Home Loan
Program Name	Missouri Clean Energy District	Residential Customer Finance Program	Available from most local and national lenders. Springfield-based Educational Community Credit Union (ECCU) used as reference.	
Program Administrator	Missouri Clean Energy Funding LLC	Empire		
Eligible Area	Several municipalities in Taney County included	Empire gas service area	No limitations	No limitations
Eligible Customers	Homeowners	Residents in 1-4 unit housing	No limitations	Requires home ownership and available equity in the home
Credit Score Requirements	None	None	Credit score impacts rates significantly; may be unavailable at lower credit rates (lower 600s and below)	Credit score impacts rates somewhat; may be unavailable at lower credit rates (lower 600s and below)
Eligible Technology	Most energy efficiency measures	Gas heating equipment and associated measures	No limitations	No limitations
Relevant Terms	Max 10-year repayment period; max of $5,000; interest rates expected to be 6.5-6.75%	Max 10-year repayment period, soft max of $10,000, interest rate is 2% above annual prime rate	Terms vary by lender; ECCU offers rates of 9.75% to 19.25%	Terms vary by lender; ECCU offers rates of 4.40% to 5.00%

Comparison of Residential Financing Program Types

This section describes comparative strengths and weaknesses of different residential financing programs based on several metrics, including these:

- **Eligibility limitations.** Some residential energy financing options are limited to homeowners, and others are prohibitively expensive for residents with poor credit.
- **Implementation pathway.** Some financing options (like PACE and on-bill financing) require specific action by state legislators, municipal leaders, or utilities to become available. Other lending options are readily available from commercial lenders.
- **Accessibility.** As can be inferred by eligibility limitations, financing programs may be more or less suitable for different customers. This assessment considers how readily accessible a program is for two types of customers likely to have trouble accessing affordable financing: (1) a low-credit homeowner, and (2) a renter. Residents may not be able to access a particular option

due either to explicit lending rules (such as homeownership requirements), creditworthiness requirements (which make finance expensive for residents with poor credit), or a lack of deliberate program design elements (while some options may be open to renters, they may not provide a long-term profit motivation for renters to participate).

- **Outcomes when a customer moves.** When a home is sold or rented to a new tenant, the obligation to repay financing could either stay with the borrower or stay with the home, depending on the program.
- **Affordability.** While specific lending rates may vary from customer to customer and program to program, some financing pathways may be lower cost than others.
- **Ability to meet financing needs.** Financing programs may have special cost-effectiveness requirements or investment caps that limit the utility of a financing pathway.
- **Utility administrative complexity.** For programs implemented by a utility, these may face varying levels of complexity.

For most of the financing options discussed below, there is ample precedent of prior programs on which to draw conclusions about the above attributes (with lessons about PAYS implementation drawn primarily from the programs implemented in cooperative utility jurisdictions). Residential equipment leasing programs, however, are rare. The discussion of equipment leasing is informed primarily by the ductless heat pump leasing program currently implemented in Vermont by Green Mountain Power.[26]

Table 24compares these attributes for a range of potential financing approaches.

[26] Green Mountain Power. "Ductless Heat Pump." Accessed March 13, 2018. Available at: https://greenmountainpower.com/product/ductless-heat-pump/

Table 24. Comparison of Residential Financing Programs

Program Type	Property Assessed Clean Energy	Equipment Leasing	Non-PAYS On-bill Finance	PAYS
Eligibility Limitations	Limited to homeowners, credit rating of minimal importance. Also limited by municipal action.	Existing programs limited to homeowners, credit rating of minimal importance.	Generally limited to homeowners, measurement of credit-worthiness varies.	Often implemented without credit requirements, designed with value proposition for renters.
Implementation Pathway	Enabling statute passed in Missouri, individual municipalities must adopt.	Existing programs administered by utilities. Administration by third parties is possible.	Utility must administer or partner in program.	Utility must administer or partner in program.
Accessibility to Low-FICO Customers	**Good.** Use of property lien allows for alternative creditworthiness standard.	**Good.** Existing programs do not use credit scores as a leasing criteria.	**Potentially Good.** Utility may choose to rely on bill payment history rather than credit score.	**Good.** Credit score is not considered.
Accessibility to Renters	**Poor.** Renters are not eligible.	**Poor.** Renters are not eligible in existing programs.	**Poor.** Renters are generally not eligible.	**Best.** Renters are eligible and are not exposed to long-term costs.
Outcome When Customer Moves	Obligation stays with home, may be negotiated.	Unclear.	Varies depending on design, loan would likely be settled with home sale.	Obligation stays with home, and paid by new resident.
Affordability	**Okay.** Interest rates vary. Long loan terms reduce monthly payments but increase total interest charges and overall cost of project.	**Varies.** Existing programs have been designed to provide net savings but a direct comparison is difficult.	**Okay.** Programs typically offer moderate interest rates, but there is no restriction on the payment relative to the savings.	**Best**. Program design insures that payments are offset by monthly bill savings, making the investment cash flow positive for the participant.
Ability to Meet Full Financing Needs	**Best.** Reasonable borrowing and cost-effectiveness requirements often in place.	**Okay.** Equipment such as heat pumps could be viable for lease. Weatherization measures likely not viable for leasing models	**Good.** Reasonable borrowing and cost-effectiveness requirements often in place.	**Okay.** Subject to strict bill savings to cost requirements that protect the participant, but that may limit financeable amount.
Utility Administrative Complexity	**None**	**High,** including customer outreach and leasing agreements (assuming a utility-administered programs)	**Moderate,** including customer outreach and loan servicing.	**High,** including customer outreach, loan servicing, and additional requirements on project approval and administration

As made clear in the prior table, all solutions require tradeoffs. The goal of a utility-administered financing program is not to increase use of financing, rather to make financing more available as a tool to increase uptake of energy efficiency measures. Therefore, these programs are most effective when targeting a specific market segment with poor access to commercial financing or other programs. Homeowners with poor credit generally face high financing costs in the market, and renters are generally unable to access financing for their own energy improvements (because they are both unable to access home equity lending and because they lack the long-term guarantee of residency and associated energy savings needed for unsecured lending).

All of the programs noted offer a solution to the barrier to financing access posed by credit score. These program models can use alternative measures of creditworthiness (such as a reliable history of property tax and utility bill payments, or liens on real property or equipment) to enable able broader access to financing. Affordability varies across program models. Though not seeking a profit, programs generally need to recoup their costs through interest rates and fees. Because programs rarely have access to the most affordable capital, and because the financing volume is much smaller than what commercial lenders might see, these programs rarely offer the most affordable rates available in the market. However, for people who do not have access to the most affordable rates (especially those with poor credit), a dedicated energy efficiency financing program can be the only accessible, affordable option.

Renters are the market segment most often poorly served by financing programs. All models reviewed except PAYS are generally available to property owners only. PAYS is the only option that directly overcomes the split incentive problem in the rental market, by tying the tariffed repayment obligation to the meter rather than the borrower. Compared to other options, PAYS offers broader access to energy improvements, but comes at the cost of administrative complexity for utilities, and potential issues regarding turnover in housing and rental stock due to the tariff obligation. The PAYS model requires that the expected monthly customer tariffed charge be less than the value of expected monthly bill savings (typically yielding a net savings of 10 to 20%). This limits the measures that can be financed through the program without a co-payment, especially compared to non-utility programs that may have no energy-saving or cost-effectiveness requirements. As a result, PAYS participants are more likely to face higher up-front costs than borrowers in other financing programs (because of a required co-payment), but are also more likely to experience net energy savings.

The ability of the program to finance a broad array of measures, and to remove the entire up-front cost, for those measures, is an important factor for borrowers. PACE has the best ability to provide a large amount of financing, since the amount is based on the value of the property. Since PACE is not administered by utilities, and no regulatory energy savings requirements apply, it’s also typically the least restrictive in terms of the measures that can be installed. Leasing programs in the residential sector are restricted to equipment that, in theory, could be repossessed in the event of default. Measures like insulation and air-sealing therefore would be ineligible. On-bill financing programs can be designed to allow a small amount of financing for non-energy saving improvements, but overall the program must drive enough energy savings to meet cost-effectiveness requirements. But the financing can be structured to cover the up-front cost for all eligible measures.

PAYS is the only program in our comparison that is not able to finance the full up-front cost for most measures that otherwise might be eligible. However, PAYS is able to finance the full up-front cost for the highest-saving, most cost-effective measures. An important factor to consider in this regard is that the PAYS program is structured to assure the borrower that the payments for the amount of money being financed will be offset by the bill savings from the equipment installed. While this type of assurance could be integrated into the other program models, it typically is not.

A final dimension to consider is the trade-off between the effectiveness of the program on measure uptake and the utility's administrative burden. For PACE, this is a null argument, since a utility has no ability to offer PACE on its own. PACE requires local government sponsorship, and is tied to local government jurisdictions rather than the utility jurisdiction. In Missouri, PACE has been enabled by state statute, but few municipalities offer PACE across the state. Leasing and on-bill financing are program models open to utilities.

Both external interviewees noted that PAYS expanded the impact of energy efficiency programs (in the case of Roanoke's program, providing a dramatic improvement over a prior utility on-bill financing program), but required a greater degree of administrative involvement and longer-term obligations for the utility than other programs.

Customer Needs and Motivation

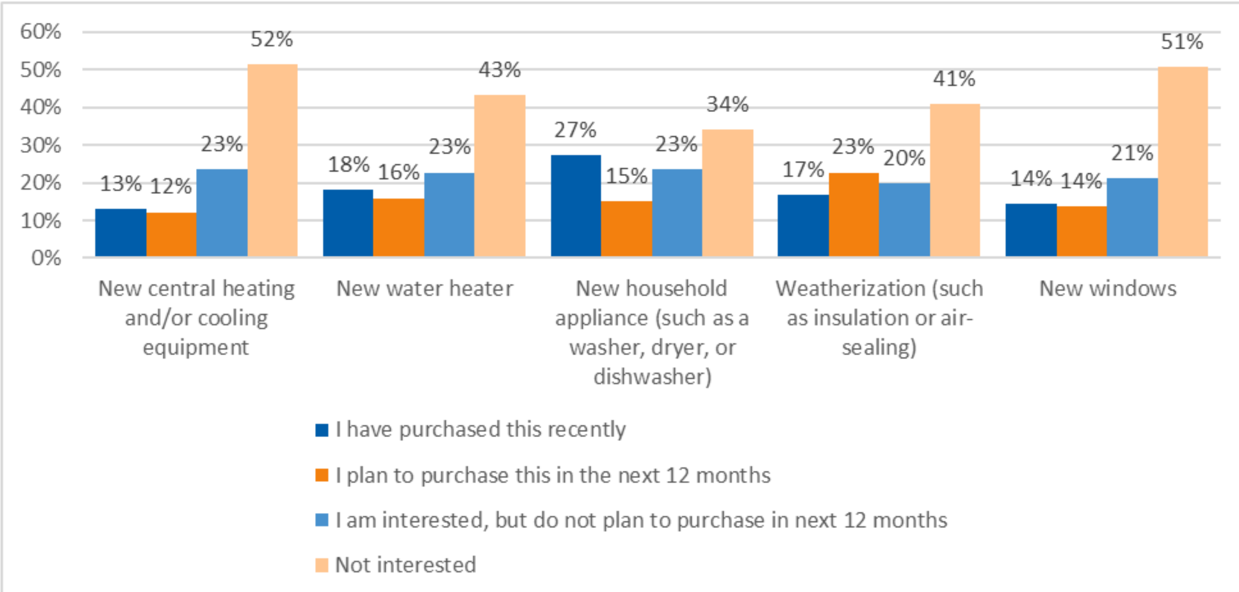
PAYS is intended to remove a financing barrier for residential customers, allowing greater uptake of energy efficiency measures. It is therefore important for Empire to understand the degree to which financing is in fact a barrier for their customers. Cadmus conducted an online survey with 210 residential customers in Empire's service territory to collect information on how they use financing, whether financing has the potential to increase energy efficiency savings, and customer attitudes towards financing in general and key characteristics of PAYS financing.

General Financing Needs and Awareness

The survey asked homeowners and renters about common energy upgrades they may have recently completed, or be interested in completing. Responses to these questions illustrate the role currently available financing plays in driving energy efficiency upgrades. Respondents who indicated no recent installations and no interest in any of the measures were terminated from the survey. This ensured that only respondents that were interested in efficiency improvements - and therefore were more likely to have recently considered their financial resources and options - answered the financial questions.

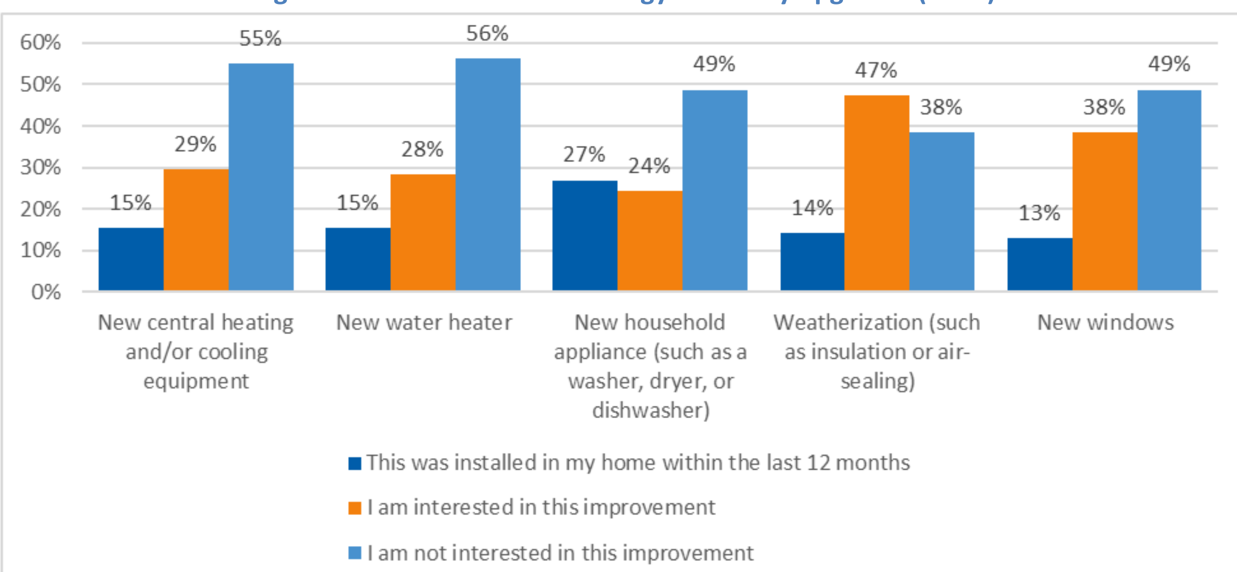
Figure 5 shows the rate of recent installation, or interest in installing, select common measures for homeowners. Household appliances were the top home improvement investment reported by homeowners, with 27% of respondents reporting that they had recently purchased a home appliance. A majority of homeowners expressed interest in or had recently invested in a new water heater, new household appliance, or weatherization. A slight majority of respondents expressed that they were not interested in new central heating and/or cooling equipment or new windows.

Figure 5. Homeowner Interest in Energy Efficiency Upgrades (n=132)



Cadmus asked renters about their interest in making energy efficiency upgrades to their home. As shown in Figure 6, weatherization (47%) and new windows (38%) garnered more interest from renters than the other efficiency upgrades presented. Of the 66 renters that indicated an improvement had recently been made, 27% paid for the improvement themselves.

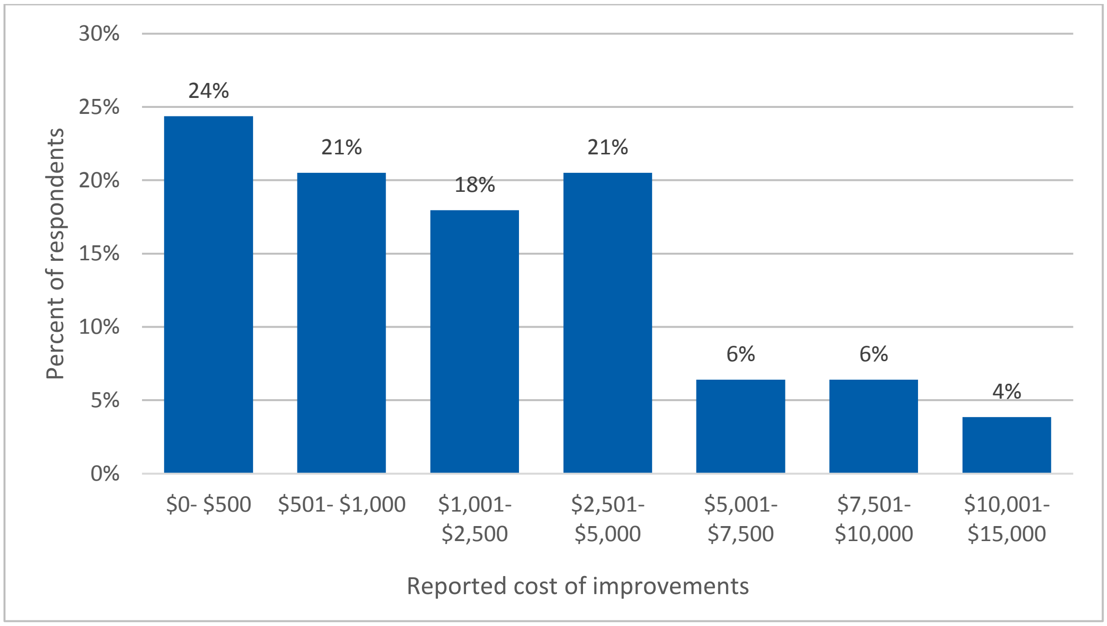
Figure 6. Renter interest in energy efficiency upgrades (n=78)



Sixty-six homeowners and 16 renters had recently purchased energy efficiency equipment or improvements. About half of the completed projects had a total cost over $1,000. Fifty-five percent of respondents reported spending more than $1,000 on their recent energy-related purchases, and 16%

reported spending more than $5,000 on recent upgrades. Figure 7 shows the frequency of projects by price range.

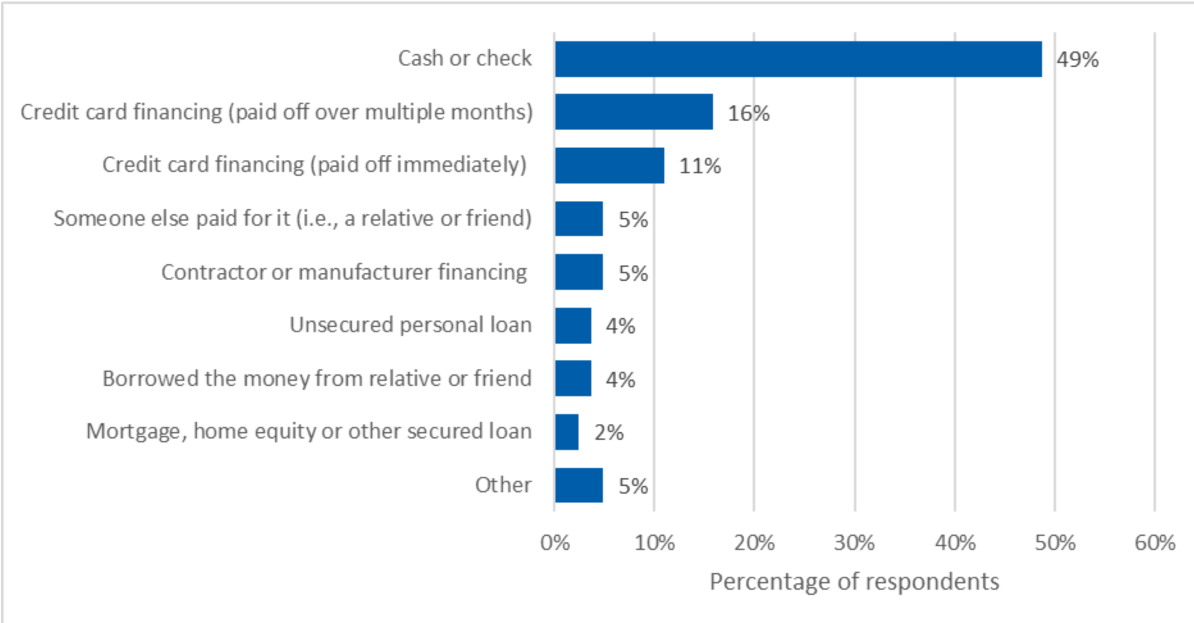
Figure 7. Reported Cost of Improvements Installed (n=78)



Need and Access to Financing for Home Improvements

Among respondents who had recently invested in an energy efficiency upgrade in their home, cash or check was the primary payment method used, followed by credit card financing, while a small share used a personal loan or other form of financing (Figure 8). Sixty-five percent made an immediate payment (paid cash, used credit card financing paid off immediately, or had someone else pay) to pay for their recent upgrades, and 30% used longer-term financing (including credit card financing paid off over time, contractor or manufacturer financing, unsecured loans, borrowing the money from a relative or friend, or a mortgage or home equity loan).

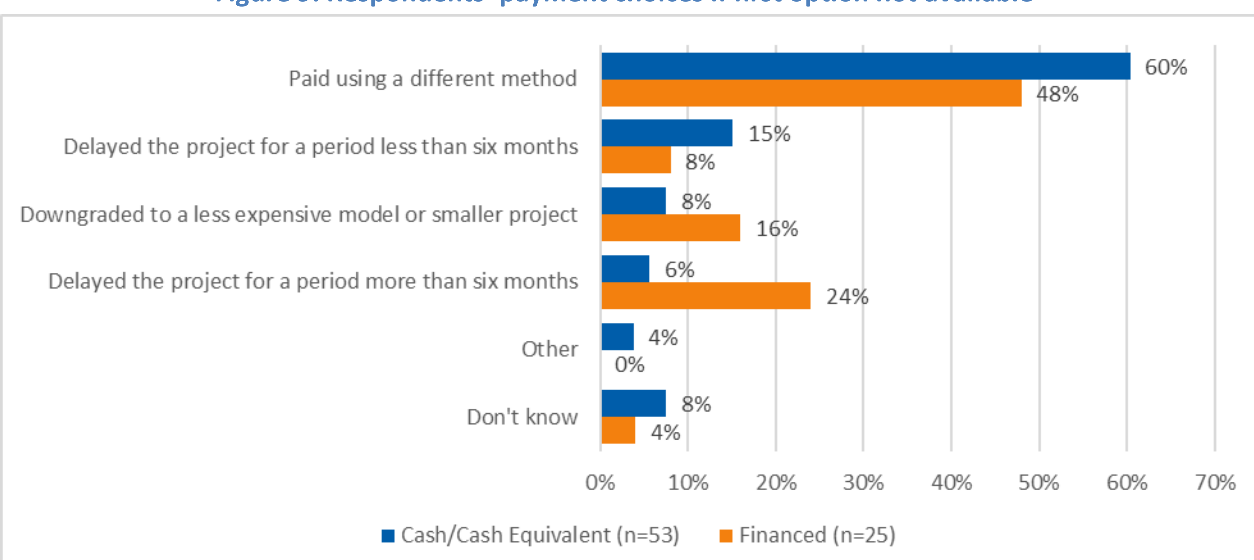
Figure 8. How respondents paid for recent energy efficiency upgrades (n=82)



Percentages may not match text exactly due to rounding.

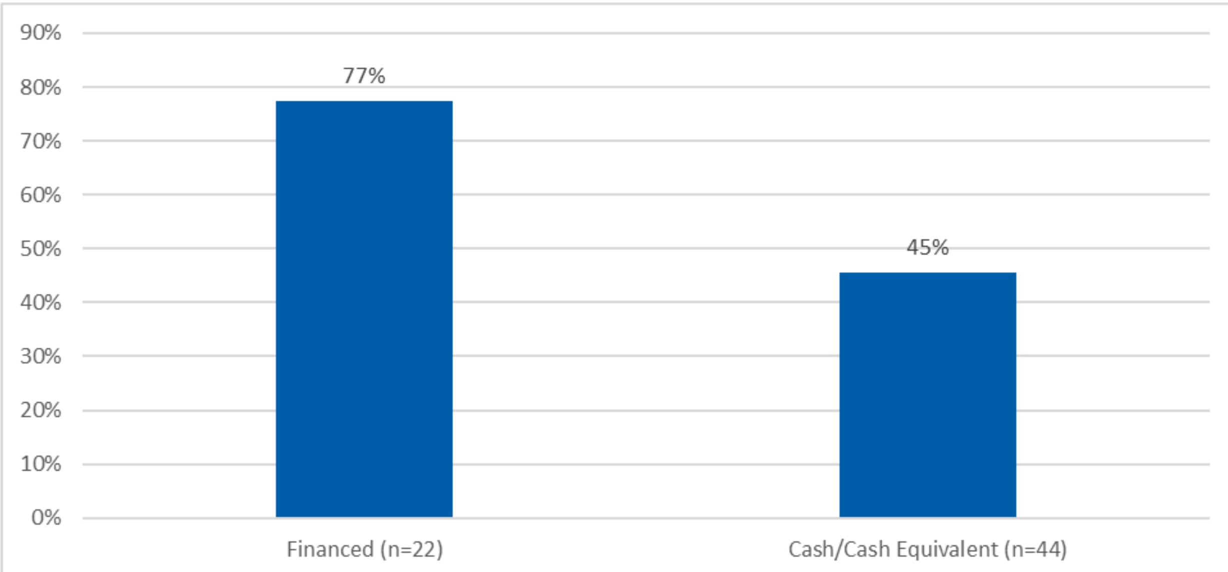
When asked how they would have paid if the option they used had not been available to them, most respondents said they would have simply used a different payment method and made the purchase at the same time. However, 28% of those that paid with cash or a cash equivalent said they would have either delayed or downgraded the project, compared to 48% of those that used some type of long-term financing (Figure 9). This indicates a potential barrier to accessible financing for some customers.

Figure 9. Respondents' payment choices if first option not available



Overall, 57% (n=78) of respondents that had completed a purchase reported that they would have considered a higher efficiency model than what they purchased had easier, more affordable financing been available. Respondents that had used financing were more likely to state they would have upgraded to a high efficiency unit if easier, more affordable financing were available than those that used cash or a cash equivalent as shown in (Figure 10).

Figure 10. Would have purchased a higher efficiency model if easier, more affordable financing were available



As shown in Table 25, among those who used cash or a cash equivalent, the primary reasons reported for not using financing were that they had the cash available, and that they choose to avoid financing if possible. (Note that Cadmus considered using a credit card in order to get reward points, and then paying it off immediately, to be a cash-equivalent method of payment).

Table 25. Reasons for Not Using Financing to Pay for Energy Efficiency Upgrades (n=55)

Answer	%
I had the cash available	53%
I don't like to use financing unless I have to	29%
I wanted the credit card reward (i.e., bonus points or cash back)	7%
I don't think it was a big enough purchase to need to finance it	5%
Financing was too much hassle/cash was easiest option	4%
I wasn't sure I could qualify for financing	2%
Total	**100%**

Among those who did use financing, the primary reasons provided by respondents were that they did not have access to the entire amount in cash, and that they wanted to take advantage of a low interest rate available to them (Table 26).

Table 26. Reasons for Using Financing to Pay for Energy Efficiency Upgrades (n=27)

Answer	%
Did not have the entire amount available in cash	48%
Wanted to take advantage of an attractive interest rate offer	30%
Wanted to preserve cash savings	11%
Wanted to include as part of a new home purchase or mortgage refinancing	7%
Wanted the credit card reward (I.e., bonus points or cash back)	4%
Total	**100%**

Customer Familiarity with Different Types of Financing and Frequency of Use

As shown in Figure 11 and Figure 12, the survey asked respondents (renters and homeowners) about their familiarity and use of different traditional, private-sector options for financing larger home purchases. Homeowners were most likely (60%) to have used credit card financing at least once, followed by an unsecured personal loan. A similar number of homeowners had used unsecured financing (34%) or secured financing (31%), though homeowners were more likely to have used unsecured lending more than once. Contractor and manufacturer financing was the least well known type of financing, with nearly half of homeowners (48%) not sure of what it was or generally unfamiliar with how it works. Only 47% of renters had used credit card financing, while 46% had used unsecured financing. Like homeowners, renters were least likely to have used or be familiar with contractor or manufacturer financing, with 65% of renters saying they had no familiarity with this type of financing.

Figure 11. Homeowners' familiarity with different types of financing (n=124)

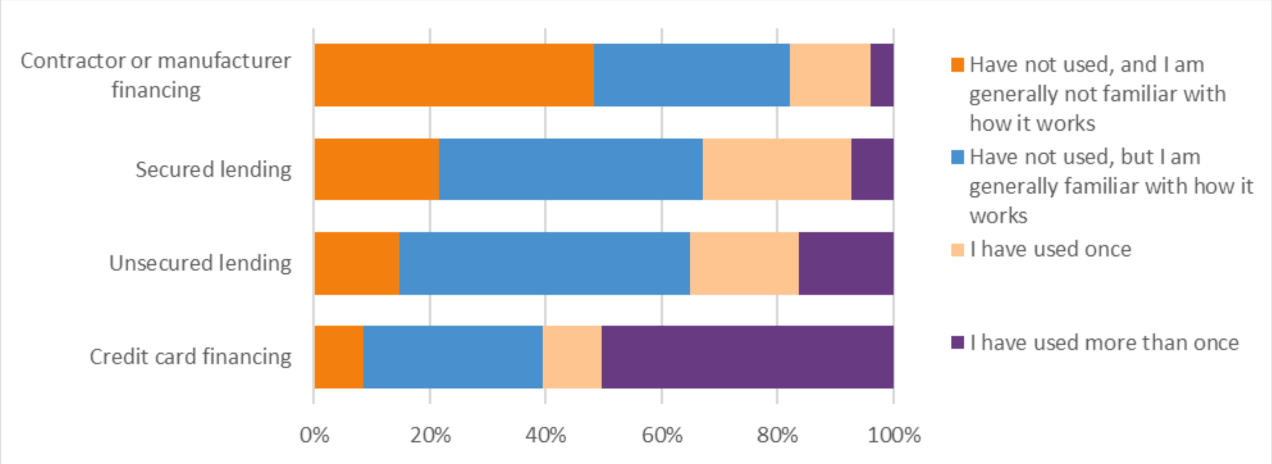
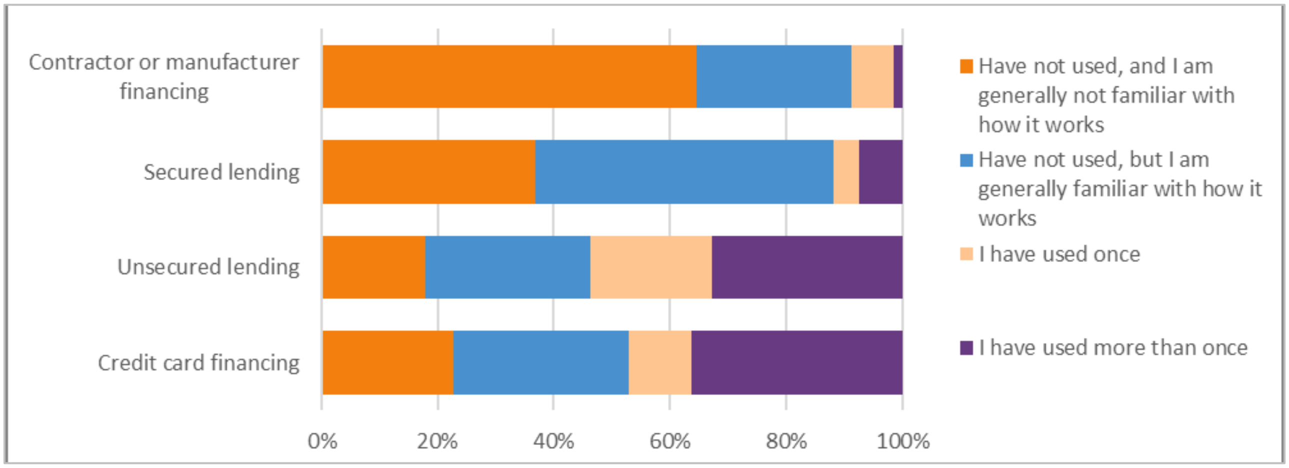


Figure 12. Renters' familiarity with different types of financing (n=66)



Customer Barriers to Uptake of Higher Efficiency CACs and Heat Pumps

The survey asked both homeowners and renters to imagine they needed to make a large-scale improvement for a total cost of about $5,000, and then asked them to rank their level of concern with several potential issues. As shown in Table 27, a majority of respondents cited two key investment barriers: not having sufficient cash to pay up front (69% rating as a 4 or a 5, with 5 being a very significant concern) and high interest rates (69% rating as a 4 or a 5). Customers also expressed concerns about not being able to qualify for a loan (46% rating as a 4 or a 5), not knowing their financing options (39% rating as a 4 or a 5), being unsure if they would be in their home long enough (35% rating as a 4 or a 5), and being unsure about being able to make regular monthly payments (33% rating as a 4 or a 5). (Percentages in the table may not match text due to rounding.)

Table 27. Reported Barriers to Large-Scale Purchase (n=98)

Potential Barrier	1 (Not A Concern)	2	3	4	5 (Very Significant Concern)
I don't have enough cash on hand right now to pay for this	15%	1%	15%	18%	50%
The interest rate I will have to pay may be too high	14%	5%	11%	25%	44%
I may not qualify for a loan	39%	7%	8%	13%	33%
I don't know if I'll live in my home long enough for a large purchase to be worthwhile	43%	13%	9%	9%	26%
I may not be able to manage regular monthly payments	38%	11%	18%	10%	22%
I rent or otherwise don't have full control over these decisions in my home	59%	6%	8%	5%	21%
I don't know of a contractor who can install this improvement	37%	11%	23%	9%	21%
I don't know what financing options are available	26%	9%	26%	19%	20%
Getting affordable financing will take too long and be a hassle	40%	11%	22%	10%	16%
I own my home, but don't have enough equity for a second mortgage or home equity loan	65%	7%	4%	10%	13%

Certain barriers stood out among low-income and renter respondents. Forty-six percent of low-income respondents rated not knowing what financing options are available a 4 or 5, compared to only 28% of higher-income respondents. Sixty-three percent of renters rated not qualifying for a loan a 4 or 5 compared to 37% of homeowners, while 54% of low-income respondents gave this concern a 4 or 5 compared to 33% of higher-income respondents. Renting or otherwise not having full control over these decisions in their homes was a *somewhat* or *very significant* concern for 43% of renters.

Assessment of Market Response to PAYS

The survey asked respondents a series of hypothetical questions to test their response to various aspects of PAYS. Because PAYS is a little-known program design, in some cases questions were necessarily complex. All scenarios reflected the savings, costs, and maximum potential of PAYS financing from the measure-level analysis.

Willingness to Accept Tariffs and Copayment

To understand homeowners' willingness to accept the terms of the PAYS model, including the tariff and copayment, the survey presented hypothetical scenarios regarding replacing respondents' heating and cooling system. In each scenario, Cadmus varied the available rebate and financing offers from the utility, and presented the total up-front cost, total rebate, total financing, monthly payment, and monthly savings for the utility offer, as well as the total cost for a baseline alternative. Cadmus used the costs and savings from the measure-level analysis to develop the scenarios.

Through Scenarios A and B, Cadmus tested the potential for a modest amount of PAYS financing, in addition to a rebate, to make an energy efficiency option more attractive. In both scenarios, the survey asked respondents to imagine that their heating and cooling system had failed and needed to be replaced. They were then asked to choose between a standard efficiency system that cost $3,500 and a new high-efficiency system that cost $5,000. The scenarios provided in the survey deliberately made the description of the system fuel-neutral to elicit responses from all respondents regardless of their heating fuel. The costs were based on the full measure cost for a new standard efficiency furnace and CAC or a new high-efficiency heat pump.

In Scenario A, the utility offers a $300 rebate for the new high-efficiency system, and the customer pays $4,700 out of pocket. In Scenario B, the utility offers a $300 rebate for the new system and finances a small amount ($300) through a PAYS tariff, and the customer pays $4,400 out of pocket. The monthly savings is $3, and the tariff amount is $2.66.

As shown in Table 28, the majority of respondents (61%) either selected the standard system or indicated they weren't sure. A substantial minority (38%) selected the high-efficiency option plus the utility rebate, while one respondent selected the high-efficiency option but rejected the rebate.

Table 28. Responses to Scenario A (n=132)

Option	%
Standard-efficiency system for $3,500	40%
High-efficiency system for $5,000, minus a $300 rebate	38%
High-efficiency system for $5,000, but I wouldn't use the rebate	1%
I'm not sure	21%
Grand Total	**100%**

Scenario B changed the scenario by adding a small amount of PAYS financing ($300), in addition to the rebate. (The amount of financing was dictated by the measure analysis, which indicated in a replace on failure scenario, PAYS could cover that amount of the cost of a new high-efficiency ASHP.) The survey only presented Scenario B to the 61% of respondents that were not convinced to purchase a high-efficiency system by Scenario A (i.e., those who selected the standard system or said they weren't sure). Table 29 shows that, among those who chose either the standard efficiency option or said they weren't sure in response to Scenario A, 11% chose the high efficiency option after PAYS was added in Scenario B.

Table 29. Response to Scenario B by "Unconvinced" Respondents (n=81)

Option	%
Standard-efficiency system for $3,500	59%
High-efficiency system for $5,000, minus a $300 rebate, plus $300 on-bill financing	11%
High-efficiency system for $5,000, but I wouldn't use the utility offer	5%
I'm not sure	25%
Total	**100%**

PAYS programs are not typically used to offer a small amount of financing. Cadmus also tested the response to PAYS scenarios that were more like the PAYS programs implemented in other jurisdictions and reflective of the measure analysis. The survey asked respondents to consider two scenarios where PAYS financing could cover either half or all of the proposed measures to be installed (Scenarios C and D).

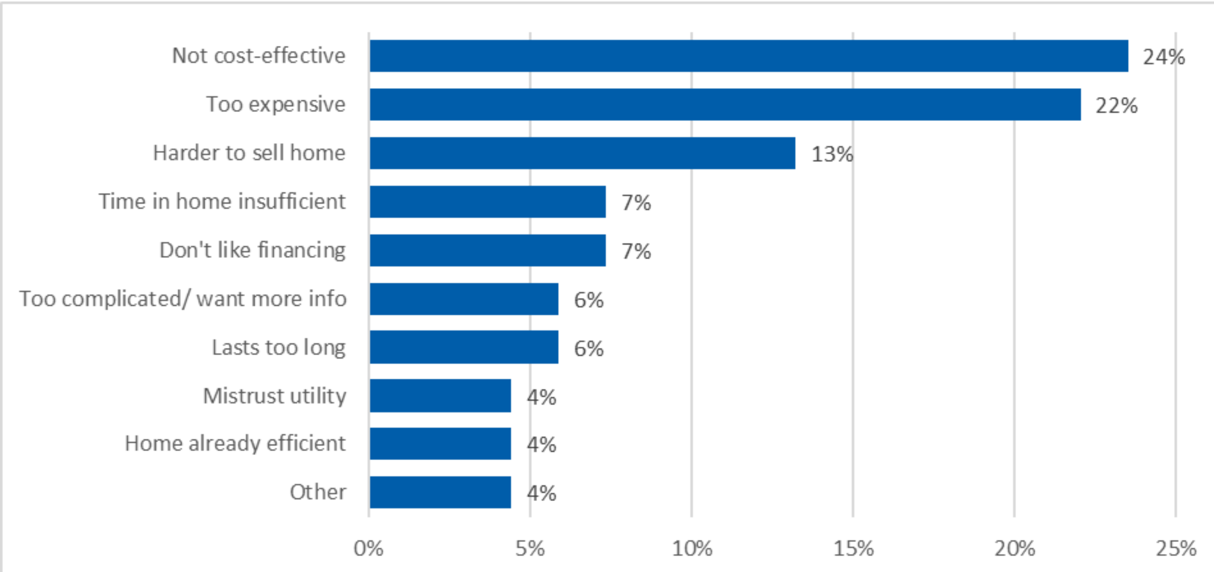
In Scenario C, respondents are asked to again imagine their heating and cooling system needs to be replaced. They still have the option of the standard system with no rebate and no savings, at a cost of $3,500. On the other hand, if the customer is willing to install a high-efficiency heating and cooling system, seal and insulate their attic, and make some other small improvements, the utility will finance half the amount on the utility bill. The total cost of the project is $9,000. The utility will finance $4,500, and the customer will pay $4,500 up front. The customer will save $45 dollars a month, in addition to enjoying increased home comfort from the improvement, and pay a $35 per month tariff for 15 years to cover the financed amount. Twenty-three percent of respondents indicated they would use the utility offer, as shown in Table 30.

Table 30. Response to Scenario C (n=132)

Option	%
Standard efficiency system for $3,500, with no other improvements	42%
All items recommended by the utility for $4,500 up front, and $4,500 financed on my utility bill	23%
High efficiency system for $5,000, with no other improvements and no assistance from the utility	9%
I'm not sure	26%
Total	**100%**

When asked why they did not choose the utility offer in Scenario C, respondents had a variety of responses, most of which had to do with the financial return on the project.

Figure 13. Reasons for Not Choosing Utility Offer in Scenario C (n=68)



In Scenario D, the survey presented an early replacement scenario, in which the utility would replace working heating and cooling equipment. The utility offers to replace their existing system with a high-efficiency system, a $5,000 value, and to finance the full cost of the upgrade on the utility bill. The utility estimates savings of $100 per month relative to the old working system and will charge a tariff of $50 per month for 10 years to recover the financing. The scenario also notes that if the respondent moves, the tariff will transfer to the next owner. Table 31 summarizes the terms of this scenario.

Table 31. Utility Financing Offer to Replace Working Heating and Cooling System

Category	Value
Utility financing	$5,000
Customer up-front cost	$0
Monthly energy savings	$100
Monthly charge	$50
Net monthly savings	$50

The alternative choice in this scenario is to do nothing, and so the survey asked the likelihood that the respondent would act on the utility offer. With this early replacement scenario, about two thirds of respondents (67%) said they would be *very* or *somewhat likely* to opt for this financing option, even if their current heating and cooling system was still working (Table 32).

Table 32. Likelihood to Accept Working HVAC Replacement Plus PAYS Financing (n=132)

Answer	%
Very likely	34%
Somewhat likely	34%
Not too likely	16%
Not at all likely	16%
Total	**100%**

To understand renters' perception of tariffed on-bill financing, the survey asked renter respondents how likely they would be to utilize a hypothetical offer from the utility. The offer included air-sealing and insulation improvements that the utility would finance up to $1,500, which would be repaid as a line item on the utility bill. The improvements would reduce their energy costs by $20 per month, with a $15 tariff for up to 12 years, for a net monthly saving of $5. Participants would be required to pay $500 up front to participate in the program. Even with a $500 copay, a majority (59.2%) of renter respondents said they would be *very* or *somewhat likely* to participate in the program (Table 33).

Table 33. Renters' Likelihood to Participate in Tariffed On-Bill Financing Program with Copay

Answer	%
Very likely	15%
Somewhat likely	44%
Not too likely	18%
Not at all likely	23%
Total	**100%**

Themes emerged among those who said they would not be likely to participate, including not being able to afford the up-front copay, a belief that the savings would not repay the up-front cost, a concern that renters would not be able to make those investments, and a feeling that those investments should be the landlord's responsibility.

Willingness to Move into a Residence with Efficiency Improvements and a Tariff

To understand respondents' willingness to buy a home with efficiency improvements and a tariff, the survey asked homeowners to express their likelihood of purchasing a home where efficiency improvements installed previously yielded $100 per month energy savings, an $80 per month tariff, and $20 of net monthly energy savings. Respondents were evenly split between being more or less likely to purchase the home, while 36% were not influenced either way (Table 34).

Table 34. Homeowners' Likelihood to Buy a Home with a Tariff

Answer	%
More Likely	32%
No Change	36%
Less Likely	32%
Total	**100%**

To understand renters' willingness to move into a home with efficiency improvements and a tariff, the survey asked renter respondents to express their likelihood of renting a home where efficiency improvements installed previously yielded different levels of monthly savings (Table 35).

Table 35. Renter Scenarios for Renting a Home with a Pre-existing Tariff

	Scenario E	Scenario F
Monthly energy savings	$10	$100
Monthly charge	$8	$80
Net savings	**$2**	**$20**

As shown in Table 36, overall, a higher share of renter respondents said that they would be more likely to move into a home with a pre-existing tariff and energy efficiency investments. For the lesser savings Scenario E, 40% of renters said they would be more likely to rent the apartment, while a majority (54%) said they would be more likely to opt for the apartment in Scenario F where they would see greater monthly savings. In both cases, a small minority (12% to 13%) said they would be less likely to rent the apartment, a much smaller share than homeowner respondents.

Table 36. Renters' Likelihood to Rent a Home with a Tariff (n=68)

Answer	Scenario E	Scenario F
More Likely	40%	54%
No Change	47%	34%
Less Likely	13%	12%
Total	**100%**	**100%**

Among those who responded that they would be less likely to rent or that their likelihood to rent would not change, the primary reasons included that the savings amount did not seem significant, they were not comfortable with financing, they felt the landlord should make the investment instead, and they were uncertain if the savings would materialize.

Willingness to Pay Interest

To gauge customers' willingness to pay interest, the survey presented different interest rates and asked respondents whether they would be more likely to pay up front or finance a large home improvement at that rate. As shown in Table 37, the majority of respondents (53%) said they would be more To gauge customers' willingness to pay interest, the survey presented different interest rates and asked respondents whether they would be more likely to pay up front or finance a large home improvement at that rate.

Table 37. Respondents' willingness to pay interest (n=210)

Interest rate	More Likely to Pay Cash or Check	More Likely to Finance	I don't know
0%	23%	63%	14%
3%	31%	53%	16%
5%	39%	35%	26%
8%	50%	23%	26%
10%	56%	19%	26%

Customer Demographics

The following figures provide a general demographic breakdown of survey respondents, with a comparison to demographic data available from the American Community Survey (ACS) for the area served by Empire or data available from the U.S. Energy Information Administration's Residential Energy Consumption Survey (EIA RECS). [27,28]

Nearly two-thirds of the respondents surveyed were homeowners (Table 38). This aligns well with the ACS data for the area.

Table 38. Homeownership status

Category	Cadmus Survey	Empire Service Area (from ACS)
Homeowners	63%	65%
Renters	37%	35%
Total	**100%**	**100%**

As illustrated in Figure 14, 56% of respondents reported household incomes of less than $50,000. This compares to 58% of Empire's overall customer base as collected from census data, though the presence of very low-income residents (less than $20,000) was underrepresented in the survey.

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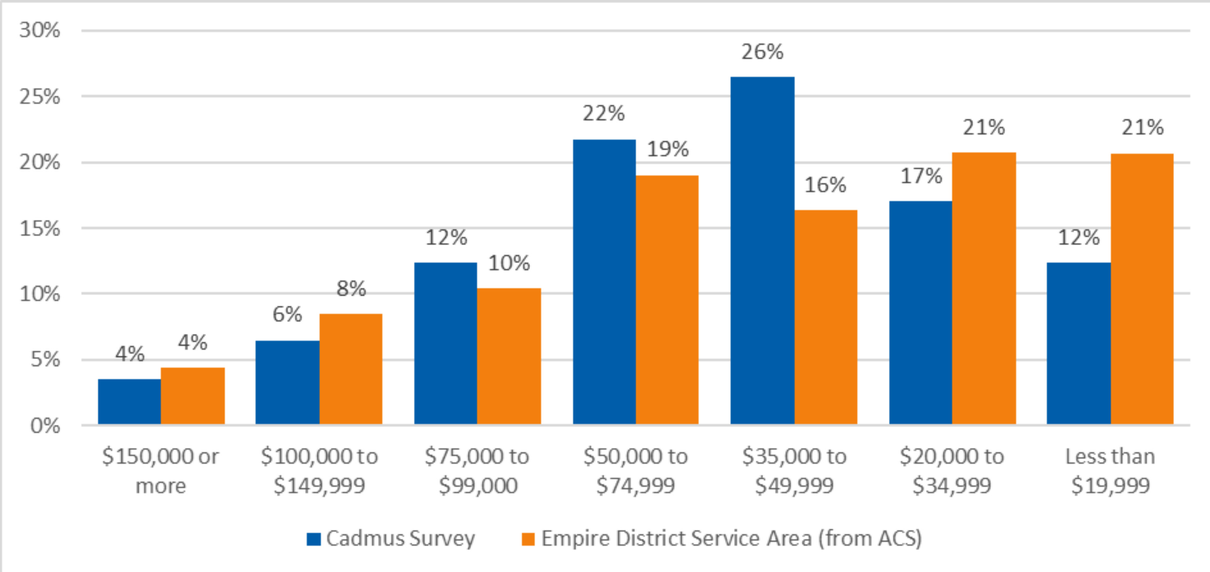
27 For this comparison, Cadmus collected aggregate demographic information for the sixteen counties included in Empire's service area, though Empire does not serve all of these counties in their entirety. Data was collected from the US Census Bureau's American Community Survey, 2015 5-year estimates.

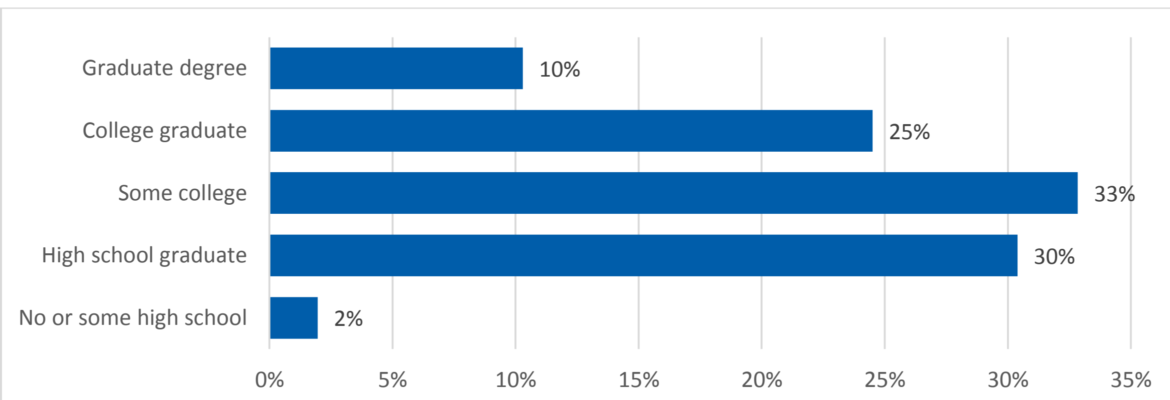
28 US Energy Information Administration. "Residential Energy Consumption Survey." Available at: https://www.eia.gov/consumption/residential/

Figure 14. Household Income Distribution



The Cadmus survey sample had slightly higher levels of education than the best available comparable census data for Empire's service area, with 98% completing high school and 35% completing college (Figure 15). In comparison, according to the census data, 90% of Joplin, Missouri residents over 25 years of age hold a high school degree or higher, and 25% hold a bachelor's degree or higher.

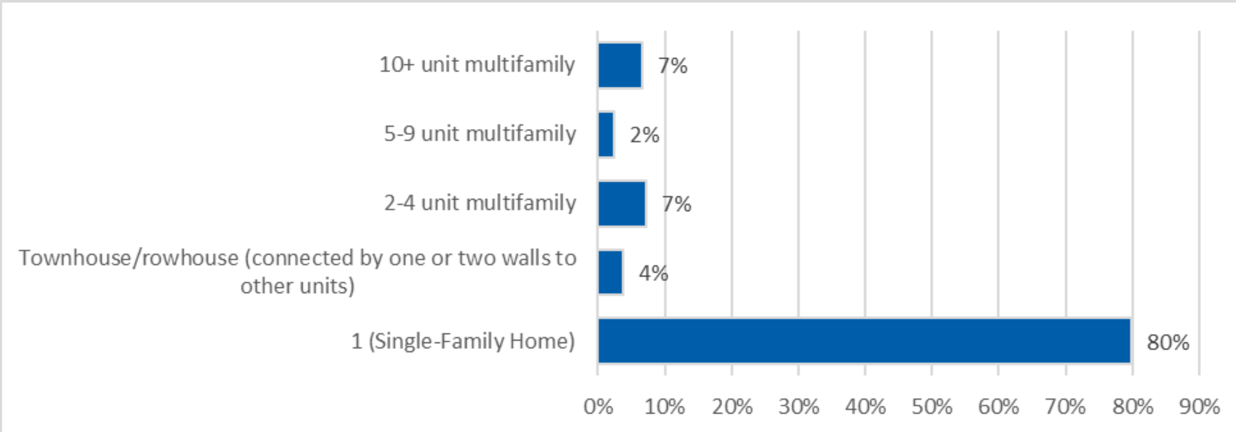
Figure 15. Education Levels of Cadmus Survey



Housing Type

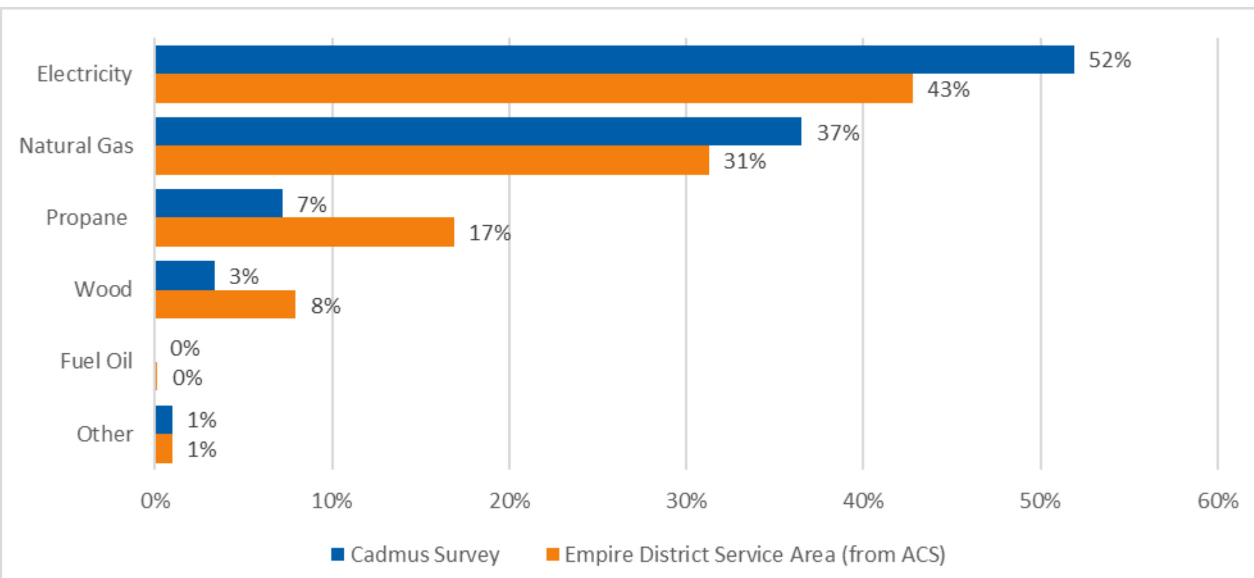
The survey asked respondents several questions about the housing unit they owned or rented. This included information about their heating and cooling systems and any efficiency investments they were aware of. The majority of respondents (80%) reported living in single-family homes (Figure 16).

Figure 16. Distribution of Housing Types in Cadmus Survey



For heating, just over half (52%) of respondents reported using electric heat, while 37% reported using natural gas heat (Figure 17). These percentages are broadly in line with those reported in the ACS data for Empire's service territory though the share of electric heat was greater in the survey population. According to the ACS data, 43% of the households in the sixteen-county area served by Empire (excluding Springfield) are primarily heated by electricity, with 31% served by natural gas, 17% by propane, and most of the remainder by wood.

Figure 17. Distribution of Home Heating Fuels in Cadmus Survey and Empire Service Area



As shown in Figure 18, nearly half of respondents reported using a furnace (either natural gas or electric) for heat, while just under 30% reported using a heat pump, and roughly 10% reported using electric resistance heating. While specific data on heating equipment types was not available for Empire's service area, the EIA RECS survey estimates that roughly 40% of homes heated by electricity in the mixed-humid climate zone that includes southern Missouri use an air source heat pump, with a slight majority of homes using electricity heated by less efficient electric furnaces or baseboard electric resistance heat (Figure 19).

Figure 18. Distribution of Home Heating Technologies in Customer Sample

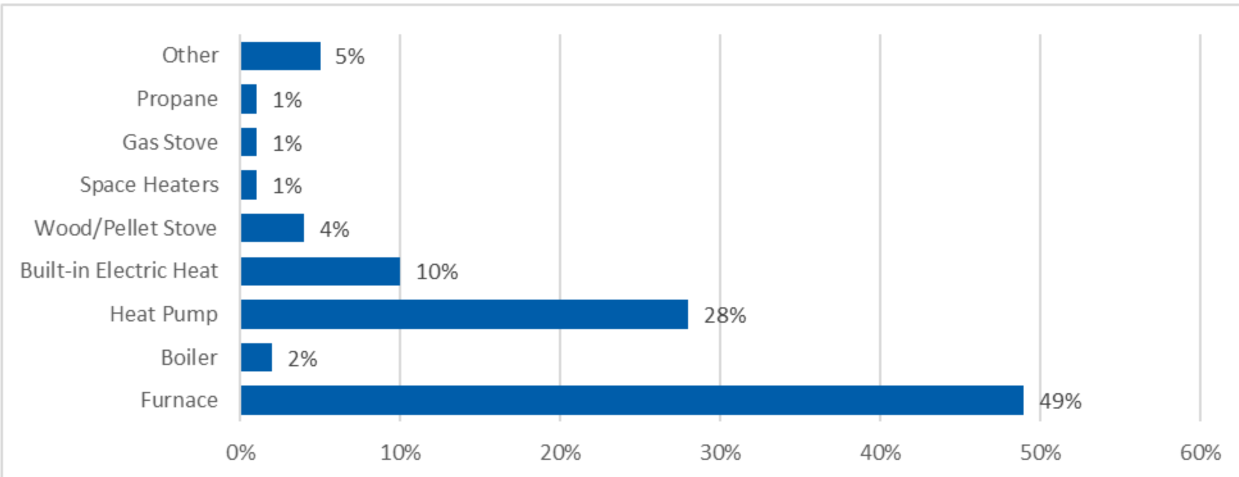
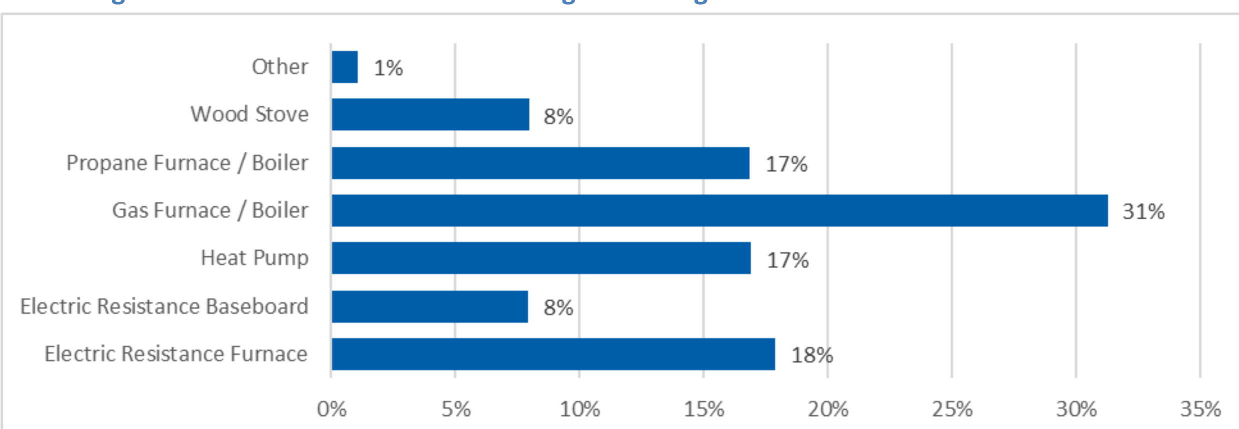
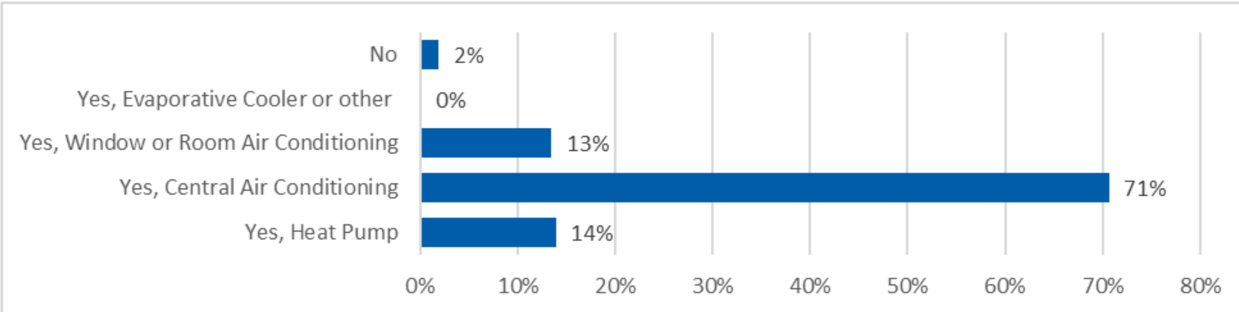


Figure 19. Distribution of Home Heating Technologies in EIA Mixed-Humid Climate Zone



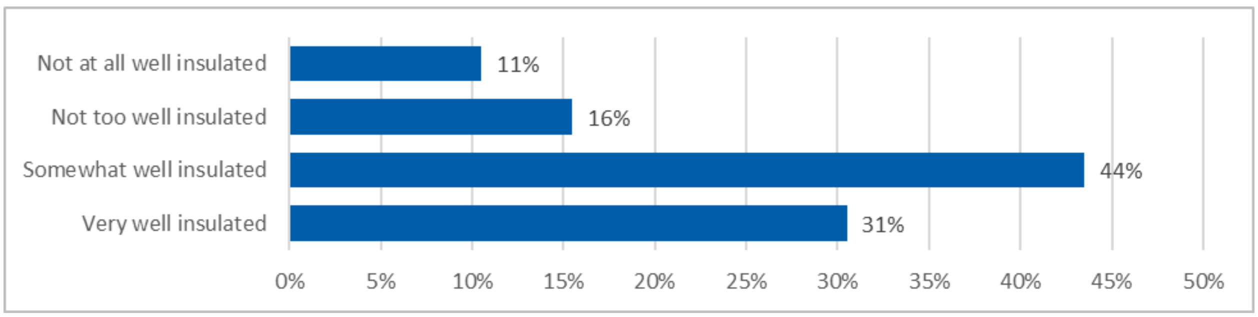
As shown in Figure 20, a majority (71%) reported using CAC, with the remainder roughly evenly split between respondents using room air conditioners and ASHPs for cooling. Only 2% of respondents reported having no air conditioning.

Figure 20. Distribution of Home Cooling Technologies in Cadmus Survey



A minority (27%) of respondents reported that their homes were *not too well insulated* or *not at all well insulated.* Twenty-eight percent of low-income respondents said their homes were *not well insulated* compared to 20% of higher-income respondents (Figure 21).

Figure 21. Distribution of Reported Home Insulation Levels in Cadmus Survey



Finally, most renters (90%) reported that they pay their electric bill directly, with only 10% reporting that this was included in their rent or paid in another way.

Conclusions and Recommendations

Based on the study findings, Cadmus concludes that a PAYS program is feasible for Empire. The specific conditions under which PAYS would be feasible are described in the following conclusions and recommendations.

Financial Analysis and Cost-effectiveness

The best measures for an Empire PAYS program are air source heat pumps, or a whole home package of measures that includes an air source heat pump, installed in all-electric homes in an early replacement scenario. ASHPs and the whole-home packages of measures provide sufficient savings that a PAYS tariff can be reduced from the maximum amount allowed by the PAYS design, and collected for a shorter time, and still cover the full cost of the measure without a customer co-payment. HPWHs are also potential candidates for a PAYS program, with savings that allow for 81% of the measures cost (for an ROF scenario) or 87% of the measure cost (for an ER scenario) to be financed. Other measures that provide enough savings for PAYS to cover 50% of the measure cost or more, are not expensive enough on their own to typically warrant financing. However, several of these measures, including attic insulation and air sealing, are highly cost-effective, and can be packaged with an ER ASHP to provide maximum bill savings.

Based on preliminary cost estimates, we found the PAYS program can be cost-effective at a modest level of participation. A program based on the three measures above (45% ASHP, 45% standard whole home package, and 10% HPWH), and a NTG ratio of 0.62, which may be overly conservative for an early replacement program, is cost effective (TRC of 1) at 70 participants.

Recommendation: If implementing a PAYS program in Empire's service territory, target the replacement of working heating and cooling equipment in all-electric homes with electric resistance heating. Do this by focusing on ASHPs, either on their own or as part of a whole-home package of upgrades, to achieve a cost-effectiveness ratio above 1. The early replacement of an ASHP in an all-electric home provides a significant cushion of savings that can compensate for the installation of a range of measures with only borderline savings-to-cost ratios, and for unforeseen program administration costs.

Customer rate sensitivity analysis shows that rates designed to encourage energy efficiency among customers tend to reduce the feasibility of PAYS, while the rate designed to remove the disincentive for utilities to pursue greater energy efficiency makes PAYS more feasible. The existing rate structure also may improve the feasibility of PAYS.

Recommendation: Empire should consider potential energy efficiency program such as PAYS, and potential rate changes designed to promote energy efficiency, holistically. Empire staff should consider the interactions of different programs and policies, to determine the optimal approach to reducing energy consumption while minimizing the impact on ratepayers.

Market Research Considerations

Based on the financing gap analysis, interviews, and secondary research, Cadmus drew several conclusions about the need for and design of a PAYS program in Empire's service territory.

More research should be done on identifying sources of capital for PAYS and the legal viability of a tariff tied to the meter. Based on the experience of other PAYS administrators, the primary obstacles to setting up a PAYS program are obtaining capital and ensuring there were no legal concerns related to the PAYS program design, especially the requirement that the tariff be tied to the meter. Cadmus was not able to confirm through this study whether there are legal or regulatory prohibitions on tying the tariff to the meter in Missouri.

Recommendation: Empire's legal counsel should thoroughly review the PAYS program design and discuss the potential legal and regulatory implications with the Missouri Public Service Commission prior to investing in detailed program design or other aspects of program set up.

A PAYS program appears to be the best program model to remove financing-related barriers to making energy efficiency upgrades in rental housing, due to the tied-to-the-meter feature. It is also a good option for customers with poor credit and customers who are very concerned about the cost of financing, because it only allows measures that provide bill savings that are greater than the tariff charge. No other common program design (PACE, a leasing model, or other on-bill financing) was likely to penetrate the rental market, and while other programs may strive to offer low interest rates, or reduce payments through long terms, PAYS is the only financing model that specifically limits eligible measures to those that provide immediate cash-positive savings (based on annual average savings).

However, the PAYS model is not ideal for the broader market or for all financing scenarios. In particular, PAYS can only finance the full up-front cost for the highest-savings measures, typically in a home that uses electricity for space or water heating and typically only under an early replacement scenario. This makes PAYS--a design requiring significant administrative oversight on the part of the utility--even with a third-party implementer of little use to customers who rely on gas for space heating.

Offering a financing program to residential customers may help Empire increase uptake of energy efficiency measures, particularly in some hard-to-reach markets. The gap analysis found that there were no other energy-efficiency financing options available to customers for electric energy efficiency upgrades, beyond what is available in the private market. PACE, the only potentially available program, is active in Missouri, but has yet to be adopted by all jurisdictions in Empire's service territory. While the Joplin, the largest single community served by Empire, recently joined the Show Me PACE financing district, only a minority of Empire's Missouri customers reside in municipalities with active PACE programs.

Survey results indicate that residential customers experience barriers to energy efficiency uptake due to the lack of affordable, accessible financing. Financing is currently an important driver of energy-related home improvements. Nearly half (48%) of the respondents who chose to use financing to make an energy-related improvement reported they would have delayed or downgraded their recent purchase if financing had not been available. In addition, 57% said they would have considered a higher-efficiency model if more affordable financing had been available.

When faced with a large-scale improvement, all respondents were most likely to be concerned about financing-related issues: not having sufficient cash to pay the up-front cost (69%) and not finding affordable interest rates (69%). Low income respondents were significantly more likely than other respondents to be concerned about knowing what financing options were available to them, and whether they could qualify for a loan. Renters were significantly more likely than homeowners to be concerned about qualifying for a loan.

An aversion to financing among some customers, and high sensitivity to the cost-effectiveness of an investment among most customers, could be potential obstacles to a PAYS program in Empire's territory. Nearly a third of respondents who used cash for a recent purchase reported an aversion to financing, stating that they prefer not use financing unless they need to. In addition, while most respondents said they would be more likely to finance a project than pay cash at low interest rates (3% and lower), respondents' willingness to use financing fell sharply once interest rates rose above 3%. Finally, when asked why they didn't take advantage of the utility offer for a whole-home upgrade, survey respondents were most likely to indicate they did not think the project was cost-effective (22%).

Based on demographics of their residential customer base, Empire should be able to achieve the necessary breakeven participation for a targeted PAYS program to be cost-effective. Empire demographics are similar to cooperatives with existing PAYS programs. Across four PAYS programs we reviewed, participation ranged from an average of 58 projects per year to 198, with even the minimum participation level closest to the breakeven participation of 62.

Recommendation: Should Empire decide to offer a PAYS program, a typical PAYS program design is the best approach. Like existing cooperative utility programs, target high use, lower income all-electric homes through a direct outreach model that facilitates close communication with participants. To mitigate the administrative burden, hire a third-party implementer for at least the initial years of the program. However, if permitted under regulatory rules, issue the financing directly and track payments internally, using the same systems currently used for the gas on-bill program. While the breakeven participation needed for a program that achieves and NTG of 0.62 is within reach for Empire, the need to achieve early replacement savings, coupled with the reduced breakeven participation level, makes a direct-install approach more feasible.

Appendix A

Cost-Effectiveness Detailed Results

Table 39 through Table 42 show detailed cost effectiveness results including BC ratios, benefits, and costs by test for net and gross participation for each of the program participation scenarios.

Table 39. Cost-Effectiveness Results for Combined Program

Test	Quantity	GROSS			NET		
		BC Ratio	Benefits	Costs	Ratio	Benefits	Costs
TRC	20	0.62	$174,593	$281,183	0.42	$108,248	$257,115
TRC	80	1.29	$698,374	$540,465	0.97	$432,992	$444,193
TRC	200	2.30	$1,745,935	$759,008	1.20	$1,082,479	$904,350
PAC	20	0.80	$174,593	$217,508	0.50	$108,248	$217,508
PAC	80	2.47	$698,374	$283,205	1.53	$432,992	$283,205
PAC	200	3.48	$1,745,935	$501,072	2.16	$1,082,479	$501,072
RIM	20	0.32	$174,593	$551,311	0.20	$108,248	$551,311
RIM	80	0.43	$698,374	$1,618,416	0.27	$432,992	$1,618,416
RIM	200	0.45	$1,745,935	$3,839,099	0.28	$1,082,479	$3,839,099

Table 40. Cost-Effectiveness Results for Single-Measure Program (ASHP)

Test	Quantity	GROSS			NET		
		BC Ratio	Benefits	Costs	Ratio	Benefits	Costs
TRC	20	0.67	$190,423	$285,252	0.47	$118,062	$252,081
TRC	80	1.37	$761,692	$554,178	1.12	$472,249	$421,496
TRC	200	1.62	$1,904,229	$1,178,505	1.39	$1,180,622	$846,799
PAC	20	0.88	$190,423	$217,419	0.54	$118,062	$217,419
PAC	80	2.69	$761,692	$282,848	1.67	$472,249	$282,848
PAC	200	3.81	$1,904,229	$500,179	2.36	$1,180,622	$500,179
RIM	20	0.34	$190,423	$559,909	0.26	$120,142	$462,632
RIM	80	0.46	$761,692	$1,652,806	0.38	$480,567	$1,263,699
RIM	200	0.49	$1,904,229	$3,925,075	0.41	$1,201,417	$2,952,307

Table 41. Cost-Effectiveness Results for Single-Measure Program (Whole Home Package)

Test	Quantity	GROSS			NET		
		BC Ratio	Benefits	Costs	Ratio	Benefits	Costs
TRC	20	0.67	$193,777	$290,207	0.47	$120,142	$255,153
TRC	80	1.35	$775,108	$574,001	1.11	$480,567	$433,786
TRC	200	1.58	$1,937,769	$1,228,061	1.37	$1,201,417	$877,523
PAC	20	0.88	$193,777	$220,896	0.54	$120,142	$220,896
PAC	80	2.61	$775,108	$296,754	1.62	$480,567	$296,754
PAC	200	3.62	$1,937,769	$534,945	2.25	$1,201,417	$534,945
RIM	20	0.32	$193,777	$610,793	0.26	$120,142	$462,632
RIM	80	0.42	$775,108	$1,856,342	0.38	$480,567	$1,263,699
RIM	200	0.44	$1,937,769	$4,433,915	0.41	$1,201,417	$2,952,307

Table 42. Cost-Effectiveness Results for Single-Measure Program (HPWH)

Test	Quantity	GROSS			NET		
		BC Ratio	Benefits	Costs	Ratio	Benefits	Costs
TRC	20	0.08	$17,035	$224,242	0.05	$10,562	$214,255
TRC	80	0.22	$68,141	$310,141	0.16	$42,247	$270,193
TRC	200	0.30	$170,352	$568,413	0.23	$105,618	$468,542
PAC	20	0.08	$17,035	$202,667	0.05	$10,562	$202,667
PAC	80	0.30	$68,141	$223,841	0.19	$42,247	$223,841
PAC	200	0.48	$170,352	$352,663	0.30	$105,618	$352,663
RIM	20	0.07	$17,035	$244,954	0.05	$10,562	$228,885
RIM	80	0.17	$68,141	$392,989	0.13	$42,247	$328,713
RIM	200	0.22	$170,352	$775,533	0.17	$105,618	$614,842

Appendix B

Load Shapes by Measure

Table 43 presents the load shape assigned to each measure.

Table 43. Load Shapes by Measure

Item #	Measure	Loadshape
1	**Central Air Conditioner**	Electricity_HVAC
2	**Central Air Conditioner**	Electricity_HVAC
3	**Clothes Dryer**	Appl_InteriorEquipment
4	**Clothes Washer**	Appl_InteriorEquipment
5	**Clothes Washer**	Appl_InteriorEquipment
6	**Clothes Washer**	Appl_InteriorEquipment
7	**Refrigerator**	Appl_InteriorEquipment
8	**Refrigerator**	Appl_InteriorEquipment
9	**Refrigerator**	Appl_InteriorEquipment
10	**HPWH**	Water Heater
11	**HPWH**	Water Heater
12	**Air Sealing**	All Electric Home
13	**Duct Sealing**	All Electric Home
14	**Window Replacement**	All Electric Home
15	**Ceiling Insulation**	All Electric Home
16	**Wall Insulation**	All Electric Home
17	**LEDs**	InteriorLights
18	**Air Source Heat Pump**	All Electric Home
19	**Air Source Heat Pump**	All Electric Home
20	**Air Source Heat Pump**	All Electric Home
21	**Air Source Heat Pump**	All Electric Home
22	**Air Source Heat Pump**	All Electric Home
23	**Air Source Heat Pump**	All Electric Home

Item #	Measure	Loadshape
24	**Air Source Heat Pump**	All Electric Home
25	**Air Source Heat Pump**	All Electric Home
P1	**Standard Whole Home (ASHP, air sealing, attic insulation, five LEDs)**	All Electric Home
P2	**Standard Whole Home (ASHP, air sealing, attic insulation, five LEDs)**	All Electric Home
P3	**Comprehensive Whole Home (Standard package plus HPWH and duct sealing)**	All Electric Home
P4	**Comprehensive Whole Home (Standard package plus HPWH and duct sealing)**	All Electric Home

Appendix C

Load Shapes by Month

Table 44 presents the percentage of on-, off-, and total annual savings by month for each load shape used in the analysis.

Table 44. Load Shapes used in Measure-Level Financial Analysis

Load Shape	Source	Month	On-Peak	Off-Peak	Total
Electricity_Facility	Empire	1	4%	5%	9%
Electricity_Facility	Empire	2	3%	4%	8%
Electricity_Facility	Empire	3	3%	4%	8%
Electricity_Facility	Empire	4	3%	4%	7%
Electricity_Facility	Empire	5	3%	4%	7%
Electricity_Facility	Empire	6	3%	5%	8%
Electricity_Facility	Empire	7	3%	7%	10%
Electricity_Facility	Empire	8	4%	7%	11%
Electricity_Facility	Empire	9	3%	7%	9%
Electricity_Facility	Empire	10	3%	4%	7%
Electricity_Facility	Empire	11	3%	4%	8%
Electricity_Facility	Empire	12	3%	5%	8%
Electricity_HVAC	Empire	1	1%	3%	4%
Electricity_HVAC	Empire	2	1%	2%	3%
Electricity_HVAC	Empire	3	1%	1%	2%
Electricity_HVAC	Empire	4	0%	1%	1%
Electricity_HVAC	Empire	5	3%	1%	3%
Electricity_HVAC	Empire	6	6%	7%	13%
Electricity_HVAC	Empire	7	8%	15%	23%
Electricity_HVAC	Empire	8	12%	17%	29%
Electricity_HVAC	Empire	9	6%	10%	16%
Electricity_HVAC	Empire	10	1%	0%	1%
Electricity_HVAC	Empire	11	0%	1%	2%
Electricity_HVAC	Empire	12	1%	2%	3%
Water Heater	Empire	1	5%	6%	11%
Water Heater	Empire	2	5%	5%	10%
Water Heater	Empire	3	5%	6%	11%
Water Heater	Empire	4	4%	5%	9%
Water Heater	Empire	5	4%	4%	7%
Water Heater	Empire	6	2%	4%	7%
Water Heater	Empire	7	2%	5%	6%
Water Heater	Empire	8	1%	4%	5%

Load Shape	Source	Month	On-Peak	Off-Peak	Total
Water Heater	Empire	9	2%	5%	7%
Water Heater	Empire	10	3%	5%	8%
Water Heater	Empire	11	4%	5%	9%
Water Heater	Empire	12	4%	5%	9%
InteriorLights	Empire	1	5%	6%	12%
InteriorLights	Empire	2	4%	5%	9%
InteriorLights	Empire	3	3%	5%	9%
InteriorLights	Empire	4	3%	4%	7%
InteriorLights	Empire	5	2%	4%	6%
InteriorLights	Empire	6	1%	4%	5%
InteriorLights	Empire	7	1%	5%	6%
InteriorLights	Empire	8	1%	5%	7%
InteriorLights	Empire	9	1%	6%	8%
InteriorLights	Empire	10	3%	6%	9%
InteriorLights	Empire	11	5%	6%	11%
InteriorLights	Empire	12	5%	7%	12%
Appl_InteriorEquipment	Empire	1	5%	4%	9%
Appl_InteriorEquipment	Empire	2	4%	4%	8%
Appl_InteriorEquipment	Empire	3	5%	4%	9%
Appl_InteriorEquipment	Empire	4	4%	4%	9%
Appl_InteriorEquipment	Empire	5	5%	4%	8%
Appl_InteriorEquipment	Empire	6	4%	5%	8%
Appl_InteriorEquipment	Empire	7	3%	6%	9%
Appl_InteriorEquipment	Empire	8	3%	5%	8%
Appl_InteriorEquipment	Empire	9	2%	6%	8%
Appl_InteriorEquipment	Empire	10	4%	5%	9%
Appl_InteriorEquipment	Empire	11	4%	4%	8%
Appl_InteriorEquipment	Empire	12	4%	4%	8%
Cooling Only	Hybrid, based on Electricity_HVAC	1	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	2	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	3	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	4	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	5	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	6	6%	7%	16%
Cooling Only	Hybrid, based on	7	8%	15%	28%

Load Shape	Source	Month	On-Peak	Off-Peak	Total
	Electricity_HVAC				
Cooling Only	Hybrid, based on Electricity_HVAC	8	12%	17%	36%
Cooling Only	Hybrid, based on Electricity_HVAC	9	6%	10%	20%
Cooling Only	Hybrid, based on Electricity_HVAC	10	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	11	n/a	n/a	n/a
Cooling Only	Hybrid, based on Electricity_HVAC	12	n/a	n/a	n/a
Heating_Gas	Empire	1	9%	19%	28%
Heating_Gas	Empire	2	5%	12%	17%
Heating_Gas	Empire	3	4%	9%	13%
Heating_Gas	Empire	4	2%	5%	7%
Heating_Gas	Empire	5	0%	0%	0%
Heating_Gas	Empire	6	0%	0%	0%
Heating_Gas	Empire	7	0%	0%	0%
Heating_Gas	Empire	8	0%	0%	0%
Heating_Gas	Empire	9	0%	0%	0%
Heating_Gas	Empire	10	0%	2%	2%
Heating_Gas	Empire	11	3%	9%	12%
Heating_Gas	Empire	12	6%	14%	20%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	1	n/a	n/a	23%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	2	n/a	n/a	14%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	3	n/a	n/a	11%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	4	n/a	n/a	7%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	5	n/a	n/a	1%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	6	n/a	n/a	3%
All Electric Home	Hybrid, based on Electricity_HVAC and	7	n/a	n/a	4%

Load Shape	Source	Month	On-Peak	Off-Peak	Total
	Heating_Gas				
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	8	n/a	n/a	5%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	9	n/a	n/a	3%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	10	n/a	n/a	3%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	11	n/a	n/a	11%
All Electric Home	Hybrid, based on Electricity_HVAC and Heating_Gas	12	n/a	n/a	16%